NUREG-0804

Staff Analysis of Public Comments on Proposed Rule 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories"

U.S. Nuclear Regulatory Commission

Office of Nuclear Regulatory Research

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Division of Health, Siting and Waste Management
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
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ABSTRACT

On February 25, 1981, the Nuclear Regulatory Commission published rules which establish procedures for the licensing of geologic disposal, by the U.S. Department of Energy, of high-level radioactive wastes. On July 8, 1981, proposed technical criteria which would be used in the evaluation of license applications under those procedural rules were published in the Federal Register. The Commission received 93 comment letters on the proposed technical criteria, 89 of which were received in time for the Commission to consider in preparing the final technical criteria which were published on June 21, 1983. This document presents a detailed analysis of the comments received on the proposed rule by the Commission's staff and also contains the Rationale for the Performance Objectives of 10 CFR Part 60.

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1	L. R. Epstein, National Association of Counties Research Inc	7/30/81
2	Dr. R L. Brodzinski, Battelle Pacific Northwest Laboratories	8/11/81
3	S. J. Goodman, P.E	8/17/81
4	J. Vadas	
5	R. V. Wyman, University of Nevada	9/4/81
6	J. Hamstra, Netherlands Energy Research Foundation	9/10/81
7	P. Sgriznoli	9/11/81
8	D. Farris, Economic Survival Training	9/16/81
9	J. M. de Montmollin	9/18/81
10	J. C. Mark, U S NRC Advisory Committee on Reactor Safeguards	9/22/81
11	M. I Lewis	9/22/81
12	B. Hafner	9/23/81
13	I. Remson, Ph.D.	9/23/81
14	H. P. Ross, Geophysical Consultant	9/25/81
15	R. A. Van Konynenburg, Lawrence Livermore Laboratories	9/28/81
16	C. R. Fisher, General Atomic Company	10/2/81
17	L. O. Del George, Commonwealth Edison	10/5/81
18	A. Muccigroso, Hydrosearch (misdocketed)	10/6/81
19	G. C. Lawrason, Southwest Research Institute	10/19/81
20	C. L. Rickard, American Nuclear Society	10/19/81
21	Hon. T. Lott, U.S. House of Representatives	10/20/81
22	A. N. Turcan, Jr., Capital-Area Groundwater Conservation Commission	10/21/81

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23	Committee on Armed Services, U.S. Senate	10/22/81
24	B. Blanchard, U.S. Department of the Interior	10/22/81
25	R. Uhrig, Florida Power and Light Company	10/23/81
26	R. Bradbury, Stone and Webster Engineering Corporation	10/26/81
27	J. Cohen	10/26/81
28	T. Smith, Institute of Electrical and Electronics Engineers	10/27/81
29	F.S. Feates, Department of the Environment, UK	10/19/81
30	L. Toth	10/28/81
31	R. Dahn	10/28/81
32	D. Nucleare	10/29/81
33	R. W. Deuster, Nuclear Fuel Services	10/30/81
34	J. A. Adam	11/2/81
35	V. McIntyre	11/2/81
36	N. D. Lewis, Energy Facility Site Evaluation Council, State of Washington	11/3/81
37	A. J. O'Donnell, Bechtel National Inc.	11/3/81
38	B. R. McElmurry	11/3/81
39	M. J. Fisher	11/3/81
40	W. J. Bryan III	11/3/81
41	E. Nemethy, Ecology/Alert	11/3/81
42	A. Baum	11/3/81
43	D. M. Petefish	11/3/81
44	R. E. L. Stanford, Utility Nuclear Waste Management Group	11/3/81
45	E. B. Wilson and K. Krauskopf, National Research Council	11/4/81

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46	R. I. Newman, American Institute of Chemical Engineers	1	1/4/81
47	D. P. Sidebotham, New England Coalition on Nuclear Pollution, Inc.	1	1/4/81
48	S. Meyers, U.S. Department of Energy	1	1/5/81
49	P. J. Nickles and C. H. Montange, Covington and Burling	1	1/5/81
50	C. Walske, Atomic Industrial Forum	1	1/6/81
51	A. M. Krill, Stearns - Roger	1	1/6/81
52	R. Roy, Pennsylvania State University	1	1/6/81
53	T. H. Pigford, University of California, Berkeley	1	1/6/81
54	M. T. Johnson, Westinghouse Electric Corp.	1	1/6/81
55	W. O. Parker, Jr, Duke Power Co.	1	1/6/81
56	J. J. Kearney, Edison Electric Institute	1	1/9/81
57	B. C. Musgrave, Lawrence Livermore Laboratory	1	1/9/81
58	R. Nilson, Exxon Nuclear Co.	1	1/9/81
59	G. R. Thompson, Union of Concerned Scientists	1	1/9/81
60	C. St. John, Applied Mechanics, Inc.	1	1/9/81
61	L. Penberthy, Penberthy Electromelt Int'l, Inc.	1	1/9/81
62	B. H. Sway, State of California, Department of Conservation	1	1/9/81
63	L. H. Bohlinger, State of Louisiana, Department of Natural Resources	1	1/10/81
64	W. N. Thomas, Virginia Electric and Power Co.	1	1/10/81
65	J. W. Green, Jr. State of Mississippi, Department of Energy and Transportation and M. B. E. Bogard, Mississippi Department of Natural Resources	1	1/10/81
66	W. C. Liebold, Sierra Club	1	1/12/81
67	Multiple Authors	1	1/13/81
68	P. C. Cahill, U.S. Environmental Protection Agency	1	1/16/81

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69	Hon. W. A. O'Neill, Governor, State of Connecticut	11/16/81
70	N. K. Olson, South Carolina Geological Survey	11/16/81
71	Dr. T. C. Gustavson, University of Texas at Austin	11/16/81
72	Mr. and Mrs. D. W. Willoughby	11/06/81
73	Mr. and Mrs M. F. Vega	11/06/81
74	Mr. and Mrs. J. Johnson	11/10/81
75	B. Houston, Hamilton and Associates, for The American Ceramic Society	11/18/81
76	E R. Weiss, Harmon and Weiss for the Natural Resources Defense Council, Inc.	11/19/81
77	D Woodbury, J L. LaFleur, State of Wisconsin, Division of Emergency Government	11/20/81
78	R. H. Neill, State of New Mexico, Environmental Evaluation Group	11/20/81
79	W. G. Counsil and J. P. Cagnetta, Northeast Utilities	11/23/81
80	Dr. F L. Parker	11/27/81
81	Z. N. Jensen, R.N.	12/02/81
82	B. D. Withers, Portland General Electric	12/14/81
83	W. E. Davis, New York State Energy Office	12/23/81
84	B. Blanchard, U.S. Department of the Interior	01/27/82
85	K. B. Robertson, U.S. Geological Survey	03/02/82
86	(misdocketed)	
87	J. P. Wing (misdocketed)	04/08/82
88	R. Montgomery (misdocketed)	04/08/82
89	P. Shewmon, Chairman, U.S. NRC Advisory Committee on Reactor Safeguards	08/24/82

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90*	L. M. Muntzing, American Nuclear Society	10/13/82
91*	S. Brewer, U.S. Department of Energy	10/29/82
92*	P. Walsh, State of Wisconsin, Radioactive Waste Review Board	12/22/82
93*	L. M. Muntzing, American Nuclear Society	02/09/83

*These comment letters were received too late to be included in the Staff Analysis of Public Comments on proposed 10 CFR Part 60. However, copies of these letters are provided in Appendix A.

OVERVIEW

1.0 BACKGROUND

1.1 Introduction

On February 25, 1981, the Nuclear Regulatory Commission (NRC) published rules which establish procedures for the licensing of geologic disposal, by the U.S. Department of Energy (DOE), of high-level radioactive wastes (HLW). 46 FR 13971. On July 8, 1981, NRC proposed technical criteria which would be used in the evaluation of license applications under those procedural rules. 46 FR 35280. NRC received 93 comment letters on these proposed technical criteria, 89 of which were received in time for the Commission to consider in preparing the final technical criteria. No significant new issues were raised in the letters received too late for consideration. The NRC staff has considered all these comments in preparing the technical criteria that they have recommended to the Commission for publication in final form. The principal comments, and the staff's responses, are reviewed in the discussion below. This discussion takes the form of a Statement of Considerations and, hence, appears to state the views of the Commission itself. In reality, it is the staff's analysis cast into a format so as to facilitate Commission consideration of the staff's recommendations on the disposition of the final technical criteria.

This overview is one of several "cuts" at the problem of analysis of the public comments received. In this overview the staff will first discuss six issues on which the Commission had specifically requested public comment. It will then review other principal changes to the rule which have been adopted in the light of comments received. The discussion will then take up suggestions of a policy nature which the staff recommends that the Commission not adopt. Finally, a section-by-section analysis reviews all changes being recommended other than those of a strictly editorial nature. A more detailed analysis of the comments is contained in Parts A and B of this document. Due to the large number of individual comments (about 700) the individual comment letters have been subdivided and categorized according to the headings found in the Table of Contents. Part A of this Staff Analysis contains responses to general comments on 10 CFR

Part 60 and nine itemized issues* not specifically linked to the text of the proposed rule (e.g., Role of the States). Part A addresses Comment Nos. 1-148. Part B contains the NRC staff responses to public comments on the text of the proposed rule and conforming amendments as well as closely associated comments on particular issues. Part B addresses Comment Nos. 149-574. The organization and numbering of these individual comments are presented in the Table of Contents. Part C of this report contains the Rationale for the numerical performance objectives that are part of the final technical criteria being recommended to the Commission. Copies of the full text of the 93 comment letters are found in Appendix A. Copies of the Federal Register notices for the final and proposed technical criteria are found in Appendices B and C, respectively. Appendix D contains a copy of the assumed EPA standard used in the analysis of the numerical performance objectives To the extent that the results of the multi-format presentations of comments and analyses of comments are duplicative, redundant or confusing, the staff apologizes. The objective was to be thorough even at the expense of extra verbage.

1.2 Licensing Procedures

The licensing procedures referenced above provide for DOE to submit site characterization reports to NRC prior to characterizing sites that may be suitable for disposal of HLW. NRC would analyze these reports, taking into account public comments, and would make appropriate comments to DOE.

The licensing process will begin with the submission of a license application with respect to a site that has been characterized. Following a hearing, DOE may be issued a construction authorization. Prior to emplacement of HLW, DOE would be required to obtain a license from NRC; an opportunity for hearing is provided prior to issuance of such a license. Permanent closure of the geologic repository and termination of the license would also require licensing action for which there would be opportunity for hearing.

*General comments or the discussion of each issue such as retrievability, discussed in the Supplementary Information at 46 FR 35282, will be answered with those addressing the provisions for retrievability set forth in the proposed rule at 46 FR 35289 (60.111)). This was done to reduce the amount of duplication in staff responses.

1.3 Purpose of the Technical Criteria

The purpose of the technical criteria is to define more clearly the bases upon which licensing determinations will be made and to provide guidance to DOE and information for the public with respect to the Commission's policies in this regard. The criteria also indicate the approach the Commission is taking with respect to implementation of an Environmental Protection Agency (EPA) standard, particularly with respect to the classification of processes and events as "anticipated" or "unanticipated" and the definition of the "accessible environment" from which radionuclides must be isolated.[1]

The Commission anticipates that licensing decisions will be complicated by the uncertainties that are associated with predicting the behavior of a geologic repository over the thousands of years during which HLW may present hazards to public health and safety. It has chosen to address this difficulty by requiring that a DOE proposal be based upon a multiple barrier approach. An engineered barrier system is required to compensate for uncertainties in predicting the performance of the geologic setting, especially during the period of high radioactivity. Similarly, because the performance of the engineered barrier system is also subject to considerable uncertainty, the geologic setting must be able to contribute significantly to isolation.

The multibarrier approach is implemented in these rules by a number of performance objectives and by more detailed siting and design criteria.[2] In addition to the objective of assuring that licensed facilities will adequately isolate

[1]Reorganization Plan No. 3 of 1970 (35 FR 15623, October 6, 1970) authorizes EPA to establish generally applicable environmental standards for radioactivity. EPA's recently proposed standard would allow higher levels of radioactivity for "unanticipated processes and events" than would be permitted if "anticipated processes and events" were to occur. The proposed standard also relates these levels to places within the "accessible environment." The Commission has assumed that these concepts will be reflected in final standards that may be established by EPA.

[2]Under the Nuclear Waste Policy Act of 1982, the Commission's technical criteria "shall provide for the use of a system of multiple barriers in the design of the repository...as the Commission deems appropriate." Section 121(b)(1)(B). The criteria set forth in this rule represent the criteria which, for purposes of this provision, the Commission deems appropriate.

HLW over the long term, these provisions also address considerations related to health and safety during the operational period prior to permanent closure of the geologic repository.

In this statement of considerations the Commission will first discuss six issues on which it had specifically requested public comment. It will then review other principal changes to the rule which have been adopted in the light of comments received. The discussion will then take up suggestions of a policy nature which the Commission has declined to adopt. Finally, a section-by-section analysis reviews all changes made other than those of a strictly editorial nature. As appropriate, reference is made to relevant provisions of the Nuclear Waste Policy Act of 1982, Pub. L. 97-425, approved January 7, 1983, and to the Environmental Protection Agency's proposed Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Wastes, 47 FR 58195, December 29, 1982 The Commission regards the publication of these rules as constituting full compliance with Section 121(b)(1)(A) of the Nuclear Waste Policy Act, which requires promulgation of the Commission's technical criteria for geologic repositories not later than January 1, 1984.[3]

[3]The technical criteria are explicitly stated to be applicable to construction authorization, § 60.101(b), and to the issuance of licenses to receive and possess high-level radioactive waste at geologic repositories, § 60.101(a). An application to authorize permanent closure requires a license amendment, § 60.51(a); the relevant technical requirements and criteria are set out in the rules here being adopted, inasmuch as the Commission is to be "guided by the considerations that govern the issuance of the initial license, to the extent applicable," § 60.45(b). The Commission interprets the statutory provision pertaining to applications for "decommissioning" to refer to the procedure described in § 60.52, pertaining to termination of a license; such an application would also require a license amendment, and the Commission here, too, would be guided by the present rules to the extent applicable, together with the additional criteria already set out at § 60.52(c). Thus, at every stage of the licensing process, the central inquiry will be the adequacy of DOE's plans and activities as they relate to the isolation of wastes (as well as to safety during operations); and for each decision point we have provided, as is appropriate, for an evaluation that takes into account both the performance objectives and the more detailed criteria that the Commission here adopts. (If Section 121(b)(1)(A) applies to the decommissioning of surface facilities, the required criteria have been included in § 60.132(a). That paragraph provides that surface facilities must be designed to facilitate decontamination or dismantling to the same extent as would be required, under other NRC regulations, for equivalent activities. This topic may be treated again, in greater detail, in connection with the development of rules that would be generally applicable to decontamination and dismantlement of facilities at which activities subject to Commission regulatory authority are carried out.)

The Commission will review these criteria after EPA's environmental standards are published in final form and will initiate subsequent rulemaking actions, as necessary, to take any such standards into account. The Commission further intends additional rulemaking to deal with any changes in licensing procedures that may be necessary in light of the Nuclear Waste Policy Act.

2.0 Issues Raised by the Commission

As noted above, the Commission specifically requested public comment on six issues, each of which will be reviewed here before turning to other considerations. These issues dealt with: (1) a single overall performance standard vs. minimum performance standards for each of the major elements of the geologic repository; (2) the need for, and appropriate duration of, a waste retrievability period; (3) the level of detail to be used in the criteria, particularly with respect to design and construction requirements; (4) the desirability of population-related siting criteria; (5) the application of an ALARA (as low as reasonably achievable) principle to the performance requirements dealing with containment and control of releases; and (6) alternative approaches on dealing with possibilities of human intrusion into the geologic repository.

2.1 Single vs. Multiple Performance Standards

The Commission identified two potentially viable approaches to assuring achievement of the desired isolation goal of controlling releases so as to assure that radioactivity in the general environment is kept to sufficiently low levels. The Commission suggested that a course that would be "reasonable and practical" would be to adopt a "defense-in-depth" approach that would prescribe minimum performance standards for each of the major elements of the geologic repository, in addition to prescribing the EPA standard as a single overall performance standard. However, as an alternative, the Commission invited comment on an approach that would specify the EPA standard as the sole measure of isolation performance.

There was general acceptance of the Commission's multiple barrier approach, with its identification of two major engineered barriers (waste packages and

underground facility), in addition to the natural barrier provided by the geologic setting.

While the usefulness of multiple barriers was recognized, the establishment of fixed numerical values for performance was extensively criticized. The criticism took two forms. First, numerous commenters argued that until such time as an EPA standard is established, no logical connection can be demonstrated between the performance of the particular barriers and the overall system performance objective. The values specified by NRC, it was argued, had not been shown to be either necessary or sufficient to meet any particular standard. The second criticism was that the performance appropriate to a particular barrier is greatly dependent upon design features and site characteristics and that values such as those proposed by the Commission could unduly restrict the applicant's flexibility--possibly imposing great additional expense without compensating protection of public health and safety.

The Commission recognizes the force of both these arguments. Nevertheless, if the Commission were simply to adopt the EPA standard as the sole measure of performance, it would have failed to convey in any meaningful way the degree of confidence which it expects must be achieved in order for it to be able to make the required licensing decisions. More should be done To that end, the Commission considers it appropriate to include reasonable generic requirements that, if satisfied, will ordinarily contribute to meeting the standards even though modifications may need to be made for some designs and locations.

The Commission's response, therefore, has been to apply, for illustrative purposes, an assumed EPA standard and to examine the values for particular barriers that would assist in arriving at the conclusion that the EPA standard has been satisfied. For this purpose, a draft EPA standard which was referred to in some of the comments has been used. A copy of this draft standard has been placed in the PDR and is also contained in Appendix D. Following publication of EPA's proposed standard in the Federal Register on December 29, 1982, a supplemental evaluation was made to take into account certain departures from EPA's earlier draft. In this way, the Commission has been able to demonstrate the logical connection which it makes between the overall system performance

objective for anticipated processes and events, as set out in EPA's proposed standard, and the performance of specific barriers. One of the considerations that affects its judgment in this regard is the need to take proper account of uncertainties in the performance of any of the barriers. As one commenter noted, "To provide a safety factor to compensate for this uncertainty, a multi-barrier system has many advantages. Since the Commission cannot answer the global problem and predict every possible combination of circumstances that might cause releases of waste, multiple, independent mechanisms of slowing or limiting the discharge of radioactive materials to the environment are desirable." There is nothing inconsistent between the multiple barrier, defense-in-depth approach and a unitary EPA standard; on the contrary, in view of the many possible circumstances that must be taken into account, the Commission firmly believes that the performance of the engineered and natural barriers must each make a definite contribution in order for the Commission to be able to conclude that the EPA standard will be met. The Commission's task is not only a mathematical one of modeling a system and fitting values for particular barriers into the model in order to arrive at a "bottom line" of overall system performance. The Commission is also concerned that its final judgments be made with a high degree of confidence. Where it is practical to do so, the Commission can and will expect barrier performance to be enhanced so as to provide greater confidence in its licensing judgments. Accordingly, a variance between actual and assumed EPA standards will not necessarily require a change of corresponding magnitude in the individual barrier performance requirements.

While use of an assumed EPA standard provides a basis for specifying anticipated performance requirements for individual barriers, it does not deal with the concern about undue restriction upon the applicant's flexibility. The Commission's response to this has not been to abandon the values altogether, but rather to allow them to be modified as the particular case warrants. Thus, to take one example, the Commission continues to be concerned that thermal disturbances of the area near the emplaced waste add significantly to the uncertainties in the calculation of the transport of radionuclides through the geologic environment. The proposed rule addressed this problem by providing that all radionuclides should be contained within the waste packages for a period of 1,000 years. The Commission continues to consider it important to

limit the source term by specifying a containment period (as well as a release rate). But the uncertainties associated with the thermal pulse will be affected by a number of factors, such as the age and nature of the waste and the design of the underground facility. For some repositories, a period substantially shorter than 1,000 years may be sufficient to allow for some of the principal sources of uncertainty to be eliminated from the evaluation of repository performance. For cases analyzed by the Commission on the basis of specified assumptions, a range of 300 years to 1,000 years would be appropriate. (These values appear in § 60.113(a)(ii)(A).) Yet even a shorter designed containment period might be specified, pursuant to § 60.113(b), in the light of conditions that are materially different from those that had been assumed. For example, if the wastes had been processed to remove the principal heat-generating radionuclides (cesium-137 and strontium-90), the 300-years provision would not be controlling. Similarly, the Commission may approve or specify a radionuclide release rate or a pre-waste-emplacement groundwater travel time that differs from the normal values, provided that the EPA standard, as it relates to anticipated processes and events, is satisfied. Appropriate values will be determined in the course of the licensing process, in a manner sensitive to the particular case, using the principles set out in the performance objectives, without having to have recourse to the exemption provisions of the regulations.

The numerical criteria for the individual barriers included in the rule are appropriate, insofar as anticipated processes and events are concerned, in assisting the Commission to determine with reasonable assurance that the proposed EPA standard has been satisfied. It should be noted, however, that in order to meet the EPA standard as it applies to unanticipated processes and events, higher levels of individual barrier performance may be required. DOE would need to provide in its design for such performance as may be necessary to meet the EPA standard with respect to such unanticipated processes and events even though in all other respects the values specified by § 60.113(a) and § 60.113(b) would be sufficient.

2.2 Retrievability

The purpose of this requirement was to implement in a practical manner the licensing procedures which provided for temporal separation of the emplacement

decision from the permanent closure decision. Since the period of emplacement would be lengthy and since the knowledge of expected repository performance could be substantially increased through a carefully planned program of testing, the Commission wished to base its decision to permanently close on such information. The only way it could envision this was to insist that ability to retrieve--retrievability--be incorporated into the design of the geologic repository

The proposed rule would have required in effect that the repository design be such as to permit retrieval of waste packages for a period of up to 110 years (30 years for emplacement, 50 years to confirm performance, 30 years to retrieve) The Commission solicited comment, noting that it would not want to approve construction of a design that would unnecessarily foreclose options for future decisionmakers, but that it was concerned that retrievability requirements not unnecessarily complicate or dominate repository design.

While the benefits of retaining the option of retrieval were recognized, the length of the proposed requirement, in the opinion of several commenters, was excessive In their view, the Commission had given inadequate consideration to the additional costs of design, construction, and operations implied in the original proposal; however, no new cost or design information was presented by the commenters.

The Commission adheres to its original position that retrievability is an important design consideration. However, in response to the concerns expressed, the Commission has decided to rephrase the requirement in functional terms. The final rule thus specifies that the design shall keep open the option of waste retrieval throughout the period during which the wastes are being emplaced and, thereafter, until the completion of a performance confirmation program and Commission review of the information obtained from such a program. By that time, significant uncertainties will have been resolved, thereby providing greater assurance that the performance objectives will be met. In particular, the performance confirmation program can provide indications whether engineered barriers are performing as predicted and whether the geologic and hydrologic response to excavation and waste emplacement is consistent with the models and tests used in the Commission's earlier evaluations.

While the Commission has provisionally specified that the design should allow retrieval to be undertaken at any time within 50 years after commencement of emplacement operations, this feature is explicitly subject to modification in the light of the planned emplacement schedule and confirmation program for the particular geologic repository.

Some commenters suggested that the technical criteria specify the conditions that would require retrieval operations to be initiated. Such provisions would not belong in Subpart E, which is concerned with siting and design. Nor are they needed elsewhere. In the Commission's view, it is clear that retrieval could be required at any time after emplacement and prior to permanent closure if the Commission no longer had reasonable assurance that the overall system performance objective would be met This situation could exist for a variety of reasons and the Commission believes that it should retain the flexibility to take into account all relevant factors and that it would be imprudent to limit the Commission's discretion by specifying in advance the particular circumstances that would make it necessary to retrieve wastes It should be noted that DOE may elect to maintain a retrievability capability for a longer period than the Commission has specified, so as to facilitate recovery of the economically valuable contents of the emplaced materials (especially spent fuel). So long as the other provisions of the rule are satisfied this would not be prohibited This consideration, however, plays no role in the Commission's requirement pertaining to retrievability. The Commission's purpose is to protect public health and safety in the event the site or design proves unsuitable. The provision is not intended to facilitate recovery for resource value.[4]

[4]Under the Nuclear Waste Policy Act of 1982, the Commission's technical criteria "shall include such restrictions on the retrievability of the solidified high-level radioactive waste and spent fuel in the repository as the Commission deems appropriate," Section 121(b)(1)(B). The criteria set forth in this rule represent the criteria which, for purposes of this provision, the Commission deems appropriate.

Section 122 of the Nuclear Waste Policy Act provides that, at the same time a repository is designed, DOE shall specify an appropriate period during which spent fuel could be retrieved for any reason pertaining to the public health and safety, or the environment, or for the purpose of permitting recovery of the economically valuable components of such spent fuel. The period of retrievability is subject to approval or disapproval by the Commission as part of the construction authorization process. Insofar as health and safety considerations are concerned, the Commission intends to grant such approval so long as its technical criteria are satisfied, and the Commission further intends to modify the licensing procedures to so specify.

The Commission has also included a specific provision clarifying its prior intention that the retrievability design features do not preclude decisions allowing earlier backfilling or permanent closure. A related clarifying change has been the incorporation of a definition of "retrieval." This definition indicates that the requirement of retrievability does not imply ready or easy access to emplaced wastes at all times prior to permanent closure. Rather, the Commission recognizes that any actual retrieval operation would be an unusual event and may be an involved and expensive operation. The idea is that it should not be made impossible or impractical to retrieve the wastes if such retrieval turns out to be necessary to protect the public health and safety. DOE may elect to backfill parts of the repository with the intent that the wastes emplaced there will never again be disturbed; this is acceptable so long as the waste retrieval option is preserved.

The Commission has thus retained the essential elements of the retrievability design feature, but has provided greater flexibility in its application. The Commission recognizes that retrievability implies additional costs--more, perhaps, for some media and designs than for others--yet it believes this is an acceptable and necessary price to pay if it enables the Commission to determine with reasonable assurance, prior to an irrevocable act of closure, that the EPA standard will be satisfied.

2.3 Level of Detail

The proposed rule contained general and detailed prescriptive requirements, derived from Commission experience and practice in licensing other facilities, with respect to the design and construction of a geologic repository. The Commission noted, however, that it was continuing to examine other possibilities for promulgating the more detailed of these requirements and it invited comments on the topic.

The public response included arguments addressed both to the level of detail generally and to specific criteria which were deemed to be unduly restrictive.

The Commission has concluded that there is merit in describing, in functional terms, the principal features which should be incorporated into geologic

repository design--such as protection against dynamic effects of equipment failure, protection against fire and explosions, emergency capability, etc. Certain of these proposed criteria, however, such as those dealing with subsurface ventilation and shaft and borehole seals, were excessively detailed and, in some cases, inappropriate. At this stage of development, the Commission believes it should place emphasis upon the objectives that must be met and not become unduly concerned about the particular techniques that may be used in doing so. The changes that have been made are addressed in some detail in the section-by-section analysis of the rule.

2.4 Population-Related Siting Criteria

The proposed rule did not include any siting requirements which dealt directly with population density or proximity of population centers to a geologic repository operations area. The Commission indicated its belief that a more realistic approach, given the long period of time involved, would be to address the issue indirectly through consideration of resources in the geologic setting.

The numerous comments submitted in response to the Commission's specific question on this issue fell generally into two categories--those that endorsed the proposed approach and those that argued that population factors were important. The latter group addressed not only the geologic repository's long-term isolation capability, but also the relevance of population considerations in connection with the period when wastes are being received and emplaced.

The Commission is persuaded that population factors may need to be considered in connection with the period when wastes are being received and emplaced through evaluation of the adequacy of DOE's emergency plans. That section of the safety analysis report dealing with emergency planning (see § 60.21(c)(9)) will be reviewed on a case-by-case basis in the licensing process according to criteria that will be set forth in the future in Subpart I. (It should also be noted that under Section 112(a) of the Nuclear Waste Policy Act of 1982, DOE is required to develop guidelines that, among other things, will specify population factors that will disqualify a site from development as a repository. Issuance of these guidelines is subject to the concurrence of the

Commission. The Commission has made no determination whether such guidelines, when issued, should in some manner be reflected in either the technical criteria or licensing procedures portions of 10 CFR Part 60.)

Population distribution over the long term is immaterial if the geologic repository operates as anticipated. Demographic factors would nevertheless be of concern to the extent that they could increase the probability or the consequences of releases associated with unanticipated processes or events. As to probability, it is difficult to relate the likelihood of releases to population factors; it is the view of the Commission that it [illegible]re realistic, as originally stated, to reduce the probability by avoiding sites [illegible] significant resource potential and by using records and monuments to caution future generations. Consequences of unanticipated releases would be greater if they should occur in densely populated areas Nevertheless, it is the view of the Commission that it makes little sense to attempt to limit such consequences by means of a population-related siting criterion, since long-range demographic forecasts are so inherently speculative and unreliable; instead, the Commission is taking the approach that releases that result from the occurrence of unanticipated processes and events must be evaluated and must satisfy the EPA standard.

While the Commission considers, based on the above, that the rule should not now contain explicit requirements, particularly numerical limits, on population density or distance from population centers, it notes that considerations related to future human activities, particularly uses of groundwater, are an important source of uncertainty in assessing future performance of a geologic repository. The Commission would consider it a favorable condition if these sources of uncertainty, which would be affected by a large nearby population, were not present at a particular site. Therefore, the Commission has included in the final rule, as a favorable condition, a low population density within the geologic setting and a controlled area that is remote from population centers.

The Commission anticipates that the selection of a densely populated area would be unlikely even in the absence of expressed constraints in NRC regulations. For one thing, such a site would be disqualified under the guidelines to be developed under the Nuclear Waste Policy Act. Additionally, DOE will need to acquire interests in land within the controlled areas and may have to have

additional powers beyond the boundaries of the controlled area. These requirements may be difficult to satisfy unless a remote location is selected for the geologic repository.

2.5 ALARA

The notice of proposed rulemaking requested comment on "whether an ALARA (as low as reasonably achievable) principle should be applied to the performance requirements dealing with containment and control of releases." Some commenters believed that ALARA should be applied to all licensed activities, and that no exception should be made for geologic repositories. Other commenters argued against incorporating ALARA, since the allowable releases under the EPA standard would already be so low as to eliminate any significant risk to public health and safety.

Based in part upon the standard recently proposed by EPA, the Commission considers it reasonable to anticipate that the permissible amounts of radioactivity in the general environment will be established at a very low level. In fact, the statement of considerations accompanying EPA's proposed rule explains that EPA has chosen to propose disposal standards that limit the risks to future generations to a level no greater than the risks which those generations would be exposed to from equivalent amounts of unmined uranium ore and thus, any risks to future generations from disposal of high-level wastes would be no greater than, and probably much less than, risks which those generations would face if the wastes had not been created in the first place. Efforts to reduce releases further would have little, if any, demonstrable value commensurate with their costs.

The EPA limits require the performance of geologic repositories to be effective over a long period of time. There will always be substantial uncertainties in predicting the long-term performance of geologic repositories. The Commission will insist upon the adoption of a variety of design features, tests, or other measures in order to be able to conclude with confidence that the EPA standard is met. The result may be the same as if the Commission were to impose similar requirements in the name of keeping releases as low as reasonably achievable.

Given the substantial uncertainties involved with predicting long-term performance, the already low EPA limits and the already stringent geologic performance requirements, it is doubtful that the ALARA concept could be applied in a meaningful way.

When the Commission finds that certain measures are needed to improve confidence in dealing with uncertainties, it is making a substantial safety judgment. The same kinds of balancing that are undertaken in ALARA determinations may be appropriate. That is, if confidence in the performance of the geologic repository is sensitive to a particular source of uncertainty, it will be in order for the Commission to take into account both the significance of the factor involved and the costs of reducing or eliminating it.

In short, the Commission has concluded that the long-term performance requirements should not explicitly be tied to an ALARA principle, and the rule remains as it was when proposed. The Commission believes the concerns of the commenters in support of the ALARA approach will be largely accommodated in connection with its treatment of uncertainties in the course of the licensing process.

EPA's proposed rule (Part 191) indicates that appropriate measures must be taken, in light of the uncertainties involved in predicting repository performance, to assure that the "containment requirements" will be met. One of the measures identified by EPA would be the selection and design of disposal systems to keep releases to the accessible environment as small as reasonably achievable, taking into account technical, social, and economic considerations. The Commission is recommending to EPA that the assurance requirements, including the ALARA provision, be omitted from the final rule. The Commission emphasizes that its rules accommodate the underlying concerns of EPA, as articulated in its statement of considerations, that measures must be taken to assure confidence that the numerical release limits will be met.

2.6 Human Intrusion

The Commission observed, in the preamble of the proposed rule, that everything that is reasonable should be done to discourage people from intruding into the geologic repository. Those measures which it believed to be reasonable included

directing site selection toward sites having little resource value and marking and documentation of the site. Beyond that, the Commission felt there would be no value in speculating on the "virtual infinity of human intrusion scenarios and whether they will or will not result in violation of the EPA standard." The Commission explained that inadvertent intrusion was highly improbable, at least for the first several hundred years during which time the wastes are most hazardous; and even if it should occur, it is logical to assume that the intruding society would have capability to assess the situation and mitigate consequences. The Commission recognized that deliberate intrusion to recover the resource potential of the wastes could result in elevated releases of radioactivity, but concluded that the acceptability of such releases was properly left to those making the decision to undertake resource recovery operations. It noted that comment on its proposal and alternative approaches would be welcome.

Commenters generally accepted the approach outlined. A number of commenters did emphasize the importance of intrusion scenarios as having the potential to lead to releases of radionuclides to the environment, so they suggested no alternative means for dealing with the prospect. One commenter correctly calls attention to the possibility of a third category of intrusion--that which is "intentional yet indifferent"--which was not covered in the earlier discussion of "inadvertent" or "deliberate" intrusion. This behavior presupposes knowledge (albeit imperfect) of the existence and nature of the geologic repository and a level of technology that could be applied to remedial action as well as to the intrusion itself, yet makes no judgment as to whether a societal decision has been made concerning the intrusion. The Commission has addressed this and other concerns in the revised language that is being adopted, as explained below.

Although the discussion accompanying the proposed rule indicated that intrusion scenarios need not be considered, the rule itself was not explicit on this point. The Commission considers it necessary to clarify its position and, in doing so, allows for examination of intrusion under appropriate bounding conditions. After careful consideration of the public comments received on questions relating to human intrusion, the Commission is of the view that while the passive control measures it is requiring will reduce significantly the likelihood of inadvertent intrusion into a geologic repository, occasional penetration of the geologic repository over the period of isolation cannot be ruled

out, and some provision should be made in the final rule for consideration of intrusion should these measures fail. Its objective is to provide a means for evaluating events that are reasonably of concern, while at the same time excluding speculative scenarios that are inherently implausible. The Commission will not require this generation to design for fanciful events which the Commission has an abiding conviction will never occur; on the contrary, it will grant a license if it is satisfied that the risk to the health and safety of future generations is not unreasonable.

The rule now incorporates a definition of "unanticipated processes and events" which are reviewable in a licensing proceeding; such processes and events expressly include intrusion scenarios that have a sufficiently high likelihood and potentially adverse consequence to exceed the threshold for review. The scenarios must be "sufficiently credible to warrant consideration." The Commission is requiring that certain assumptions be made in assessing this likelihood. First, the monuments required by the rule are assumed to be sufficiently permanent to serve their intended purpose. The Commission takes this position because of its confidence that monuments can be built to survive. While it assumes that the monuments will last, it does not automatically assume that their significance will continue to be understood. Second, the Commission requires an assumption that the value to future generations of potential resources can be assessed adequately at this time. Consistent with its previously stated views, it thinks that the selection of a site with no foreseeably valuable resources could so reduce the likelihood of intrusion as to reduce, or eliminate, any further need for it to be considered. Third, the Commission requires the assumption that some functioning institutions--though not necessarily those undertaking the intrusion--understand the nature of radioactivity and appreciate its hazards. The extent of intergenerational transfer of knowledge is, of course, debatable; it is conservative, in the light of human history to date, to predict this minimal level of information and to take it into account in assessing the likelihood that intrusion will occur. Fourth, the Commission provides that relevant records are preserved, and remain accessible, for several hundred years after permanent closure. While perhaps this period could not be justified on the basis of historic precedents alone, the Commission considers the required deposit in land records and archives, together with current data handling technology, to provide a

sufficient basis for assuming that information about the geologic repository will continue to be available for several hundred years.

The definition of "unanticipated processes and events" also implicitly bounds the consequences of intrusion scenarios. This is accomplished not only by the assumption of continued understanding of radioactivity and survival of records, but also by the further assumptions that if there are institutions that can cause intrusion at depth in the first place, there will also be institutions able to assess the risk and take remedial action. It need not be assumed that today's technology would be used--merely that a level of social organization and technological competence equivalent to that applied in initiating the processes or events concerned would be available to deal with the situation.

It was suggested that another way to reduce the likelihood of human intrusion would be to adopt additional design criteria for the waste form or waste package. These would prohibit, or at least discourage, the emplacement of materials which themselves might attract recovery operations--for example, operations to recover the residual energy resource value in spent fuel or scarce and expensive materials in the waste package. But, under the definition of "unanticipated processes and events" in the final rule, intrusion for such purposes would have to be reviewed in the licensing process if the particular circumstances are sufficiently credible to warrant consideration. This imposes a reasonable constraint. The Commission believes that any further limitation would unduly interfere with the flexibility of DOE as a designer and could, in the case of spent fuel disposal, conflict with other national objectives

In summary, the Commission has retained the principle that highly speculative intrusion scenarios should not be allowed to become the driving force in license reviews, but has introduced some flexibility to permit consideration of intrusion on a case-by-case basis where circumstances warrant.

3.0 Other Principal Changes in the Final Rule

3.1 Anticipated/Unanticipated Processes and Events

The proposed rule defined anticipated processes and events as "those natural processes and events that are reasonably likely to occur during the period the

intended performance objective must be achieved and from which the design bases for the engineered system are derived." At the same time, the Commission was requiring that the facility be designed so as to assure that long-term releases conform to standards established by EPA. The statement of considerations pointed out that if the process or event is unlikely, the overall system must still limit the rele e consistent with the EPA standard as applied to such events. This created a contradiction because on the one hand it was stated that the design bases should be derived from anticipated processes and events while, on the other hand, the design was to meet an EPA standard as applied to what was unanticipated.

The Commission has resolved this conflict by eliminating the reference to design bases from the definition of "anticipated processes and events." It has also included a definition of "unanticipated processes and events." In the final rule, numerical performance objectives are established for particular barriers, assuming "anticipated processes and events." Such numerical criteria are not established for "unanticipated processes and events." Rather, additional requirements may be found to be necessary to satisfy the overall system performance objective as it relates to unanticipated processes and events.

It should be noted that the distinction between anticipated and unanticipated processes and events relates solely to natural processes and events affecting the geologic setting. The Commission intends that a judgment whether a natural process or event is anticipated or unanticipated be based upon a careful review of the geologic record. Such processes or events would not be anticipated unless they were reasonably likely, assuming that processes operating in the geologic setting during the Quaternary Period were to continue to operate but with the perturbations caused by the presence of emplaced waste superimposed thereon. Unanticipated processes and events would include those that are judged not to be reasonably likely to occur during the period the intended performance objective must be achieved, but which nevertheless are sufficiently credible to warrant consideration. These include processes and events which are not evidenced during the Quaternary Period or which, though evidenced during the Quaternary, are not likely to occur during the relevant time frame. Identification of anticipated and unanticipated processes and events for a particular

site will require considerable judgment and will not be amenable to accurate quantification, by statistical analysis, of their probability of occurrence.[5]

Because the design basis for the engineered barrier system will be derived from the identification of anticipated and unanticipated processes and events, such identification will have a pervasive effect on the basic structure of the licensing proceedings. The Commission therefore contemplates directing that rulings made in the course of construction authorization hearings on the scope of anticipated and unanticipated processes and events be separately identified by the presiding officers and certified to the Commission for interlocutory review, pursuant to 10 CFR 2.718(i).

The license review will thus need to include a determination whether the proposed activities will meet the EPA standard as applied to anticipated processes and events and as applied to such unanticipated processes and events, if any, as have been found to warrant consideration. Each determination will be made in the light of assessments which will involve interpretation of the geologic record and consideration of credible human-induced events as bounded by the assumptions set forth above. Worst-case scenarios would be analyzed to the extent they may be encompassed by the definition of unanticipated processes and events. Complex quantitative models will need to be employed, and a wide range of factors considered in arriving at a determination of whether there is reasonable assurance, making allowance for the time period and hazards involved, that the EPA standard will be met. There are two principal elements that will go into the Commission's application of this "reasonable assurance" concept. First, the performance assessment which has been performed must indicate that the likelihood of exceeding the EPA standard is low. Second, the Commission must be satisfied that the performance assessment is sufficiently conservative, and its limitations are sufficiently well understood, that the actual performance of the geologic repository will be within predicted limits.

[5]The Commission views the proposed EPA standard as being directed to the evaluation of releases arising out of the categories that we have defined as "anticipated processes and events" and "unanticipated processes and events." As EPA itself recognizes, there can only be estimates rather than rigorous demonstrations of probabilities of occurrence. The Commission's translation of the EPA language into qualitative terms provides a clearer basis for judging, under the Atomic Energy Act, whether there is unreasonable risk to the health and safety of the public.

3.2 Transuranic Waste (TRU)

The proposed rule included a definition of transuranic waste and performance objectives that would apply to the disposal of TRU in a licensed geologic repository. This was widely misconstrued as a requirement that radioactive material conforming to the definition must be disposed of in this manner. This was not the intention, nor in fact did the rule so specify. Rather, the Commission was merely indicating what performance objectives would apply if TRU were disposed of in a licensed geologic repository. Some commenters also took exception to the definition of TRU in the rule.

Whether or not a geologic repository is subject to licensing depends upon the applicability of Sections 202(3) and 202(4) of the Energy Reorganization Act of 1974. (See definition of "HLW facility.") If a facility is licensed, then the Commission must consider the radiological hazards associated with whatever wastes may be emplaced. The Commission attempted, in the proposed rule, to address the requirements for one such kind of waste--TRU. But the Commission was too restrictive, in that its definition of TRU was too limited for present purposes and in that wastes other than HLW and TRU were not covered at all. For the time being, the Commission has concluded that the matter is best handled by eliminating all references to TRU. The remaining performance objectives provide adequate guidance to deal with TRU-related issues that may arise.

The Commission has also reviewed the waste package requirements, which as originally written would have applied to all emplaced radioactive waste It is appropriate to include such requirements for HLW, which must necessarily be disposed of in a licensed facility. Since the Commission does not know what other radioactive wastes, if any, will also be emplaced, and what their chemical, radiological, thermal, and other characteristics may be, it has decided to leave pertinent waste package requirements to be determined on a case-by-case basis as the need arises.

3.3 Siting Criteria

Although provisions relating to site characteristics have been revised, the Commission has retained the same two basic concepts. First, a site should exhibit an appropriate combination of favorable conditions, so as to encourage

the selection of a site that is among the best that reasonably can be found. By referring to a "combination" of conditions, it implies that the analysis must reflect the interactive nature of geologic systems. Second, any potentially adverse conditions should be assessed in order to assure that they will not compromise the ability of the geologic repository to meet the performance objectives. It is important to recognize that a site is not disqualified as a result of the absence of a favorable condition or the presence of a potentially adverse condition. The Commission emphasizes this point here because several commenters who characterized the siting criteria as unduly restrictive failed to appreciate that the presence of potentially adverse conditions would not exclude a site from further consideration while others mistakenly assumed that favorable conditions were requirements.

The changes do not reflect any departure from the Commission's original philosophy, but they are designed to express its purpose more clearly. Thus, its interest in specifying that the geologic setting shall have exhibited "stability" since the start of the Quaternary Period was to assure only that the processes be such as to enable the recent history to be interpreted and to permit near-term geologic changes to be projected over the relevant time period with relatively high confidence. This concept is best applied by identifying, as potentially adverse conditions, those factors which stand in the way of such interpretation and projection; this is the approach the Commission has chosen to follow.

One revision is the elimination of the classification of potentially adverse conditions into one set pertaining to the "geologic setting" (corresponding to "site" in the final rule) and one set pertaining to the "disturbed zone." The Commission has determined that by defining these conditions as potentially adverse only when they occur in the site or disturbed zone, respectively, some significant factors bearing upon waste isolation may not be assessed. The Commission has changed the siting criteria, therefore, so that the presence of any of the enumerated conditions is to be regarded as potentially adverse if it applies to the controlled area and, in addition, such a condition outside the controlled area is to be regarded as potentially adverse if it may affect isolation within the controlled area.

Another change, discussed under Single vs. Multiple Performance Standards, may have the effect of increasing the importance of the geological conditions. Under the final rule, the performance objectives for the engineered barrier system (§ 60.113(a)(1)) may be adjusted, on a case-by-case basis, if the overall system performance objective, as it relates to anticipated processes and events, is satisfied. This feature of the final rule may provide the designer additional incentive to select the site so as to maximize its isolation capabilities.

The Commission's review of the siting criteria, as modified, has led it to conclude that the isolation capabilities of the geologic repository will be given the emphasis that they merit. This review has included a consideration of suggestions that the rule require that the slate of sites be among the best that can be found on the basis of geological factors alone and that the geologic characteristics of the site provide the highest reasonably available degree of the site's isolation capabilities. These topics are discussed below, under the heading Geological Conditions.

A detailed review of the siting criteria is contained in the Section-by-Section Analysis.[6]

3.4 Containment

Several commenters took exception to the performance objective calling for a design of the waste packages to "contain all radionuclides" for a specified period after permanent closure. The objections were: first, that 100% performance cannot be expected in view of the very large number of containers that may be emplaced; second, that 100% performance cannot be justified as being needed in order to meet any likely EPA standard; and, third, that the

[6]Under Section 112(a) of the Nuclear Waste Policy Act of 1982, DOE is required to develop guidelines for the recommendation of sites for repositories. Among other things, such guidelines are to "specify detailed geologic considerations that shall be primary criteria for the selection of sites in various geologic media." Issuance of these guidelines is subject to the concurrence of the Commission. The Commission has made no determination whether such guidelines, when issued, should in some manner be reflected in either the technical criteria or licensing procedures portions of 10 CFR Part 60.

adequacy of design to contain "all" radionuclides for long periods of time is not demonstrable. The commenters failed, in part, to recognize that under the specified standard of proof (see Reasonable Assurance, below), the applicant would not be forced to carry an impossible burden. Nevertheless, since the Commission does not expect proof that literally all radionuclides will be contained. the performance objective now requires design so that containment of HLW within the high-level waste packages will be "substantially complete" for the specified period.

4.0 Terminology

Several commenters criticized, as vague or confusing, the terms used by the Commission to describe the various geographical locations that are addressed by the rule. There are many such locations--and there must be--because the Commission must deal with different concerns during site characterization, during operations, and after permanent closure. The Commission has nevertheless attempted to clarify the terms. In addition to the significant changes reviewed here, see also the discussion in the Section-by-Section Analysis.

4.1 Accessible Environment/Controlled Area

The isolation capability of a geologic repository is evaluated at a boundary which the Commission has referred to as the "accessible environment." Under the proposed rule, this was defined as "portions of the environment directly in contact with or readily available for use by human beings." Several commenters criticized this definition as being excessively vague; further, the definition failed to assure that the isolation capability of the rock surrounding the underground facility would be given appropriate weight in licensing reviews.

The Commission agrees with the criticism and has revised the definition in several respects--most importantly by excluding from the accessible environment that portion of the lithosphere that is inside what the Commission is calling, in the final rule, a "controlled area." This is an area marked with monuments designed to caution future generations against subsurface penetrations. The size and shape of the controlled area will depend upon the characteristics of

the particular geologic repository, but it must be small enough to justify confidence that the monuments will effectively discourage subsurface disturbances. The Commission has therefore limited the size of the controlled area so that it extends no more than 10 kilometers from the emplaced waste. The term "accessible environment" also appears in the proposed EPA standard. The Commission has used the EPA language as a starting point--for example, in specifying the surface locations that are part of the accessible environment. But there is an important difference between the two definitions, in that EPA includes in the accessible environment only those parts of the lithosphere that are more than 10 kilometers from the emplaced waste, whereas NRC may include parts of the lithosphere that are less than 10 kilometers from the emplaced waste, depending on the extent of the "controlled area" for a geologic repository. In other words, the accessible environment may be larger under 10 CFR Part 60 than might be the case under the proposed EPA standard. The two definitions are nevertheless consistent in the sense that if the isolation requirements are satisfied at the boundary of the accessible environment specified by 10 CFR Part 60, they will necessarily be satisfied at the boundary defined by EPA as well.

Both technical and legal considerations have influenced the Commission's decision not to adopt an unqualified 10-kilometer standard. The technical consideration is that uncertainties about activities that may be undertaken in the area outside the controlled area are so great that the Commission would not be warranted in giving credit to the isolation capability of the undisturbed lithosphere there. The legal consideration is that the standards established by EPA are to apply outside the boundaries of locations controlled by NRC licensees, and in the context of 10 CFR Part 60 this refers most appropriately to the "controlled area" as defined by the regulation. The Commission believes that the final rule is fully responsive to the concerns of the commenters while conforming as well to the policies underlying EPA's proposed standard.

4.2 Geologic Setting

The proposed rule limited this term to systems that provide isolation of the waste. This is too restrictive a definition to cover the wider region of interest which the Commission seeks to encompass by "geologic setting." The

definition has accordingly been extended to include the geologic hydrologic, and geochemical systems of the region in which a geologic reposi ory operations area is or may be located.

4.3 Site

"Site" had been defined in the proposed rule as being equivalent to "geologic setting." This was appropriate where geologic setting referred o an area having isolation capability. In the final rule, isolation is to be provided within a controlled area rather than within the geologic setting and accordingly "site" now refers to the location of this controlled area.

4.4 Decommissioning

As used in the proposed technical criteria, the term "decommissioning" was intended to apply to that stage at which the underground facility was closed and shafts and boreholes were sealed It was these activities that were addressed in § 60.51, "License amendment to decommission." This intention is better expressed by employing the term "permanent closure." Several commenters on the proposed rule expressed the opinion that including the requirement for dismantlement of all surface facilities in the definition of the term "decommissioning" may be unnecessary and overly restrictive. Upon consideration of these comments the Commission believes that where there is a need to refer to decontamination or dismantlement of surface facilities, this can readily be done without referring to "decommissioning."

Accordingly, references to "decommissioning" with one exception (see § 60.132(e)), have been deleted from the rule, and the language now refers to "permanent closure" or to "decontamination or dismantlement of surface facilities," as appropriate.

4.5 Important to Safety

In response to public comments on Part 60, the NRC has adopted a numerical criterion for determining which structures, systems, and components are important to safety. Structures, systems, and components are important to safety if, in the

event they fail to perform their intended function, an accident could result which causes a dose commitment greater than 0.5 rem to the whole body or any organ of an individual in an unrestricted area.[7] The value of 0.5 rem is equal to the annual dose to the whole body of an individual in an unrestricted area that would be permitted under 10 CFR Part 20 for normal operations, the same as permitted for normal operations of certain other activities licensed by NRC. Such systems, structures, and components would be subject to additional design requirements and to a quality assurance program to ensure that they performed their intended functions. The choice of 0.5 rem in this instance should not be construed as implying that it would be appropriate if applied to any other types of activities subject to regulation by the Commission. (The permissible annual dose in unrestricted areas--now 0.5 rem--is currently under review. The Commission contemplates that if this dose limit were to be revised, a corresponding change would be considered here.)

In the final rule, the term "important to safety" applies solely to the functioning of structures, systems, and components during the period of operations prior to repository closure. The proposed rule had also applied this term to structures, systems, and components which must function in a particular way in order to meet the long-term isolation objective after repository closure. In the final rule, this latter group, which is intended to meet the design criteria that address long-term performance, is characterized as "important to waste isolation." Quality assurance requirements apply to structures, systems, and components equally whether they be "important to safety" or "important to waste isolation."

5.0 Discussion of Other Comments

These issues raised by commenters merit discussion here even though they have resulted in no change to the rule.

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10 CFR Part 50, Appendix A, uses the term "important to safety" in a different context for nuclear power plants. The 10 CFR Part 60 definition does not supersede the 10 CFR Part 50 definition in nuclear power application.

5.1 Comparative Safety Analyses

Several commenters took exception to the proposed requirement that the safety analysis report include a comparative evaluation of alternatives to the major design features that are important to radionuclide containment and isolation, [now termed "important to waste isolation"], on the ground that a safety analysis should be directed at the specific design being proposed. As a general principle, the commenters are correct. In the context of licensing activities at a geologic repository operations area, however, the Commission thinks it is well within its discretion to seek the requested information. If the Commission finds, on the basis of its review, that the adoption of some alternative design feature would significantly increase its confidence that the performance objectives would be satisfied, and that the costs of such an approach are commensurate with the benefits, it should not hesitate to insist that the alternative be so adopted. This is consistent with the views expressed above in the discussion of the ALARA principle and, also, with the provisions of the revised performance objectives which contemplate that the performance objectives for particular barriers are subject to modification, on a case-by-case basis, as needed to satisfy applicable EPA standards.

5.2 Unsaturated Zone

The Commission had explained that the proposed criteria were developed for disposal in saturated media, and that additional or alternative criteria might need to be developed for regulating disposal in the unsaturated zone. Accordingly, the performance objective for the engineered barrier system (proposed § 60.111(b)(2)(i)) was written so as to require the assumption of full or partial saturation of the underground facility and the favorable and potentially adverse conditions concerned only siting in the saturated zone.

This approach was criticized on the basis that disposal in the unsaturated zone was a viable alternative, and that since the criteria were generally applicable without regard to the possibility of saturation, their scope and applicability should not be unduly restricted. The Commission has reviewed the criteria in the light of the comments and finds this criticism to be well-founded. Although

the criteria as written are generally appropriate to disposal in both the saturated zone and the unsaturated zone, some distinctions do need to be made. Rather than promulgating the criteria which will apply to the unsaturated zone at this time, the Commission will shortly issue such criteria in proposed form so as to afford a further opportunity for public comment. However, those criteria that are uniquely applicable to the saturated zone are so indicated.

5.3 Geological Conditions

One commenter recommended that the rule should require that the slate of sites characterized by DOE be among the best that can reasonably be found on the basis of geological factors alone. The Commission did indicate, when it adopted licensing procedures, that the site characterization requirements will assure that DOE's preferred site will be chosen from a slate of sites that are among the best that reasonably could be found. The standard proposed by the commenter is quite different. The Commission intended that DOE should be able to take into account a variety of non-geological considerations in its screening process. It could properly exclude such locations as (1) areas, such as national parks and wilderness, devoted to other paramount uses, (2) locations which would be subject to unusually severe environmental and socioeconomic impacts, and (3) locations where necessary surface, mineral, and water rights may be obtainable only at great expense and with severe dislocating effects on residents. The Commission considers the rule, as written, properly conveys its meaning on this score.

The same commenter urged it to require a demonstration that the geologic characteristics of the chosen site provide the highest reasonably achievable degree of enhancement of the waste isolation capabilities of the geologic repository. Again, the Commission declines to accept the suggestion. In the first place, it anticipates that DOE would on its own initiative strive to maximize isolation capabilities in order to demonstrate more conclusively the facility's compliance with the performance objectives and other technical criteria. Beyond this, however, the Commission believes the proposal could have undesirable and unintended consequences. Maximizing isolation capabilities could dictate development at one particular location instead of at

another a few miles away; this could result in the same kind of adverse environmental or other effects as were described above. Furthermore, adherence to the proposed standard could unduly interfere with, or increase the cost of, achievement of other goals, such as maintenance of retrievability, providing for worker safety, etc.

There were other related comments which argue that the Commission's approach places too great an emphasis on engineered barriers and provides insufficient incentive to select a site with optimal geologic and hydrologic characteristics. The Commission considers both engineered and natural barriers to be important, and it has structured the technical criteria in a manner that demands not only the use of advanced engineering methods, but also selection of a site with excellent isolation capabilities. As explained in the discussion of Reasonable Assurance, below, uncertainties in the models used in the analysis of repository performance must be considered in the Commission's deliberations on the issuance of a construction authorization or license. Selection of a site with favorable geologic conditions will greatly enhance the Commission's ability to make the prescribed findings. Moreover, since the final rule provides flexibility for the Commission to approve or specify performance objectives for the engineered barriers on a case-by-case basis, the applicant is afforded still a further incentive to pick a site in which the host rock has favorable geochemical characteristics or in which other particular sources of uncertainty about hydrogeologic conditions are substantially reduced. But in any event, the Commission anticipates that a high standard of engineering will be necessary--not only to compensate for geologic uncertainties at even the best reasonably available sites, but perhaps also to mitigate the consequences of unanticipated processes and events (including potential intrusion) during the years when fission product inventories remain high.

Although the Commission agrees with the underlying appraisal of the commenters that the isolation capabilities of the site play a key role in assuring that the performance objectives will be met, it finds no reason to change the rule's basic approach.

5.4 Reasonable Assurance

The proposed rule stated that with respect to the long-term objectives and criteria under consideration, "what is required is reasonable assurance, making allowance for the time period and hazards involved, that the outcome will be in conformance with those objectives and criteria." A number of commenters took exception to this formulation on the ground that it provides inadequate guidance as to the required level of proof. Others were concerned that "reasonable assurance" was too weak a test and that the Commission should not license DOE activities without a "high degree of confidence" that releases would be very small. Some commenters suggested that a statistical definition of acceptability should be employed. For the reasons set forth below, the Commission has not modified the language.

In the Commission's view, the "reasonable assurance" standard neither implies a lack of conservatism nor creates a standard which is impossible to meet. On the contrary, it parallels language which the Commission has applied in other contexts, such as the licensing of nuclear reactors, for many years. See 10 CFR 50.35(a) and 50.40(a). The reasonable assurance standard is derived from the finding the Commission is required to make under the Atomic Energy Act that the licensed activity provide "adequate protection" to the health and safety of the public; the standard has been approved by the Supreme Court Power Reactor Development Co. v. Electrical Union, 367 U.S. 396, 407 (1961). This standard, in addition to being commonly used and accepted in the Commission's licensing activities, allows the flexibility necessary for the Commission to make judgmental distinctions with respect to quantitative data which may have large uncertainties (in the mathematical sense) associated with it.

The Commission has not modified the language, but has explained elsewhere (see Anticipated/Unanticipated Processes and Events, above) how the concept will be applied. The Commission expects that the information considered in a licensing proceeding will include probability distribution functions for the consequences from anticipated and unanticipated processes and events. Even if the calculated probability of meeting the Commission's standards is very high that would not be sufficient for the Commission to have "reasonable assurance"; the Commission would still have to assess uncertainties associated with the models and data that had been considered. This involves qualitative as well as quantitative

assessments. The Commission would not issue a license unless it were to conclude, after such assessments, that there is reasonable assurance that the outcome will in fact conform to the relevant standards and criteria.

It is important to keep in mind this distinction between, first, a standard of performance and, second, the quality of the evidence that is available to support a finding that the standard of performance has been met. In principle, there is no reason why the first of these--the performance standard--cannot be expressed in quantitative terms. The rule does this in several places--notably, in including as performance objectives a designed containment period, a radionuclide release rate, and a pre-waste-emplacement groundwater travel time. Similarly, EPA's standard will establish limits on concentrations or quantities of radioactive material in the general environment.

Expressing a requisite level of confidence in quantitative terms is far more problematical. To be sure, measurement uncertainties are amenable to statistical analyses. Even though there may be practical limitations on the accuracy and precision of measurements of relevant properties, it is possible to make some quantitative statement as to how well these values are known. The licensing decisions which the Commission will be called upon to make involve additional uncertainties--those pertaining to the correctness of the models being used to describe the physical systems--which are not quantifiable by statistical methods. Conclusions as to the performance of the geologic repository and particular barriers over long periods of time must largely be based upon inference; there will be no opportunity to carry out test programs that simulate the full range of relevant conditions over the periods for which waste isolation must be maintained.

The validity of the necessary inferences cannot be reduced, by statistical methods, to quantitative expressions of the level of confidence in predictions of long-term repository performance. Similarly, the Commission will not be able to rigorously determine the probability of occurrence of an outcome that fails to satisfy the performance standards. It must use some other language, such as "reasonable assurance," to characterize the required confidence that the performance objectives will be met. In practice, this means that modeling uncertainties will be reduced by projecting behavior from well understood but

simpler systems which conservatively approximate the systems in question. Available data must be evaluated in the light of accepted physical principles; but, having done so, the Commission must make a judgment whether it has reasonable assurance that the actual performance will conform to the standards the Commission has specified in this rule.

It should also be borne in mind that the fact-finding process is an administrative task for which the terminology of law, not science, is appropriate. The degree of certainty implied by statistical definition has never characterized the administrative process. It is particularly inappropriate where evidence is "difficult to come by, uncertain or conflicting because it is on the frontiers of scientific knowledge." Ethyl Corp. v. EPA, 541 F.2d 1, 28 (D.C. Cir. 1976).

5.5 Population vs. Individual Dose

Some commenters noted that the performance objectives are derived from an assumed EPA standard that is based upon consideration of doses to populations as a whole rather than to the maximally exposed individual. Several other analyses of repository design have examined prospective requirements in terms of keeping individual doses below specified values, and as a consequence have led to different conclusions. The differences represent a source of potential uncertainty regarding the overall goal for safety performance. However, the resolution of this question is a matter within the province of EPA. The Commission has assumed that the EPA approach will be based upon population dose, since that is the direction reflected in its working documents and its recently proposed standard. The Commission's rule, especially as modified to allow performance objectives for particular barriers to be adapted in the light of the EPA standard, can be applied whether the overall safety goal is expressed in terms of total releases to the environment or in terms of maximum dose to an individual or maximum concentration at any place or time.

If EPA were to establish a standard based upon individual doses, the Commission would review the provisions dealing with the content of the license application (§ 60.21) so as to develop requirements for any additional analyses that might be needed to evaluate site-specific pathways for released radionuclides to reach humans.

5.6 Long-Term Post-Closure Monitoring

Several of the commenters suggested that the performance confirmation program be required to be continued for as long as one thousand years after permanent closure of the underground facility. The Commission considers such measures unnecessary and unlikely to provide useful information on the performance of a geologic repository. The multiple barrier approach the Commission has adopted will result in containment of substantially all of the radioactive materials within the waste packages for centuries after permanent closure, the feasibility of obtaining reliable data on subsurface conditions over a period of centuries is questionable, and the practicality of taking remedial action after sealing of the shafts is doubtful. Moreover, the emplacement of remote subsurface monitoring instruments and the provision of data transmission capabilities, could provide additional pathways for release that would make it more difficult to achieve isolation. Rather, the Commission has adopted an approach where the retrievability option is maintained until a performance confirmation program can be completed that will allow the Commission to decide, with reasonable assurance, that permanent closure of the facility, with no further active human intervention with the emplaced wastes, will not cause an unreasonable risk to public health and safety. See also, Retrievability, above.

6.0 Section-by-Section Analysis

The final rule included numerous changes that reflect the considerations discussed above. Other changes, not involving significant policy issues, have also been incorporated in the final rule. The following section-by-section analysis identifies the changes from the proposed rule and includes an appropriate explanation for the revisions not previously discussed. Principal references are to the text of the final rule. Where the counterpart provision of the proposed (or procedural) rule appeared in a different place, that citation is given in brackets

§ 60.2 Definitions.

"Accessible environment." See Accessible Environment/Controlled Area, above.

"Anticipated processes and events." See Anticipated/Unanticipated Processes and Events, above.

"Candidate area." This term is unchanged, but will be considered again in connection with the Commission's review of the licensing procedures in the light of the Nuclear Waste Policy Act.

"Controlled area." New. See Accessible Environment/Controlled Area, above.

"Decommissioning." Deleted. See Decommissioning, above.

"Disposal." The undefined term "biosphere" has been changed to "accessible environment." As used in these rules, "isolation" refers specifically to radioactive materials entering the accessible environment. The definition here is related to the concept of isolation rather than to the concept of emplacement, as in Section 2(9) of the Nuclear Waste Policy Act; the Commission believes that in each instance the term is defined in a manner appropriate to its context, and that the differences in the definitions will not result in confusion or conflict.

"Disturbed zone." The term "disturbed zone" has been modified to relate changes in the physical or chemical properties of the controlled area to the performance of the geologic repository.

"Engineered barrier system." This term refers to the system for which containment and release rate requirements are specified. It does not include the shafts and boreholes, and their seals. The proposed rule referred instead to "engineered systems," a term that was misleading because it could be understood to include shaft and borehole seals. However, the Commission recognizes that as used in the Nuclear Waste Policy Act of 1982, the related term "engineered barriers" might be construed to include shaft and borehole seals. The NRC will review whether the definition requires change in light of the Nuclear Waste Policy Act. Preliminary review does not indicate a need for change in this definition.

"Far field." The term "far field" has been deleted from the rule. Therefore, the definition is no longer necessary.

"Floodplain." Deleted. This definition was taken from Executive Order 11988 which relates to environmental consequences of occupancy and modification of floodplains. Those effects need to be considered as part of the Commission's environmental review, but they do not implicate the radiological concerns that are addressed in Part 60. The term "floodplain" still appears in § 60.122(c)(1). However, rather than establishing any particular frequency as the means for defining its extent, the Commission will allow the factors specified in § 60.122(a)(3) to be used in assessing the significance of flooding, whenever it may occur.

"Geologic repository." Clarifying change, to bring the terminology into line with common usage. The new definition includes only that portion of the geologic setting that provides isolation--not the entire geologic setting. The term, as defined, is considered to be synonymous with "repository" as defined at Section 2(18) of the Nuclear Waste Policy Act. (The added clause "or may be used for" conforms to the statutory definition as well as the definition in existing Part 60.)

"Geologic setting." See Terminology, above. The phrase "spatially distributed" was superfluous and has been deleted.

"High-level radioactive waste." The Nuclear Waste Policy Act distinguishes between "high-level radioactive waste" and "spent nuclear fuel." These technical criteria are applicable equally to both categories. Accordingly, no change in the definition of high-level radioactive waste is required at this time.

"Important to safety." See "Important to Safety," above.

"Medium" or "geologic medium." Deleted. For the sake of clarity, the term "medium" is now replaced by "geologic medium" throughout the rule. Since the term "geologic medium" should be sufficiently clear to the professional community, it no longer appears necessary to define it.

"Overpack." This term has been deleted. Because the overpack could be a component of the waste package, it was included in the definition of the term "waste package." However, this term is not used in the final rule.

"Performance confirmation." The final rule's performance objective with respect to retrievability of the waste refers to the completion of a performance confirmation program and Commission review of the information obtained from such a program. The addition of this definition is intended to clarify the intended purpose of the performance confirmation program.

"Permanent closure." New. See Decommissioning, above.

"Restricted Area." New. See Important to Safety, above.

"Retrieval." New. See Retrievability, above.

"Saturated zone." New. Since the performance objectives in the final rule specifically refer to disposal in the saturated zone, a definition derived from Water Supply Paper 1988 (U.S.G.S., 1972) has been included.

"Site." See Terminology, above.

"Stability." Deleted. See Siting Criteria, above. Also, Section by Section Analysis, § 60.113, below.

"Subsurface facility." Deleted. Both "subsurface facility" and "underground facility" were defined in the proposed rule. The use of the two closely similar terms resulted in some confusion. "Subsurface facility" has been deleted and replaced (see definition of "Permanent closure") by explicit reference to shafts and boreholes, as well as the underground facility, where appropriate.

"Transuranic wastes." Deleted. See Transuranic Waste, above.

"Unanticipated processes and events." New. See Human Intrusion, above.

"Waste form." Clarifying change to bring terminology into line with common usage.

"Waste package." Revised. Commenters questioned the clarity of this proposed definition and one commenter suggested an alternative definition. One commenter misinterpreted the proposed definition to require that the outermost component of the waste package be an airtight, watertight, sealed container. The revised definition no longer uses the terms "discrete backfill" or "overpack," which were ambiguous. To the extent that absorbent materials or packing are placed around a container to protect it from corrosion by groundwater, or to retard the transport of radioactive material to the host rock, these materials would be considered part of the waste package. However, while the final rule no longer imposes a requirement for an airtight, watertight, sealed container as part of the waste package, the Commission believes it likely that DOE will incorporate such a component into the design of the waste package in order to meet the performance objectives for the engineered barrier system for the period following permanent closure. The related terms "disposal package" and "package," as defined at Section 2(10) of the Nuclear Waste Policy Act, include unspecified overpacks; for purposes of the Commission's rules, and specifically in connection with the performance objective set out at Section 60.113(a)(1)(ii)(A), a more precise definition is needed. The differences in the definitions will not, in the judgment of the Commission, result in confusion or conflict.

"Water table." New. Required because the term appears in the definition of "saturated zone." The definition is derived from U.S. Geological Survey Water Supply Paper 1988.

§ 60.10 Site characterization.

One amendment clarifies the point that investigations shall be conducted in such a manner as to limit adverse effects; the original language could have been construed to mean that the purpose of the investigations was to limit such effects. The provision calling, as a minimum, for the selection of borehole locations to limit subsurface penetrations was said to be confusing; the

revision, which expresses the Commission's intention more clearly, includes a phrase that emphasizes that the number of penetrations must be adequate to obtain needed site characterization data. References to the "repository" have been replaced by terms that are more appropriate in their context.

§ 60.11 Site characterization report.

The ambiguous term "repository" has been replaced by defined terms ("geologic repository operations area" and "geologic repository") as appropriate in the context (in § 60.11(a)(6)(ii)).

§ 60.21 Content of application.

§ 60.21(c)(1)

Proposed § 60.21(c)(1) called for information regarding subsurface conditions "in the vicinity of the proposed underground facility." This has been clarified to refer to the controlled area and to other areas to the extent that subsurface conditions there may affect isolation within the controlled area.

§ 60.21(c)(1)(i)

The requirement for analysis of potential pathways has been extended to include "potentially permeable features" whether or not they are, as stated in the proposed rule, "permeable anomalies." Whether the feature is actually permeable or anomalous is not the point; what matters is the potential permeability.

The adjective "bulk," as applied to geomechanical, hydrogeologic, and geochemical properties, has been deleted as ambiguous and confusing.

§ 60.21(c)(1)(ii)(A)

Clarifying change to include analysis of climatology as well as meteorology.

§ 60.21(c)(1)(ii)(B) [§ 60.123(b)]

This paragraph concerns analyses of the favorable and potentially adverse conditions listed in § 60.122. The addition of language pertaining to the depth and breadth of investigations assures that the information needed to analyze these conditions will be available for NRC review This is a modification of proposed § 60.123(b) for conduct of such investigations. The modification ties the extent of investigations to effects of potentially adverse conditions on waste isolation within the controlled area, rather than to specified distances, as originally proposed.

§ 60.21(c)(1)(ii)(C)

References to "expected" performance and releases have been deleted from § 60 21(c)(1)(ii)(C) because, as revised, the evaluation must also take into account the assumed occurrence of unanticipated processes and events. Since the performance objectives provide for consideration of unanticipated processes and events, relevant information must be included in the safety analysis report. The evaluation is limited to periods after permanent closure, as the option to retrieve the wastes is available earlier.

§ 60 21(c)(1)(ii)(D) [§ 60.21(c)(3)(iii)]

This paragraph reflects text that formerly was in § 60.21(c)(3). The latter paragraph relates to structures, systems, and components "important to safety." The term "important to safety," as used in the final rule, pertains to the period of operations. Because the requirement for evaluating the effectiveness of the barriers was directed to questions regarding containment and isolation, it was relocated so as to place it in the proper context.

§ 60.21(c)(1)(ii)(E) [§ 60.21(c)(1)(ii)(D)]

This paragraph, as proposed, was duplicative insofar as it related to performance of the geologic repository after permanent closure. It has therefore been revised so as to pertain solely to identification of structures,

systems, and components important to safety. [As in § 60.21(c)(1)(ii)(C) reference to "expected" has been deleted as confusing.]

§ 60.21(c)(1)(ii)(F) [§ 60.21(c)(1)(ii)(E)]

This paragraph has been revised to require that analyses and models used to predict future conditions and changes in the geologic setting be "supported by" rather than "confirmed by" an appropriate combination of methods such as enumerated in the rule. Such support concerns not only the reliability of the codes themselves, but also the representativeness of the models with respect to the physical conditions of the site. The Commission recognizes that confirmation, in the strict sense, is not achievable. The term "field verified laboratory tests" has been clarified to read "laboratory tests which are representative of field conditions."

§ 60.21(c)(4)

Section 60.21(c)(4) has been amended to reflect the limitation on the scope of "important to safety." The footnote reference to 10 CFR Part 50 has been deleted because of the cross-reference contained in Subpart G.

§ 60.21(c)(8)

Section 60.21(c)(8) required a description of controls to restrict access. After permanent closure, monuments will be an important control. The paragraph has been amended to require that a conceptual design of such monuments be provided.

§ 60.21(c)(9) and § 60.21(c)(11)

Conforming changes required by elimination of the term "decommissioning."

§ 60.21(c)(13)

The changes in this paragraph reflect the revised definitions of "geologic setting," "site," "geologic repository," and "disturbed zone." No substantive change is intended.

§ 60.21(c)(14)

Conforming change reflecting limitation of "important to safety" to concerns related to the period of operations.

§ 60.21(c)(15)(i)

Editorial change limiting information on DOE organizational structure to that which pertains to construction and operation of the geologic repository operations area.

§ 60.21(c)(15)(ii)

Deleted This provision was redundant with § 60.21(c)(4). (Subsequent paragraphs have been renumbered.)

§ 60.21(c)(15)(vi)

Conforming change required by elimination of the term "decommissioning."

§ 60.21(c)(15)(vii) [§ 60.21(c)(15)(viii)]

Conforming change reflecting limitation of "important to safety" to concerns related to the period of operations.

§ 60.22 Filing and distribution of application.

Section 60.22(a) has been revised to conform to § 60.3(a). In both places, the rule now refers to receipt and possession of source, special nuclear, and byproduct material "at a geologic repository operations area."

The reference in § 60.22(d) to "geologic repository" has also been changed to "geologic repository operations area," as the latter term is a more precise designation of the HLW facility that is the subject of the proposed licensing action.

§ 60.31 Construction authorization.

The overall safety finding is related to the "geologic repository operations area" because that term refers to the HLW facility subject to NRC licensing authority. [This is also the reason for the change in § 60.31(a)(1)(ii).] In order to assure that the relevant features of the controlled area are considered in arriving at this finding, § 60.31(a)(2) now specifically refers to consideration of the "geologic repository." Because siting and design criteria are supplemental to performance objectives in Subpart E, § 60.31(a)(2) has been amended to provide for evaluation of the geologic repository's compliance with the performance objectives as well. The reference to Subpart F has been deleted; that subpart, which pertains to DOE's performance confirmation program, is now referenced in § 60.74.

§ 60.32 Conditions of construction authorization.

The change of "site data" to "data about the site," in § 60.32(b), is a clarifying editorial amendment.

In § 60.32(c), "repository" has been replaced by the defined term "geologic repository." The restrictions that may be imposed under this paragraph can include measures to prevent adverse effects on the geologic setting as well as measures related to the design and construction of the geologic repository operations area.

§ 60.43 License specifications.

Section 60.43(b)(3) has been clarified by substituting "host rock" for the ambiguous and undefined term "storage medium" that previously appeared.

Section 60.43(b)(5) has been amended to require that license conditions include items in the category of controls related to the controlled area rather than the geologic repository operations area. This is a conforming change, which is made possible by the new definition of "controlled area" as an area which may extend beyond the boundaries of the geologic repository operations

area. However, since additional controls may be needed outside of the controlled area (see § 60.121), the provision is not limited to the controlled area alone. Under 10 CFR Part 20 and this part, the licensee will have to establish restricted areas for purposes of assuring radiological protection during the period of operations, but this will not necessarily require the incorporation of specific conditions in the license. (See 10 CFR § 50.36, a corresponding provision in the Commission's facility licensing regulations.)

§ 60.46 Particular activities requiring license amendment.

Section 60.46(a)(3) has been amended for the reasons stated in the discussion of § 60.43(b)(5), to refer to the controlled area. This requirement would continue to be applicable even after permanent closure unless and until the license is terminated pursuant to § 60.52.

Section 60.46(a)(6). See Decommissioning, above.

A conforming change has been made to § 60.46(a), "Particular activities requiring license amendment," which adds a new paragraph (a)(7) to make clear that any activity involving an unreviewed safety question requires a license amendment. In its proposed form § 60.46(a) could have been read to require a license amendment only for the six specific activities listed. While the enumerated activities are quite broad and may well include any change involving an unreviewed safety question, the conforming language is intended to make this point explicit. It is of course clear that an amendment would also be necessary to accomplish a change in the license conditions incorporated in the license. (The revision in no way affects the authority of DOE, under § 60.44(a)(1), without prior Commission approval, to make changes, tests, or experiments that involve neither a change in the license conditions incorporated in the license nor an unreviewed safety question.)

§ 60.51 License amendment for permanent closure.

Conforming changes have been made to refer to "permanent closure" instead of "decommissioning." See Decommissioning, above.

The area required to be identified is now stated to be the "controlled area" because that encompasses the region in which waste isolation is required.

The significance of preserving information is discussed in the section on Human Intrusion, above. To assure complete recording of the location of the geologic repository, the Commission has now provided for information to be placed in land record systems as well as archives; this better reflects its original intention. It also includes a reference to State government agencies in order to further assure comprehensiveness. It is not the Commission's intention to require that any new systems or archives be created, but only that those that are available and appropriate should be employed. A further modification expresses the intention that information concerning the detailed location of the underground facility and boreholes and shafts, as well as the boundaries of the controlled area, must be recorded.

In § 60.51(a)(4), the undefined phrase "emplacement media" has been changed to "host rock."

§ 60.52 Termination of license.

Conforming changes. See Decommissioning, above.

Subpart D - Records, Reports, Tests, and Inspections.

There are two substantive changes in Subpart D. First, the specification of required construction records has been determined to be more appropriately included here rather than in the design criteria in Subpart E. Editorial changes, including renumbering of sections, have been made to accomplish this. Second, the final rule now requires not only that the geologic repository operations area be designed so as to permit implementation of a performance confirmation program but, as the Commission had originally intended, that such a performance confirmation program should actually be required to be carried out.

§ 60.71 General recordkeeping and reporting requirement.

Paragraphs (a) and (b) have been retained. Paragraph (c) is moved to § 60.73. The caption has been changed because records and reports are now treated in §§ 60.71-60.73, rather than § 60.71 alone.

§ 60.72 Construction records [§ 60.134(c)].

Transferred from Subpart E. Survey records are to cover "underground facility excavations, shafts, and boreholes" rather than "underground excavations and shafts." This makes the inclusion of borehole records explicit. A clarifying amendment was made to indicate that the records must include a description of materials encountered rather than the materials themselves.

§ 60.73 Reports of deficiencies [§ 60.71(c)].

Renumbered. The change of "site characteristics" to "characteristics of the site" is editorial.

§ 60.74 Tests [§ 60.72].

A new paragraph (§ 60.74(b)) of a clarifying nature has been added which requires tests carried out under this section to include a performance confirmation program carried out in accordance with Subpart F of this part. The proposed rule inadvertently did not require such a program, merely a description of one.

§ 60.75 Inspections [§ 60.73].

References to "site" have been changed to "geologic repository operations area" or "location" where appropriate. See Terminology.

Subpart E - Technical Criteria

§ 60.101 Purpose and nature of findings.

A change has been made to § 60.101(a)(2) with respect to evaluations of performance of the engineered barrier systems and geologic media. The point that is being made is that the further into the future one must project, the greater the uncertainties will be. The Commission did not mean to suggest that the specific period of a thousand years is especially significant; the more general "many hundreds of years" specified in the final rule better expresses the Commission's intent.

A sentence has been added to § 60.101(a)(2) that emphasizes that demonstration of compliance with long-term performance objectives and criteria will involve the use of data from accelerated tests and suitably supported predictive models.

A reference to "repository" in § 60.101(b) has been changed to "geologic repository operations area" to conform with a parallel change in § 60.31.

§ 60.102 Concepts.

An introductory paragraph has been added to explain the purpose of this section and to indicate that it is subordinate to the definitions contained in § 60.2.

See Transuranic Waste (TRU), above, with respect to the deletion of the reference to TRU.

The section on Terminology, above, explains changes affecting the terms "accessible environment," "controlled area," "geologic setting," and "site." These changes are reflected in amended § 60.102(c). The reference to the host rock was deleted so as to avoid any implication that other characteristics of the geologic setting might not, where appropriate, also receive "particular attention."

See Decommissioning, above, for an explanation of the change in the discussion of "permanent closure." Because activities unrelated to waste isolation may continue at the geologic repository operations area after permanent closure, the last sentence of § 60.102(d) has been deleted.

The treatment of containment and isolation has been consolidated in light of changes made in the performance objectives. The reference to assessment of uncertainties instead of prediction of consequences takes into account the need to compensate for a broader range of factors, such as identification of the events which are to be considered in the license review. See Reasonable Assurance and Anticipated/Unanticipated Processes and Events, above. A second reason for the change stems from a commenter's criticism of the statement that consequences of events are "especially difficult to predict rigorously" early during the life of a repository; on the contrary, he suggested, consequences would be more difficult to predict over longer periods of time. The matter need not be resolved in those terms. The point the Commission was trying to make is that containment measures are appropriate to compensate for the uncertainties involved in assessing radionuclide transport in the presence of high radiation and thermal levels.

The respective contributions of the engineered barrier system and the geologic setting to the achievement of isolation are highlighted in a new sentence. Other changes are made to conform with revised definitions. See analysis of § 60.2.

PERFORMANCE OBJECTIVES

§ 60.111 Performance of the geologic repository operations area through permanent closure [§ 60.111(a)].

The provisions of § 60.111(a) dealing with radiation protection and releases of radioactive material for the period through permanent closure of the underground facility are unchanged in substance from the proposed rule. The paragraph has been renumbered and some editorial changes have been made.

The provisions of § 60.111(b) dealing with retrievability of waste have been modified to link the period of retrievability more closely to the performance confirmation program and to allow the Commission to modify the retrievability period on a case-by-case basis based on the waste emplacement schedule and the planned performance confirmation program. The final rule also specifies that the period of retrievability begin at the initiation of waste emplacement rather than after waste emplacement is complete. Finally, the final rule explicitly states that backfilling of portions of the underground facility is not precluded, provided the retrievability option is maintained, and that the Commission may decide to allow permanent closure of the underground facility prior to the end of the designed retrievability period. While these provisions were discussed in the supporting information, they were not explicitly stated in the proposed rule. Also see Retrievability, above.

§ 60.112 Overall system performance objective for the geologic repository after permanent closure [§ 60.111(b)(1)].

The term "subsurface facility" has been deleted, as explained in the analysis of § 60.2, and conforming changes have been made.

There is no conceptual difference between the proposed rule's reference to releases from the geologic repository and the final rule's reference to releases to the accessible environment. The Commission prefers the latter formulation because it more closely conforms to the standard-setting authority of EPA. The proposed rule's definition of "accessible environment" was too general to allow such an approach. Under the final rule, however, the subsurface portions of the accessible environment and the geologic repository are contiguous. See Terminology, above.

See also the discussion, above, relating to Anticipated/Unanticipated Processes and Events.

Several commenters recommended that it would be preferable to leave the rule in proposed form until the EPA standard had been published, at which time NRC could adapt its regulations to the standards that EPA actually promulgates. The Commission would, of course, prefer to have final EPA rules available; and,

if they were, it could build EPA's provisions, where appropriate, into Part 60. In the absence of the final EPA standard, however, the Commission deems it important to provide not only to DOE but also to other interested persons, including governmental institutions, firm guidance with respect to the Commission's regulatory approach. As discussed under Single vs. Multiple Performance Standards above, the technical criteria provide some flexibility to take into account a range of standards that might be adopted by EPA. Should such standards, when adopted, depart from those that the Commission has assumed for purposes of analysis, the Commission would consider whether further rulemaking on its part would be desirable. The procedure that is being followed conforms to that prescribed by Section 121(b) of the Nuclear Waste Policy Act. See also the discussion regarding Population vs. Individual Dose.

§ 60.113 Performance of particular barriers after permanent closure [§ 60.111(b)(2)-(3); § 60.112].

The performance objectives for particular barriers have been modified for reasons discussed at length above.

The analysis of Single vs. Multiple Performance Standards explains the basis for retaining numerical values, while allowing them to be modified as the particular case warrants. The factors alluded to there as among those that might be taken into account are set out in § 60.113(b). Section 60.113(c) reflects the observation there that considerations related to unanticipated processes and events could form the basis for additional performance requirements for individual barriers.

For the reasons presented under the heading ALARA, above, the Commission has elected not to apply an ALARA principle to the performance requirements in this section.

The reasons for elimination of requirements referring specifically to TRU are described in the section on Transuranic Waste, above. It should be noted, however, that the release requirements in § 60.113 apply to all radionuclides, including those that may be contained in any TRU that may be disposed of at a geologic repository operations area.

The proposed rule required an assumption that groundwater saturate the facility and that the performance of the waste packages be evaluated on this basis. This approach was proposed because mechanisms exist for groundwater transport to the underground facility, in salt formations as well as hard rock. It may not always be necessary or technically reasonable to assume the specified saturation conditions, provided that appropriate evaluations are made in the context of a particular application; the final rule therefore calls for the partial and complete filling with groundwater of available void spaces in the underground facility to be considered and analysed among the anticipated processes and events in designing the engineered barrier system. This provision would not appear to be needed for disposal in the unsaturated zone, even though there may be water transport from the underground facility, primarily because the design can, in principle, provide for adequate drainage. (Criteria applicable to disposal in the unsaturated zone will be the subject of additional rulemaking.) Other changes in the provision are of a clarifying or editorial nature.

Editorial changes have been made to avoid repetitious language in the performance objectives relating to the engineered barrier system's containment and controlled-release capabilities.

The proposed requirement with respect to containment would have specified that the HLW waste packages contain all radionuclides for at least the first 1,000 years after permanent closure. In response to comments relating to the demonstrability of a design to contain "all" radionuclides for an extended period, the Commission has modified the requirement so that the design must provide "substantially complete" containment. The reason for relying on containment as one means for assuring achievement of the overall system performance objective is that many sources of uncertainty are particularly significant during the period when radiation and thermal conditions in the underground facility are dominated by fission product decay. This period will depend, to some extent, on the characteristics of the particular facility. The Commission has therefore allowed the containment period to be fixed, where appropriate, at a shorter period. See, also, the discussion of <u>Single vs. Multiple Performance Standards</u>.

The incorporation of a general standard for release of radionuclides from the engineered barrier system ("a gradual process which results in small fractional releases to the geologic setting over long times") places the specific criteria into context, thereby emphasizing the policy objective underlying these criteria. Moreover, it indicates the close relationship between the provisions dealing with containment and limited release. These are coupled parameters that should not be varied independently, but rather should be viewed as a system to control the release to the geologic setting. Again, see Single vs. Multiple Performance Standards.

The fractional release rate has been modified slightly to eliminate an ambiguity identified by one commenter. The new language makes it clear that "one part in 100,000 per year" refers to the activity at 1,000 years following permanent closure. This is a substitute for 1 part in 100,000 of the maximum inventory of the particular radionuclide at any time after 1,000 years after permanent closure. The underlying concern in the proposed rule was that the amounts of certain radionuclides, such as Ra-226 and other actinide daughters, increased with time, and that it was necessary to consider the maximum inventory of these nuclides in assessing repository performance. The analyses performed in the rationale document indicate that these nuclides are not important with respect to meeting the EPA standard as presently formulated. Accordingly, the Commission has chosen the less complicated formulation that appears in the final rule. It should be noted that the release rate refers to activity at 1,000 years after closure, even though a different containment period may be approved or specified by the Commission; the rate may also be modified, however, under the provisions of the final rule. DOE, in its comments on the proposed rule, suggested that the fractional release rate requirement should not apply to nuclides that constituted less than 0.1% of the inventory remaining at 1,000 years. This recommendation has not been adopted since it could lead to excessive releases. Table 5 of the rationale document in Part C shows that the inventory of radioactive material in a repository containing 100,000 metric tons of spent fuel is 1.7×10^8 curies after 1,000 years. The DOE suggestion would eliminate nuclides whose inventories were less than 170,000 curies from consideration of their release rate from the engineered barrier system, whereas the NRC provisions of § 60.113(a)(1)(ii)(B) would eliminate nuclides whose

release rates were less than 1.7 curies/yr from further consideration. While the Commission has not adopted the recommended change it notes that, under the provisions of the final rule, DOE could recommend an alternative release rate for nuclides in the light of the standard adopted by EPA or the geochemical characteristics of the host rock, surrounding strata, and groundwater. In particular, the characteristics of the host rock immediately adjacent to the underground facility may be well understood because of the excavation activities and, where appropriate, such characteristics could be taken into account in specifying the nuclide release rate.

The previously proposed performance objective for the geologic setting [§ 60.111(b)(3)] has been deleted. The new definition of "anticipated processes and events" includes the assumption that processes operating in the Quaternary Period continue to operate but with perturbations caused by the presence of emplaced radioactive waste superimposed thereon. The remainder of the proposed paragraph merely restates part of the overall system performance objective with respect to performance of the geologic setting and would be redundant.

The references to "stability" in the geologic setting since the start of the Quaternary Period have been deleted. What the Commission had intended was that the structural, tectonic, hydrogeologic, geochemical, and geomorphic processes be such as to enable the recent history to be interpreted and to permit near-term geologic changes to be projected with relatively high confidence. The selection of the term "stability" to convey this meaning was unfortunate. Commenters correctly pointed out that a geologic setting can only be said to exhibit stability in a relative sense. As they noted, the proposed rule gave no guidance as to the degree of required stability and, accordingly, the provision would introduce ambiguity with respect to one of the major elements of the geologic repository. The factors the Commission had identified are all important, but the appropriate way to consider them is to assess them in the context of favorable and unfavorable conditions and to evaluate the extent to which the geologic repository's achievement of the overall system performance objective might be affected. If the relevant processes are not well understood, one or more of the potentially adverse conditions will be exhibited and such an evaluation will be required.

The pre-waste-emplacement groundwater travel time provision is subject to adjustment on a case-by-case basis. See Single vs. Multiple Performance Standards. A clarifying amendment relates the travel time provision, as previously only implied, to the "fastest path of likely radionuclide travel from the disturbed zone to the accessible environment." Relating this provision to the "disturbed zone" instead of the "far field" involves no substantive change. As stated in the analysis of § 60.2, the term "far field" has been deleted from the rule.

Some commenters suggested that the groundwater travel time be expressed in terms of post-emplacement as well as pre-emplacement conditions. This assumes that post-emplacement changes would be significant. By definition, however, the portion of the geologic setting significantly affected by waste emplacement constitutes the "disturbed zone." The groundwater travel time provision applies to transport from the disturbed zone to the accessible environment. This parameter is not dependent upon the effects of waste emplacement.

One commenter characterized the travel time performance objective as "invalid" without a clear definition of "accessible environment." The Commission agrees that the proposed rule was subject to a number of interpretations. However, the modified definition provides a means for delineating the limits of the accessible environment so as to take proper account of site-specific conditions. Under this revised definition, a subsurface area extending no more than 10 kilometers from the underground facility may be used to isolate the waste from the accessible environment. This, in effect, places an upper limit on the rate of groundwater travel to the accessible environment. Refer to the discussion of "accessible environment" and "controlled area" under Terminology, above.

LAND OWNERSHIP AND CONTROL

§ 60.121 Requirements for ownership and control of interests in land.

The proposed rule sets out ownership and control requirements for the "geologic repository operations area." The text, however, related these requirements to the achievement of isolation. To express this concept

properly, the Commission has made the requirements in § 60.121(a) applicable not only to the geologic repository operations area, but to the controlled area as well. Section 60.121(b), which deals with isolation and not with the period of operations, is amended so as to refer to the controlled area. (The reference here to the "geologic repository" instead of "site or engineered system" is not substantive; it reflects the revised definitions identified in the analysis of § 60.2.) A conforming change has also been made to the caption of the section.

In response to a commenter's suggestion, the acquisition of appropriate water rights is now explicitly required. This will not necessitate any separate action on the part of DOE if it appears that such needed water rights have been obtained, by implication, as a result of reservation or acquisition of lands. See U.S. v. New Mexico, 438 U.S. 696 (1978), Cappaert v. U.S., 426 U.S. 128 (1976). The "purpose of the geologic repository operations area" is intended to be construed broadly to include the isolation of radioactive wastes after permanent closure as well as any water rights needed during the period of operations.

The Commission declines an invitation to define a specific area that must be acquired to assure public health and safety prior to permanent closure. The size of this area will depend upon the particular activities to be carried out by DOE. There must be an "unrestricted area" to which releases of radioactive materials will be maintained within the limits specified in 10 CFR Part 20. § 60.111(a). The establishment of this unrestricted area must also take accidents into consideration, since structures, systems, and components "important to safety," as defined in § 60.2, must be designed so as to limit radiation doses under accident conditions to 0.5 rem at the boundary of the unrestricted area.

SITING CRITERIA

§ 60.122 Siting criteria [§ 60.122-60.124].

The following detailed comments supplement the discussion under the caption "Siting Criteria" in the main text, above.

Section 60.122(a) consolidates the introductory paragraphs of proposed §§ 60.122 and 60.123, together with proposed § 60.124. This change is designed to provide a clearer statement of the relationship between the favorable and potentially adverse conditions. The revised language makes it clear that all such conditions relate to isolation of the waste after permanent closure.

Proposed § 60.124 had specified ways to demonstrate that potentially adverse conditions would not "impair significantly" the isolation ability of the geologic repository. This has been modified so as to refer instead to "compromise" of such site suitability. This change is made to eliminate any question regarding the difference between the two terms. No such difference was intended. Both terms relate to conditions which would potentially preclude the Commission from finding that the geologic repository would achieve the performance objectives.

The rule now provides for evaluating the effect of the potentially adverse conditions on the "site" rather than the "geologic setting" or "disturbed zone." See Siting Criteria, above.

In the provision which states that potentially adverse conditions may be compensated by the presence of favorable conditions, the Commission has specified the standard for measuring the adequacy of such compensation--namely, achievement of the performance objectives relating to isolation of waste.

§ 60.122(b)(1) [§ 60.122(a)-(e)]

Proposed paragraphs 60.122(a), (c), (d), and (e) have been consolidated for editorial reasons. Even if some of the cited processes might have an adverse effect on the geologic repository's ability to isolate the waste, the

Commission intends that the other processes may nevertheless be treated as favorable conditions. The distinction between "tectonic" and "structural" processes is so "fine," as it was characterized by one commenter, that the final rule uses only the former term. The references to "the start of the Quaternary Period" have been removed because of the difficulties that might be involved in dating this point with precision; for present purposes, all that is important is that processes "operating during the Quaternary Period" be identified and evaluated, and this is reflected in the revised language. Note the fact that while the provision, as before, applies to favorable conditions in the "geologic setting," the broader definition of that term in the final rule recognizes that processes operating more remotely from the geologic repository must be taken into account.

§ 60.122(b)(2) [§ 60.122(f)]

The proposed rule included siting criteria applicable only to disposal in the saturated zone. This paragraph adapts the provision that dealt with hydrogeologic conditions in the host rock and is appropriately limited to the saturated zone option. The Commission no longer identifies "low groundwater content" as a favorable condition because it is the rate and direction of groundwater movement rather than the amount of groundwater present that is of primary significance; thus, instead, the final rule substitutes a reference to low permeability and downward hydraulic gradient. This change also addresses more clearly the prior consideration about inhibition of groundwater circulation in the host rock. Similarly, instead of referring to inhibition of groundwater flow between hydrogeologic units, the Commission specifies the properties which result in such inhibition, namely low vertical permeability and low hydraulic potential. Since the paragraph relates to the host rock, the reference to shafts, drifts, and boreholes was not fully appropriate and, in any event, is dealt with by identification of the pertinent properties.

The reference to groundwater travel time has been modified to conform with the language of the related performance objective. The proposed rule measured this property from the underground facility. However, the changes that may occur in the disturbed zone may negate the favorable condition in that part of the geologic setting and, accordingly, the final rule specifies that the travel

time in question is to be measured from the disturbed zone to the accessible environment. There is no basis for identifying a particular number of years that will be deemed to be substantially in excess of 1,000 years. If for a particular site the value is sufficiently high to enhance the Commission's confidence that the performance objectives will be met, then it can appropriately be considered as a favorable condition.

§ 60.122(b)(3) [§ 60.122(g)]

Since the listed geochemical conditions may or may not occur simultaneously, yet since any of them may retard the transport of radionuclides, the paragraph has been stated in the disjunctive in the final rule (by substituting "or" in place of "and").

§ 60.122(b)(4) [§ 60.122(h)]

This paragraph concerns transformation of "mineral assemblages" under thermal loading. It would be a favorable condition if changes left the capacity to inhibit radionuclide transport unaffected; the proposed rule, which spoke only of "increased" capacity, was too restrictive.

The paragraph is concerned primarily with the behavior of mineral assemblages which form coatings along the fracture paths along which radionuclides are anticipated to migrate; it would be incorrect, when referring to this surface zone, to adopt a commenter's suggestion that the Commission refers instead to "rock" or "geologic media."

§ 60.122(b)(5) [§ 60.122(i)]

This paragraph, relating to depth of emplacement, is unchanged. The purpose of the provision is to reflect the consideration that wastes buried at least 300 meters below the surface are less subject to disturbance, especially by human intrusion, than wastes closer to ground level would be. As in the case of the other favorable conditions, it should be emphasized that the absence of

a particular one or more of them does not rule out a site or even demand explanation; it simply means that other favorable conditions must be cited to show that the criterion set out in §60.122(a)(1) has been satisfied. (The elevation being referred to is the altitude above mean sea level of the lowest point on the surface, but the Commission perceives no need to express the concept, as one commenter had suggested, in such detail.)

§ 60.122(b)(6)

New. See Population-Related Siting Criteria, above

[§ 60.122(j)]

The proposed rule would have treated as a favorable condition "any local condition of the disturbed zone that contributes to isolation." This was criticized as being unduly general and vague. As the key favorable conditions appear to have been identified, the Commission has concluded that inclusion of such a "catch all" is unwarranted.

§ 60.122(c)(1) [§ 60.123(a)(1) and (6)]

This paragraph is adapted from two provisions of the proposed rule. Unlike most of the potentially adverse conditions, the prospect of flooding is of most concern prior to permanent closure. Even though criteria in § 60.133 provide that the underground facility be designed to handle water intrusion, the anticipated design features need not be sufficient to cope with massive inflows that could result from submersion of boreholes and shafts. Should such a situation develop, the ability of the geologic repository to achieve isolation of the wastes that had been emplaced could be compromised.

Because the concern relates to waste isolation, the paragraph has been rewritten so as to be limited to flooding of the underground facility. The design criteria for structures, systems, and components important to safety require that appropriate measures be taken to protect surface facilities against the consequences of flooding.

As there is no reason to differentiate between floods resulting from natural causes (i.e., from occupancy and modification of floodplains) and those resulting from failure of impoundments, the two pertinent paragraphs have been combined.

With respect to required investigations [§ 60.123(b)], see Section-by-Section Analysis, § 60.21(c)(1)(ii)(B).

§ 60.122(c)(2) [§ 60.123(a)(2) and (3)]

Two paragraphs related to the groundwater flow system have been consolidated. The conditions are to be regarded as potentially adverse if the activities in question are "foreseeable." This is more conservative than the original rule, which only identified "planned" activities. The proposed rule encompassed such activities with a potential to "significantly" affect groundwater flow. Any "adverse" effect should be treated as significant, and the final rule makes a change to reflect this.

§ 60.122(c)(3) [§ 60.123(a)(7)]

No substantive change from proposed rule.

§ 60.122(c)(4) [§ 60.123(b)(8)]
[§ 60.123(a)(5)]
[§ 60.123(b)(6)]
[§ 60.123(b)(7)]

Structural deformation would have been regarded as a potentially adverse condition only if occurring within the disturbed zone during the Quaternary Period. This approach was unduly limiting. Structural deformation in the geologic setting, whether or not of recent origin, is potentially adverse because of the effects which it may have upon the regional groundwater flow system. Of course, it is to be expected that structural deformation remote from the site, especially if ancient, can readily be found not to significantly affect the ability of the geologic repository to isolate the waste. Still, it is a potentially adverse condition and should be recognized as such.

Faulting is one kind of structural deformation. By including it here, the prior specific references to faulting can be eliminated.

§ 60.122(c)(5) [§ 60.123(b)(12)]

This paragraph is no longer restricted to the disturbed zone, but otherwise is unchanged in substance.

§ 60.122(c)(6) [§ 60.123(a)(8)]

The proposed rule referred to "expected climatic changes." Climatology is not sufficiently understood to enable us to limit our concern to "expected" changes, and the final rule therefore refers to characteristics of the geologic setting likely to be affected directly by reasonably foreseeable climatic change, viz., the hydrologic conditions.

§ 60.122(c)(7) [§ 60.123(b)(14)]

This paragraph referred to groundwater conditions that could "affect" solubility and chemical reactivity. The concern is not with effects per se, but rather with effects that increase the solubility or chemical reactivity of the engineered barrier system. This was not made explicit. In order to be more comprehensive, chemical composition of the host rock is added to the relevant groundwater conditions.

§ 60.122(c)(8) [§ 60.123(b)(15)]

Aside from the extension of this paragraph beyond the disturbed zone, there are no changes in substance. One clarifying addition, "of radionuclides," following "sorption" was made.

§ 60.122(c)(9) [§ 60.123(b)(13)]

This paragraph, related to non-reducing groundwater conditions, is only appropriate to disposal in the saturated zone.

§ 60.122(c)(10) [§ 60.123(b)(5)]

Dissolutioning will be treated as a potentially adverse condition throughout the geologic setting. Examples of the kinds of features that provide evidence of dissolutioning have been included so as to make it clear that the paragraph refers to processes that provide gross manifestations of their presence.

§ 60.122(c)(11) [§ 60.123(b)(8)]

No substantive changes.

§ 60.122(c)(12) [§ 60.123(a)(4)]
§ 60.122(c)(13) [§ 60.123(b)(10)]
§ 60.122(c)(14) [§ 60.123(b)(9)]
§ 60.122(c)(15) [§ 60.123(b)(11)]
§ 60.122(c)(16) [§ 60.123(b)(4)]

Extended from disturbed zone to the entire geologic setting, but otherwise unchanged.

§ 60.122(c)(17) [§ 60.123(b)(3)]

Consistent with the references to resources in the requirements for the content of the safety analysis report, § 60.21(c)(13), the presence of naturally occurring materials for which economic extraction is currently feasible or potentially feasible during the forseeable future may give rise to a potentially adverse condition. The provision now applies to the site, rather than the disturbed zone, since it is the site that provides isolation of the waste.

§ 60.122(c)(18) [§ 60.123(b)(1)]

Extended from the disturbed zone to the site.

§ 60.122(c)(19) [§ 60.123(b)(2)]

Extended from the disturbed zone to the site.

§ 60.122(c)(20) [§ 60.123(b)(16)]

The paragraph refers to "rock or groundwater" conditions that would require complex engineering measures. Although the engineering measures being referred to would be applied before permanent closure, the reason for having this criterion--as in the remainder of § 60.122(c)--stems from concerns about the ability of the geologic repository to satisfy the performance objectives with respect to isolation of the waste. Although complex engineering measures are not inherently unacceptable, their reliability must be carefully scrutinized in a licensing process. A geologic setting that requires the adoption of such complex engineering measures therefore can be viewed as exhibiting a potentially adverse condition. Although the final rule applies to the geologic setting instead of the disturbed zone, this paragraph would apply over only that part of the geologic setting that has features relevant to the selection of engineering measures.

§ 60.122(c)(21) [§ 60.123(b)(17)]

The criterion pertaining to stable underground openings is also unchanged in substance, except that it is no longer expressly limited to the disturbed zone. This is another criterion that pertains to the period of operations. However, like the preceding one, its underlying purpose is to assure that waste isolation objectives can be achieved. Failure of underground openings could result in the inability of the licensee to retrieve the wastes practicably, should such a course of action be found to be warranted. The consequence of this failure could be a transport of radionuclides to the accessible environment at levels exceeding the performance objectives.

DESIGN CRITERIA FOR THE GEOLOGIC REPOSITORY OPERATIONS AREA

§ 60.130 Scope of design criteria for the geologic repository operations area. [§ 60.130(a)]

The separation of final § 60.130 from related sections is an editorial change.

As indicated in § 60.131, Subpart E is intended to specify site and design criteria. References to construction requirements are therefore inappropriate and have been deleted.

§ 60.131 General design criteria for the geologic repository operations area.

(a) Radiological protection. [§ 60.130(b)(1)]

Aside from editorial changes, the only revision relates to the design of the radiation alarm system; the language has been modified to conform to 10 CFR § 72.74(b), and reference to radioactivity in effluents was deleted since this section has to do with radiation protection in restricted areas. Provisions for control of radioactivity in effluents are contained in § 60.131(b)(4), for emergency conditions, and in § 60.132(c), for normal operations.

(b) Structures, systems, and components important to safety.

(1) Protection against natural phenomena and environmental conditions. [§ 60.130(b)(2)]

The two proposed subparagraphs were duplicative and have been consolidated. The change of "site" to "geologic repository operations area" is appropriate because the concern being addressed is accident conditions at the HLW facility that could result in specified doses at the boundary. Similarly, "any relevant time period" has been deleted since this provision deals with the prevention or mitigation of accidents associated with waste storage and handling activities. Also, since it is accident conditions that are of concern, the provisions of

the proposed rule dealing with operations, maintenance and testing were inappropriate and have been deleted. (The effects of natural phenomena and environmental conditions on waste isolation are addressed in § 60.122.)

(2) Protection against dynamic effects of equipment failure and similar events. [§ 60.130(b)(3)]

Editorial change, characterizing missile impacts as dynamic effects.

(3) Protection against fires and explosives. [§ 60.130(b)(4)]

The design criterion pertaining to continued operation during and after fires has been limited to such events as are "credible." This responds to comments that suggested that the proposed language could be interpreted to require protection against any fire or explosion that might be physically possible.

Because Subpart E is concerned with siting and design criteria, the Commission has not adopted a suggestion to incorporate, at this point, a requirement that explosives be excluded from areas containing radioactive materials. However, such a provision could be one of the license specifications found to be appropriate under § 60.43.

(4) Emergency capability. [§ 60.130(b)(5)]

Provision has been made to require control of effluents during emergency conditions; see § 60.131(a). Otherwise unchanged.

(5) Utility services. [§ 60.130(b)(6)]

Paragraph (i) has been clarified by inserting an explicit reference to systems "important to safety." Since the definition of "important to safety" refers to "accidents," the term "emergency conditions" has been changed to "accident conditions."

Proposed paragraph (iii) has been deleted because it was redundant with the general provision for inspection, testing, and maintenance.

Proposed paragraph (iv) [now (iii)] has been abbreviated. As proposed, it could have been interpreted as requiring systems, even if redundant, to be functional at all times. The intent was to assure that timely emergency power can be provided to structures, systems, and components important to safety. The provision has been modified accordingly. There is no need to state that emergency power be sufficient to allow safe conditions to be maintained, since this is implicit in the remainder of the text.

(6) Inspection, testing, and maintenance. [§ 60.130(b)(7)]

No change from proposed rule.

(7) Criticality control. [§ 60.130(b)(8)]

No change from proposed rule.

(8) Instrumentation and control systems. [§ 60.130(b)(9)]

The adjective "engineered" has been deleted, in reference to systems important to safety, so as to retain uniform terminology throughout the rule.

The provision for design "with sufficient redundancy to ensure that adequate margins of safety are maintained," which was criticized as being vague, has been deleted. The objective was to ensure that the design incorporate needed instrumentation and this has been accomplished more clearly by the amended language.

(9) Compliance with mining regulations. [§ 60.130(b)(10)]

No change from proposed rule. It should be noted that this provision is not intended to assert NRC authority over mining safety practices generally, but to the extent that the safety of workers is necessary for systems important

to safety to perform their intended functions, the relevant design features are a legitimate concern to NRC.

(10) Shaft conveyances used in radioactive waste handling. [§ 60.133(c)]

The specific criteria applicable to hoists important to safety have remained unchanged. The general requirement that shaft conveyances used to transport radioactive materials be designed to satisfy the requirements for systems, structures, and components important to safety has been deleted because it was unduly broad; to the extent that the shaft conveyances are in fact important to safety, the applicable design requirements will still apply.

§ 60.132 Additional design criteria for surface facilities in the geologic repository operations area. [§ 60.131]

(a) Facilities for receipt and retrieval of waste. [§ 60.131(a)]

This paragraph has been shortened by deleting redundant and unnecessary detail. The requirement for safe handling and storage implies provision for inspection, repair, and decontamination as appropriate. Similarly, it is not necessary to state that surface storage capacity need not be provided for all emplaced waste; there must be sufficient capacity, however, to allow safe handling and storage.

(b) Surface facility ventilation. [§ 60.131(b)]

The only change is the reference to § 60.111(a) by paragraph. This is not a substantive amendment, as this is the only part of the performance objectives relevant to ventilation.

(c) Radiation control and monitoring. [§ 60.131(c)]

The reference to emergency operations is omitted because that subject is covered by § 60.131(b)(4). Editorial changes have been made here for the same reasons as were discussed in connection with that paragraph.

(d) Waste treatment. [§ 60.131(d)]

No change from proposed rule.

(e) Consideration of decommissioning. [§ 60.131(e)]

See Decommissioning, above. The term "decommissioning" has been retained in this context because surface facilities may continue to be used even after permanent closure. The requirement has been made more precise by specifying that the same standards apply here as to other activities licensed by NRC.

§ 60 133 Additional subsurface design criteria [§ 60.132].

(a) General criteria for the underground facility. [§ 60.132(a)]

Proposed paragraphs (a)(1) and (a)(2) have been deleted because they were redundant.

The requirement that design features "enhance [containment and isolation of radionuclides] to the extent practicable at the site" has been changed to provide that the design shall "contribute" to such containment and isolation. As proposed, this provision could have been construed as imposing requirements substantially in excess of those needed to satisfy the performance objectives. This was not the intention. See also the discussion of ALARA, above.

The requirement to design the underground facility against the effects of disruptive events has been modified to apply to events occurring during the period of operations and to exclude water and gas intrusions to eliminate redundancy with other provisions of the rule. The requirement is also limited to consideration of credible disruptive events.

(b) Flexibility of design. [§ 60.132(b)]

The only change, in punctuation, is editorial.

(c) Retrieval of waste. [§ 60.132(d)]

Proposed paragraph (d)(2) has been deleted because it was redundant with proposed paragraph (d)(1) and was read to prohibit backfilling.

Proposed paragraph (d)(3) has been deleted because it is subsumed in the remaining text of the paragraph.

(d) Control of water and gas. [§ 60.132(g)]

Because of confusion about the meaning of the term "service water," the design requirement has been rephrased so as to refer more generally to "water or gas intrusion."

Additional proposed requirements have been deleted in response to comments regarding the level of detail in the rule. (See Level of Detail, above.) While each of the items that had been addressed will in all probability be needed, the remaining general design criterion for control of water and gas is adequate to ensure that each of the features will be incorporated in the design where necessary.

(e) Underground openings. [§ 60.132(e)]

This paragraph has been rewritten in functional terms so as to require design so that operations in the underground facility "can be carried out safely and the retrievability option maintained."

The requirement that the design reduce the potential for deleterious rock movement or fracturing of rock has been retained. The identification of considerations that must be taken into account has been deleted as being more appropriate for treatment in regulatory guides. The Commission anticipates, however, that each of the factors that had been listed would in fact have been included in complying with this paragraph.

(f) Rock excavation. [§ 60.132(f)]

The proposed rule required design to "limit damage to and fracturing of rock." The extent to which damage should be "limited" was not stated. Moreover, for some geologic media and sites, the requirement could be interpreted to prescribe particular excavation methods, which was not the intent. The paragraph has been rephrased to indicate that the design must reduce the potential for creating a preferential pathway to the accessible environment.

(g) Underground facility ventilation. [§ 60.132(h)]

The term "subsurface facility" has been eliminated, conforming to the caption of the section. Paragraph (g)(1) now refers to control within and from the "underground facility."

Proposed paragraph (h)(2), which would have required design to permit continuous occupancy of all excavated areas through permanent closure, was excessively restrictive. Ventilation will need to be maintained, however, where normal operations are being carried out, so as to satisfy paragraph (g)(1).

Proposed paragraph (h)(3) was deleted. It is adequately covered by paragraph (g)(1).

As in some other contexts, reference is now made to "accident conditions" instead of "emergency conditions" (see discussion of § 60.131(b)(5) above). The requirement for design to assure continued function is retained, but the means for accomplishing this is left to the designer. Redundant equipment and fail-safe control systems would continue to be employed where necessary and appropriate.

(h) Engineered barriers. [§ 60.132(i)]

The proposed rule, in paragraph (i), would have specified several design requirements for the engineered barriers, including backfill and barriers at shafts. While the Commission continues to expect that such features will

ordinarily be incorporated into the design, it has concluded that its earlier approach would have been unduly restrictive. The Commission has therefore left only the general functional statement that the engineered barriers shall be designed to assist the geologic setting in meeting long-term performance objectives.

(i) Thermal loads. [§ 60 132(k)]

This provision retains the substance of proposed paragraph (k)(1). The reference to the "ability of the natural or engineered barriers to retard radionuclide migration" is deleted because it is already covered by requiring that the performance objectives be met.

Proposed (k)(2), identifying factors to be taken into account in the design of waste loading and waste spacings, has been omitted as containing excessive detail.

Other omitted provisions. [§§ 60.132(c), 60.132(j)]

Proposed § 60.132(c), dealing with the modular concept, was excessively restrictive. The Commission recognizes that to some degree the concurrent conduct of excavation with waste emplacement could "impair" waste emplacement or retrieval operations. Concurrent excavation and waste emplacement would be acceptable, provided that all other applicable requirements are satisfied. The provision for insulation of individual modules is not necessary, since paragraph (a)(3) requires that the design limit the effects of disruptive events and paragraph (g)(2) provides that the design assure continued function of ventilation systems under accident conditions. Section 60.131(a), including the design requirement to control the dispersal of radioactive contamination, is also relevant.

Proposed § 60.132(j) would have specified fail-safe designs in systems for handling, transporting, and emplacing wastes. This too was excessively restrictive. What protective measures are needed will be determined in the light of a range of factors, including the probability and consequences of

mishaps and the costs of alternative means for dealing with them. Similarly, the final rule does not require that handling systems "minimize the potential for operator error"; specifications for such systems will depend upon an evaluation of the particular risks involved. Where protective measures are needed, particularly insofar as they relate to radiological consequences, the remaining design requirements suffice.

[§ 60.134 Construction specifications for surface and subsurface facilities.]

The proposed rule contained a section on construction specifications that was not appropriate, since (under § 60.31(a)(2)) the scope of Subpart E was limited to site and design criteria.

Although the section has therefore been deleted, this does not mean that construction procedures are not of vital significance. As stated in § 60.31(a)(1)(iv), the Commission will consider whether DOE has adequately described construction procedures which may affect the capability of the geologic repository to serve its intended function. Appropriate provisions will be included in a construction authorization, as provided in § 60.32.

Proposed § 60.134(c), dealing with construction records, has been retained, with minor modifications. It now appears as § 60.72, and is discussed in the analysis of that section.

§ 60.134 Design of seals for shafts and boreholes [§ 60.133].

The proposed rule contained a number of provisions which commenters criticized as being unachievable, or at least incapable of being demonstrated. Specifically, there was objection to the requirements that shaft and seal design not create preferential pathways and that sealed shafts and boreholes inhibit radionuclide transport to, at the least, the same degree as the undisturbed rock. The Commission acknowledges that in some cases a pathway may be created that may be preferential in relation to the undisturbed rock. Whether or not this is acceptable will depend upon the characteristics of the rock in question, the quality of the seal under projected conditions, the age,

nature, and location of the waste, and the design of the underground facility. The important thing is that the seals not become pathways that compromise the geologic repository's ability to meet the performance objectives for the period relating to isolation of the waste. This concept now appears as § 60.134(a).

Additionally, although the Commission's general approach has been to avoid ALARA-type concepts, it has in this instance specified that materials and placement methods for seals be selected to reduce, to the extent practicable, the potential for creating a preferential pathway or the migration of radionuclides through existing pathways. This approach is based upon a concern that significant deficiencies in seal design could largely, or entirely, eliminate the contribution to waste isolation which is to be provided by the geologic setting. By insisting that seal design reduce preferential pathways to the extent practicable, the Commission ensures that the design will facilitate its arriving at licensing decisions.

Proposed § 60.133(b)(1) provided that shafts and boreholes be sealed as soon as possible after they have served their operational purpose. As in the other portions of the section, the objective was to address the question of long-term isolation. Early sealing can prevent deformations that might otherwise develop prior to permanent closure; such events could make it more difficult or impractical to achieve maximum integrity of the permanent seals when they are put into place. To the extent that this is an important concern, it too is covered under the text of the final § 60.134.

DESIGN CRITERIA FOR THE WASTE PACKAGE

§ 60.135 Criteria for the waste package and its components.

A geologic repository operations area, by definition, is a facility that may be used for the disposal of high-level radioactive waste. The rule must therefore address matters related to HLW, including as appropriate requirements as to HLW waste form and waste package. Whether or not other radioactive materials are emplaced in the facility is speculative, and even if this should occur, the quantities, specific activity, half-lives and other relevant factors

may be so variable as to make it impossible at this time to establish reasonable rules. The final rule accordingly expressly limits the applicability of the requirements of this section to high-level radioactive waste. Nonradioactive wastes are not addressed at all. The Commission defers for later consideration, should the occasion arise, an examination of the legal and technical questions that would be presented if the disposal of nonradioactive wastes in a geologic repository operations area were to be proposed.

§ 60.135(a) High-level waste package design in general.

This paragraph has been revised editorially. It is now limited to HLW packages, but is otherwise unchanged in substance from the proposed rule.

§ 60.135(b) Specific criteria for HLW package design. [§ 60.135(c)]

Two paragraphs relate to contents of the waste package--one dealing with explosive, pyrophoric, and chemically reactive materials and a second dealing with free liquids. Editorial changes have been made so as to provide parallel language. Insofar as the period of operations is concerned, this is done by adopting the proposed language that has applied to free liquids. Insofar as waste isolation is concerned, both paragraphs are related to the relevant performance objective, adapting for this purpose the proposed provisions on explosive, pyrophoric, and chemically reactive materials.

Also, as revised, the provision pertaining to explosive, pyrophoric, and chemically reactive materials avoids the possible interpretation that insignificant quantities of such materials may not be incorporated in waste packages.

Other changes are merely editorial.

§ 60.135(c) Waste form criteria for HLW. [§ 60.135(b)]

The portion of this paragraph that deals with combustibles has been modified so as to specify that a fire involving waste packages containing combustibles will not affect the integrity of other waste packages, adversely

affect any structures, systems or components important to safety, or compromise the ability of the underground facility to contribute to waste isolation. This parallels the corresponding changes in the waste package design criteria.

The reference to structures, systems, or components is modified by the defined term "important to safety" rather than the undefined adjective "safety-related."

§ 60.135(d) Design criteria for other radioactive wastes.

This paragraph is new. Its purpose is described in the introductory analysis for this section.

PERFORMANCE CONFIRMATION REQUIREMENTS

§ 60.137 General requirements for performance confirmation.

Unchanged from proposed rule.

Subpart F - Performance Confirmation Program

§ 60.140 General requirements.

The proposed rule would have specified that the performance confirmation program "ascertain" certain data. While achievement of that goal would be desirable; it is more accurate to state that the program is to "provide data which indicates, where practicable," whether conditions are within assumed limits and systems are functioning as intended.

The proposed requirement that the confirmation program be implemented so as not to "adversely affect" the natural and engineered barriers, § 60.140(d)(1), also needed to be qualified. The Commission's intention was not to prohibit useful tests that would have trivial impacts upon the repository's performance;

instead, it wishes to assure that significant potentially adverse effects are taken into account in designing the performance confirmation program. The paragraph has been modified accordingly.

See also the amendment to § 60.74, which provides for the conduct of the performance confirmation program.

§ 60.141 Confirmation of geotechnical and design parameters.

Unchanged from proposed rule.

§ 60.142 Design testing.

Unchanged from proposed rule.

§ 60.143 Monitoring and testing waste packages.

The ambiguous term "repository" has been replaced by the defined terms "geologic repository operations area" or "underground facility," as appropriate. Other changes are editorial in nature.

Subpart G - Quality Assurance

§ 60.150 Scope.

This section has been revised to correspond to the counterpart provision of 10 CFR Part 50, Appendix B. Where the same term (here, "quality assurance") is employed in related contexts, it is generally desirable to use a common definition. For this reason, the Commission has declined to substitute "reasonable assurance" for "adequate confidence" as the measure of satisfactory performance.

§ 60.151 Applicability.

The final rule defines "important to safety" in a manner related to the period of operations. Because quality assurance requirements must be applied with a view to long-term performance, Subpart G is also made applicable to those elements of the geologic repository that must function in a prescribed manner so as to satisfy the performance objectives for the period after permanent closure. The proposed rule's reference to "events that could cause an undue risk to the health and safety of the public" has been deleted because of the inclusion of the more definite standards that are referred to in the revised first sentence of the section.

Further, the Commission has adopted a suggestion to revise the list of activities to which Subpart G pertains so as to correspond more closely with the structure of the rule.

§ 60.152 Implementation.

Unchanged from proposed rule.

[§ 60.153 Quality assurance for performance confirmation.]

This section of the proposed rule has been deleted because performance confirmation is now made subject, by § 60.151(b), to explicit requirements for the conduct of performance confirmation.

Subpart H - Training and Certification of Personnel

Provisions for Training and Certification of Personnel are unchanged in substance from the proposed rule. The rule has been clarified by replacing the undefined term "operations important to safety" with the phrase "operations of systems and components important to safety." Other changes are merely editorial.

Subpart I - Emergency Planning Criteria

Section 60.31(a) provides that one of the considerations bearing upon the issuance of a construction authorization is whether DOE's emergency plan complies with the criteria contained in Subpart I. The proposed technical criteria were silent with respect to Subpart I, and the contents of that subpart here continue to be reserved.

PART A

GENERAL COMMENTS ON PROPOSED RULE - 10 CFR PART 60:

The following general comments (1-18) are included in this staff analysis to provide information on the general opinions on the proposed rule expressed by the commenters. The staff does not believe it is necessary to provide responses to these general comments.

Comment No. 1: J. Carson Mark, Advisory Committee on Reactor Safeguards (10)

The NRC staff is to be complimented on moving ahead even in the absence of confirmed, supporting standards which are to be provided by the U.S. Environmental Protection Agency. Although we believe certain changes and improvements should be made in the proposed rule, the published draft reflects a good grasp of the subject and incorporates a wide range of input from other Federal agencies and outside groups.

Comment No. 2: Southwest Research Institute (19)

Southwest Research Institute, a not-for-profit corporation whose principal activity is applied engineering in the public good, is privileged to respond to the subject proposed rules. The Institute finds its services to the electric power utilities, and particularly those who have nuclear reactors, growing at a rapid rate. Moreover, this service has become worldwide and our personnel are onsite and in touch with reactor and regulatory people in most of the countries of the Western World.

1. The Institute is firmly in favor of the proposed rule as outlined by the Commission. The United States desperately needs such a repository.

2. The Institute would, however, much prefer to see the repository limited to, and designed for, only those high-level wastes that result from the reprocessing of spent reactor fuels and the manufacture of nuclear weapons. The Institute believes that domestic uranium is a depletable U.S. resource that, in the long term, will be critically important. Reprocessing would appear to be essential in the future. If a reprocessing plant(s) could come on stream within a reasonable period of time, costs of the proposed repository would be reduced because the need for retrieval would be eliminated. Further, <u>any</u> spent fuel in storage is a waste of energy-generating capability.

Comment No. 3: U.S. DOE (48)

The Commission is to be commended for its considerable efforts and determination to move forward with this most important rule. Many Department concerns with specifics of the rule, some of them major, have already been resolved by the Commission staff. The statement added since the ANPR on the concept of "reasonable assurance" is a major contribution toward a credible regulation.

I might note here that we generally support the Commission's position on siting requirements and human intrusion, and we agree that ALARA (as-low-as-reasonably-achievable) principles should not be applied. However, we still have differences of opinion on the proposed rule and have proposed alternative language for parts of the rule which will mitigate these differences.

Comment No. 4: J. A. Adam (34)

The amendments as proposed are adequate and should be adopted without any major change. The provisions of the technical criteria, if achieved, will adequately protect the public safety and the environment, both now and in the future. At the same time, the criteria are realistic and can likely be satisfied. The criteria are also reasonably complete. However, I do have observations to make and suggestions to offer.

Comment No. 5: I. Remson (13)

I found this to be a surprising and distressing document. It summarily discards the ideas and methodologies developed by all review groups and professionals with whom I have been associated over the past several years. It makes pronouncements about the status of geology, hydrology and modeling that are wrong. Finally, its "component" approach (as constrasted with the "systems" approach) has led to decisions, use of terminology and numerical choices in several difficult technological areas that are not logical and cannot be implemented.

In short, the proposed rule summarily discards the results painfully arrived at by the technological community. A few specific examples are discussed below. I trust that additional examples will be presented in the report of the ONI panel workshop.

Comment No. 6: I. Remson (13)

The proposed rule essentially abandons the concept of deep geologic disposal.

Five years ago, the geology had to do the entire job of radionuclide containment. All that the canister had to do was get the wastes to the site. Now, we are at the other extreme. The proposed rule gives the geology and hydrology no containment credit except for the 1,000 year groundwater travel requirement.

With the proposed rule in place, there would be no reason to continue any of the ongoing geology and hydrology site studies. Every one of the sites that I am familiar with meets the 1,000 year groundwater travel requirement. In fact, many of the sites that have been rejected would meet the rule specifications if we engineered the package and repository. Therefore, why should one study the sites further?

Comment No. 7: H. Ross (14)

My general impression of the proposed rule is one of disappointment and concern. Professionals concerned with problems of nuclear waste storage and the entire nuclear industry are well aware of the need for finalizing the regulatory

guidelines for high level radioactive waste disposal in a timely manner. The proposed rule as presently written may needlessly complicate and postpone licensing a repository and completing the necessary site selection, characterization, and technical support studies. What is described as a proposed rule for "storage of HLW in geologic repositories" shows a basic mistrust of the geology itself and now places a number of arbitrary and impossible to verify numerical criteria on the performance of engineered barriers and the geologic site. This philosophy ignores the multiple favorable aspects of the combined engineering and geologic barriers. This is a system of multiple barriers which should be evaluated and regulated as an integrated system, on a site specific basis, rather than as a series of independent component-

Comment No. 8: B. R. McElmurry (38)

This proposed regulation is flawed in several ways. Basically, it does not recognize the existence in nature of numerous naturally radioactive soils and regions in which there is a history of unlimited human use for many generations. Such areas include China, India, France, South America, and several districts within the United States. There is not, and can never be, a sound basis for requiring repositories to perform better than nature. I know of no instances where people have been required to evacuate an area because the natural background is too high.

Comment No. 9: R. I. Newman, American Institute of Chemical Engineers (46)

Technical criteria are, of course, needed for the Department of Energy to move forward with construction and operation of a geologic repository. However, in our view, these specific proposed criteria go so far beyond those required to protect the environment and the public that they constitute a basis for needless and costly delay in moving forward with the repository. In fact, we believe that these criteria, however well intentioned, provide a prime example of the type of overregulation being addressed by the President's Task Force on Regulatory Relief, chaired by Vice President Bush. Consequently, a copy of this letter is being sent to the Vice President.

Comment No. 10: Institute of Geological Sciences, London (29)

In its present generalised form the 'Proposed rule' highlights the areas in which more technical data are required and illustrates the difficulty (and danger) of framing comprehensive technical criteria which define safe limits for complex, interactive parameters. That there will be a need for technical criteria to be defined at sometime in the future cannot be argued, but current research programmes are providing data relevant to the definition of such criteria and the publication of a definitive rule for universal application should await the completion of many, if not all, of those studies. In the meantime individual applications for site licenses should be dealt with on a site-specific basis to ensure that performance objectives can be met.

Comment No. 11: Nuclear Fuel Services, Inc. (33)

Nuclear Fuel Services, Inc. has thoughtfully reviewed the comments, conclusions and recommendations made by the American Nuclear Society in their submission

of October 14, 1981 concerning the proposed rule 10 CFR Part 60. NFS agrees with the ANS position and urges the Commission to give it a thorough and detailed consideration.

Comment No. 12: D. M. Petefish (43)

I first must express my own personal view as to the utility of having a regulation for high level waste disposal, particularly a regulation which casts HLW disposal in the conventional review process. Given the uniqueness of the project (i.e., in terms of the few (if more than one) disposal options which in all practicality will be realized given political, social, environmental, scientific (especially geological) restraints, federal government ownership and operation, the monumental urgency in establishing long term HLW disposal solutions; and its impact on the nuclear option, and even defense, I must call to question the decision which has seemingly been made, as reflected by the draft regulation, that we will proceed to handle HLW disposal in the same manner as we have licensed conventional facilities. In my view, this is nothing short of ludicrous, of wasting government and public resources, of over-reaction on the part of government regulators to show the public we are doing our job in an open atmosphere The project deserves more, much more, from us

Similarly, it must be realized that those agencies (e g , NRC, EPA, USGS) which will be involved in the safety and environmental review are now working with DOE and DOE laboratories in coming to grips, in developing rational solutions, to the waste disposal problem. I believe this is the way it should be done This combined concern--this combined tapping of a broad spectrum of government expertise--is essential The Energy Reorganization Act states the NRC will participate in assisting ERDA (DOE) in resolving the waste disposal problem.

It is also somewhat ambiguous in that it states we will license ERDA (DOE) HLW waste. Thus, the Act although it split the functions of the AEC, still maintained a tie between agencies in dealing with HLW. Yet, this tie is not clearly expressed in the regulation. How will this be viewed by the public if we follow the usual review scheme as promulgated by this regulation, where we are supposedly conducting an objective review (when in fact we are involved with DOE now)? How will our credibility be viewed? It is a certainty cries will ring out that we are "all in bed together," that the licensing process is a sham.

Irrespective of my expressed view, I have tried to review the draft regulation as I review all documents presented to me for comment. In this case, I assume such regulations are as given and will be established.

Comment No. 13: D. M. Petefish (43)

As a whole, I find the language of the regulation difficult to comprehend; as such, I appreciate the statement that only the interpretation of the General Counsel is binding. The subject matter in the regulation touches upon a

variety of disciplines, lawyers, administrators, engineers, scientists, hearing boards, etc. Surely, the language of the regulation can be simplified and "de-bureaucratized"

Comment No. 14: C. Walske, Atomic Industrial Forum (50)

A final observation that extends beyond the general comments set forth above, and beyond the detailed comments enclosed, is that the proposed rule in its present form is unduly complex. There are numerous ways in which it could be simplified to the advantage of DOE as the licensee as well as to those in NRC who will be responsible for its implementation.

In light of the above, we respectfully request that the rule in its present form be reworked and reissued for comment. Although we appreciate that such action could delay promulgation of a final rule by as much as a year, it is our understanding that such a delay would not adversely impact DOE's schedule for bringing a waste repository into operation.

Comment No. 15: Westinghouse Corp. (54)

Westinghouse also concurs with the AIF recommendation that the rule in its present form be reworked and reissued for comments.

Comment No. 16: D. M. Petefish (43)

Because of the diversity of subjects included, I suggest a flow chart be developed highlighting the procedures and requirements and be incorporated as part of the regulation.

Comment No. 17: M. J. Lewis (11)

This document is very difficult to follow. This document really doesn't do what the Summary in the proposed rule says it does. The proposed criteria do not address "siting, design and performance in a geological repository" in anything like a meaningful manner.

Comment No. 18: D. M. Petefish (43)

From the title of subpart E it would seem that it would mostly concern itself with describing the physical parameters and requirements of establishing a geologic repository. I find it limited in this respect. Rather, it appears to mostly concern itself with matters which are applicable to any option for disposal, e.g., systems, components and structures; accounting for radioactive waste; ownership and control; quality assurance. All these factors could be incorporated (and appear to already be) in the main body of the regulation. I would limit the Subpart to only the factors unique to deep geologic repositories.

2. FIVE COMMENTERS ADDRESSED THE RELATIONSHIP BETWEEN FEDERAL AND STATE AGENCIES IN HLW DISPOSAL

GENERAL RESPONSE TO COMMENTS 19 - 23

Several comments questioned the adequacy of the role to be accorded State agencies in the geologic disposal of HLW. Provisions set forth in 10 CFR Part 60 Subpart C at 46 FR 13986 (February 25, 1981) ensure that both State and local governments have an opportunity to make significant contributions to the license review. The consultation role of the States in reviewing applicable NRC regulations and licensing procedures, as well as participation in the licensing process, was treated explicitly in the Supplementary Information to the proposed licensing procedures set forth at 44 FR 70412 (December 6, 1979), and reiterated in the Supplementary Information to the final licensing procedures (46 FR 13973). The relationship of DOE to other Federal agencies in the disposal of HLW in geologic repositories was set forth in the Supplementary Information section of the proposed technical criteria (46 FR 35280-35281). Provisions for review of DOE's site characterization report by the States are set forth in the final licensing procedures at 60.11(c) (46 FR 13981). Provisions for further input by the States in the site review process are also set forth at 60.61, 60.62, and 60.63 (46 FR 13986). If a State wishes to form an "oversight interdisciplinary group" such as suggested by some commenters to serve as a State review panel, it may include such provisions within its proposal for State participation (46 FR 13986). The staff does not believe that it is necessary to specify this option in the rule. Although this analysis reflects the situation under the existing licensing procedures, the staff recognizes the need to review those procedures in the light of the Nuclear Waste Policy Act of 1982; the relationship between NRC and State agencies may therefore be subject to modification.

Comment No. 19: N. D. Lewis, State of Washington Energy Facility Site Evaluation (36)

We continue to have concerns about the relatively minor role afforded the states on the siting, design, construction and operation of these facilities. Inasmuch as the State of Washington appears to be a highly probable location for a repository, our concerns on this matter merit attention.

Staff Response to Comment No. 19:

See General Response to Comment Nos. 19 - 23.

Comment No. 20: National Association of Counties Research, Inc. (1)

Finally, NACo believes that despite the regulation and control of radioactive disposal at the federal level, among the Department of Energy, the Environmental Protection Agency, and the NRC, there is a role for state and local governments to play. In the past, these governments have been ignored, and the public consequences of those actions have been loud and visible. At the least, consultation and information-sharing between the federal agencies involved and the appropriate state and local governments should be regularized by a statement to that effect in this (and other) rule(s).

Staff Response to Comment No. 20:

See General Response to Comment Nos. 19 - 23.

Comment No. 21: Div. of Emergency Government, State of Wisconsin (77)

The relationship of DOE to other federal agencies and to state agencies is unclear, especially if the state agency personnel disagree with DOE evaluations of candidate site geological characteristics.

Staff Response to Comment No. 21:

See General Response to Comment Nos. 19 - 23.

Comment No. 22: Capital-Area Groundwater Conservation Commission (22)

The regulations for radwaste should require for each state an "oversight interdisciplinary group" that would serve as a state review panel to the prime contractors, to state officials, and the involved federal agencies. Its function would not include the review of contracts nor the control of activities. The creation of such a group would assure the data collection and interpretive multidisciplinary studies are not fragmented, assure that the assigned tasks are accomplished with the state's needs in mind, provide input and information to the executive and legislative branches of the state government, and serve as a "route" for information to governmental agencies and to the concerned public.

Staff Response to Comment No. 22:

See General Response to Comment Nos. 19 - 23.

Comment No. 23: Louisiana Department of Natural Resources (63)

The regulations for radwaste should require for each State an "oversight interdisciplinary group" that would serve as a State Review panel to the prime contractors, to State officials, and the involved Federal agencies. Its function would not include the review of contracts nor the control of activities. The creation of such a group would assure the data-collection and interpretive multidisciplinary studies are not fragmented, assure that the assigned tasks are accomplished with the State's needs in mind, provide input and information to the executive and legislative branches of the State government, and serve as a "route" for information to governmental agencies and to the concerned public.

Staff Response to Comment No. 23:

See General Response to Comment Nos. 19 - 23.

3. THE FOLLOWING COMMENTERS ADDRESSED THE SUBJECT OF ALTERNATIVE APPROACHES: GENERAL RESPONSE TO COMMENT NOS. 24 - 83

Commenters addressed generally the questions of alternative approaches--overall systems approach or multibarrier approach and whether or not there should be numerical performance objectives for particular barriers, particularly as EPA had not yet promulgated its standard. These questions are addressed in the Overview, especially in Section 2.1, Single vs. Multiple Performance Standards; as well as in Part C, which is the rationale document for the numerical performanc objectives and includes discussion of the uncertainties associated with geologic disposal of HLW, the achievability and reasonableness of the numerical requirements, and the contributions of containment, controlled release and groundwater travel time to meeting the assumed EPA standard. Other issues raised by the commenters are addressed, as appropriate, in the individual responses, usually by reference to another section of the Overview. In certain instances a unique point raised is treated through amplified discussion.

Comment No. 24: Becntel National, Inc (37)

We appreciate the opportunity to provide comments on the proposed technical criteria for regulating geologic disposal of high-level radioactive waste. In general, we are pleased that the NRC is developing such licensing criteria; however, we continue to be disappointed that the proposed rule has not changed appreciably from an earlier version. As expressed previously, the EPA concept of a single, overall repository performance standard is preferred over the NRC's basic approach of applying several specific, subsystem performance standards. We firmly believe that reasonable assurance can be realized for complying with a single, overall performance standard for the total repository system through the use of current and proven engineering practices. Further, such a single standard will provide the basis for allowing flexibility in design for differing waste package and site specific characteristics, while protecting the public health and safety and the environment.

Staff Response to Comment No. 24:

See Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 25: T. H. Pigford (53)

NRC's proposed rule 10 CFR 60 specifies technical criteria for disposal of high-level radioactive waste in geologic repositories. NRC considers the criteria to be necessary for it to fulfill its statutory obligations concerning the licensing and regulating of facilities used for the receipt and storage of high-level radioactive waste. In its Notice of Rulemaking and in the accompanying Rationale for Technical Performance Objectives, NRC states four purposes for these criteria:

1. To specify site and design criteria which, if satisfied, will support a finding of no unreasonable risk to the health and safety to the public.

2. To enhance NRC's confidence that the EPA standard will be met.

3. To simplify the NRC review of DOE's applications to construct a licensed repository.

4. To guide DOE in siting, designing, and constructing a repository in manner that public health and safety will be protected.

This review of NRC's proposed rule and accompanying rationale addresses the question of whether or not the proposed technical criteria have been shown by NRC to be either necessary or sufficient to achieve the stated purposes. NRC's technical basis for the numerical technical criteria are also reviewed.

Staff Response to Comment No. 25:

See Overview, Section 1.3. Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 26: T. H. Pigford (53)

NRC has not identified what safety standard or "unreasonable risk to health and safety to the public" its technical criteria are intended to achieve. NRC has submitted no evidence, rationale, or discussion concerning "unreasonable risk to the health and safety to the public" and the relation of the technical criteria thereto. Consequently, there is no basis for concluding that the technical criteria are either necessary or sufficient for the first purpose stated by NRC.

The EPA standard for geologic isolation of radioactive waste is yet to be determined, so it is premature for NRC to conclude that its proposed technical criteria will enhance confidence that the EPA standard can be met.

In this regard, NRC states:

> "The Environmental Protection Agency (EPA) has the authority and responsibility for setting generally applicable standards for radiation in the environment. It is the responsibility of the NRC to implement those standards in this licensing action and assure the public health and safety are protected. Although no EPA standard for disposal of HLW yet exists, these proposed technical criteria for regulating geologic disposal of HLW have been developed to be compatible with a generally applicable environmental standard."

Although many of the descriptive criteria proposed by NRC are reasonable considerations to follow in selecting a site and in developing a repository design, the specification of numerical values and technical criteria, which are to help meet and to be compatible with the EPA standard, is premature without the existence of the radiation safety standard which these technical criteria are intended to help achieve. NRC has submitted no evidence that the numerical criteria can "support a finding of no unreasonable risk to the health and safety to the public."

Staff Response to Comment No. 26:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 27: T. H. Pigford (53)

NRC argues that its proposed technical criteria will simplify the NRC review of an application by DOE to construct a licensed repository. NRC states that if the DOE-proposed site, underground facility, and waste package perform according to the technical criteria specified by the proposed regulations, including the specific numerical criteria, NRC's evaluation of repository performance will be greatly simplified. The objective of simplifying the licensing review appears to be a main purpose for many of the technical criteria in the proposed regulation.

While it is desirable to simplify licensing review so as to focus on the main issues of public health and safety, we question whether the present NRC approach does not, in fact, detract from focusing on long-term radiation safety. Requiring DOE to show that its design of components meets specific numerical criteria might simplify initial licensing review by NRC staff, but licensing review does not end there. If NRC criteria are not adequately founded and are not shown to be necessary or sufficient to achieve the overall safety standard, there is substantive basis for challenging the criteria and the rule.

More importantly, such a regulatory approach, in the absence of a showing that detailed numerical criteria are related to an overall performance goal, can interfere with and detract from suitable emphasis upon overall safety. The difficulty and challenge of complying with NRC's proposed numerical criteria, as discussed later in Sections 9.6, 10.5, 11, and 13.4, can overshadow the more important task of focusing on overall safety performance of the waste isolation system. It can divert DOE from its central responsibility of providing reasonable assurance that the performance of the overall system and of the subsystems and components will meet the overall performance required of the geologic isolation system, in terms of health and safety to the public. It can divert NRC from its responsibility of evaluating the overall system performance.

This approach by NRC towards its regulation for public health and safety has come under increasing scrutiny and criticism in recent years. The danger of this approach was forcefully articulated by the President's Commission on the Accident at Three Mile Island[8], which stated that:

> "The existence of a vast body of regulations by NRC tends to focus industry attention narrowly on the meeting of regulations rather than on a systematic concern for safety."

[8]J. G. Kemeny, et al., "Report of the President's Commission on the Accident at Three Mile Island," October, 1979.

The NRC was also strongly criticized for not setting or identifying goals of public health and safety to be achieved, and for not sufficiently relating its detailed technical guidelines and regulations towards achieving those goals.

In later sections we question the validity of portions of the NRC analyses which led to some of the numerical criteria in the proposed rule. Without sufficient validity or foundation, the proposed technical criteria are more likely to complicate rather than simplify the overall licensing process.

This is not to say that NRC regulations and guides should never incorporate numerical criteria for performance of components and subsystems. There are many examples in NRC practice which do indeed simplify the regulatory process and do not interfere with the careful development of technology aimed at solving the more important problems of safety. However, the numerical criteria now proposed by NRC are premature for that purpose.

Staff Response to Comment No. 27:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 28: T. H. Pigford (53)

The purpose of technical criteria in regulations and guides should be to help achieve public health and safety. When sufficient and necessary such technical criteria can be useful as long as their technical bases remain sound. Regardless of how well founded and formulated such technical criteria may be at the time promulgated by NRC, it is likely that increased technical knowledge will warrant change, particularly in the case of numerical technical criteria. It is likely that better technical knowledge in the future would result in less uncertainty in predicting performance and will thereby justify less margin for uncertainty than was incorporated in the numerical criteria when originally adopted.

If the technical purpose and foundation of the original criteria are not clear and sound, and if the numerical criteria are adopted without adequate reference to their basis, then the technical framework for later review and challenge of the need and adequacy of such technical criteria has been lost. The technical criteria then become viewed as arbitrary numbers which are sacred within themselves, rather than as representing necessary technical functions and performance which these numerical criteria are intended to achieve. To the extent that numerical technical criteria are finally adopted by NRC, adequate descriptions of their technical purpose, foundation, and assumptions should be included.

Staff Response to Comment No. 28:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 29: T. H. Pigford (53)

To the extent that numerical technical performance criteria by NRC are justified, they are better suited to be incorporated in NRC's regulatory guides rather than in its regulations. When numerical criteria appear in regulations, they are formally enacted and consequently difficult to change. NRC has utilized the guideline approach for promulgating most of the vast body of its technical requirements in other licensing procedures. When numerical criteria do become justified, they should be incorporated in NRC guides, along with the technical bases for their justification.

Staff Response to Comment No. 29:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 30: T. H. Pigford (53)

Many of the general considerations stated in NRC's proposed rule may be useful guidance to DOE, in that they define some of the issues which NRC will question in its review of a future license application by DOE. However, there is no showing by NRC that the numerical criteria are useful to or needed by DOE. DOE representatives[31] have expressed no such need. Instead, they have observed, as have we, that these numerical criteria could steer the DOE program in unprofitable directions.

DOE's contractors for site exploration must be guided by knowledge of desirable geohydrologic characteristics desirable for overall waste-isolation performance, and DOE's designers of the waste package and of the repository need to design to performance specifications of systems and components. However, developing a technological data base of such specifications and providing these specifications to the repository contractors is a primary responsibility of DOE in managing and implementing the national waste isolation program. It is from DOE that such guidance is to be expected.

However, the national program for geologic waste isolation urgently needs guidance in terms of the overall goal for safety performance. As has been shown in Section 8, the published performance analyses by DOE contractors and others, including those relied upon by NRC[5,6,7] assume an overall performance standard

[31] C. Heath (U.S. Department of Energy), Meeting of the Board on Radioactive Waste Management, National Research Council, September 17, 1981.

[5] H. C. Burkholder, "Management Perspectives for Nuclear Fuel Cycle Wastes," Nuclear Waste Management and Transportation Quarterly Report, Jan.-Mar., 1976, Battelle Pacific Northwest Laboratories, Richland, WA.

[6] M. L. Cloninger, "A Perspective Analysis on the Use of Engineered Barriers for Geologic Isolation of Spent Fuel," Proc. NWTS Info. Mtg., Oct. 30 - Nov. 1, 1979.

[7] U.S. Department of Energy, Draft Environmental Impact Statement on the Management of Commercially Generated Radioactive Waste, DOE/EIS-0046-D, 1979.

in terms of radiation dose to a maximally exposed individual, based upon past precedence in NRC licensing, and these analyses have included estimates of such individual doses for hundreds of thousands of years in the future. Yet, the "EPA Standard" assumed by NRC is based instead upon a specified maximum number of total premature cancers to a population, rather than to individuals, calculated for future times no greater than 10,000 years. The two approaches are markedly different, and the differences should be resolved. This is where guidance is needed, but it has neither been discussed nor supplied in NRC's proposed rule and rationale.

Staff Response to Comment No. 30:

The NRC assumes that the overall safety standard for a geologic repository will be similar to the proposed EPA standard (limits on total quantities of radioactivity released), and has shown the relationship between such a standard and the Part 60 performance objectives in the rationale document which accompanies the final rule. (See Part C of this document.) See also Overview, Section 5.5, Population vs. Individual Dose.

Comment No. 31: T. H. Pigford (53)

There have been suggestions[4,32] that the numerical criteria should be interpreted flexibly, and that sites and repository designs could trade high performance in some of the areas specified by NRC's numerical criteria against weaker performance in other areas. Whereas guidance as to interpretation and compliance is an important and vital ingredient in a workable rule, there are two problems with the suggested more liberal interpretations of the rule as now proposed. First, such interpretation is not mentioned in the rule nor in its rationale. Good intentions by the architects of the proposed rule, if not written into the rule, can become forgotten history to the different individuals who must implement the rule in the future. Second, when the numerical criteria are, to a large extent, arbitrary and not based upon clearly understood contributions to overall safety performance, there is little technical basis for settling tradeoffs on such performance parameters.

Flexibility of interpretation and means of verifying compliance should be primary considerations when the overall performance standard is proposed.

[4] M. J. Bell (U.S. Nuclear Regulatory Commission), Meeting of Board on Radioactive Waste Management, National Research Council, September 17, 1981.

[32] U.S. Nuclear Regulatory Commission, Advisory Committee on Reactor Safeguards, Subcommittee on Radioactive Waste Management, Minutes of Meeting of September 2, 1981.

Staff Response to Comment No. 31:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 32: T. H. Pigford (53)

The above questions the need, sufficiency, and technical validity of NRC's proposed numerical criteria. Verification of compliance with the numerical criteria would be very difficult, if not impossible.

NRC should carefully review the technical justification for these numerical criteria in light of the comments herein. Any consideration of promulgating numerical criteria should await the enactment of the EPA standard, which these criteria are intended to support. To the extent that any numerical criteria are adopted by NRC, they should appear in regulatory guides rather than in formally enacted rules. They should be accompanied in these guides by clear rationale as to purpose, need, technical basis, and assumptions. The NRC rule should be based on a single overall performance standard.

This review has been limited largely to the technical information and rationale offered by NRC in justifying its proposed criteria. Deficiencies noted in NRC's rationale are not to be interpreted as deficiencies in the national program for geologic isolation of high-level waste. There are data and programs of research, development, and design that bear upon all of the issues raised in this document. It is important that at this stage of waste-isolation development there be sufficient flexibility to apply this information towards achieving reliable waste isolation performance, without the limiting constraints of the numerical criteria proposed by NRC. It is important to avoid adopting parameters which, because of their questionable basis, can steer the national program in directions which may be unproductive in achieving long-term public health and safety.

Staff Response to Comment No. 32:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 33: J. Carson Mark, Advisory Committee on Reactor Safeguards (10)

While we generally agree with the criteria specified in the proposed rule, we believe that the licensee should be given a greater degree of flexibility for compliance with the overall safety goal. One approach would be to emphasize

the fact that the NRC will be evaluating the anticipated performance of the total waste repository as a system, in contrast to the performance of its individual components. Since we foresee only one or two repositories being built within the next several decades, we believe that each should be evaluated in relation to overall performance on a case-by-case basis.

Staff Response to Comment No. 33:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Perforance Standards.

Comment No. 34: Utility Nuclear Waste Management Group (44)

The current rule, as proposed, incorporates a number of improvements over earlier versions, and the UNWMG wishes to commend the NRC on its continuing effort toward further improvement. However, the UNWMG continues to have a fundamental concern over the specific, quantitative performance objectives for separate components of the repository system still contained in the rule. We also believe that other provisions of the proposed rule can be improved.

Staff Response to Comment No. 34:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See also Part C which contains the rationale for the specific quantitative performance objectives.

Comment No. 35: U.S. DOE (48)

Given the sum of these comments, we urge a restructuring of the rule, first and foremost to emphasize the overall system performance objective and to provide flexibility in meeting individual barrier design objectives. Compliance with the regulation should be demonstrated by systems analysis techniques and the use of mutually-agreed-upon modeling and testing methods developed into Regulatory Guides. Finally, the rule should be clarified and simplified to permit the maximum utilization of engineering ingenuity in meeting the goal of assuring the public's health and safety.

Staff Response to Comment No. 35:

This comment summarizes the commenter's views on a number of issues. The rule as revised provides flexibility in meeting individual barrier design objectives (see Overview, Sections 1.3, 2.1 and 5.4, Purpose of the Technical Criteria, Single vs. Multiple Performance Standards and Reasonable Assurance, respectively). The licensing procedures establish a process whereby prior to submittal of an

application for a license to dispose of HLW at a particular site DOE shall conduct a program of site characterization with respect to that site. (See § 60.10.) During the period of site characterization the Director of the licensing Office may make specific recommendations to DOE on any matter related to site characterization (see § 60.11). In this manner, DOE may learn of and be responsive to current NRC staff views on these matters. For more detailed responses to comments on these issues, see the individual DOE comments and staff responses.

Comment No. 36: Div. of Emergency Government, State of Wisconsin (77)

The difficulties in implementing a program of this magnitude are apparent. The disconcerting part is use of terms (i e., controlled release) that leaves the reader assured of program success.

Since major program approval is located in the Nuclear Regulatory Commission, the responsibility for the final alternative (and its location) is with the NRC. Approval of a final alternative should include a candid discussion of potential impacts plus that approval must guarantee a long-term (at least 1,000 years) monitoring program. Admittedly, it would be difficult to maintain viable system monitoring capability within the repository pathways (i.e., groundwater) must be performed in order that contingency plans could be implemented in case of system failures. A philosophy of providing monitoring for only a "short period" (50-100 years, for example) following repository closure would be inadequate. These materials are hazardous for far too many years to completely rely on an unproven technology.

Staff Response to Comment No. 36:

The staff believes that the unpredictability of future human events makes it impractical to rely upon the continued viability of active institutional controls. There can be no guarantee that a monitoring program will be carried out over a term of 1,000 years or more, and NRC has not taken a regulatory approach that relies on such monitoring. Further, the need for, and desirability of, a monitoring program such as that proposed by the commenter is not clear. See Overview, Section 5.6, Long-Term Post-Closure Monitoring.

Comment No. 37: J. Hamstra, Netherlands Energy Research Foundation (6)

It is evident from the preceding comments that there should be only one approach for setting performance criteria for a high-level waste repository. That

approach should be the prescription of a single performance standard for the overall disposal system. The development of that system will be fully site and host rock specific and be accomplished in an iterative process of system development and safety assessment. The disposal system should remain flexible in order to be able to cope with future developments in both qualitative and quantitative sense.

Staff Response to Comment No. 37:

See Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 38: H. Ross (14)

As proposed in 10 CFR Part 60 NRC favors a component by component performance specification rather than an overall system analysis performance criteria. In so doing arbitrary numerical limits have been established which cannot be verified (i.e., a 1,000 year waste package containment). The entire basis for a mined geologic repository as a means of HLW isolation is the recognition of a system of natural (geological) barriers to provide long term isolation. Engineered barriers offer additional near term containment and further enhance the entire isolation system. Thus it seems more appropriate to select Alternative 1 as described on Federal Register page 35283.

Alternative 2, now favored by the NRC, calls for minimum performance standards for each of the major elements in addition to meeting the EPA standard. Long term (more than 100 years) performance periods cannot be verified and would require costly over-engineering. Specialized materials may be required that would increase the possibility of human intrusion to recover these materials (forming the waste package) at some time in the future. Alternative 2, if adopted, should qualify specif : numerical requirements (time, release rates) with "reasonable assurance" comments.

Staff Response to Comment No. 38:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. Also, see Overview, Sections 3.1 and 5.4, Anticipated/Unanticipated Process and Events and Reasonable Assurance, respectively.

Comment No. 39: C. R. Fisher, General Atomic Co. (16)

General Atomic prefers that the first alternative for formulating performance criteria be used. This alternative gives maximum flexibility in facility design and site choice. It is important to maximize the flexibility of design during repository development, so that no innovations or potential improvements are precluded due to the ill-advised imposition of overly restrictive criteria. The first alternative assures that the safety and health of the public are adequately protected while allowing the designers and operators to devise the most efficient and economical way to satisfy the overall performance standard. In addition, in the absence of a cost/benefit analysis supporting alternative 2

or 3, it would be overly conservative to use any alternative other than alternative 1. Furthermore, because of the importance of flexibility, it appears to be inappropriate to require three barriers as delineated in the proposed rule. The number of barriers should remain unspecified until design development indicates that the desired goal can not be reached without the imposition of a requirement for a specific number of barriers. In summary, General Atomic suggests that alternative 1 be used in formulating the proposed 10 CFR Part 60 and that alternative 2 be adopted only after NRC determines that the designs resulting from alternative 1 are unacceptable.

Staff Response to Comment No. 39:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 40: R. H. Neill, State of New Mexico (78)

Multiple Barriers Concept (§60.111 and Preamble)

The multiple requirements of (1) a 1,000 year waste package lifetime; (2) a leach rate of less than 10^{-5} per year from the package and the engineered facility; and (3) a minimum groundwater transit time of 1,000 years to the accessible environment introduce a great deal of conservatism into repository design. We believe the minimum values chosen may be unnecessarily conservative. Alternative 1 on page 35283 ("prescribe a single overall performance standard that must be met.") may be preferable and should be reconsidered This alternative has the disadvantages of relying completely on the ability to characterize the system as a whole and on requiring no standardization at all between repositories. We suggest a combination of alternative 1 and 2 be considered. For example, the following criteria might be appropriate:

1. Require a minimum waste package lifetime of about 400 years.

2. Require a minimum groundwater travel time of 1,000 years.

3. Require the maximum leach rate to be permitted in the repository to vary from 10^{-4}/y to $< 10^{-5}$/y dependent on the specific geological conditions and on the degree of uncertainty at a specific site.

The rationale behind this specific suggestion is:

1. Analyses (Cloninger, PNL-3356) indicate that there is little reduction in individual radiation doses received by increasing waste package life from about 400 years to 1,000 (or even 10,000) years. Also, a 1,000 year package would be more expensive (although the amount is uncertain) and would require additional time to develop and verify.

2. A minimum groundwater travel time of 1,000 years is obtainable at many sites and there appears to be no real need to settle for lower travel times. Also, we believe that caution must be exercised in choosing the appropriate K_d values to use in radionuclide travel time evaluations and

that longer groundwater travel times will partially compensate for uncertainty in the K_d values.

3. This approach would permit the waste package lifetime and leachability to be standardized for all repositories. In the event that a site was obtained with exceptional geological, hydrological, and geochemical characteristics and little uncertainty there would be no need to engineer greater leach resistance into the repository. However, if necessary lower leach rates could be designed in a specific repository.

The following aspects of the performance objective are not precise and should be clarified:

1. What percentage of waste packages could be predicted to fail in less than 1,000 years and still meet the criteria?

2. Does the 1,000 year groundwater travel time refer to the average velocity, leading edge of the plume or some other velocity? Also, is the accessible environment considered to be a well drilled just outside the area of DOE control?

The proposed rule does not indicate the statistical tests that must be met in order to demonstrate compliance with these criteria.

Staff Response to Comment No. 40:

See Overview, Sections 2.1, 4.1, 5.4 and 5.5, Single vs. Multiple Performance Standards, Accessible Environment/Controlled Area, Reasonable Assurance and Population vs. Individual Dose, respectively. Also, see Section-by-Section Analysis, § 60.113. See Part C, which contains the rationale document.

Comment No. 41: American Nuclear Society (20)

NRC lists three alternatives to regulate geologic disposal of high-level waste. They are:

1. Alternative No. 1: Prescribe a single overall performance standard for the repository that must be met. The standard in this case would be the EPA standard.

2. Alternative No. 2: Prescribe minimum performance standards for each of the major elements or subsystems, in addition to requiring the overall system to meet EPA standards.

3. Alternative No. 3: Prescribe detailed numerical criteria on critical engineering attributes of the repository system.

NRC concludes that Alternative No. 2 appears to be the most practical compromise between Alternative Nos. 1 and 3. However, a compromise alternative is not necessarily the best alternative. Alternative No. 1 is more acceptable because it permits the use of a systems concept to incorporate the contributions from

natural and engineered barriers. Overly restrictive and specific component and subsystem performance standards are not necessary and are likely to add to the overall cost of waste disposal, without achieving any significant degree of benefit to the public health and safety.

Using current engineering practices, a carefully sited, engineered, and designed repository coupled with effective confirmation and design validation can assure compliance with a single, overall performance criterion for the repository as a whole system. In satisfying a system or repository performance standard, the use of natural and engineered barriers will assure acceptable containment of the waste for the appropriate period of time and provide the required protection of the public health and safety and man's environment.

During operation of the first repository, appropriate modifications can be made in design features and repository layout if results of operation necessitate such changes. Therefore the overly restrictive standards now proposed for components and subsystems are not warranted.

Staff Response to Comment No. 41.

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 42: Stone & Webster Engineering Corp. (26)

The discussion on pages 35283-35284 of Alternatives 1, 2, and 3 is not clear. The NRC acknowledges that Alternative 1 gives the most flexibility but is concerned with how to measure performance. Alternative 2 is preferred in setting minimum standards on each element, and still requiring overall performance standards. If standards and performance can be established and measured for each element, then it can be for the whole - as is required in Alternative 2 as well as in Alternative 1. The argument used to prefer Alternative 2 is illogical. If the requirements of Alternative 2 can be done, then the requirements of Alternative 1 can be done as well; and since Alternative 1 comes to the same conclusion without restricting flexibility, it should be the preferred alternative.

Staff Response to Comment No. 42:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

This comment argues that if individual barrier performance criteria can be established and complied with, then an overall system performance standard can also be established and complied with. Since individual barrier criteria

restrict the designer's flexibility, the comment argues that only an overall performance standard should be applied to a repository.

The NRC staff agrees that a relationship can be shown between individual barrier performance and overall repository performance, and has completed analyses which show the relationship between the NRC's proposed performance objectives and an assumed EPA standard. The staff continues to believe that a subtantial contribution to waste isolation by each of the major barriers is needed to provide confidence that the overall system will perform as intended. By avoiding excessive reliance on any one barrier, the Commission can be confident that the unanticipated failure of a repository component will not cause the overall level of repository performance to be excessively degraded. As noted in the Overview, Section 2 1, Single vs. Multiple Performance Standards, the Commission has added provisions to the performance objectives to increase the designer's flexibility where appropriate.

Comment No. 43. Institute of Electrical and Electronics Engineers (28)

The NRC requested comment on the general approach to technical regulation of HLW disposal. The approach taken is listed as Alternative 2. The consensus of this reviewing body, however, is that an approach closer to Alternative 1 would be preferable. Overall system performance requirements should be established. This approach would be more consistent with the EPA approach and would allow DOE more freedom in the design of the waste packaging repository system. Some of the proposed requirements on the waste package (e.g., 1000-year containment) may prove to be unreasonable to meet and impossible to verify within a meaningful time period. Finally, an approach closer to Alternative 1 would give meaning to the stated need to evaluate the repository and waste package as a system. (See p. 35281, column 3, paragraph 1; and p. 35285, column 1, paragraph 4.) The proposed criteria are very similar to the multiple independent barriers required for nuclear reactors. The criteria should be revised to reflect total system performance and possible risk to the public, relative to natural risks already existing.

Staff Response to Comment No. 43:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Commment No. 44: National Radiological Protection Board, UK (29)

Alternative Approaches (to prescribing criteria) - The "alternative approaches" (p. 35283, column 3, para. 2) considered by NRC should not be considered as alternatives, they represent stages in developing criteria and performance objectives for geologic disposal. In order to develop a consistent set of

criteria it is necessary to set a "single overall performance standard", to derive "minimum performance standards for each of the major elements" from this overall standard via safety assessments and then to derive detailed numerical and engineering criteria from these performance standards for the system elements. In choosing "Alternative 2" NRC are acting prematurely and limiting the designers' flexibility to an unreasonable extent (see also general comments).

Staff Response to Comment No. 44:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 45: UK Atomic Energy Authority (29)

Of the 3 "alternatives" at this stage we strongly favour 1, the setting of a single overall performance standard. It should then be possible to move to 2, setting of minimum performance standards for major elements as more experience and evidence becomes available.

Staff Response to Comment No. 45:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 46: Bechtel National, Inc. (37)

The Commission seeks comments on alternative approaches to performance criteria:

(a) The Commission seeks comments on the use of Alternative 1 which prescribes a single, overall system performance standard that must be met.

We are of the firm view that Alternative 1 is the most appropriate of the three presented in the proposed technical criteria of 10 CFR Part 60. The fundamental reason for the selection of Alternative 1 is that this is a more realistic approach for utilizing the compensating benefits of both the engineered barriers and those provided by the geologic medium. Additionally, the application of Alternative 1 could realize important trade offs in the design of the repository components and subsystems for differing site specific characteristics. Further, Alternative 1 would be compatible with the approach of EPA and its application could prevent regulatory conflict. Thus, the application of Alternative 1 or a single overall performance standard for the repository will allow flexibility in design, while protecting the public health and safety and the environment.

(b) If commentors favor Alternative 1, address ways in which NRC might find reasonable assurance that the ultimate standards are met without prescribing standards for the major elements of a repository.

One can apply current and proven engineering practices coupled with a single, overall repository performance standard -- in providing reasonable assurance that after repository decommissioning, radioactive waste would

be isolated for the protection of the public health and safety. The careful application of site investigation techniques can determine the characteristics of the geological setting as the first step in identifying potential and significant performance uncertainties that may reside in the geologic medium. These and other potential performance uncertainties can be reduced in importance and made inconsequential by conservative analysis and design that incorporates compensating design margins in the engineered and geologic medium barriers for differing site specific characteristics. Thus, the ultimate or single repository performance standard could be satisfied in a more flexible, practical and optimized manner -- rather than the needlessly stringent approach of depending on one set of overly conservative standards for the subsystems or engineered barriers.

Staff Response to Comment No. 46:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

The NRC staff does not consider that either Alternative 1 or Alternative 2 would result in "regulatory conflict" with the EPA standard. In fact, Appendix D shows how the objectives for individual barrier performance contribute to meeting an assumed EPA standard.

Comment No. 47: J. Hamstra, Netherlands Energy Research Foundation (6)

It is evident from the preceding comments that there should be only one approach for setting performance criteria for a high-level waste repository. That approach should be the prescription of a single performance standard for the overall disposal system. The development of that system will be fully site and host rock specific and be accomplished in an iterative process of system development and safety assessment. The disposal system should remain flexible in order to be able to cope with future developments in both qualitative and quantitative sense.

The ultimate goal should be:

- to provide for a confinement of the buried waste for a minimum of 1,000 years within a geologic boundary that remains far from man's direct environment,
- to extend the confinement period as long thereafter as is reasonably achievable for a given site and its geologic setting, and
- to limit any eventual subsequent release of waste nuclides to the environment in amount and concentration to acceptable levels, or as far below that as reasonably is achievable.

Staff Response to Comment No. 47:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 48: Utility Nuclear Waste Management Group (44)

Alternative approaches; systems approach v. barrier performance objectives (46 Fed. Reg. 35,283-84)

While it is generally agreed that the use of separate nuclide barriers and other features -- such as a reasonably long-lived waste package, a stable waste form and a favorable geologic setting (exemplified, in part, by significant water travel times to the accessible environment) -- is appropriate for a repository system, the fundamental, basic consideration is assurance that such barriers and features operate in a way so as to preclude the excessive release of radioactive materials to the accessible environment. From this perspective the NRC barrier performance objectives approach, as embodied in the current proposed regulations, can only be viewed as the arbitrary imposition, on individual system components, of specific-value standards that are without scientific or other technical support. Moreover, it is intrinsically at odds with an important aspect of sound repository design and operation, i.e., the interaction of individual components to achieve, on a combined basis, the required level of repository system performance. Further, we cannot agree that the inclusion of such component requirement will increase the ability to show compliance with an overall system performance requirement (e.g., EPA protection standards), since such a showing will necessarily involve the use of mathematical models independent of specific component performance requirements

UNWMG is firmly of the view that overall repository performance should be addressed directly by means of the systems approach. Utilization of an overall performance standard would correctly serve to focus attention on total repository performance. In addition, it would provide for appropriate design flexibility; something which is important in order to both be able to take advantage of new developments, as this new undertaking proceeds, and to accommodate and effectively utilize the specific characteristics of individual sites.

In particular, use of the EPA environmental standards in 10 CFR Part 191 -- which are currently in draft form and, when adopted, will have to be met anyway -- would provide a unified, supportable basis for regulation and, at the same time, preclude the possibility of conflicting regulatory requirements.

Utilization of a systems approach, based on such overall system performance standards, would have the additional advantage of being universally applicable to all geologic repositories. Thus, special criteria pertinent to disposal in, for example, the vadose zone, would be unnecessary.

UNWMG notes that the Commission could, consistent with a systems approach, specifically require the utilization of certain components (a waste package, stable site geology, etc.) in any and all repositories. However, the prescription of separate numerical barrier performance objectives should be avoided.

This, of course, could be accomplished either by eliminating individual numerical requirements, or by specifying that variations and departures from them would be equally acceptable as long as the overall performance requirements for the repository system were met.

Whether or not the Commission decides to require the use of specific components, however, UNWMG urges that the NRC adopt a rule which properly implements the systems approach by prescribing performance standards for the entire repository system, rather than imposing numerical requirements for individual components.

Staff Response to Comment No. 48:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 49. Harmon and Weiss for NRDC (76)

The proposed rule establishes performance standards for each of two major engineered barriers - the waste package and the underground facility - in addition to requirements for containment, controlled release rate and 1,000 year groundwater transit time, all of which act independently of EPA's generally applicable overall system performance criterion. This regulatory scheme is referred to as Alternative 2. (46 Fed. Reg. 35282) NRDC strongly supports the adoption of this alternative approach.* Given the difficulty in characterizing and modelling the natural systems over the required periods of time to any reasonable degree of precision, the use of multiple engineered barriers, each judged by objective performance criteria, is the only way to find reasonable assurance that the overall system objectives will be met.

We are aware that much of the nuclear industry as well as DOE oppose the use of performance criteria for independent barriers, preferring to rely solely on the EPA overall system objective. This is justified in the name of "flexibility."

However, the desire for flexibility (or conversely, the resistance to objective criteria) cannot be permitted to override the ultimate purpose of this rulemaking, which is to provide a framework under which DOE can proceed to design a system and NRC can verify with a high level of assurance that the system will successfully contain radioactive waste from the environment until that waste is harmless. Reliance solely on overall system criteria will not provide the certainty and guidance which the designers of the repository should have and will force NRC to make its decision on the basis of highly uncertain

*NRDC believes that suitable geologic site characteristics should be considered as the third "barrier." As noted previously, however, NRDC does not consider the site performance standard -- the 1,000 year groundwater transit time -- by itself as representing a satisfactory site selection criterion. Furthermore, under the assumption that the other two barriers fail, this groundwater performance standard is inadequate to insure public safety. We urge the Commission to establish site selection criteria that would insure that sites which are in close proximity to aquifers are not selected as candidate sites.

assumptions and computer calculations which are essentially unverifiable and in which little real confidence can be placed.

If the NRC discards the approach of independent barriers with independent performance objectives, it will have in essence delegated to the regulated party, DOE, the task of setting limits. It is absolutely predictable that this will result in the following course of events: Not until DOE presents NRC with its application will the Commission learn in any detail the criteria used by DOE to design the engineered system and the means used to verify compliance with those criteria. In all probability, the information provided by DOE will require substantial supplementation and NRC will have many technical questions requiring DOE's response. Meanwhile, DOE and the nuclear industry will begin to exert pressure for an "expedited" decision on the application, either subtly or overtly painting NRC as dilatory or obstructionist. This pressure would be particularly onerous if Congress adopts a version of the waste bills currently under consideration which set extremely tight timetables for the development of a waste repository.

As a practical matter, NRC's ability to re-examine the proposed system and to question DOE's analyses will be nil, given the fact that it is likely to take several years to design the components of the engineered system. Thus, without performance criteria established prior to the design of the system, it is virtually assured that NRC will be forced to accept DOE's proposal, thus forfeiting its role as independent regulator.

Some of the industry commenters have taken the position that Alternative 2 constitutes a rejection of the "systems" approach to design of the repository. These commenters generally misconstrue the meaning of the systems approach which is, contrary to their assertions, not inconsistent with the defense-in-depth concept incorporated in Alternative 2. The systems approach dictates a method of analyzing the capability of each component of the system by taking into account the manner in which it is influenced by other interacting components. For example, in evaluating the performance of the waste cannister, the systems approach calls for consideration of the environment into which it is placed, including the thermal conduction away from the cannister, the pressure upon the cannister, the amount of moisture present, etc. The systems approach is thus in no way inconsistent with the use of objective performance criteria for each major independent barrier; it merely represents a method of analyzing compliance with those criteria.

NRDC urges the Commission to adhere to the judgment reflected in these proposed rules that, considering the enormous uncertainties involved in predicting repository performance over thousands of years, reasonable assurance in the adequacy of the geologic repository as a whole must be based upon independent barriers whose capability is judged according to pre-established and objective performance criteria. Such an approach is neither overly prescriptive nor over-conservative. On the contrary, it represents an appropriately prudent approach to the unique difficulties inherent in licensing for the first time a formidably complex system of engineered and natural components which must be capable of performing successfully over periods of time of unprecedented length.

Staff Response to Comment No. 49:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

The staff agrees with the commenter's observation that the systems approach and the NRC approach are not incompatible. As to the commenter's last point the staff considers that the siting criteria assure that the presence and significance of nearby aquifers will be fully evaluated and taken into account.

Comment No. 50: B. D. Withers, Portland General Electric Co. (82)

Alternative 1, the setting of a single performance standard for the entire repository system, is much more desirable than setting performance objectives for each major system element (Alternate 2), or prescribing detailed numerical criteria on critical engineering alternates of the system (Alternate 3). The overall objective of the repository system is to limit radiation exposure to the public through isolation of high-level wastes from the biosphere until such time and in such quantities as to present minimal risk. Multiple barrier performance objectives and prescribed detailed engineering criteria needlessly restrict the designer's flexibility in producing an integrated design to best meet the overall objectives.

Staff Response to Comment No. 50:

See Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 51: U.S. DOE (48)

Issue

Definition of the most effective approach for specifying the performance objectives for the geologic repository.

DOE Position

The NRC should establish a level of performance for the total system and provide that multiple barriers be used for containment and control of release. DOE should be given the responsibility to analyze each site-specific system, define the boundaries of the accessible environment, and propose the barriers and the contribution of each in achieving the level of performance of the total system. In this approach, DOE should be required to show how the specific level of performance for each component contributes to the total performance requirement and the site. It will be necessary to show how the analysis of the system is internally consistent. Alternative language to achieve this approach is provided for section 60.111 among the section-by-section comments attached to this response.

Discussion

In 10 CFR 60, NRC establishes four specific performance objectives for the waste isolation system and its components. The performance objectives include the following:

1. Containment of the radionuclide in the waste package for a specified time (1,000 years).

2. Control of release of the radionuclides from the engineered system (one part in 100,000 of the inventory).

3. Minimum groundwater travel time (1,000 years) between the engineered system and the accessible environment.

4. Maximum quantities of radionuclides that can enter the accessible environment throughout the isolation period (EPA Standard)

Sections 60.111 and 60.112 of the rule appear to give the greatest emphasis to the first three performance objectives thereby placing greater reliance on individual components than on the total waste isolation system. We believe that this emphasis is unintentional and believe that the alternative language proposed will more properly reflect the desired intent.

The performance of the total waste isolation system will depend on the performance of each of the components that comprise the system. However, if the desired level of performance of the total system is known initially, then the required level of performance of the components must be derived from the total system performance, based on the physical conditions of any portion of the system that is already in place and cannot be changed. Independently establishing generic performance requirements for the total system and its major subsystems without recognition that they are interdependent may severely limit the flexibility of DOE and NRC to design and license the most effective waste isolation system.

We support the requirement to establish a set of regulations that will provide a basis for licensing a waste repository. However, we believe that the current version of the rule contains basic impediments that may make it difficult or impossible to reach closure in the licensing process. The potential difficulties result from the following three factors:

1. Internal inconsistencies in the proposed rule.

2. Failure to consider analysis of the contribution of various barriers, and limits the DOE's flexibility to engineer the total system.

3. Lack of clarity regarding basis for demonstration of compliance.

Internal Inconsistencies in the Proposal Rule

In the introduction to the rule, NRC states that its goal in developing the barrier performance objectives is to ensure that compliance with the draft EPA release limits can be shown. It appears that the selection of the numerical objectives were estimates based on judgement rather than quantitative models,

demonstrable engineering considerations or site-specific data. However, it is not clear how the individual performance objectives are related to the EPA release limits using the techniques of performance analysis and an understanding of the geologic and hydrologic environments. The relationship needs to be based on the realities of physics and chemistry that govern the release and movement of radionuclides. Because the proposed numerical performance objectives have no clearly defined technical basis, they appear arbitrary. They become inflexible since there can be no basis for changing them. Should they happen to be insufficient within the context of a specific application, the regulation will be criticized; and should they be too restrictive, cost will exceed what is warranted by radiological safety considerations.

An important factor in establishing the containment period was the time during which the thermal pulse is dominated by the decay heat from the fission products. An indication of the length of this period is the point when the peak temperature is reached. In the NRC Rationale document it is stated on page 28 "The maximum temperature of the repository as a whole is reached during the period of 100 to 500 years after emplacement...". On page 49 it is stated that "...maximum rock temperatures in the underground facility occur at approximately 35 years after emplacement for reprocessed waste and at 75 years after emplacement for disposal of spent fuel. By 100 years after emplacement, near-field rock temperatures have started to slowly decrease for both waste types in all four media...". The length of the containment period should be reexamined in view of these results presented by the NRC staff. Such a review might indicate that the containment period could be on the order of 300 years since the power output of the waste decreases two orders of magnitude over the first 300 years and only half an order of magnitude over the next 700 years.

In support of the 1,000 year containment period, it is argued in the NRC Rationale document that "Containment for 1,000 years also requires only extrapolation by a small factor beyond what the Department has already been considering for bedded salt...". Further, on page 31-32 it states that "Containment for 300 years...appears to be achievable at reasonable cost...". It is argued that the NRC requirement is only a modest extension of technology that is already established. In contrast, the work that is used as the basis for the NRC position is in the early R&D stages and has "the goal of estimating the potential of a material to survive 300 years" (Magnani and Braithwaite, 1980). The cost quoted in this study ($3,000) is for the <u>material</u> for a canister of 304-L stainless steel surrounded by TiCode-12 and not for design, fabrication, testing, QA, and other factors to be included in determination of waste package cost. The study concludes "This material may well survive 300 years or more. However, further study is still necessary to qualify the material for such an extended lifetime." The conclusion drawn by NRC that containment for 300 years appears to be achievable at reasonable cost on the basis of this study is unjustified. The implication that extrapolation from 300 year life-time is essentially trivial is purely unsupported conjecture. The qualification of any package and its material will be based upon extrapolation of short-term tests. Extrapolation to 300 years involves significant uncertainties and extrapolation to 1,000 years can only serve to make these uncertainties greater.

Failure to Consider Analysis of the Contribution of Various Barriers

The NRC has proposed performance objectives for container lifetime, release rate and groundwater travel time for the three major waste isolation subsystems.

A preliminary study of the sensitivity of the total waste isolation system to these parameters has been completed [1] The mathematical models used to study the system included transport processes and the probabilities of important failure events. The model computed the maximum total 70-year whole body dose to the average individual in the local population and expressed the results as a fraction of the equivalent natural background dose. These three subsystem parameters for which performance objectives have been proposed were varied as a basis for evaluating the barriers for three different geologic environments

The results of these calculations are compared with proposed 10 CFR 60 criteria in Figures 1, 2, and 3. (See PDR letter 78, pp. A-16 - A-18.) Although this study used spent fuel as a source term solidified HLW from reprocessing should give qualitatively similar results Doses resulting from human intrusion are not included in this analysis.

The effect of varying the delay time for water to penetrate the containment over a range of five orders of magnitude is shown in Figure 1. For all three geologic environments, the analysis shows that the effect of a 1,000 year lifetime package is not significantly different from that of a 100 year lifetime package. In all cases the analysis indicates that the maximum exposure is below background.

Once containment has been breached, the effect of varying the release rate over a range of four orders of magnitude is shown in Figure 2. There is no significant change in calculated population dose as the waste release rate is increased from the proposed maximum criterion of 10^{-5} fraction per year to a rate of 10^{-4} per year for a nominal repository. Of course, further reductions of release rate toward the theoretical zero release would marginally reduce computed release to the accessible environment, but it is very doubtful that the additional reduction in the maximum exposure below the already extremely low level would be justified.

The effect of varying the groundwater travel time from the waste to the biosphere over a 3,000-fold range is shown in Figure 3. The population dose decreases as the travel time is increased over the entire range for both extremes. Thus, it can be seen that the isolation system is by far more sensitive to groundwater travel time than to the performance of the engineered barriers.

Because detailed site-specific modeling has not yet been done, these calculations were conducted to compare effects. Conclusions from these figures should not be extended to doses at real sites. However, this study does indicate the relative difference each of the barriers make in the isolation of the waste.

[1] H. C. Burkholder, Engineered Components for High-Level Radioactive Waste Isolation Systems--Are They Technically Justified?, ONWI-286, Office of Nuclear Waste Isolation, Battelle Memorial Institute (Draft Report).

Another study performed by Hill (1980)[2] on high-level waste in a non-salt repository indicated that delay of initiation of waste transport could only affect maximum dose if delay time was large compared to the groundwater travel time, the time for complete dissolution of the waste form, and the half-life of the major nuclides contribution to dose.

A study performed by Sutcliff, et al. (1981)[3] which considered sensitivities and uncertainties of system performance showed that maximum discharged rates were insensitive to container lifetime.

The above mentioned studies used differing assumptions in their analyses, and yet resulted in similar conclusions. No study performed to date has shown otherwise.

In view of the results of these studies, we are concerned about the significance these specific numerical values will have on the outcome of the licensing review and recommend restructuring section 60.111 as noted in the section-by-section comments attached

Lack of Clarity Regarding Basis for Demonstrating Compliance

The NRC explains that the engineered system is a means to deal with uncertainty in the performance of the site. However, in establishing the engineered system NRC has created additional engineering uncertainties since se[illegible] of the critical concepts will lack the definitions that are necessary to fac[illegible]tate design. For example, the boundary of the engineered system over which the [illegible]elease rate of one part in 10^5 must be evaluated is inadequately defined. It [illegible]s not clear whether the engineered system includes any of the geologi[illegible] formati[illegible] or whether it is limited to the waste package and the tunnel backfil[illegible]

With regard to the 1,000 years for containment, when consi[illegible] a population of 50,000 waste packages, the total significance of the 1,0[illegible]rs is unclear. Does it repesent a mean value or a minimum value? If it is a [illegible]imum value, no waste package failure could be allowed in 1,000 years. Allowing for probabilistic variations, it must be concluded in any design that some chance of failure exists.

Another detailed issue concerns the identification of the actual failure mode leading to loss of containment. There are numerous degradation mechanisms that could lead to failure and one or two may be dominant. We have considered the issue of the elimination of the non-important failure modes that may be active over 1,000 years based on, say, 5 years experience. The data needed to allow confident selection between the important and unimportant failure modes must be

[2]M. D. Hill, "The Effect of Variations in Parameter Values on the Predicted Radiological Consequences of Geological Disposal of High-Level Waste," Scientific Basis for Nuclear Waste Management, 2, 753 (1980).

[3]W. G. Sutcliff, et al. Uncertainties and Sensitivities in the Performance of Geologic Nuclear Waste Isolation Systems, UCRL-53142, University of California, Lawrence Livermore National Laboratory, Livermore, CA (1981).

carefully developed. This decision on the required data will be important for establishing a rational design basis for the waste package.

The NRC requirements state that "The engineered system shall be designed so that....the waste packages will contain all radionuclides for at least 1,000 years...." This requirement is stated in absolute terms, implying that any release before the 1,000 year period ends would constitute noncompliance.

Even extraordinarily high reliability factors and safety margins for the waste package will not meet the absolute wording of the performance ojectives in the proposed rule. To achieve a single-package reliability of 0.9999 that the minimum lifetime is 1,000 years would require a median design lifetime between 10,000 years and several million years. Achieving this level of reliability even for systems that operate in the short term under relatively well-defined conditions is unprecedented. Proving that this reliability can be achieved for a system that is to operate for 1,000 years under less well-defined conditions will be a requirement well beyond any previous engineered system. Therefore, rather than achieving the objective of reducing uncertainty and simplifying the licensing process, the use of such a waste package quantitative performance objective could, instead, complicate the licensing process with additional uncertainties. In view of the incomplete understanding of the demonstration of compliance, we recommend caution regarding the premature commitment to numerical values without fully defining their meaning and without providing flexibility to adjust the requirements for each component for specific sites in order to collectively perform to meet the overall system criteria.

Staff Response to Comment No. 51:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document for the numerical performance objectives. The staff recognizes that the uncertainties in demonstrating compliance require judgments that are not entirely quantitative. See Overview, Section 5.4, Reasonable Assurance and Section-by-Section Analysis, §60.113.

On the question of reliability, see Overview, Section 5.4, Reasonable Assurance. The engineered barrier system does not include the geologic formation. However, the radionuclide retardation capability of the host rock is one of the factors the Commission will consider in approving an alternative to the one part in 100,000 per year release rate specified in paragraph 60.113(a)(1)(ii)(B); and it, therefore, could be taken into account to the extent that DOE can characterize its performance as a barrier based on tests and measurements conducted during the site characterization program.

The process established in the licensing procedures related to the conduct of site characterization will enable NRC staff to provide recommendations on matters related to site characterization and waste form and packaging research, such as data needs and the failure modes to be considered in establishing the design basis for the waste package (see §§60.10 and 60.11).

Comment No. 52: C. Walske, Atomic Industrial Forum (50)

1. "Prescribe a single overall performance standard that must be met. The standard in this case would be the EPA standard;

2. "Prescribe minimum performance standards for each of the major elements, in addition to requiring the overall system to meet the EPA standards; and

3. "Prescribe detailed numerical criteria on critical engineering attributes of the repository system."

The Commission prefers Alternative 2 as a "reasonable and practical compromise" between a single overall performance standard and detailed criteria on the critical attributes of the repository system.

In our comments on the FR May 13, 1980 Advance Notice of Proposed Rulemaking, we noted:

> "The approach being taken by the NRC is not consistent with the objective stated on page 31396 nor with the 'systems approach' recommended by the IRG. We believe that the NRC should be establishing appropriate criteria and standards for the performance of the overall system rather than defining specific performance values for individual components. The systems designer (DOE) should have the flexibility, for example, to permit optimum trade-offs between the waste for the container design as long as the overall system meets those criteria that insure public health and safety."

We have carefully considered the NRC staff's comments and logic supporting its preference for Alternative 2. However, we continue to recommend an overall systems approach to the design of a geologic repository. By this we mean that the engineered features and the geologic features of a repository would be optimized to work together to meet the overall performance objectives of the repository. We find no well defined technical justification for specific numbers, such as a 1000-year containment period for a waste package. Many decisions remain on the final choice of a repository, the waste form, and the design of a waste package. The design values that might be required for one site could very well be different for another site. Thus, prescribing a specific set of design criteria in the proposed rule could be overly restrictive, and would not give the system designer the flexibility to make trade-offs desirable to optimize a system that would meet overall performance objectives.

NRC requests those who recommend Alternative 1 to indicate ways in which NRC "might find reasonable assurance that the ultimate standards are met without prescribing standards for the major elements of a repository." We do not

understand the basis for the concern implied in this request. Only one applicant, DOE, will be applying for a license for a high level waste repository, and this applicant is carrying out a thorough and integrated implementation process. Thus, NRC should be able to find "reasonable assurance" through careful review of DOE's analytical, experimental and decision-making processes that DOE is meeting the goals of Alternative 2. There would appear to be no basis for writing the rule as though there will be a number of applicants of varying backgrounds and qualifications undertaking parallel projects.

While continuing to support an overall systems approach, i.e., Alternative 1, if the NRC believes it necessary to define quantitative performance criteria for the various components of a repository, we strongly recommend that these criteria take the form of "design guidance," not minimum or fixed criteria. This "design guidance" should permit the designer flexibility in choosing specific design parameters on a specific case basis, as long as the overall system performance objectives can be shown to be attainable. We have reflected this latter approach, which in a sense is a combination of Alternatives 1 and 2, in our specific comments on the proposed rule.

Staff Response to Comment No. 52:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

The NRC staff sees no conflict between the IRG recommendation and the performance objectives of Part 60. The IRG recommended that a repository "can and should provide multiple, and to some extent independent, natural and engineered barriers...." The performance objectives of Part 60 require such barriers and allow the flexibility to deviate from the numerical performance values if appropriate. We believe the flexibility provisions of the revised performance objectives accommodate the concerns expressed in the last paragraph of this comment.

Comment No. 53: State of California Department of Conservation (62)

CDC has considered the Commission's specific request (FR p. 35283) for comment as to the level of detail in which the performance criteria for a geological HLW repository should be prescribed. The three alternative approaches listed, range from 1) Single overall performance standard -- to EPA standard, 2) Overall EPA standard, plus minimum performance standards for each of the major elements, and 3) Detailed numerical criteria for critical engineering attributes of the repository system.

CDC believes the principal issues on which to base a choice, among this continuum of alternatives which range from very simple to very complex data requirement, are 1) The general public confidence engendered, and 2) The practicality of providing and of evaluating the alternate levels of detail

that would be required. Further, this issue must be considered in the light of present unavailability of the EPA standards on which alternatives 1 and 2 would be based, as well as the procedural fact that a lesser level of detail is acceptable in this set of technical criteria than will be required at the future stage of site- and design-specific data, when license applications are prepared for each specific proposed disposal site.

CDC's position is that maximum practical detail of performance criteria is valuable, for confidence in the overall safety of any proposed site, but that as long as detailed numerical criteria are mandatory in each license application, the compromise alternative ("2. Prescribe minimum performance standards for each of the major elements, in addition to requiring the overall system to meet the EPA standards.") is appropriate for the purpose of this proposed rulemaking. In endorsing this approach, we understand the "major elements" are the engineered barriers (waste package and underground facility), and the natural barrier provided by the geological setting. Further, as we discussed below under "Performance Objectives" and "ALARA Principle," we believe that the criteria for each of those elements should be made as numerically specifc as practical, by incorporation of the requirement of probabilistic analysis, based on the worst-case scenario.

Staff Response to Comment No. 53:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. See also Overview, Section 5.4, Reasonable Assurance.

Comment No. 54: Div. of Emergency Government, State of Wisconsin (77)

Alternative 1 (a single performance standard) may be laudable and provide greatest flexibility, but also alternative 1 becomes too subjective in the evaluation process.

Staff Response to Comment No. 54:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. See also Overview, Section 5.4, Reasonable Assurance.

Comment No. 55: Duke Power Co. (55)

However, in our view a fundamental problem still exists in the rule as proposed in the area of individual barrier minimum performance standards. The Commission has correctly recognized this as an important issue, and has specifically requested comments on alternative approaches to this question. Duke believes, for reasons detailed below, that it is preferable to prescribe a single performance standard which must be met by the entire disposal system. This is in contrast to the prescription of minimum performance standards for each of the major elements of the system, as embodied in the proposed rule.

Regardless of performance standards imposed on individual system elements, assessment of overall repository performance will have to be performed to ensure that the environmental standard which presumably will be promulgated by the EPA is met. This is because meeting the individual performance standards does not guarantee that the overall environmental standard is met.

Such an assessment will necessarily involve the combination of mathematical models of each element of the system, appropriately benchmarked to whatever test data is available and applicable. Since the models and test data used to perform the overall assessment will presumably be the same ones used to demonstrate the effectiveness of each individual barrier, the arbitrary prescription of a number of barrier performance standards is, at best, unnecessary, and at worst, counterproductive, in the sense that a repository system which can be shown to have a very large overall margin of safety might well be judged unacceptable in a licensing proceeding due to a deficiency in only one part of the system.

It goes without saying that such a result would have an undesirable impact on a program of national importance, both in terms of schedule and cost.

We believe this issue must be dealt with by the Commission, in view of the fundamental role it plays throughout the rule as written, and appreciate this opportunity to comment. We wish at this time to endorse the more detailed comments on the proposed rule submitted by the Utility Nuclear Waste Management Group on November 2, 1981.

Staff Response to Comment No. 55:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. See also Overview, Section 5.4, Reasonable Assurance.

Comment No. 56: Northeast Utilities (79)

Alternative Approaches; Systems Approach vs. Barrier Performance Objectives

While it is generally agreed that the use of particular nuclide barriers and other features -- such as a reasonably long-lived waste package, a stable waste form and an appropriate geologic setting are integral components of the repository system, the basic consideration is assurance that these barriers and repository system features operate in a way that provides control over the release of radioactive materials to the accessible environment over time.

On this basis, the NRC barrier performance requirements approach, as contained in the current proposed regulations, appears to be without scientific or technical support. Also, it is unclear that the inclusion of such component requirements increases the ability to show compliance with an overall system performance requirement.

We strongly believe that overall repository performance should be addressed directly by means of a systems approach. This would provide for appropriate design flexibility to take advantage of new developments as they occur and to effectively utilize the specific site characteristics.

In particular, use of standards such as proposed by EPA in 10 CFR Part 191 would provide a unified, supportable basis for regulation and, would minimize the possibility of conflicting regulatory requirements. Utilization of a systems approach, based on overall system performance standards, would have the additional advantage of being universally applicable to all geologic repositories.

Staff Response to Comment No. 56:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 57. State of Mississippi, Department of Natural Resources (65)

We agree with NRC's selection of alternative #2 regarding the detail of performance criteria. The design and construction should be based on existing knowledge and technology and should not depend on future breakthroughs.

Staff Response to Comment No. 57:

See Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 58: Dr. F. L. Parker (80)

Alternative Performance Criteria

The first question to be answered is which of the three alternatives NRC should adopt - a single overall performance standard that would be equivalent to the EPA standard; minimum performance standards for each of the major elements as well as meeting the EPA standards; or detailed numerical criteria on the critical engineering attributes of the repository system. As is now known, NRC has chosen the second on the basis that this would be easier for it to implement. This route leads to three of the four technical requirements - the thousand-year waste package containment time, the thousand-year groundwater travel time in the undisturbed environment, and 10^{-5} annual release rate.

I think that one of the major failures in the NRC approach is that the three designated numerical criteria relate neither to a curie release to the environment nor to a dose to the population which should be the major objective of the regulation, as indicated in the purpose, Sec. 60.101. According to the simulations by Burkholder, Cloninger, Sutcliff, etc., the use of these three numerical values in modeling schemes gives results that would appear to meet even the most restrictive EPA requirements.

I believe that the NRC route, provided that the rule is amended to allow negotiable performance criteria, is the best route because it allows DOE to proceed now to design waste package systems and repositories. If during the design phase, DOE finds that the costs to meet these criteria are exorbitant, then they can negotiate with NRC. NRC should also include in their rule limits on radioactive control similar to those included in Apperdix I to 10 CFR 50. If that $1,000 (or something similar) per man-rem were made part of the regulations, it would facilitate negotiations. The consequences of following the first approach are also clear. The EPA standard is not yet published. There is still opportunity for drastic revision. Are these the numbers toward which DOE should be designing? How do they proceed now? What do they do when they come to the NRC hearings with a single overall measure and each step in the modeling process is challenged and the uncertainty in each of these numbers, the leach rates, the waste package life, the K_Ds, the water flow times are debated.

If acceptable values or ranges of values for these parameters are negotiated beforehand and protocols for determining them are established, then the licensing process should be far smoother while still protecting the public health and safety.

Staff Response to Comment No. 58:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. See Overview, Section 5.5, for a discussion of standards based on population vs. individual dose. 10 CFR Part 50, Appendix I refers to meeting the ALARA criterion for power reactor effluents. Because the ALARA principle is not part of the performance objectives, for reasons explained in our analysis of ALARA (see Overview, Section 2.5), a direct parallel to Appendix I would be inappropriate.

Comment No. 59: Penberthy Electromelt International (61)

I prefer alternative 2 which prescribes minimum performance standards for each of the major elements, as long as there are only two major elements. The waste package element includes a top quality waste form, monolithic shape, with inert glass cladding. The other element is the physical barrier such as 100 feet of dirt or rock or two feet of seismic boat wall topped with ten feet of dirt.

Staff Response to Comment No. 59:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

MULTIPLE BARRIERS APPROACH:

Comment No. 60: J. Hamstra, Netherlands Energy Research Foundation (6)

Different explanatory texts are selected here to summarize that the Nuclear Regulatory Commission's approach for disposal of H.L.W. in geologic repositories is basically

- that the repository must consist of multiple barriers,
- that the waste form and other engineered barriers are elemental to the performance of the repository system,
- that each of the engineered features has to meet their specific performance objective,
- this because the geologic setting (i.e., the natural barrier) does not inspire the Commission's confidence, by reason of uncertainties.

My comments on the NRC's multibarriers approach is that it may be a good technical approach in case of a HLW-emplacement in a permeable host rock but that it certainly is not an appropriate approach for a HLW-repository to be mined in a salt dome.

There is only one general approach for a mined HLW repository in any type of host rock and that is the overall system approach. It is irrational to assume that one single engineered component out of a total system of components will have to perform the isolation or containment capability of that system without any assistance from the other repository system components. Especially the natural components such as the host rock containment shield surrounding the repository and the geologic environment surrounding and overlying the host rock can never be made ineffective.

It is only by means of an iterative process of safety assessment and repository system improvement that the relative importance of the different components to the overall systems can be evaluated.

Staff Response to Comment No. 60:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 61: American Nuclear Society (20)

In evaluating multiple barriers, NRC has considered three alternatives. These are:

1. rely entirely on the natural barriers of the site to meet the system performance standard;

2. rely entirely on engineered barriers to meet the system performance standard; and

3. rely on a combination of engineered and natural barriers to meet the system performance standards. 46 Fed. Reg. 35281 (July 8, 1981).

Alternative Nos. 1 and 2 were abandoned by NRC because of (1) uncertainties in the natural barrier performance under the stress of waste-induced changes, and (2) avoiding "unduly constraining system design."

In adopting Alternative No. 3, NRC states (see, Enclosure J at 26)* that the "staff decided to set a long-term release rate for the underground facility and waste packages working together," without mention of the natural barriers as a part of the system. This is not Alternative No. 3; but rather a more tightly constrained Alternative No. 2.

The concept of the repository as a radioactive waste isolation system requires consideration of the contribution of all barriers in arriving at a regulatory decision. Each repository site will be able to place differing reliance on the natural barriers and, therefore, the site-independent numerical subsystem performance specifications stated in Sections 60.111 and 60.112 should be withdrawn.

EPA in its working draft of 40 CFR Part 191 (1981) has commented on the system concept in several places. Specifically, EPA's draft notes: "We believe that making the overall disposal system meet numerical performance requirements by taking advantage of substantial protection from each of its components will provide adequate protection most economically" (40 CFR Part 191 at 13). This concept more nearly complies with Alternative No. 3 than specific numerical design specifications for each subsystem or component.

Staff Response to Comment No. 61:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 62: M. J. Fisher (39)

I must strongly disagree with your multiple barrier philosophy. Didn't Lyons, Kansas teach you a lesson? From a practical standpoint, it may sound good, but for the time spans and depths you are concerned with, the site is the most important issue. If DOE can do a good investigation of the site including all the critical parameters and processes, then the repository's performance can be conservatively determined.

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*Enclosure J, Commission Paper SEC-81-267, Rationale for Performance Objectives and Required Characteristics of the Geologic Setting (April 27, 1981).

Staff Response to Comment No. 62:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 63: R. A. Van Konynenburg, Lawrence Livermore Laboratories (15)

I note that the Commission has endorsed the multiple barrier philosophy, which I agree is the most prudent approach. However, I am concerned with the way in which the Commission has chosen to distribute the reliance to be placed upon the several barriers. In particular, I do not believe it is either necessary or reasonable to require that "reasonable assurance" be given that "the waste package will contain all radionuclides for at least the first 1000 years after permanent closure." Neither do I believe that it is possible for anyone to give such assurance. Instead of the 1000-year limit as proposed, I would suggest that the containment period be shortened to consist only of the period during which the retrievability option is to be preserved, namely 110 years, and that the degree of containment be set at a reasonable minimum, such as 99% of each radionuclide, rather than "all radionuclides."

Staff Response to Comment No. 63:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. See also Overview, Section 5.4, Reasonable Assurance.

Comment No. 64: U.S. DOE (48)

We wish to reemphasize our support for the development of a multibarrier repository system. This concept is basic to our waste isolation program, as is the development of a high-integrity long-lived waste package. However, we believe that inflexible numerical criteria for individual components should not be established at this time but instead specifications should be derived from an overall system performance standard and supported by technical justification for a specific site.

Staff Response to Comment No. 64:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 65: P. C. Cahill, U.S. EPA (68)

EPA endorses the proposed use of multiple barriers for these repositories. This is an approach that will be incorporated in EPA's own forthcoming standards for high-level nuclear waste disposal. As we commented earlier, we are concerned that the emphasis of the proposed rule is on engineered barriers

rather than on favorable geology. The proposal presents specific numerical requirements for the waste package, the leachability of the waste, and the travel time of water from the repository to the accessible environment. We think that you should consider guidelines relating to such geological properties as sorption. We urge the Commission to extend the multiple barrier approach to the geology and geochemistry of the disposal site.

Staff Response to Comment No. 65:

The staff does not agree with the interpretation that geologic factors are not as important as engineered factors. Both are important components of a multiple barrier approach that has been adopted to achieve confidence that the overall system performance objective (the EPA standard) is met. (See Overview, Sections 1.3 and 2.1, Purpose of the Technical Criteria and Single vs. Multiple Performance Standards, respectively.) NRC has not placed numerical performance standards on geochemical sorption because of the large uncertainties associated with measurement of such effects. (See Part C for a discussion of uncertainties associated with both geology and engineering.) However, geochemical sorption and other geologic factors would need to be evaluated and would be taken into account in assessment of overall performance of a particular site.

Comment No. 66: Dr. F. L. Parker (80)

Defense in Depth

As has been noted in many studies of the radioactive waste disposal problem, there will always be residual uncertainties. To provide a safety factor to compensate for this uncertainty, a multiple-barrier system has many advantages. Since we cannot answer the global problem and predict every possible combination of circumstances that might cause releases of waste, multiple, independent mechanisms of slowing or limiting the discharge of radioactive materials to the environment are desirable.

Staff Response to Comment No. 66:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. The staff agrees with this comment on the appropriateness of the multibarrier (defense-in-depth) approach.

Comment No. 67: Westinghouse Corp. (54)

Westinghouse endorses the use of a multiple barrier approach to waste isolation, including the use of engineered barriers, but we consider that the designer should specify the engineered barriers and associated requirements

necessary to meet the overall performance objective for the geologic repository system; namely, the EPA standard. Thus, we disagree with the NRC approach of setting rigid numerical requirements on individual system components, which are not only arbitrary but also tend to establish the specific components to be included in the system. This position is based on a number of reasons including the following:

1. The number of system components, the degree of redundancy, and the performance requirements placed on the system components depend on a number of factors including the characteristics of the site, the characteristics of the waste, and the performance characteristics of the individual engineered components. Thus, a single set of component performance criteria, as proposed by NRC, is not necessarily appropriate for all situations. For example, if waste having a low heat generation rate (causing a very low thermal pulse in the geology) and a relatively low proportion of long-lived actinides is placed in a repository having highly favorable characteristics (e.g., a very long water travel time), then the need for 1000-year containment and a release rate of one part in 100,000 is highly questionable. Another example is the use of a container having a very long life that is achieved by a favorable combination of material and geochemical environment. If the expected life of the container is several hundred thousand years, then the requirement on the waste form can be relaxed.

2. The use of a single set of rigid component performance criteria does not permit the use of trade-offs within the system, thereby precluding innovation by the designer and the use of future technological developments and improved understanding of geologic processes to reduce costs while maintaining the same overall system of performance.

3. The 10 CFR 60 rules pertain to a single applicant and to a few repositories that will be constructed several years in the future. It seems entirely reasonable for the NRC to evaluate a proposed repository system design on its individual merits at the time of application, rather than prejudging at this time what the system components should be and what requirements should apply to the components.

4. While safety must be the principal concern in designing a repository system, cost cannot be dismissed as a factor. The rule must be sufficiently flexible to allow the achievement of safety goals in a cost effective manner.

5. A multiple barrier system implies redundancy; that is, satisfactory system performance is not dependent upon a single component of the system. The level of redundancy provided depends on a number of factors, but ultimately it is based on a judgment made after weighing all of the pertinent factors. The rule should be sufficiently flexible to permit the exercise of that judgment on the part of both the applicant in deriving a design and the NRC in evaluating the design, based on available information.

While we strongly object to including in the rule rigid requirements on individual system components, we also understand that the NRC must be able to establish a basis for concluding that the health and safety of the public will be adequately protected and it is appropriate for the NRC to communicate the factors it currently considers important in establishing that basis. Therefore, it may be appropriate to include in the rule performance guidelines, in the form of design objectives for individual system components, that the NRC currently considers acceptable, together with a clear statement that alternatives will be considered as long as the NRC can establish a satisfactory basis for concluding that the issuance of a license will not constitute an unreasonable risk to the health and safety of the public.

Staff Response to Comment No. 67:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 68: B. Houston, Hamilton & Assoc. for The American Ceramic Society (75)

Multiple barriers provide increased assurance that wastes will be contained during their high toxicity period. There are at least four barriers during this period...the waste form, the engineered package, the hydrology and the geology. This redundancy is more than needed. Most analysis that we have seen have indicated that two barriers are sufficient for considerations other than for a well drilled into the repository. The question then becomes, "how much are we willing to pay in order to reduce a low probability but high risk incident for a few individual(s)?" Since waste packages can be expected to cost $10 to $100K each; and there are about 14 packages (PNL-3838) per reactor per year; and a repository will hold about 4000 reactor years of waste (NUREG-0116); the cost per repository would then be about $0.5 to $5 billion. We feel that this sum of money could be better spent to save many more lives in other areas of society, such as automobile safety. Such trade-offs between cost and safety do not appear to have been sufficiently considered in formulating the regulations.

Staff Response to Comment No. 68:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. The overall level of safety will be set by the EPA standard. EPA will consider trade-offs in costs and health effects in establishing this standard. The performance objectives and siting and design criteria of 10 CFR Part 60 are needed to have confidence that the EPA standard will be met.

Comment 69: Penberthy Electromelt International (61)

The nation cannot afford too many multiples of barriers. Three are justified but not more. The first barrier is the use of a high durability alumino-silicate glass as the radwaste host. The glass composition should be similar to the Atomic Energy of Canada Ltd composition buried in the soil in 1960 with monitored excellent results. Alumino-silicate glasses of this type form a protective skin after 100-200 days of leaching, and show distinctly superior resistance to peformance when compared with the soft borosilicates previously planned (Penberthy 1981).

The next justifiable barrier is to have the waste glass annealed to a monolith rather than allowing it to shatter by uncontrolled cooling. Savannah River Laboratory is planning to allow their glass castings to shatter, which has the disadvantage of increasing the surface area available for leaching by a factor of 100 to 1000. Retention of the monolithic shape is easy and reasonable in cost to attain, and there is no reason why this should not be done.

I realize that the NRC in 10 CFR 60 is working to a perceived objective rather than to particulars such as monolithic versus shattering, but annealing to a monolithic block is in simple accordance with the as-good-as-reasonably-achievable principle.

Another barrier which should be contemplated is physical isolation. This can be accomplished quite adequately without going 1000 feet down. A tunnel bored into a rocky structure where the inner end of the tunnel is say 100 feet below the rock surface is a formidable barrier against intrusion. The heavy concrete portal and concrete plug at the entrance provide a sufficient barrier against accidental intrusion.

With the above system, the canister is used only for processing and transportation. It can be made of mild carbon steel rather than an alloy steel. It is easy to coat the steel with a rust preventative coating such as zinc or nickel, but it can be remembered that carbon steel does not rust when its temperature is significantly above the dew point.

In the event there is no significant hill at the place where the wastes are glassified, then the storage can be in a seismic boat. This seismic boat is a concrete building resting on a concrete slab with a one-inch layer of sand between the slab and the floor of the boat. In the event of an earthquake, the earthquake forces cannot be transmitted to the boat through the sand slip layer.

Staff Response to Comment No. 69:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document The design suggestion contained in this comment should be directed to DOE.

THE SYSTEMS APPROACH:

Comment No. 70: I. Remson (13)

Every committee and every panel that I have been involved with over the past few years has been unanimous in arguing the need for a systems approach. In short, a single standard should be applied to the entire repository with perhaps the requirement that multiple barriers be used. The latter is to ensure that more than one barrier be used even if a single barrier is capable of meeting the standard. Of course, in the optimization of each repository and site, constraints specific to that site would be used for the individual barriers in order to constrain the total system optimization. In this way, the best advantage could be taken of the components of each site and of their interactions to produce a suitable repository.

Without adequate justification, the systems approach is abandoned in favor of an approach that places fixed specifications on each component of the repository regardless of the site. This ignores all differences between sites and ignores all possibility of inconsistencies and redundancy in the treatment of the components.

Unfortunately, the component approach is consistent with the document's philosophy of giving virtually no containment credit to the geology or hydrology, and this will result in far less secure and far more expensive repositories. For example, no one should pick a site where the groundwater travel time to the biosphere is 1,000 years (the component specification) or even 10,000 years. Who is going to spend money on reinforcing geologic barriers suitable for a site when his budget will be exhausted by engineering the 1,000-year package whether it is needed or not? Besides, he will receive no credit for anything he does to improve the geologic barriers.

On entering the business of component specification, the authors of this document were forced to consider a variety of technical areas having very difficult technology. It is not surprising that the discussions of such components sometimes display lack of logic, dubious terminology and a lack of awareness that what has been proposed cannot be implemented. Many examples were cited at the ONI panel workshop and they should be documented in the ONI report.

Staff Response to Comment No. 70:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. See also staff response to Comment No. 65.

Comment No. 71: American Nuclear Society (20)

The American Nuclear Society (ANS) respectfully submits that the proposed regulation should be withdrawn or, at a minimum, extensively revised.

ANS is of the concerted view that the draft regulation should apply the systems concept, instead of the present stress on subsystems, and as recommended by the Environmental Protection Agency (EPA) in the March 19, 1981, Working Draft of 40 CFR Part 191.* Further, the present draft regulation contains significant sections, with related arguments, that are technically unjustifiable and that overly constrain the design of specific components and subsystems.

The concept of the repository as a system requires consideration of both natural and engineered barriers in arriving at a regulatory decision. Each repository site will differ in the reliance that can be placed on natural barriers and, therefore, varying degrees of compensating design margins through engineered systems should be permitted. The designer should not be constrained from optimizing these relationships by the imposition of "design specifications" or subsystem numerical performance requirements such as those stated by the Nuclear Regulatory Commission (NRC) in the proposed rule.

ANS strongly recommends that all subsystem numerical performance requirements be deleted in favor of more general performance objectives which would permit subsystem trade-offs to achieve the desired overall repository system performance. Specifically the following values should be deleted:

1. 1,000-Year Waste Package Life (Section 60.111(b)(2));

2. 10^{-5} Long-Term Release Rate (Section 60.111(b)(2)(ii)(A));

3. 1,000-Year Undisturbed Water Travel Time (Section 60.112(c)); and

4. 50-Year Retrieval Time (Section 60.111(a)(2)).

Staff Response to Comment No. 71:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. See also staff response to Comment No. 46.

Comment No. 72: American Nuclear Society (20)

ANS is of the concerted view that the present draft regulation should apply the systems concept instead of the present stress on subsystems, and contains significant sections, with related arguments, that are technically unjustifiable and overly constrain the design of specific components and subsystems. Therefore, the proposed regulation should be withdrawn or, at a minimum, extensively revised. The following general conclusions are made:

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*Environmental Protection Agency, 40 CFR Part 191 (1981), Environmental Standards and Federal Radiation Protection Guidance for Management and Disposal of Spent Fuel, HLW and TRU Wastes, Working Draft 19 (March 19, 1981).

- With regard to the regulatory approach and the technical criteria alternatives, Alternative No. 1 or a single overall repository performance standard is more acceptable. Overly restrictive component and subsystem performance standards are not necessary and are likely to add to the overall cost of waste disposal, without achieving any significant degree of benefit to the public health and safety.

- The concept of the repository as a radioactive waste isolation system requires consideration of the contribution of all barriers in arriving at a regulatory decision. Each repository site will be able to place differing reliance on the natural barriers and, therefore, design margins through engineered systems should be provided on a site-specific basis.

- NRC has placed undue emphasis on the nature of the uncertainties associated with the transport of the waste through the geosphere to the exclusion of other important considerations. Such uncertainties can be ascertained and made inconsequential by bounding analysis and design.

- Analyses have shown that NRC's stipulated 1,000-year waste-package containment period results in relatively no benefit for reduction in radionuclide releases as compared to that for the natural barriers.

- The setting of annual release rates for radionuclides would be better handled through the establishment of an overall repository release limit by incorporating this limit in an overall system performance standard.

- In the absence of analyses justifying 1,000-year water travel time for differing site-specific characteristics and a clear definition of "accessible environment," the validity of this numerical value is questionable.

- The retrievability concept reflected in the current NWTS position presents a logical approach for satisfying the retrievability objective and is more appropriate than the proposed 50-year period.

ANS strongly recommends all subsystem numerical performance requirements be deleted in favor of more general performance objectives which would permit subsystem trade-offs to achieve the desired overall repository system performance.

Specifically the following values should be deleted:

1. 1,000-Year Waste Package Life;
2. 10^{-5} Long-term Release Rate;
3. 1,000-Year Undisturbed Water Travel Time;
4. 50-Year Retrieval Time;

Staff Response to Comment No. 72:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. See also Overview, Sections 2.2 and 4.1, Retrievability and Accessible Environment/Controlled Area, respectively.

Comment No. 73: Stearns-Roger (51)

We endorse the basic comments and position of the American Nuclear Society as stated in its letter of October 14, 1981. Specifically, an overall performance criterion for the entire repository system would be superior to the individual subsystem performance criteria in the proposed rule.

Staff Response to Comment No. 73:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 74: Institute of Electrical and Electronics Engineers (28)

We support the need for these rules. We believe that the proposed rules identify and address relevant issues in the disposal of high-level and transuranic wastes.

We are concerned, however, with the lack of a systems approach in criteria for individual components of the repository system. Analytical models of repository safety performance exist and can be used to reflect the interactions between repository components. The site selection and performance criteria should more fully reflect the fact that alternative combinations of parameter values can satisfy health and safety objectives. Under some circumstances, for example, relatively high leach rates can be compensated by advantageous factors in radionuclide retardation or travel time, without causing an unacceptable increase in future dose.

You may wish to indicate that the Waste Isolation Pilot Plant for disposing of defense transuranic waste is absolved by law from compliance with these rules.

Staff Response to Comment No. 74:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 75: F. S. Feates, Department of the Environment, UK (29)

In taking account of the many technical factors to be considered in a choice between the several options for creating a repository for heat-emitting wastes, we have adopted a systems study approach in order to bring together the many

areas of research and operation. As a result we would not wish to set down specific criteria or defined levels for all variables, because these levels will differ from site to site. We think it advisable for any regulatory procedure to make allowance for natural variation.

Staff Response to Comment No. 75:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 76: Virginia Electric & Power Co. (64)

The major concern with the NRC's proposed rule is the use of specific barrier performance objectives for repository components rather than the use of overall system performance objectives. The selection of the current barrier performance standards, i.e , 1,000 year waste package life and 1,000 year water travel times to the accessible environment, appear to be an imposition of arbitrary standards without scientific or technical support. The use of individual performance standards is also at odds with an important factor of sound repository design and operation; the interaction of individual components to achieve, on a combined basis, the required level of repository system performance. Use of an overall system performance standard would focus attention on total repository performance while permitting appropriate design flexibility to take advantage of new developments and permit the use of specific characteristics for individual sites.

Staff Response to Comment No. 76:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 77: U.S. DOE (48)

The Department agrees that the Commission must establish the philosophy in developing this regulation from among alternatives such as those posed in the Federal Register notice. We would find a position closer to alternative 1, as proposed by the Commission in the Supplementary Information Section, to be more appropriate. We are concerned that the imposition of inflexible intermediate component performance requirements as now proposed in the Federal Register notice would distract both the NRC staff and our own from the central issue of the licensing process, which is that of demonstrating that the public health and safety will be protected. The alternative language we have proposed in the enclosure would allow the Department, as a license applicant, to propose performance objectives for the several subsystems on a site-specific basis. These detailed objectives would then reflect the results of site-specific investigations and an improved understanding of the required performance of each individual component.

A second concern is with the treatment of transuranic (TRU) wastes in the proposed rule without appropriate consideration of the comparative hazard of these wastes, relative to high level wastes. We suggest that TRU wastes be eliminated from the rule with provision that they would be considered on a case-by-case basis, with reasonable assurance that the functional performance of the repository system would not be significantly compromised by emplacing TRU wastes in a repository

Staff Response to Comment No. 77:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. See also Overview, Section 3.2, Transuranic Waste (TRU).

Comment No. 78: Commonwealth Edison (17)

The "systems approach" is not only essential but it has been supported by the IRG and all other major government studies. This means the establishment of a performance criterion for the entire repository system. The multi-barrier approach is acceptable, however, arbitrary criteria for the performance of individual barriers is unacceptable.

We do not contend that the geologic barrier is adequate to assure absolute isolation in all design cases. We do recognize that the various barriers can and should contribute.

However, any arbitrary performance criteria will restrict the flexibility of the designer.

Staff Response to Comment No. 78:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. See also staff response to Comment No. 52.

Comment No. 79: Exxon Nuclear Co. (58)

We continue to support the view that the NRC should establish appropriate criteria and standards for the performance of the overall system, rather than defining specific performance values for individual components.

It is encouraging to note that the NRC has now agreed to consider three alternative approaches in which alternative 1 is consistent with our earlier recommendation. Alternative 2, which appears to be a hybrid between the overall approach alternative 1, and the detailed approach alternative 3, seems to be now preferred by the NRC as offering a reasonable and practical compromise. It is also consistent with the approach proposed in the rule governing disposal of low level waste, 10 CFR 61. However, after careful consideration of the Commission's

comments and logic supporting their preference for alternative 2, we continue to support the overall approach represented by alternative 1 for the following reasons:

1. If the minimum performance standards cannot be met for one of the major components of the system, no allowance is provided to compensate for this by exceeding the standard in another major component in a manner which preserves the overall performance.

2. Site specific characteristics cannot be used to advantage in designing the waste package or underground facility.

3. The ultimate requirement in the performance objective approach is the meeting of EPA's generally applicable environmental standards during all times that the overall system must protect the environment and public health and safety. How this is accomplished by combining the major components should be left to the designer to balance the considerations of cost and system effectiveness

The NRC states that alternatve 2 substantially enhances their confidence that the overall standards will be met. It is not stated how this confidence is enhanced. Any degree of confidence could be specified by establishing a requisite confidence level in the overall performance standard. This is not an uncommon approach in designing other systems which have risks. In addition, the Commission would be able to review the designer's values for each component, including technical bases and uncertainties, and with that information be assured that the overall performance objectives are met.

With the above approach, the individual performance standards can be retained as guides for the designer with departures properly justified by engineering analyses.

Staff Response to Comment No. 79:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. See also Overview, Section 5.4, Reasonable Assurance.

Comment No. 80: Edison Electric Institute (56)

In particular, EEI wishes to emphasize the view expressed in the comments [i.e., those of Utility Nuclear Waste Management Group] that the NRC should utilize the systems approach (identified as "Alternative 1" in the notice of rulemaking) rather than the barrier performance objectives approach ("Alternative 2"), which is the basis for the rule as currently proposed. EEI believes that the specific requirements for separate components and subsystems prescribed in the proposed rule are not only unnecessary, but would deny the DOE reasonable flexibility in achieving overall system safety and performance objectives. Accordingly, EEI urges that, in adopting a final rule, the NRC select the approach embodied in Alternative 1 rather than that of Alternative 2, which is now reflected in the rule as proposed.

Staff Response to Comment No. 80:

See Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 81: J. Carson Mark, Advisory Committee on Reactor Safeguards (10)

Prescription of Criteria for a Repository

We agree that the rule must include an overall safety goal or objective for the repository. However, only minimum performance standards for each of the major elements are needed. Although we favor the approach that has been taken, we believe that the interpretation of the numerical standards needs further clarification. Additional comments on this matter are given in Section 3.a of this report.

Staff Response to Comment No. 81:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document.

Comment No. 82: American Nuclear Society (20)

It is our concerted view that overly restrictive and specific performance standards are not necessary, and that such standards in regulation form are likely to add to the overall cost of waste disposal without achieving any degree of benefit to the public health and safety. Instead, using current engineering practices, a carefully sited, engineered, and designed repository coupled with effective confirmation and design validation can assure compliance with a single, overall performance criterion for the repository as a whole system. The application of such a single performance standard would not only coincide with the Environmental Protection Agency's recommended approach of the systems concept, but would permit repository designers to optimize the repository as a system of both natural and engineered barriers for differing site and geologic medium characteristics.

Staff Response to Comment No. 82:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See Part C, which contains the rationale document. See also response to Comment No. 46.

Comment No. 83: Northeast Utilities (79)

These comments are submitted on behalf of Northeast Nuclear Energy Company (NNECO) and Connecticut Yankee Atomic Power Company (CYAPCO) the operators of the Millstone 1 and 2 and Connecticut Yankee nuclear power plants. We commend the NRC on its effort to address permanent disposal of high-level waste, an

issue which is of vital importance to the future of nuclear power development in the United States. However, we have serious concerns with the proposed assignment of specific, quantitative performance requirements for system components. Establishment of performance requirements for the waste repository system as a whole would still maintain system performance while permitting flexibility in the design and construction of system components to effectively utilize site-specific characteristics and thereby reduce repository costs.

Staff Response to Comment No. 83:

See Overview, Section 2.1, Single vs. Multiple Performance Standards.

4. THE ISSUE OF HUMAN INTRUSION

Comment No. 84: J. Hamstra, Netherlands Energy Research Foundation (6)

In general the Commission's approach to the Human Intrusion question is a very rational one. A difficult future access to the emplaced waste, once the burial facility is closed down and sealed, helps to discourage people from intruding into a repository of which the knowledge of existence is still there. In this respect it might be more encouraging if the waste is known to have been emplaced in a retrievable way.

The resource value of the spent fuel that was declared a waste and of thick-walled canisters of precious material are to be considered in combination with such a retrievable disposal system, because they often go together in present-day plans. However, a possibility of deliberate intrusion should not be considered too seriously, such that everything is to be done to discourage a future generation to do so. It is the responsibility of future generations to decide whether the hazards are worth the benefits.

The inadvertent intrusion should be considered more seriously, but as is stated in the proposed rules the scientific and technical capability required to recontact the wastes at greater depths will also enable the explorer to recognize in time what man-made anomaly he is encountering.

Comment No. 85: J. Carson Mark, U.S. NRC Advisory Committee on Reactor Safeguards (10)

We believe the treatment of this subject is well done. We recommend retention of the existing text.

Comment No. 86: Institute of Electrical and Electronics Engineers (28)

The NRC requested comment on its approach to the human-intrusion question. The approach taken in the Proposed Rule generally seems reasonable.

The discussion is believed, however, to overstate the reliability of transfer of human knowledge. The fact that knowledge exists in one group of people does not guarantee the transfer of that knowledge to all potential intruders.

In addition, the possibility should be recognized that intentional intruders might be aware of the presence of radiation but indifferent to its dangers. One can cite several recent situations in which this attitude has existed (e.g., use of uranium mill tailings for construction, diversions of materials from the Beatty waste-disposal site).

Finally, deliberate intrusion is not believed to require a conscious collective societal decision. All that would be required is the failure of institutional control, plus a group of dedicated individuals.

Staff Response to Comment Nos. 84-86:

See Overview, Section 2.6, Human Intrusion.

Comment No. 87: Utility Nuclear Waste Management Group (44)

Human Intrusion

The treatment of this subject is proper and should be preserved in the final rule. In this same general connection, however, UNWMG believes that the importance of avoiding natural resources, in the siting of a repository, is overemphasized. This point is considered in additional detail in the Attachment to this letter.

Comment No. 88: Northeast Utilities (29)

The treatment of this subject is proper and should be preserved in the final rule. However, we believe that the importance of avoiding natural resources in the siting of a repository is overemphasized.

Comment No. 89: U.S. DOE (48)

Issue

Deliberate and Inadvertent Intrusion.

DOE Position

The Commission's discussion of deliberate intrusion and inadvertent intrusion in the Supplementary Information of the proposed rule is well-reasoned. The Department supports the Commission's position on this issue.

We endorse the Commission's position and feel the general approach to human intrusion set forth in the Supplementary Information, e.g., avoiding resources to diminish the likelihood of inadvertent intrusion and using long-term communication and identification measures, is reasonable. The potential for exploiting mineral, energy, water, and subsurface land-use resources both now and in the future will be assessed throughout the site-selection process (i.e., via site selection criteria for the National Waste Terminal Storage Program). Beyond site selection factors, additional protective measures will be used to communicate knowledge of the existence and location of repositories to future generations.

Discussion

We endorse the position of the Commission as stated in the Supplementary Information but have a concern with respect to the Commission's consideration of resources presented under "Potentially adverse conditions," section 60.123(b)(3). Our concern is explained in the section-by-section comments on section 60.123.

A Licensing Topical Report to be issued by DOE will elaborate on long-term communication measures the Department could use to forewarn future societies of the existence of repositories, e.g., monuments.

Staff Response to Comment Nos. 87-89:

The staff believes that natural resources are an important consideration in the siting of a geologic repository. Further, the staff believes that directing site selection toward sites having little resource value is a reasonable measure to take to discourage human intrusion into a geologic repository. In the staff's judgment, the emphasis on avoiding natural resources is correct, especially in view of the fact that the resources are treated along with other characteristics of the geologic setting in review of favorable and potentially adverse conditions.

Comment No. 90: C. Walske, Atomic Industrial Forum (50)

The discussion of human intrusion is logical and practical and places this issue in clear perspective; namely, that intrusion into the repository is a low probability event unless it is the result of a deliberate and conscious decision to do so in which case proper precautions will be taken. This conclusion is based on the requirements proposed in 10 CFR 60, which call for selection of sites having minimal resource value, reliable documentation of the site, and the placement of appropriate site markers. Thus, in response to the request for comment on this approach, we conclude that the proposed approach to the human intrusion issue is reasonable.

Staff Response to Comment No. 90:

See Overview, Section 2.6, Human Intrusion.

Comment No. 91: Duke Power Co. (55)

In particular, we believe the issues of human intrusion, population-based siting requirements, and ALARA considerations are appropriately treated in the proposed rules.

Staff Response to Comment No. 91:

See Overview, Section 2.6, Human Instrusion. See also Overview, Sections 2.4 and 2.5, Population-Related Siting Criteria and ALARA, respectively.

Comment No. 92: R. H. Neill, State of New Mexico (78)

Human Intrusion (§60.51 and preamble)

The coverage of human intrusion is generally well done and complete. We do have two comments:

1. Deliberate intrusion would not necessarily require a conscious collective societal decision. All that would be required would be the failure or absence of institutional control, plus a group of dedicated and competent persons.

2. We do not agree with the statement "once the site is selected, marked, and documented, it does no use to argue over whether these measures will be adequate in the future..." Society would always have the ability to continue or to reclaim positive institutional control over a site if the need is indicated. It is noted that no specific time period for control (e.g., the 100 years being suggested by EPA) is mentioned in the proposed rule. We believe it is not necessary at this time to make an arbitrary determination of the length of time that positive institutional control will be maintained over a site. However, before a final decision is made to relinquish control there should be a thorough evaluation of the benefits and costs of continued positive control.

Staff Response to Comment No. 92:

See Overview, Section 2.6, Human Intrusion.

Comment No. 93: F. S. Feates, Department of the Environment, UK (29)

In regard to problems of human intrusion into a repository, our view is that institutional controls are required only over that period during which the hazard is primarily due to the fission products. Similarly, our existing control over potential repository sites does not take into consideration present-day population distribution, since we cannot predict population changes in the future.

Staff Response to Comment No. 93:

The regulations specify controls which are designed to minimize the risk of intrusion during any period when such intrusion may result in significant releases of radionuclides to the general environment. Because such consequences are not limited to the period when this hazard is primarily due to the fission

products, the staff believes the duration of the controls should not be limited, as proposed by the commenter. Therefore, monuments are appropriately required (under § 60.51(a)(2)) to be designed to be as permanent as practicable. See also Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 94: National Radiological Protection Board, UK (29)

Human Intrusion - It is reasonable to distinguish between deliberate intrusion and inadvertent intrusion, and to ignore the former possibility when setting criteria. However, the probability and consequences of inadvertent intrusion should be considered when setting technical criteria such as the minimum disposal depth, and in specifying site selection and marking requirements. The statement (p. 35283, column 2, para. 2) that it "does no use to argue" over measures designed to prevent intrusion or to "speculate" on intrusion scenarios is inconsistent with the discussion which precedes it. Such arguments and speculations should play a part in deciding whether a repository is acceptable.

Staff Response to Comment No. 94:

See Overview, Section 2.6, Human Intrusion.

Comment No. 95: Mississippi Dept. of Natural Resources (65)

Page 35283, Columns 1 and 2

We agree that site selection should be directed toward sites of little resource value or scientific interest and for which there is no attraction for future societies. If this criterion is to be followed, then this would tend to eliminate salt domes since they are potential sites for: solution mining of salt; storage of hydrocarbons, gases, or pumped air; sulfur extraction; oil and gas exploration; and geothermal energy activities. It would seem that bedded salt would better fit the requirement. Although we cannot offer any alternative approaches to the Human Intrusion question, we do not believe that the resource potential of the Mississippi salt domes has been adequately assessed in the NWTS Program to date. We have reason to believe that oil and gas resources may exist that have not been explored for yet.

Staff Response to Comment No. 95:

See response to Comment No. 99.

Comment No. 96: T. H. Pigford (53)

The proposed criteria are written to direct site selection towards sites of little resource value and for which there does not appear to be attraction for future societies. The consideration is worthwhile. While it is difficult to make meaningful predictions of what will constitute important resources several

hundred years from now, predictions on the basis of present views of potential resources would be useful guidance.

NRC also suggests that the emplaced wastes may attract future intrusion. This should appear more explicitly as a consideration in the selection of the waste package and waste form. Relevant here are the value of unreprocessed spent fuel if emplaced as waste and the value of special and expensive materials which may be incorporated in the waste package.

Staff Response to Comment No. 96:

See Overview, Section 2.6, Human Intrusion.

Comment No. 97: C. R. Fisher, General Atomic Co. (16)

The term, "little resource value," is worrisome in that it is insufficiently specific to allow one to make decisions pertaining to the acceptability of a proposed site with a requisite degree of confidence. General Atomic requests that quantitative criteria be given which allow one to assess the acceptability of a site based on its "resource value" relative to some standard.

Staff Response to Comment No. 97:

The term "little resource value" referred to in the comment is not part of the regulation but refers only in a general way to the provisions describing favorable and potentially adverse conditions in the geologic setting. See Section 60.122 and staff responses to the comments on that section, including those in the Section-by-Section Analysis.

Comment No. 98: Sierra Club (66)

The most likely long-term threat to the integrity of a high-level waste repository is human intrusion. As an example, a DOE-funded study has shown that 29 million deaths could be caused by solution mining for table salt (PNL-2955). Just the drilling for resources, and not even the removal of those materials, could undermine the integrity of a waste repository. It is therefore important not to locate a repository near perceived resources, where humans are likely to drill. We therefore propose the following wording:

> The geologic medium and the site selected for geologic disposal should be chosen to minimize the possibility of future human intrusion during periods after which the permanence of records can no longer be relied upon. Hence, neither the medium should be a valuable resource, nor should the site be located in an area where other valuable resources have been suspected or are likely to be mined.

Rather than reflect this view of perceived resources, the regulations only require an assessment of present resources near a proposed repository. Under 60.21, the application must include

> "an identification and evaluation of the natural resources at the site, including estimates as to undiscovered deposits, the exploitation of which could affect the ability of the site to isolate radioactive wastes. Undiscovered deposits..."

While we agree that present resources or potential resources should be estimated, there should also be an assessment of past resources and drilling activities.

The region as a whole must be assessed for past drilling activity and not just the immediate site. E.g., of 162 salt domes in the Gulf Coast region potentially usable for a Federal repository, 95 of these have already been drilled (Y/OWI/SUB-7414/1,p 174). This indicates that for the Gulf Coast region as a whole, there is a high probability that a salt dome will be drilled. Thus, in 60.123, a potentially adverse human activity that significantly affects the hydrogeology is drilling holes and this must be assessed in 60.124.

Staff Response to Comment No. 98:

The staff believes that the rule addresses perceived resources. A location perceived as likely to have resources that would attract intrusion normally would be classed as having resources of greater value than the average for other locations in the geologic setting. This would be a potentially adverse condition. Further, the safety analysis report prepared by DOE not only would extend to proven resources but also would include estimates of undiscovered deposits. See paragraph 60.21(c)(13). The staff believes that together these provisions accomplish the objectives identified by the commenter. See also staff response to Comment No. 99.

Comment No. 99: Calif. Dept. of Conservation (62)

Inadvertent Human Intrusion

The proposed rules in Section 60.123 Potentially adverse conditions (FR p. 35290) do not clearly address the issue of potential resources in the repository area which should be considered before siting the repository, to avoid future inadvertent intrusion into the facility. That section states "(3) Resources that have either greater growth value, net value, or commercial potential than the average for other representative areas of similar size that are representative of and located in the geologic setting."

CDC recommends an addition to this section, to read "Studies of mineral resources should be made to determine whether or not such minerals exist at the site, and if so, whether they may have strategic value during the life of the repository.

If such resources were found, their presence should be considered an adverse condition in locating a HLW repository at the site."

Staff Response to Comment No. 99.

Paragraph 60.21(c)(13) of the rule requires an assessment of resource potential of the site. This assessment must include a comparison of the site with representative areas within the geologic setting. Should the assessment show the resource potential of the site to be greater than these other areas, a further assessment would be required to show how disposal at that site would not compromise isolation (see Section 60.122 of the final rule). For example, in the case of salt domes, the resource potential of any salt dome would be greater than that of other representative areas in the geologic setting. This would constitute a potentially adverse condition and the resulting assessment to show why disposal in a salt dome should be allowed.

Additional conditions of the site such as drilling for any purpose on evidence of mining would also constitute potentially adverse conditions requiring such analysis. Thus, it is the staff's view that both the proposed rule and the final rule are responsive to the issues raised in these comments concerning the adequacy of the resource analysis requirement and past exploration as a potentially adverse condition.

Comment No. 100: J. M. de Montmollin (9)

Page 35282* - The arguments on the continuity of information transfer and relative technological capabilities are unconvincing. While much information is available from many periods over historic time, there have been long intervals during which information was lost, to be recovered only after lapses of hundreds of years. Even today, information from European civilization from the decline of the Roman Empire to the onset of the Renaissance, about 1100 A.D., is fragmentary and incomplete; it is difficult to separate fact from legend. The time since the Dark Ages in Europe is of the same order, about 1000 years, as the time considered necessary to contain the wastes.

Contrary to the assertion on page 35283, it does not follow that a future generation could logically be expected to understand the nature of the wastes and the necessary control measures merely because they had the technical capability to penetrate to that depth. Hard-rock mining at greater depths was carried out by the Romans in Cornwall, and the Chinese drilled for oil at depths of about 3000 feet centuries before the discovery of natural radioactivity. In both these examples the depths worked were much greater than the proposed repository depth.

*Page numbers refer to Vol. 46, No. 130, Federal Register, July 8, 1981.

Staff Response to Comment No. 100:

The staff recognizes that continuity of information transfer cannot be guaranteed, but considers it likely that knowledge of the repository and the hazard of the wastes can be preserved during the time the wastes are most hazardous. The staff is not relying on preservation of records alone, but on a combination of measures to reduce the risk of human intrusion into the repository, viz., selection of sites of little resource value; preservation of records of the location of the repository and the nature of the wastes in multiple offsite locations likely to be consulted by a potential intruder; permanent markers of the controlled area; and Federal government control of land and land use. However, we recognize that these measures cannot be guaranteed, and, in the final rule we allow for the consideration of human intrusion scenarios on a limited basis. See Overview, Section 2.6, Human Intrusion.

Comment No. 101: Div. of Emergency Government, State of Wisconsin (77)

Arguments involving human intrusion may well be valid, but within the past 30 years, we have evidence that "substantial continuity of information transfer over time" does not occur. We would cite the problems of Love Canal in New York, in which the toxic nature of the waste was ignored by government authorities in permitting construction of residential and other buildings. In addition, information is very likely to be lost if there are major movements of people due to climate change (migration in past), major wars, or a widespread epidemic (pandemic) that kills a large fraction of the population. Over the next 1,000-2,000 years the probability of one of these events is highly likely. We have strong doubts that information will survive.

Staff Response to Comment No. 101:

The staff's approach is to attempt to favor selection of sites where intrusion for resource value is unlikely and to preserve the knowledge of the location and hazard of the waste. We cannot guarantee that the hazard will not be ignored. However, as in the case of Love Canal, we consider that the hazard would be recognized and some form of remedial action, e.g., relocation of residents, would be likely.

The provisions to require records to be kept in multiple offsite locations, as well as for permanent markers, make it less likely that knowledge of the site will be lost due to scenarios of the kinds cited in the comment. Still, we recognize that

human intrusion cannot be entirely ruled out, and the final rule allows for consideration of human intrusion on a limited basis. See Overview, Section 2.6, Human Intrusion.

THE FOLLOWING COMMENTERS ADDRESSED PUBLIC HEALTH AND SAFETY ISSUES:

Comment No. 102: D. P. Sidebotham, New England Coalition on Nuclear Pollution, Inc. (47)

New England Coalition on Nuclear Pollution Inc. comments on proposed rule incorporate by reference in toto comments by Sierra Club Nuclear Subcommittee of the National Energy Committee. We emphasize particular concerns that maximum protection of public health and safety must be principal goal now and for full period of toxicity of wastes. Therefore urge:

A. Most exacting criteria for determining environmental impact before storage of test radwaste.

B. Goal of zero releases of radionuclides.

C. Thorough assessment of mineral resources in candidate regions and human intrusion past, present, and future.

D. Choice of sites which assure public safety despite possible failure of long term controls (i.e., far from population centers present or future).

E. Primary and separate consideration of human health effects separate from dollar value in evaluating sites.

F. Full statement by NRC of condition of waste retrieval before deposition even for test purposes.

G. Strict limitation of amount of waste in test sites to avoid defacto unlicensed repositories.

NECNP reiterates protection of public health and safety must be overriding consideration in every decision.

Staff Response to Comment No. 102:

A. The use of radwaste during site characterization was discussed at 46 FR 13975. For the reasons stated there, more exacting criteria would be inappropriate.

B. The staff anticipates that generally applicable environmental standards will be established by the Environmental Protection Agency.

C. Mineral resources and human intrusion issues will be addressed during the license review under the appropriate provisions of the rule. See §§ 60.11, 60.21, and 60.123.

D. See response to Comment Nos. 485-512.

E. Compliance with the performance objectives must be shown without regard to dollar value.

F. See response A., above.

G. See response A., above.

Comment No. 103: J. L. Cohen (27)

For over ten years, I have been engaged in several research activities related to the radioactive waste problem. I have been an advisor to both the International Atomic Energy Agency and the World Health Organization in areas involving radioactive waste management. From my review of technical data and literature, it is apparent that the specter of severe hazard related to radioactive waste management is simply not supported by objective analysis of available information. Radioactive waste is not nearly as hazardous as people think it is!

I would like to call your attention to a simple reality in public administration. Excessive regulation devoted to control of any single hazard, particularly where such degree of control is unwarranted (transuranic waste provides an excellent case in point), is actually detrimental to overall public health. This practice necessarily results in the needless diversion of limited public resources from areas where they might be more beneficially applied (e.g., drug abuse, traffic safety, etc.). It is indeed unfortunate that NRC does not have a mandate to consider problems under its purview within the larger framework of public health so that optimal decisions could be made in the best interest of the general public health and welfare. Precious time, money, and talent needlessly squandered on minor problems such as radioactive waste management, become irretrievably lost and unavailable to cope with the far more pressing problems facing our society.

Staff Response to Comment No. 103:

Under the Atomic Energy Act and the Energy Reorganization Act, the NRC is charged with licensing and related regulatory authority with respect to radioactive waste management. The regulations constitute a conscientious effort to comply with this mandate.

Comment No. 104: Multiple Authors (67)

I the undersigned for mere humankind sanctuaries protecting public health safety in peace now here command public vote for energy recovery conversion from archaic nuclear waste to renewable energies including technical economic concepts in the best interests of public health safety in peace nowhere.

Staff Response to Comment No. 104:

See response to Comment No. 103.

Comment No. 105: Z. M. Jensen (81)

In my opinion nuclear wastes, both high and low level, should be permanently disposed of in underground geologic repositories. This problem should not be left for future generations to resolve.

As nuclear worker radiation doses rise, the long-term implications are frightening, given the recent estimates of cancer risks associated with low-level radiation exposure. Therefore, efforts should be made to forge a new partnership among federal, state and local officials concerning all decisions of the disposal of radioactive wastes.

Staff Response to Comment No. 105:

The NRC published final licensing requirements for land disposal of low level radioactive waste (10 CFR Part 61) on December 27, 1982. Provisions of the licensing procedures describe opportunities for State and local participation in the licensing process.

Comment No. 106: C. R. Fisher, General Atomic Co. (16)

The major area of concern treated in 10 CFR 60 is radiological risk. General Atomic believes that in addition to radiological risk the potential risk from chemical hazards associated with the materials used in the waste packages, shaft and borehole seals, and other activities which occur during the construction and operation of the repository should also be considered.

Staff Response to Comment No. 106:

Any chemical hazards associated with the materials used in the waste package, shaft and borehole seals, etc., would be considered by NRC in the course of its review under the National Environmental Policy Act.

THE APPLICABILITY OF THE REGULATIONS TO TRANSURANIC (TRU) WASTES

After careful consideration of the public comments addressing the applicability of the regulation to TRU, the NRC staff has decided to delete references to TRU from the final rule. The following comments (nos. 107-114) and those which specifically addressed the definition of the term TRU in 60.2 (nos. 212-222) are provided to illustrate the concensus of public opinion on TRU. No specific staff responses are provided for these comments since the provisions for TRU waste disposal have been deleted from the rule.

GENERAL STAFF RESPONSE TO COMMENT NOS. 107-114:

For Comment Nos. 107-114, see Overview, Section 3.2, Transuranic Waste (TRU). For Comment No. 112, concerning the basis for the containment period, that subject is covered fully in Part C, Rationale for Performance Objectives in 10 CFR Part 60, Chapter VII.

Comment No. 107: J. Carson Mark, U.S. NRC Advisory Committee on Reactor Safeguards (10)

We recommend that regulations for the management and disposal of TRU wastes be developed in a separate document. If this were done, some of the complexity within the current proposed rule would be avoided. This approach would also allow attention to he directed to the unique aspects of the TRU waste disposal problem, especially for wastes in which radionuclide concentrations were low. A supporting decision is needed to clarify the minimum radionuclide concentration which denotes TRU wastes.

Comment No. 108: Florida Power and Light Co. (25)

It should be noted that it is our belief that the proposed criteria established for transuranic wastes as stated could have a significantly adverse impact on the nuclear utility industry. It is recommended that these criteria be carefully reconsidered.

Comment No. 109: U.S. DOE (48)

Issue

Inclusion of TRU wastes in the rule.

DOE Position

We believe that it is inappropriate to issue specific requirements for commercial TRU waste disposal in this rule.

Discussion

Transuranic (TRU) waste consists of a diverse mixture of materials and equipment that have been contaminated by association with transuranics. Generally, fission product levels are very low and heat generation rates average a few hundredths of a watt per container. The physical and chemical properties of this waste inventory can be highly variable and quite unlike high-level waste (HLW).

In many cases it will be impractical to process such waste to the extent that may be required to meet the 1×10^{-5} annual fractional release rate, and in some cases, it may be impossible. A considerable body of knowledge on migration of transuranics in geologic media exists and shows that such restrictive package release rates are not necessary to protect the environment and maintain public health and safety.

Because of the variability of TRU waste it is difficult to assess the reasonableness of the NRC requirements as they are presently formulated. It is not clear that in light of the relative hazard of TRU waste as compared to HLW that the requirements in 10 CFR 60 are justifiable. Knowledge (of commercial TRU waste) that needs to be gained to determine the impact of these requirements (and in our opinion, to develop appropriate requirements) includes: 1) the quantities and radionuclide composition of TRU waste; 2) lifetime of TRU waste packages; 3) the release rate from various TRU waste forms as a function of temperature; 4) potential effects of TRU wastes on the repository performance; 5) cost of processing and packaging TRU waste; 6) hazard index for TRU as compared to HLW; 7) and the cost/benefit tradeoffs of the options for disposing of TRU wastes in a respository.

Defining TRU waste in this rule as any material containing over 10 nCi/gm of activity from transuranics suggests that any such material must be disposed of by geologic isolation. The draft rule on low-level waste, 10 CFR 61, states that waste exceeding 10 nCi/gm is unsuitable for shallow land burial disposal but that other modes of land disposal giving greater confinement are possible for these higher-activity wastes and that detailed technical criteria for such disposal are to follow at a later date. We believe that separate guidance or case by case handling would be the proper way to address TRU waste and it is suggested that direct references to TRU waste be dropped entirely from the 10 CFR 60.

Such guidance should recognize the unique nature of the waste type and the hazards associated with it. It should not be merely a duplication of the high-level waste rule but based on available information on the behavior of TRU waste elements in the disposal environments including any temperature constraints, containment requirement, etc. This approach could fully consider all aspects of TRU disposal and result in requirements that provide totally adequate protection and are also practical to implement.

Finally, we are unaware of any statutory authority for Commission exercise of regulatory control over the disposal of TRU waste by DOE.

Comment No. 110: Westinghouse Corp. (54)

Addressing transuranic (TRU) waste in this rule is inappropriate. The NRC has not yet established regulations dealing with the disposal of TRU waste, and the overly stringent requirements for TRU waste in this rule might establish inappropriate precedents with respect to future TRU regulations that might be proposed. Accordingly, it is strongly recommended that all reference to TRU waste be deleted from the 10 CFR 60 Technical Criteria.

Comment No. 111: F. L. Parker (80)

The minimal references to the TRU wastes only confuse the document. I believe it would be better to remove these references entirely, since the definition of TRU waste is different by a factor of 10 for the NRC and the unpublished draft of EPA rules.

Comment No. 112: Institute of Electrical and Electronics Engineers (28)

In the statement, "Since transuranic waste does not generate significant amounts of heat, there is no advantage to containment for any specified period," the

conclusion does not follow from the Premise. Containment is required because of the radiological hazard, which diminishes in accordance with the half life. Heat generation is not a direct concern. Suppose, for purposes of argument, that transuranic waste were more toxic and longer lived than high-level waste. Should it not then have an equivalent or greater containment requirement, independent of heat generation?

Similarly, for HLW, the 1000-year period should be related to risk reduction from radioactive decay, not to the period of uncertainty due to thermal effects.

Comment No. 113: Institute of Electrical and Electronic Engineers (28)

The scope of the proposed rule should be made more clear in the opening paragraphs: (1) the rule applies not only to high-level radioactive waste (HLW), but also to (nondefense) transuranic waste; (2) it would be helpful to state that, by public law, the rule does not apply to the WIPP facility for defense transuranic waste.

Comment No. 114: T. H. Pigford (53)

NRC's proposed rule deals with high-level and transuranic wastes but ignores other wastes which are logical candidates for a geologic repository. These include the iodine-129 now required by EPA to be recovered separately in fuel reprocessing, recovered carbon-14, and possibly krypton-85. These radionuclides are all present in spent fuel. Both iodine-129 and carbon-14 are potential contributors to radiation exposures in the environment through hydrogeologic transport. They may be in different forms than the high level and transuranic waste. Other possibilities are parts of retired and dismantled process equipment. These wastes should be considered in the proposed rule.

NRC defines "transuranic wastes" as radioactive waste containing alpha emitting transuranic elements, with radioactive half-lives greater than five years, in excess of 10 nanocuries per gram. This is ten-fold lower than the definition in the EPA internal draft standard. The differences should be resolved.

THE FOLLOWING COMMENTERS ADDRESSED THE ISSUE OF UNCERTAINTIES:

Comment No. 115: I. Remson (13)

The requirement of the 1,000-year canister and the other evidences of lack of confidence in the geology and hydrology stem from erroneous perceptions of the nature of uncertainty as applied to geology and hydrology. An example will illustrate my point.

The BWIP staff recently described to their Geology and Hydrology Overview Committees a groundwater model that postulated radionuclide escape from the Umtanum Formation to the adjacent more-permeable interbed. There was considerable disagreement between the BWIP staff and some committee members about the location of the sites of groundwater discharge to the biosphere. If the BWIP staff is correct, the travel time will be about 120,000 years. If the committee members are correct, the travel time will be about 60,000 years. This is the nature of the uncertainty, and future work will resolve it.

Questions about the reliability of the mathematics and code used in the BWIP model are nonsense. My back-of-the-envelope computation showed that the model results were in the correct ball park for the parameters chosen. No possible uncertainties in the future climatic events can affect these numbers by more than one percent, if that much. Even if the hydraulic conductivity values are an order of magnitude low (something hard to believe), we would still have a 6,000 year groundwater travel time to the biosphere through the interbed. Furthermore, this conservative groundwater model gives no credit to the dispersion, to the sorption, or to the containment or retardation by the Umtanum Formation, by the canister or by any of the engineered barriers in the repository.

It is inconceivable that any shorter path to the environment through the many lava flows would be missed during the detailed exploration, the repository excavation, the repository filling and the performance confirmation before the repository sealing. As for future credible geologic events, the entire tectonic picture insures for the next 10,000 years a continuation of the geologic patterns of the past several million years.

In summary, every member of the BWIP staff and Overview Committees recognized the nature of the uncertainties. However, it was clear to everyone that no combination of unfavorable credible events could reduce radionuclide travel times from the encapsulated wastes to the biosphere below several tens of thousands of years for a properly sited, designed and constructed repository. When considering uncertainties, one must understand their ranges, effects, sensitivities and impacts on specific repositories. Generic considerations, divorced from realworld repository sites, are meaningless and lead to the erroneous conclusions about uncertainties that have been incorporated in the proposed rule.

Staff Response to Comment No. 115:

See staff response to Comment No. 70 concerning the relative emphasis on geology and engineering.

Determination of the travel time of groundwater to the accessible environment is potentially one of the most important aspects of site characterization and long-term performance assessment. It must be recognized, however, that the estimation of groundwater travel times for realistic environments in the vicinity of potential repository sites is not an easy task. Presumably, repositories will be located in rocks with relatively slow groundwater flow, which is desirable, but this makes many methods used to determine flow in aquifers inappropriate. The direction of groundwater flow in slow-flow environments is not always easy to determine, and the flow must be estimated through highly heterogeneous and anisotropic environments over distances of travel which may approach 100 km or more. For further discussion

of uncertainties in the geologic setting, see Part C, Rationale for Performance Objectives in 10 CFR Part 60, Chapter V.

The identification of a minimum groundwater travel time of 1,000 years in 10 CFR Part 60 does not mean that sites with much longer travel times should not be sought. In fact, groundwater travel times that substantially exceed 1,000 years would be identified as a favorable condition. The NRC certainly encourages the selection of sites which enhance the margin of safety provided by the natural geologic barriers.

Comment No. 116: T. H. Pigford (53)

The proposed rule appropriately mentions uncertainties in site characterization, engineering design, and prediction. However, NRC has not analyzed these uncertainties, and unknown safety margins underline NRC's views of performance of subsystems and components necessary to meet the yet undetermined EPA standard of overall performance. In the absence of sufficient technical analysis by NRC, adopting such criteria with unknown safety margins is not justified, especially if considerable safety margins are likely to be incorporated into the EPA standard. Without adequate evaluation of the uncertainties before establishing the regulations and standards, there will emerge a set of mandated requirements which provide some degree of public health and safety, but without that degree of protection known or understood by the regulators, the implementators of the technology, or the public.

A more meaningful approach would be to establish the safety goal, determine the means of achieving that goal on a realistic basis, analyze the uncertainties inherent in achieving that goal, and then consciously incorporate the necessary margins and safety factors to distinguish expected performance from necessary performance. To accomplish that, it is necessary to know the safety goal and the safety margins incorporated in that goal. There is needed a better technical knowledge of performance and performance uncertainties than is reflected in NRC's proposed rule and rationale.

NRC's assumptions of uncertainties in justifying its proposed numerical criteria are discussed in the following sections.

Staff Response to Comment No. 116:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs Multiple Performance Standards, and Part C, Rationale for Performance Objectives in 10 CFR Part 60.

Comment No. 117: American Nuclear Society (20)

NRC has placed undue emphasis on the nature of the uncertainties associated with the transport of the waste through the geosphere to the exclusion of other important considerations. For example, uncertainties can be ascertained and made inconsequential by bounding analysis and design. Potential performance uncertainties are better addressed and minimized in the design of a repository and other features through the establishment and incorporation of acceptable nonregulatory design limits for the uncertainties which may reside in a particular set of circumstances, rather than the establishment of overly conservative technical criteria in the form of a rule to cover all supposed repository arrangements and contingencies. Further, a careful site selection process, using currently available investigatory techniques and engineering practices and based on the proven historical stability of the geologic setting, can minimize tectonic and hydrogeologic uncertainties and provide adequate protection of the public health and safety and man's environment.

Staff Response to Comment No. 117:

See Part C, Rationale for Performance Objectives in 10 CFR Part 60, for extensive discussion of the relationship between uncertainties and the performance objectives. In addition, it should be noted that under § 60.113(b) the performance objectives for particular barriers are subject to modification to take account or to reflect particular sources of uncertainties. In view of these considerations the staff considers the criteria to be appropriate and by no means overly conservative.

Comment No. 118: J. Hamstra, Netherlands Energy Research Foundation (6)

At the top of the first column on page 35282 it is stated that the thermal disturbance of the area near the emplaced wastes adds significantly to the uncertainties in the calculation of transport of the radionuclides through the geologic environment. This may be the case in fissured crystalline rock and in the direct vicinity of the emplaced waste, for a mined repository with the HLW emplaced in deep boreholes; in a salt dome this is not relevant. The host rock itself is impermeable and any future radionuclide transport in the permeable geologic environment surrounding the salt dome will not have the slightest disturbance from the limited temperature rise of the rock salt at the periphery of the salt dome.

Staff Response to Comment No. 118:

While it may be reasonable to assume that thermal perturbations due to waste emplacement will have little effect on crystalline rock surrounding a repository in salt, it does not seem reasonable to assume that the thermal pulse will have no effect on the salt itself and the possibility of radionuclide transport

through it. With increased temperature in salt, the migration rates of brine inclusions will presumably increase, leading to a more rapid accumulation of the brine in the vicinity of the waste packages. Thermal deformation of the salt can also cause deterioration of shaft and borehole seals, allowing water to enter the geologic repository. This process could increase the rate of radionuclide transport from the underground facility to the accessible environment.

Comment No. 119: C. R. Fisher, General Atomic Co. (16)

Consideration and discussion of high-level waste (HLW) beyond 20,000 to 30,000 years appear to be inappropriate. After that amount of time, even the hazard index for spent unreprocessed fuel (one form of HLW) is less than that for uranium ore deposits, many of which lie in alluvial deposits which have been infiltrated by ground water. General Atomic suggests that all discussion of HLW beyond 20,000 to 30,000 years be deleted.

Staff Response to Comment No. 119:

The relevant period for purposes of these requirements will depend upon the EPA standard.

Comment No. 120: UK Atomic Energy Authority (29)

10,000 years is a speculative number and nothing is gained by stating it.

Staff Response to Comment No. 120:

In the Supplementary Information for the proposed rule, the NRC stated that "the area surrounding the emplaced wastes will not return to temperatures near those before the wastes were emplaced until after about 10,000 years." The staff agrees that the duration of thermal disturbance may depend upon the characteristics of a particular geologic repository. These characteristics may be taken into account in considering the necessary containment period. See final rule, § 60.113(b).

THE FOLLOWING COMMENTERS ADDRESSED THE UNSATURATED ZONE:

GENERAL STAFF RESPONSE TO COMMENT NOS. 121-127:

A general discussion of considerations related to disposal in the unsaturated zone is found in the Overview, Section 5.2. Particular issues raised by commenters are treated below as appropriate.

Comment No. 121: U.S. DOE (48)

Discussion of the Supplementary Information Section of 10 CFR 60

This section provides much needed insight into the staff's intent and thought processes and has proved to be very helpful. We do have certain specific comments on portions of this section.

Specifically, we noted the staff's comment on earlier DOE program plans that emphasized fully saturated geologic formations. Since opportunities may arise for exploratory studies in unsaturated structures, we request that the NRC staff reexamine the rule and make whatever changes (i.e., rewording, insertion or deletions) they deem necessary to ensure that the rule will apply to all geologic media.

Staff Response to Comment No. 121:

The staff is currently developing technical criteria which apply to the disposal of HLW in the unsaturated zone. These technical criteria will be published as proposed amendments to 10 CFR Part 60, and public comment solicited.

Comment No. 122: F. L. Parker (80)

Unsaturated Zone

I believe that regulations could apply equally well to the unsaturated zone with only minor changes. One necessary change, of course, is the requirement of the 300 meters of cover.

Staff Response to Comment No. 122.

Favorable conditions of the geologic setting (see § 60.122(b)) are not requirements. Favorable conditions may enhance waste isolation potential. Hence, a minimum depth of 300 meters for waste emplacement is a favorable condition because the deeper the waste is emplaced the less likely it is to be disturbed. In that light such depth is a favorable condition irrespective of zone. Therefore, the staff does not see the basis for the comment.

Comment No. 123: J. Carson Mark, U.S. NRC Advisory Committee on Reactor Safeguards (10)

The rule would appear to be equally applicable to mined geologic repositories in the Vadoze Zone. As a result, a separate rule for disposal of high-level radioactive wastes in the unsaturated zone does not appear to be necessary.

Staff Response to Comment No. 123:

See staff response to Comment No. 121.

Comment No. 124: M.J. Fisher (39)

In your "Supplementary Information: Background" you state that "additional or alternative criteria may be needed to be developed for regulating disposal in the unsaturated or vadose". What do you mean by this? I would think that during construction and operation of the repository, the waste package would be "unsaturated" and for a long period of time following closure. The question of "resaturation" and possible movement of the chemically leached or diffused radioactive and/or toxic material I think should be addressed. For example, the method by which the water gets from the surface to the "saturated" area and how the water moves back into the tunnels and shafts is very important.

Staff Response to Comment No. 124:

See staff response to Comment No. 121.

Comment No. 125: C. Walske, Atomic Industrial Forum (50)

p. 35281 (Background). Comment: The term "saturated zone" as used here and elsewhere in the regulation is misleading, and could be interpreted in different ways for different geologic circumstances. We suggest using the term "beneath the groundwater table."

Staff Response to Comment No. 125:

The staff believes the term "saturated zone" is used consistently throughout the regulation. However, to avoid any misinterpretation, a definition of the term "saturated zone" has been added to section 60.2 and is consistent with the definition provided in Definitions of Selected Ground-Water Terms--Revisions and Conceptual Refinements, U.S. Geological Survey Water Supply Paper No. 1988 (1972), Washington, D.C., pp. 21.

Comment No. 126: B. Blanchard, U.S. Department of the Interior (84)

On page 35281 the supplementary information states that in view of Department of Energy's (DOE) current plans, which call for disposal in a repository in the saturated zone, these criteria were developed for disposal in saturated media. Further, it states that additional or alternative criteria may need to be developed for regulating disposal in the unsaturated zone.

We urge that the proposed rule be modified at this time to consider the possibility of a repository in either the saturated or unsaturated zones. There are sound technical reasons for this, the essential one being that under appropriate conditions the unsaturated zone would provide one more natural barrier to the movement of waste radionuclides from the repository to the water table. Another consideration is that there is a good possibility, under the present accelerated schedule for constructing a shaft at each of three potential sites under investigation, that the DOE could consider the unsaturated welded tuff as a suitable host medium at Yucca Mountain on the Nevada Test Site.

In view of the fact that most of the language of the proposed rule is generalized, presumably to allow some flexibility of action on the part of the DOE, it is our opinion that the task of making the appropriate modifications to consider the unsaturated zone would not be difficult or time consuming.

Staff Response to Comment No. 126:

See staff response to Comment No. 121.

Comment No. 127: U.S. Geological Survey (85)

We have reviewed the proposed rule (10 CFR 60) which specifies technical criteria for disposal of high-level radioactive wastes (HLW) in geologic repositories, published in the Federal Register of July 8, 1981, regarding modifications that would be desirable to allow consideration of a repository in either the saturated or unsaturated zones. It is our opinion that appropriate modification of the following parts of the proposed rule would enable the technical criteria to apply to unsaturated as well as saturated zones.

Page 35287, Col. I. part [ii(a)]: Precise determination of the rates and quantities of expected releases from the unsaturated zone via the saturated zone to the accessible environment using differential equations to describe the flow of solutes through fractured rocks in the unsatured zone currently is not possible. However, in some environments it can be demonstrated qualitatively that the water flux through the unsaturated zone is acceptably small and that water is unlikely to contact the waste canisters for more than brief periods, if at all; therefore, such numerical modeling should not be needed to assess the performance of a repository located in that kind of environment.

Page 35289, Col 2, (2): "Performance of the engineered system - (i) containment of wastes" and (ii) control of releases." As presently stated, the first of these items requires that saturation of the repository be assumed in evaluating the potential for long-term containment by the engineered system. One of the advantages of the unsaturated zone is that well-drained rocks within it will never be saturated and thus the goals of long-term containment and very slow release rates become easier to achieve. This advantage is negated, however, with the current wording because the Department of Energy must assume full or partial saturation in its performance assessment. We suggest that the wording proposed in attachment B, pages 22-24, of the memorandum for

Mr. Samuel Chilk, Nuclear Regulatory Commission from Sheldon Meyers, Department of Energy, dated November 5, 1981, may be appropriate for both these items.

Page 35290, Col. 2, paragraph 2 - (f) (2) and (3): A compelling argument for use of the unsaturated zone for a repository for HLW is predicted on the observation that this zone constitutes a major barrier to the contact of ground water with emplaced radioactive wastes. The strategy for locating a repository in the unsaturated zone is to select a repository horizon with high vertical conductivity that will allow the limited amount of recharge water reaching the repository to pass easily through this horizon into underlying units with little or no contact with the canisters of waste. Thus, "inhibition of ground water circulation in the host rock" is an undesirable condition in a repository horizon in the unsaturated zone. In the unsaturated zone, the presence of fractures or faults help to drain the repository horizon, rather than serve as possible short circuits to the biosphere, as would be the case in the saturated zone. Similarly, inhibition of ground-water flow between hydrogeologic units--is not a favorable condition between the repository horizon and underlying units in the unsaturated zone. Indeed, gravel-filled boreholes could be engineered to assure rapid drainage of water from the repository horizon to the unsaturated zone. We suggest that following addition to (f) to follow (3): In unsaturated zone environments by contrast well-drained rocks unlikely to retain perched ground water constitute favorable conditions.

Page 35290, Col. 3, (b) (6): "The existence of a fault that has been active during the Quaternary Period." This may not necessarily be an adverse condition in the unsaturated zone.

Page 35293, Col. 2, paragraph i, (3): "Backfill placed in the underground facility shall be designed as a barrier" and page 35293, Col. 3, (ii), (A) "It shall provide a barrier to ground-water movement into and from the underground facility," and (ii) (c) "It shall reduce and control ground-water movement within the underground facility." In the unsaturated zone, backfill placed in the underground facility should promote ground-water movement and vertical drainage from the repository. It should not provide a barrier to ground-water movement from the repository and it should provide for vertical ground-water movement through and drainage of the underground facility.

Page 35294, Col. 2, 60.134 (f): In the unsaturated zone, water encountered during excavation is expected to drain through the repository horizon to underlying units. No purpose appears to be served by attempting to move this water to the surface. We suggest the following wording of this part might be appropriate: (f) Water control. The construction specifications shall provide that water encountered in excavations shall be controlled in accordance with design requirements for radiation control and monitoring.

Staff Response to Comment No. 127:

This is a comment on a requirement of the safety analysis report: "(C) An evaluation of the expected performance of the proposed geologic repository noting the rates and quantities of expected releases of radionuclides to the

accessible environment as a function of time." The commenter assumes that NRC will require the use of models involving differential equations that describe the flow of solutes through fractured rocks to satisfy this information requirement. However, the information requirements of the rule are not specific as to the kinds of models required to provide the requested information. What will be required is adequate information to find that the performance objectives with regard to isolation are met.

In reference to the second point raised by the USGS, the revised performance objectives explicitly state that "for disposal in the saturated zone, both the partial and complete filling with groundwater of available void spaces in the underground facility shall be appropriately considered and analysed among the anticipated processes and events in designing the engineered barrier system." The staff believes that changes made in 60.122(f)(2) and (3) are responsive to the USGS comments pertaining to these paragraphs. The staff agrees with the USGS that the existence of a fault that has been active during the Quaternary may not necessarily be an adverse condition in the unsaturated zone. However, the staff believes that other natural phenomena that may be associated with active faulting could adversely affect a geologic repository. Therefore, the staff believes that active faulting still constitutes a potentially adverse condition that should be evaluated. 60.122(f)(2) and (3) are responsive to the USGS comments on the paragraphs.

The staff agrees with the USGS comment on paragraph 60.132(b)(6). The presence of any potentially adverse condition at a site will necessitate an analysis of that condition to determine it effect on site safety and suitability. One possible outcome of such an analysis would be the finding that the presence of the condition would not have a potentially adverse affect on the ability of the site to host a repository. Therefore, the staff does not consider it necessary to adopt the USGS's suggestion on this point.

Finally, with respect to the final two issues addressed by the USGS, these provisions have been deleted from the rule to allow flexibility for the engineered barrier system to meet the performance objectives.

THE FOLLOWING COMMENTERS ADDRESSED COMPUTER MODELS:

Comment No. 128: J. Carson Mark, U.S. NRC Advisory Committee on Reactor Safeguards (10)

At the present time, there are a number of organizations within the U.S. that are involved in the development of computer models for estimating the environmental transport of radionuclides. To check for deficiencies in these models, and to assure that the best models are applied in estimating the performance of a high-level waste repository, we suggest that an evaluation program for such models be conducted.

Staff Response to Comment No. 128:

The NRC staff has a program underway to evaluate and benchmark computer codes expected to be used in assessing repository performance. In addition, DOE is required to provide in its license application an explanation of methods used to support models used to assess repository performance (See § 60.21(c)(1)(ii)(F) of the final rule).

Comment No. 129: M. J. Fisher (39)

Place more emphasis on site investigations and assessments and less on modeling.

Staff Response to Comment No. 129:

The staff's opinion on the relationship between field testing (site investigations and assessments) and modeling coincides with that of the scientific community in general: there has to be an iterative interplay between the two. Field testing can expose deficiencies in models and vice versa. Models can serve as guides to the conduct of field tests and vice versa. Either to overemphasize field testing at the expense of modeling or modeling at the expense of field testing is scientifically counterproductive.

Comment No. 130: J. Carson Mark, U.S. NRC Advisory Committee on Reactor Safeguards (10)

One of the important issues concerning the rule will be the techniques used for validating compliance with the specified criteria. Specific mention should be made that acceptable models must be available for evaluating repository performance, and that accelerated testing and certified data will be necessary for determining system performance over long periods of time. Since absolute conformance cannot be guaranteed, it may be useful to express compliance with

numerical criteria in terms of the required confidence level that a certain fraction of a given system component (e.g., waste packages) must meet, keeping in mind what levels of confidence it may be practical to achieve.

Staff Response to Comment No. 130:

The staff agrees that techniques for validating compliance with the technical criteria are important and has included a number of provisions in 10 CFR Part 60 related to the points raised in this comment. Paragraph 60.21(c)(1)(ii)(F) requires an explanation of the measures used to support the models used to perform the assessments required by the rule. Models are required to be supported by a combination of methods, such as field tests, in situ tests, laboratory tests, monitoring data and natural analog studies, that collectively will give confidence in the models' validity. Acquisition of data used in the models will be subject to a quality assurance program required by Subpart G of the regulation, and a program of performance confirmation will be required to be conducted throughout the operating life of the repository to confirm that performance of certain components is within the bounds predicted by the models. As noted by several other commenters, however, true confirmat _- of performance cannot be achieved [see Overview, Section-by-Section Analysis, 60.21(c)]. We decline to adopt the commenter's suggestion that a required confidence level for component performance be specified (see Overview, Section 5.4, Reasonable Assurance).

Comment No. 131: F. L. Parker (80)

Verification

Complete verification, in the usual sense of the word, will not be possible unless we are willing to delay disposal millions of years. That is not an attractive alternative, since the hazard of waste near the surface surely exceeds the hazard of waste buried in favorable sites 500 to 1,000 meters deep. Possibly more important, by issuing the regulations at this time, NRC will have the opportunity to produce Regulatory Guides that will establish protocols for "verification." This "verification" will be an extended procedure and the sooner it commences, the better.

Staff Response to Comment No. 131:

The staff agrees with this comment.

10. COMMENTS RECEIVED WHICH ADDRESSED MISCELLANEOUS TOPICS (#132-148):

Comment No. 132: W. J. Bryan III (40)

SUBJECT: Storage and Usage of High Level, Radioactive, Short Life Wastes

SOLUTION: 1. These products can be an asset! How? Heat!
There is more than enough heat to produce electricity on a macro scale. The ideal situation for this would be to store these products in large, air-tight tanks with heat exchange coils in the soup. The heat produced will create steam, the steam will move turbines, and the turbines will power generators. This is a very broad outline; but, simplistic though it is, it will work.

REASONS FOR SOLUTION #1: The USSR found out what could happen if these type wastes were not properly cooled and contained; their underground storage areas suffered a disastrous BLEVE. (Boiling Liquid Expanding Vapor Explosion).

Geothermal power plants tooted as a safe method of power production by 'environmentalists', use the heat from decaying radioactive isotopes in the earth's crust to heat water--latent heat in the earth's crust comes from radioactivity.

SOLUTION: #2. This solution ties in with Solution #1. Out of sight, out of mind can be translated to: Invisible, crazy. These radioactive wastes have to be monitored! These radioactive wastes are radioactive! Redundant? Answer: Didactic. I do not have a college degree; but, I am continually appalled at the ignorance of scientists regarding radioactivity. Radioactive chemicals put out hydrogen gas, radon, helium, etc. and change chemically as they transmute to other elements. Storage in stainless steel barrels is a waste of steel as this type of radioactive soup creates tremendous internal pressures, creates an extremely acid environment and the combination makes for a very short container life. (Twenty years ago I wrote a letter to the old AEC protesting stainless steel containment and the dumping of same into the ocean. Events since then have borne out my predictions when some of those old drums were dredged from the ocean and found to be leaking; some were leaking after only ten years.) Vitrification is better; but, flawed by the same problem, the nature of radioactive decay.

Staff Response to Comment No. 132:

NRC has no authority to spend funds developing uses for radioactive wastes. It is authorized only to license waste disposal. The rule is directed toward licensing one method of disposal which appears to be favored by the Department of Energy.

The staff believes that waste packaging can make a significant contribution to the containment of radioactive waste in a geologic repository. (See Part C, Rationale for Performance Objectives in 10 CFR Part 60.)

Comment No. 133: E. Nemethy, Ecology/Alert (41)

1. At least four areas of the country are now heavily contaminated with waste sites. Instead of opening more dumps, why not repair, improve and reinforce dumps already in in existence?

2. Would it be safe and/or feasible to use the sites of underground atomic tests as dumps?

Staff Response to Comment No. 133:

The radioactive waste disposal sites currently in existence are for low-level wastes. These sites are not appropriate for disposal of high-level wastes.

The proposed regulation addresses disposal in mined geologic repositories. If DOE proposes disposal in cavities formed by underground nuclear weapons tests different considerations would be involved in evaluating the safety and feasibility of such a disposal method. The DOE can consider areas adjacent to underground weapons tests in their site selection process for a mined geologic repository. Such a site would be evaluated for safety and feasibility under this regulation.

Comment No. 134: D. M. Petefish (43)

As I read the regulation, it would imply decommissioning is the state where the repository is filled in, and is thus in an irretrievable mode. It seems to imply that nothing further is required. Shouldn't we have requirements for long term observation (i.e., on the order of decades)?

Staff Response to Comment No. 134:

See response to Comment No. 655.

Comment No. 135: D. M. Petefish (43)

I can appreciate the general nature of a regulation and the desire to develop details in regulatory guides, i.e., acceptable means of implementation and the like. Given the lack or incomplete nature of available information, can we produce meaningful regulatory guides to supplement this regulation? In the time frame called for?

Given the few repositories that will be developed and the individualized treatment they will require and deserve, what purpose will regulatory guides serve? Will we write regulatory guides for each potential repository? If detailed information presently exists applicable to all potential repositories, then I believe it should be included in this regulation. As it now stands, detailed technical information is surely lacking.

Staff Response to Comment No. 135:

As the commenter points out, the detailed technical aspects of a repository are site specific. For that reason, and because regulations appropriately contain broad performance requirements and not restrictive design details, detailed technical information is not found in the regulation. As detailed technical information on alternative methods of satisfying the regulatory requirements is developed it will be published as staff positions or in other appropriate forms.

Comment No. 136: D. M. Petefish (43)

The staff paper does not contain viable Value/Impact Statement. Has one been prepared, or is one being prepared? The decision-making process that went into the decision to develop regulations placing the review of HLW repositories in the usual review scheme is essential and should be made public.

Staff Response to Comment No. 136:

The proposed rule describes the need and reasons for the rule which were the basis of the decision to develop the regulation in the proposed form. A value/impact statement was included with the staff paper to the Commissioners as Attachment E.

Comment No. 137: D. M. Petefish (43)

The staff paper does not contain a Report Justification Analysis. Has one been prepared or is one being prepared?

Staff Response to Comment No. 137:

The application/reporting/recordkeeping requirements contained in 10 CFR Part 60 affect fewer than 10 persons, and, therefore, are not subject to Office of Management and Budget clearance.

Comment No. 138: D. M. Petefish (43)

It is my opinion that if the Appendix goes out for public comment as is, without a more detailed explanation as to its scope, the geologic community

will be up in arms as to its deficiency. I would suggest either we say more, or we say less. What is stated now is neither sufficient nor broad enough in scope. If our intent is to be broad, we should just state, "all relevant geologic and seismologic factors will be considered." If our intent is to provide a more limited approach we should expand the technical requirements now given. As they stand, they say little if anything beyond an elementary textbook.

Staff Response to Comment No. 138:

Appendix J to Commission Paper SECY-82-267--"Rationale for Performance Objectives and Required Characteristics of the Geologic Setting" was made available for public comment along with the proposed rule. A revised rationale document was prepared during the development of the final rule and is included as Part C of this document.

Comment No. 139: D. M. Petefish (43)

The Supplementary Information statement does not contain a NEPA declaration. If an environmental report is being prepared, the SI should state this; if not, the SI should contain a negative declaration.

Staff Response to Comment No. 139:

Pursuant to Section 121(c) of the Nuclear Waste Policy Act of 1982, the promulgation of these criteria shall not require the preparation of an environmental impact statement under Section 102(2)(C) of the National Environmental Policy Act of 1969 or any environmental review under subparagraph (E) or (F) of Section 102(2) of such Act.

Comment No. 140: D. M. Petefish (43)

As I interpret the regulation, the body is applicable to any HLW disposal concept and Subpart E to the Deep Geologic repository option. The Supplemental information statement should include some discussion of this and the development of additional regulations if other options become available.

Staff Response to Comment No. 140:

The commenter's interpretation of the regulation is incorrect. The entire regulation is applicable only to disposal of HLW in a geologic repository. This is

clearly stated in numerous places in the proposed rule including (1) the title of the regulation "Disposal of High Level Radioactive Wastes in Geologic Repositories" (emphasis supplied); and (2) the first sentence of the Summary section--"The NRC is publishing proposed amendments which specify technical criteria for disposal of high-level radioactive wastes (HLW) in geologic repositories." See also § 60.1 of the final rule.

Comment No. 141: Mississippi Dept. of Energy & Trans. (65)

General

A question which the proposed rule raised is will there be ground storage of nuclear material at the repository and if so what will be the criteria?

Staff Response to Comment No. 141.

There may be ground storage of nuclear material at a repository site. If so, the performance objectives stated in § 60.111, together with the relevant design requirements (see especially § 60.131 and § 60.132) would apply, unless the activity is otherwise licensed under some other part.

Comment No. 142: Penberthy Electromelt International (61)

Interim Storage

10 CFR 60 should allow for interim storage for say 90 years as an integral part of the tunnel repository plan. The waste will have decayed in 90 years to a self-heating level only one-eighth as high as when made. This can make the repository only one-eighth as big, with considerable saving in capital costs.

This is discussed by Zen (1980).

Staff Response to Comment No. 142:

Nothing in 10 CFR 60 prohibits interim storage of wastes.

Comment No. 143: Mississippi Dept. of Energy & Trans. (65)

The criteria related to the effectiveness of various barriers should be stated in terms of probability of occurrence for the worst predictable case with the worst case being defined in the criteria.

Staff Response to Comment No. 143:

See Overview, Sections 3.1 and 5.4, Anticipated/Unanticipated Processes and Events and Reasonable Assurance, respectively.

Comment No. 144: Sierra Club (66)

EIS at Site Characterization Stage

We feel strongly that an environmental impact statement should be prepared before a site is characterized. The EIS must include an evaluation of the testing and site characterization activities on the integrity of the potential repository. For example, if drill holes are used to characterize salt, how many drill holes will there be and what will be the effect? If drill holes are made in granite, what effect will that have? How much waste material placed in the proposed repository is necessary to characterize the site? How will that nuclear waste material be removed?

The placement of radioactive wastes in a proposed repository should be licensed by the NRC and there should be a limit on the amount of radioactive wastes permitted during the site characterization stage. If this is not done, the testing stage could lead directly to an unlicensed repository. The proposed rule does not explicitly limit the amount of wastes for testing purposes, does not call for an EIS at the site characterization stage, and does not require the licensing of wastes placed in a repository for testing purposes.

Staff Response to Comment No. 144:

Environmental review of sites to be characterized is governed by Section 112 of the Nuclear Waste Policy Act of 1982. Safety-related issues will be addressed, under Section 113, in a site characterization plan. Although there is no requirement for licensing at the site characterization stage, NRC concurrence will be required pursuant to Section 113(c)(2)(A) if radioactive materials are to be used during site characterization. The technical criteria are consistent with this statutory direction, but changes to the licensing procedures may be found to be necessary.

Comment No. 145: Sierra Club (66)

The proposed rule does not provide for an environmental impact statement before test radioactive wastes are placed in the ground, only an environmental assessment. The Sierra Club considers this test placement of radioactive wastes "a major Federal action significantly affecting the environment," requiring an EIS.

Staff Response to Comment No. 145:

See Response to Comment Nos. 144 and 230.

Comment No. 146: Sierra Club (66)

Long-term controls

Not enough thought has been given, in the proposed rules, to long-term controls and whether such controls are possible for the time periods during which the materials in the repository remain extremely hazardous and have high heat content. Further NRC guidance and EPA standards are needed here. If effective and specific long-term controls for 1,000 years cannot be exercised, then sites must be chosen with this knowledge in mind.

Staff Response to Comment No. 146:

The regulation does not depend upon exercising long-term controls. For this reason, the technical criteria will direct site selection to areas which have little resource value and which are unlikely to be disrupted by future societies. See also Overview, Section 2.6, Human Intrusion.

Comment No. 147: Harmon and Weiss for the Natural Resources Defense Council, Inc. (76)

Section 51.40(d) of the procedural rule requires the characterization of three sites, at least one of which is not in salt. This is said by NRC to provide "a workable mechanism by which the DOE will be able to develop a slate of candidate sites that are among the best that can reasonably be found..." 46 Fed. Reg. 13973.** While it may be true that the site characterization process is capable of providing such a mechanism, it is at least equally capable of failing to do so. There is certainly nothing in the site characterization process either alone or combined with any other rule which provides any assurance of identifying and selecting a site that is "among the best that can reasonably be found." No rule requires that DOE demonstrate either that the sites characterized or the site ultimately selected are "among the best" nor even that the process by which they were selected was based on geologic considerations. On the contrary, the rules would appear to incorporate an incentive for selecting two unsuitable sites for characterization in order to enhance the prospects for approval of a predetermined third site which has relative advantages only in comparison with the other two.

**Although the "procedural" rules were adopted in final form in February, 1981, a number of sections would be amended by the proposal now under review, in recognition of the interrelated nature of the two sets of rules. Several of the changes which NRDC suggests below would further amend the procedural rules.

Staff Response to Comment No. 147:

The site selection process is governed by subtitle A of Title I of the Nuclear Waste Policy Act of 1982. See also Overview, Section 5.3, Geologic Conditions.

Comment No. 148: J. Hamstra, Netherlands Energy Research Foundation (6)

In the middle column of page 35281 it is stated that waste/rock interactions that result from the emplacement of the wastes or the gradual deterioration of bore hole seals are to be included in repository performance argumentation as disruptive processes that are to be anticipated.

At the bottom of that same column the statement is made that the host rock in the area close to the emplaced HLW is physically and chemically disturbed by the heat generated by the waste. This thermal disturbance is stated to add significantly to the uncertainties in the calculation of the transport of the radionuclides through the geologic environment (top left column page 35282).

It is evident that the disposal system should and can be engineered in such a way that no waste/rock interaction need be the cause of a disruptive process or event. Again for rock salt we know for sure that we can control the thermal load on the host rock directly surrounding the waste canisters such that no chemical or physical changes will take place that can be considered to be a real disturbance in the disposal area itself. Even more distant from the qualification disturbance are the farfield consequences of the disposal of high level waste in the isolation shield of rock salt that will be provided in sufficient thickness around the disposal area.

It is questionable whether a gradual deterioration of borehole seals needs to be considered as an anticipated process leading to disrupture of the overall system. In our case of deep disposal boreholes natural materials such as a mixture of crushed salt and clay dust are proposed to provide one of several successive plugs that are to be used for sealing the borehole. There is no reason for deterioration, on the contrary, borehole convergence will gradually make the plug tighter than originally.

The reactivation of a fault, mentioned as an unlikely disruptive event, should in reality be considered in the proper geologic setting of the repository site. For the salt domes under consideration for waste disposal in the Netherlands and Western Germany the geology overlying and surrounding the salt domes is one of sedimentary origin. They do not have the capability to store large amounts of displacement energy. The rock salt itself is, due to its viscoplastic behavior even less capable of accepting a fault to penetrate the host rock and thus creating passageway for groundwater to reach given to underline that general rules for geologic disposal should always accredit the specific behavior of the different host rocks and their geologic setting.

Staff Response to Comment No. 148:

We recognize that waste rock interactions will depend on age and nature of the waste, the repository design and the characteristics of the host rock. These factors have been explicitly identified in final rule as reasons for allowing flexibility in the performance objectives for the engineered barrier system.

The commenter is correct in stating that certain conditions such as faulting may not always be disruptive (adverse) conditions of the site. However, the presence of such a condition is a potentially adverse condition which must be characterized and evaluated. See §§ 60.122(c) and 60.21(c)(1)(ii)(B).

PART B

GENERAL RESPONSE TO COMMENTS IN PART B

The reader is referred, in general, to the Overview, Section-by-Section Analysis, for detailed discussion of changes made to the proposed rule. Such discussion is supplemented as appropriate by discussion of the comments in individual responses and by reference to relevant sections of the Overview or Part C.

SPECIFIC COMMENTS ON THE TEXT OF THE PROPOSED RULE:

60.2 DEFINITIONS

Comment No. 149: UK Atomic Energy Authority (29)

In a number of cases the definitions quoted differ in detail from those published in the IAEA Nuclear Waste Management Glossary (Draft, April 1981). It would be advantageous if the internationally agreed definitions could be used wherever possible.

Staff Response to Comment No. 149:

The glossary referred to by the commenter is still in draft form and there is uncertainty as to when it will be adopted. At least for the present, therefore, staff continues to believe that the definitions used in rule are adequate and appropriate.

Comment No. 150: Institute of Geological Sciences, London (29)

The major features of the proposed rule are considered under six subheads:

(1) Overall description

(2) Performance objectives

(3) Siting requirements

(4) Design and construction

(5) Waste package

(6) Performance confirmation.

There is a geological component embodied in all of these subheads but before considering the detail it is pertinent to discuss two general points. The

first relates to Section 60.2 Definitions (pp 35285-6). Definitions are given for "Geologic repository", "Geologic repository operations area", "Geological setting" or "site" and the "Disturbed zone" but these are amplified in later sections of the report e.g., the "disturbed zone" is rather tightly defined on p. 35290 (column 3). These subdivisions of the geological environment lead to possible differentiation between the criteria necessary to define the characteristics of the "near" and "far" fields. As they stand the definitions are ambiguous, particularly in relation to the "Geological setting" or "site" which emerges as an amorphous concept of unknown dimensions and characteristics.

Staff Response to Comment No. 150:

See responses to comments on particular definitions discussed below.

Comment No. 151. J. Carson Mark, U.S. NRC Advisory Committee on Reactor Safeguards (10)

Many of the definitions used in the proposed rule, particularly those pertaining to geologic terms, are not technically correct. Examples are the use of the terms, "fracture zone," and "fault rupture surface." In addition, in several instances the terms used do not convey the intentions. For example, reference is made to the "geologic or tectonic" stability of the site when what was really being referred to was the stability of the "repository" itself. We recommend that the text be carefully screened to correct these deficiencies.

Staff Response to Comment No. 151:

The cited terms no longer appear in the rule.

Comment No. 152: Louisiana Dept. of Natural Resources (63)

Section 60.2 Definitions

Should include definitions of hydrologic terms such as ground water, etc. Excellent sources of definitions are U.S. Geological Survey Water Supply Papers 1988 and 1541 A. U.S. Geological Survey Circular 779 is an excellent "thinking document" when considering radwaste and earth science.

Staff Response to Comment No. 152:

These definitions for hydrologic terms in the final rule correspond to the language appearing in the cited paper.

Comment No. 153: U.S. DOE (48)

10 CFR 60.2 "Accessible Environment"

NRC Proposed Wording:

"Accessible Environment" - those portions of the environment directly in contact with or readily available for use by human beings.

Recommended Revision:

Reword to be consistent with EPA definition.

Rationale:

The definition of "accessible environment" in 10 CFR 60 should be consistent with the EPA definition of the term; however, as proposed it is not consistent with the wording given in the latest draft of 40 CFR 191. Furthermore, any changes made in the EPA definition when it becomes final should be reflected in 10 CFR 60. While DOE has not developed a complete alternative definition at this time, we recommend that groundwater to be considered as part of the accessible environment should be limited to significant quantities of readily available potable water located at, or past, a distance (site specific) from the repository. Further discussions between NRC, EPA, and DOE are warranted to develop a commonly accepted definition of this term.

Staff Response to Comment No. 153:

In response to public comment, the definition of the term "accessible environment" has been modified. The accessible environment includes those portions of the environment that are subject to EPA's standard setting authority. Under Reorganization Plan No. 3 of 1970, EPA standards do not apply to locations under the control of persons possessing or using radioactive material. In the context of HLW disposal, these locations are those that will be marked by permanent monuments. (NRC requirements with respect to land use are also addressed in the technical criteria. See Section 60.121.) See § 60.2 for definition of "controlled area".

Comment No. 154: P. C. Cahill, U.S. EPA (68)

EPA is, as you know, developing standards for the disposal of high-level nuclear waste, and we hope to propose them early in 1982. Close coordination between the NRC and EPA will be necessary to ensure that our respective regulations are compatible, including definitions of such terms as "retrievability," "storage," "accessible environment," "barrier," and "disposal."

Staff Response to Comment No. 154:

The staff agrees that compatible terminology would be desirable. For the present, the staff believes that the terms used in this rule are appropriate for the purposes for which the rule is designed.

Comment No. 155: V. McIntyre (35)

Accessible Environment

1. It is not clear from a regulatory perspective as to who will make this determination. Will it be DOE or NRC?

2. The supplementary information should explain why this term is used rather than the well recognized term "biosphere". Isn't it the "biosphere" NRC is concerned about rather than some postulated environment that man might conceivably reach several hundred years from now.

3. I recommend dropping "accessible environment" and replacing it with "biosphere".

Staff Response to Comment No. 155:

While "biosphere" may be a familiar term, it would not be a good one to use in this regulatory context. The term "accessible environment" reflects the regulatory considerations described in response to Comment No. 141. For a particular geologic repository operations area, the extent of the controlled area (and hence of the accessible environment) will be determined in the course of the licensing process. DOE would identify the accessible environment in its license application but the limits of the controlled area would be subject to review and modification in the course of the licensing process.

Comment No. 156: M.J. Fisher (39)

I recommend the following definition for "accessible environment" "means that portion of the earth and its atmosphere with which humans have routine contact, and includes the atmosphere, soil, mineral and water resources actively being developed, and surface water bodies."

Staff Response to Comment No. 156:

See response to Comment No. 153.

Comment No. 157: C. Walske, Atomic Industrial Forum (50)

Some of the definitions are unclear. In the suggested versions that follow, new wording is underlined.

"Accessible Environment" means those portions of the environment outside the geological respository operations area and directly in contact with or readily available to human beings. For surface access, the accessible environment is defined as the site boundary; for groundwater flow, the accessible environment is defined as the point at which the groundwater enters a potable surface or near surface water body.

Staff Response to Comment No. 157:

See response to Comment No. 153.

Comment No. 158: Mississippi Dept. of Natural Resources (65)

The definition of "accessible environment" needs to be refined and clarified. It is defined as "those portions of the environment directly in contact with or readily available for use by human beings." With present technology boreholes and shafts can and do penetrate to repository depth. The whole repository can be considered to be in the accessible environment. Previous publications have maintained that waste needs to be isolated from the biosphere, which is said to be the base of fresh water. There seems to be a conflict between the two criteria. The ambiguity of the present definition will cause problems in interpretation of several sections in Subpart E.

Staff Response to Comment No. 158:

See response to Comment No. 153.

Comment No 159: B. Blanchard, U.S. Department of the Interior (24)

Accessible environment

Especially in a desert setting, the accessible environment could be construed to mean a water-bearing rock that yields even a small (household) supply to a drilled well. Most saturated rocks fit this category, and trying to determine ground-water flow times from a repository through the far field to the accessible environment becomes a meaningless exercise. Perhaps some elements of "likelihood" or "significant use" should be incorporated into the definition.

Staff Response to Comment No. 159:

See response to Comment No. 153.

Comment No. 160: P. Shewmon, NRC Advisory Committee on Reactor Safeguards (89)

During its 268th meeting on August 12-14, 1982, the ACRS discussed the status of the draft regulation, "Disposal of High Level Radioactive Wastes in Geologic Repositories," 10 CFR 60. This matter was also discussed with the NRC Staff at a meeting held by our Subcommittee on Waste Management on June 8, 1982.

As you know, we submitted a report to you on September 16, 1981 concerning an earlier version of these regulations that appeared in the Federal Register on July 8, 1981. Our latest meetings with the NRC Staff indicate that they have given detailed consideration to our comments. In particular, we endorse the change in approach in which the disposal of transuranic wastes in a repository will be considered by the Commission on a case-by-case basis.

A new concern, however, is the proposed change in the definition of the "accessible environment" as it relates to the potential impact of radioactive wastes placed in a repository. Although the Staff stated that this change was suggested to make the rule compatible with current concepts within the U.S. Environmental Protection Agency, it appears this goal was not achieved. We believe that the proposed NRC definition is vague and would make difficult the confirmation of acceptable performance by the operator of a disposal facility. We are particularly concerned how compliance with the required 1,000-year groundwater travel time to the accessible environment can be verified under the proposed definition. We suggest reconsideration of the original definition. In a similar manner, we believe that the suggested redefinition of the "waste package" to exclude clay backfill may make it more difficult to determine compliance with the 1,000-year containment requirement.

Staff Response to Comment No. 160

See Overview, Section 4.1, Accessible Environment/Controlled Area. For the commenter's concern regarding verification of compliance with the 1,000-year groundwater travel time criterion, see Chapter VII of Part C.

The revised definition of the waste package is not intended to exclude clay placed around the metal container from consideration as part of the waste package. See Overview, Section-by-Section Analysis, §60.2, Definitions, under "Waste Package."

ON THE DEFINITION OF THE TERM "ANTICIPATED PROCESSES AND EVENTS":

Comment No. 161: Institute of Electrical and Electronics Engineers (28)

In the definition of "anticipated processes and events," the phrase "reasonably likely to occur" should be clarified, or replaced with a more specific phrase.

Staff Response to Comment No. 161:

See Overview, Sections 3.1 and 5.4, Anticipated/Unanticipated Events and Processes and Reasonable Assurance, respectively. See also, Overview, Section-by-Section Analysis, § 60.2.

Comment No. 162: V. McIntyre (35)

Anticipated Processes and events

Who is to make the determination of what they are? This should be explicitly stated in the technical criteria. It should not be buried in the licensing procedures.

Staff Response to Comment No. 162:

This determination will be made by the Commission. DOE would identify anticipated and unanticipated processes and events in its application, but they would be subject to review and modification in the licensing process. We expect that the scope of anticipated/unanticipated processes and events would be separately identified by the preceding offices and certified to the Commission for interlocutory review, pursuant to 10 CFR 2.718(i).

ONE COMMENTER SUGGESTED THAT A DEFINITION OF THE TERM "BUFFER" BE ADDED TO 60.2:

Comment No. 163: C. R. Fisher, General Atomic Co. (16)

General Atomic requests that a definition of the term, "Buffer," be added to this Section. This term is used in the proposed rule and should be defined to ensure consistent interpretation.

Staff Response to Comment No. 163:

The term "buffer" has been deleted from the provisions of the final rule. Therefore, there is no longer a need to define the term.

ON THE DEFINITION OF THE TERM "CANDIDATE AREA":

Comment No. 164: V. McIntyre (35)

Candidate Area

The definition is mumbo jumbo and it is susceptible to multiple interpretations. The supplementary information should explain what the term means with multiple examples. For ex., how would it be applied at Hanford? Would it include the drainage of the Columbia River Basin or just the Pasco Basin? Similarily, how would it be applied with one of the Gulf Coast Salt domes?

Also, who is the party whc is to make the determination of the limits of the candidate area. This should be explicitly stated in the technical criteria. It should not be buried in the licensing procedures.

Staff Response to Comment No. 164:

The site selection process is governed by Subtitle A of Title I of the Nuclear Waste Policy Act of 1982. See also Overview, Section 5.3, Geologic Conditions.

ON THE DEFINITION OF THE TERM "CONTAINER":

Comment No. 165: U.S. DOE (48)

10 CFR 60.2 "Container"

NRC Proposed Wording:

10 CFR 60.102(e)(2) states: "The container which is the first major sealed enclosure that holds the waste form."

Recommended Revision:

Delete the term "container" and, if such a term is necessary, replace with "canister" with the following definition in section 60.2: Canister - a component of the waste package that provides the means of safely handling the waste form after production, during waste package assembly, or during any required movements or transport between the sites of production of the waste form and assembly of the waste package.

Rationale:

In the comment on The Advanced Notice of Proposed Rulemaking, DOE noted that "canister" is a more commonly used term than "container" and further that NRC's definition included the unclear term "f st [illegible] canister may or may not be a sealed component of the waste package. [illegible] omments still apply since, although the definition of "cont iner" w[illegible] oved from 60.2, the term "container" remains in 60.102. (Note th[illegible] he [illegible] inition of canister does not preclude the canister from performing an [illegible] lat[illegible] function, but does permit the assignment of such functions to other [illegible] nts of the waste package.) References to "container" might be approp[illegible] replaced with references to "overpack."

Staff Response to Comment No. 165:

The staff does not believe it is necessary to define "canister" because there are no requirements applicable to such a component.

ONE COMMENTER SUGGESTED THE ADDITION OF A DEFINITION OF THE TERM "CONTAINMENT PERIOD":

Comment No. 166: U.S. DOE (48)

10 CFR 60.2 "Containment Period"

NRC Proposed Wording:

While not defined in 60.2, the discussion of "containment" in 60.102 states, "Early during the repository life, when radiation and thermal levels are high and the consequences of events are especially difficult to predict rigorously, special emphasis is placed upon the ability to contain the wastes by waste packages within an engineered system. This is known as the containment period."

Recommended Revision:

In section 60.2 define "containment period" as: "The time after closure of the repository when the containment of the radioactive waste must be virtually complete within the engineered system."

Rationale:

The concept as expressed in section 60.102 is not clear and would benefit from a definition in section 60.2. The discussion in section 60.102 could then be amended to explain that for HLW and spent fuel, the containment period would coincide with the time period when radioactivity levels and heat production within the waste are dominated by fission product decay. This period is more precise than the stated "when levels are high and the consequences of events are especially difficult to predict rigorously."

Staff Response to Comment No. 166:

We believe the meaning of "containment period" is clear. It is that period as specified in § 60.113(a)(1)(ii)(A), subject to modification as provided in § 60.113(b). See also, Overview, Section 3.4, Containment, as well as Part C, Chapter VII.

TWO COMMENTERS ADDRESSED THE USE OF THE TERM "DOE":

Comment No. 167: H. Ross (14)

Suggested wording change - "DOE" means the U.S. Department of Energy, or its appropriate successor agencies responsible for High-Level Radioactive Waste Disposal, or duly authorized representatives of these government agencies.

"Retrievability" - Definition should be included for this key term.

Comment No. 168: D. M. Petefish (43)

Throughout the regulation the term DOE is used. In the event of the imminent demise of DOE I suggest such words be striken and replaced with "responsible federal agency".

Staff Response to Comment Nos. 167 and 168:

The staff declines to make the suggested changes. If at some future date DOE's programmatic responsibility for the construction and operation of HLW repositories is transferred to another agency, the rule will be amended to reflect this change. With respect to "retrievability," see response to Comment No. 191.

ON THE DEFINITION OF THE TERM "DECOMMISSIONING":

General Staff Response to Comment Nos. 169-172:

The term "decommissioning" was intended to apply to that stage at which the underground facility was closed and shafts and boreholes were sealed. It is these activities that were addressed in § 60.51, "License amendment to decommission." This intention is better expressed by employing the term "permanent

closure." Where there is a need to refer to decontamination or dismantlement of surface facilities, this can readily be done without referring to "decommissioning." See Overview, Section 4.4, Decommissioning.

Accordingly, references to "decommissioning" have been deleted from the rule, and the language now refers to "permanent closure" or to "decontamination or dismantlement of surface facilities," as appropriate. This means that even after permanent closure has been accomplished, surface facilities may continue to be possessed or used by DOE. Having been established as part of a licenseable facility, however, they would continue to be subject to NRC licensing and regulatory authority until they had been properly decommissioned.

After permanent closure, prescribed design requirements would cease to apply to remaining surface facilities. Certain provisions of NRC regulations, including 10 CFR Part 20, would still remain in force. These regulations together with conditions in DOE's license, would assure the necessary continuing protection of public health and safety. Site restoration considerations would be evaluated in accordance with applicable law in the context of license termination.

The changes are fully responsive to Comment Nos. 169 and 170, and responsive in substance to Comment No. 171. We have not referred to partial decommissioning, as suggested in Comment No. 171, although we agree that partial backfilling may be undertaken prior to permanent closure. This point is a substantive one and not appropriate in the definitions section. Moreover, the performance objective dealing with retrievability makes it evident that backfilling of portions of the underground facility may be allowed in advance of permanent closure.

We believe that Comment No. 172 is also accommodated, even though we refer to closing the underground facility (in which waste packages have been emplaced) with backfill instead of "sealing...the underground excavation with a barrier system consisting of an appropriate combination of engineered structures and backfill." The difference between the proposed and the final rule involves mere choices of phraseology. See also staff responses to the other comments above.

Comment No. 169: Institute of Electrical and Electronics Engineers (28)

In the definition of "decommissioning," the requirement for dismantlement of surface facilities seems unnecessarily restrictive.

Comment No. 170: R. H. Neill, State of New Mexico (78)

The decommissioning definition appears to require dismantlement of all surface facilities at the repository. This may not be necessary, since some buildings might be usable with no adverse health and safety aspects.

Comment No. 171: U.S. DOE (48)

10 CFR 60.2 "Decommissioning'

NRC Proposed Wording:

"Decommissioning", or "permanent closure", means final backfilling of subsurface facilities, sealing of shafts, and decontamination and dismantlement of surface facilities.

Recommended Revision:

"Decommissioning" or "permanent closure" means the final backfilling and sealing of underground excavations, including main entries, shafts, and boreholes; the decontamination and dismantlement or retirement of surface facilities; the off site transport of any materials not disposed of on site; and site restoration work. This does not preclude decommissioning of portions of the repository earlier than the time of permanent closure

Rationale:

The clarification of the excavations to be backfilled during decommissioning emphasizes the differences between final backfilling" and room backfilling which may be performed prior to decommissioning. The dismantlement of surface facilities should not be mandatory as it may be desirable to leave portions of the facilities as markers or to employ them for other purposes; hence, retirement from use as a component of the waste disposal system should be an option. Material disposal and site restoration work should be included in the definition to ensure that such activities are considered within the scope of decommissioning activities.

Comment No. 172: C. Walske, Atomic Industrial Forum (50)

"Decommissioning" or "permanent closure" means the sealing of subsurface openings consisting of shafts, boreholes, and all or part of the underground excavation with a barrier system consisting of an appropriate combination of engineered structures and backfill; the decontamination and dismantlement of surface facilities; and completion of all other appropriate site restoration work. (AIF suggested new wording underlined)

ON THE DEFINITION OF THE TERM "DISPOSAL":

Comment No. 173: Institute of Electrical and Electronics Engineers (28)

The definition of "disposal" creates confusion (with the word "storage") because there is no mention of the fact that disposal involves no intent for later retrieval. "Storage" is used later (page 35288, column 3, first full paragraph) with no definition. In fact, "storage" is said to include "disposal." Perhaps, some particular wording related to the Commission's authority necessitates this approach, but it does cause confusion

Staff Response to Comment No. 173:

The commenter is correct that the wording of the Commission's authority accounts for the usage of the word "storage" in § 60.102(b)(3). The statutory provision (Section 202 of the Energy Reorganization Act of 1974) appears in the footnote to the definition of "HLW facility " Accordingly, the staff believes no change should be made to the rule.

Comment No. 174: National Radiological Protection Board, UK (29)

Definitions of "Disposal" and "Isolation" - Taken together the definitions of disposal and isolation (Section 60.2, P 35285-5) are consistent with UK concepts and include recognition that isolation implies control of releases to the environment, rather than zero release

Staff Response to Comment No. 174:

No response required.

Comment No. 175: U.S. DOE (48)

10 CFR 60.2 "Disposal"

NRC Proposed Wording:

"Disposal" means the isolation of radioactive wastes from the biosphere.

Recommended Revision:

Disposal - the permanent emplacement of radioactive waste in a geologic repository to isolate the wastes from the biosphere.

Rationale:

The definition as currently stated would appear to be applicable to storage as well as permanent placement. The recommended revision recognizes that disposal is an act which is performed with the intent to achieve isolation.

Staff Response to Comment No. 175:

The staff considers that it is the attribute of isolation rather than the act of emplacement that characterizes "disposal." For this reason, the suggestions regarding "permanent emplacement" have not been accepted.

ON THE DEFINITION OF THE TERM "DISTURBED ZONE":

Comment No. 176: V. McIntyre (35)

Disturbed Zone

Who is the party that will make the determination as to how far the disturbed zone extends. This should be explicitly stated and not buried in the licensing procedures

Staff Response to Comment No. 176:

In its license application, DOE will choose the extent of the disturbed zone based upon an analysis which NRC will review during the licensing process in determining what the extent should be

Comment No. 177: Utility Nuclear Waste Management Group (44)

The definition of "disturbed zone" should specifically refer to the properties of the geologic setting which are of interest insofar as disruption is concerned. In particular, "disturbed zone" would be better defined as "that portion of the geologic setting the physical and/or chemical properties of which is significantly affected by construction of the subsurface facility or by the heat generated by the emplacement of radioactive waste."

Staff Response to Comment No. 177:

The definition of the term "disturbed zone" has been modified as follows: the disturbed zone means that portion of the controlled area the physical or chemical properties of which have changed as a result of underground facility construction or as a result of heat generated by the emplaced radioactive wastes such that the resultant change of properties may have a significant effect on the performance of the geologic repository. The staff believes that this modification accommodates the concerns of both the UNWMG and DOE. See Overview, Section-by-Section Analysis, Section 60.2 on definition of "disturbed zone."

Comment No. 178: U.S. DOE (48)

10 CFR 60.2 "Disturbed Zone"

NRC Proposed Wording:

"Disturbed zone" means that portion of the geologic setting that is significantly affected by construction of the subsurface facility or by the heat generated by the emplacement of radioactive waste.

Recommended Revision:

"Disturbed Zone" means that portion of the geologic setting whose physical or chemical character has changed as a result of subsurface facility construction or from heat generated by the emplaced radioactive wastes such that the resultant changes of character may have a significant effect on the performance of the disposal system. Investigations of the disturbed zone conducted in accordance with section 60.123(b) will not determine the real extent for the establishment of controls required by section 60 121(b).

Rationale:

"Significantly affected" could be interpreted to apply to any measurable effect, whether or not it would have any impact on the performance of the waste isolation system. The recommended revision ties the concept of disturbances to significant effects on the performance of the disposal system. Note that changes in actual values would not necessarily result in changes in character of the geologic setting. Induced changes which would not significantly affect performance should not be considered to be disturbances. Also, the proposed phrasing could be rigidly interpreted to refer to the frictional heat generated between canister and emplacement hole, because of the wording "heat generated by the emplacement of radioactive waste" rather than "heat generated by emplaced radioactive waste." Section 60.123(b) requires certain investigations to be conducted at specific distances. We recommend the addition of the last sentence to avoid the possibility that the distance, chosen for those investigations, would determine the real extent for the establishment of controls required by section 60.121(b).

Staff Response to Comment No. 178:

See response to Comment No. 177.

ON THE DEFINITION OF THE TERM "ENGINEERED SYSTEM":

Comment No. 179: U.S. DOE (48)

10 CFR 60.2 "Engineered System"

NRC Proposed Wording:

"Engineered system" means the waste packages and the underground facility.

Recommended Revision

"Engineered System" - Includes the repository waste package, backfill and seals, and includes a portion of the host rock. The extent of this inclusion of the host rock will be determined on a case-by-case basis.

Rationale:

Since "underground facility" excludes shafts, boreholes, and seals, the above definition implies that these entities, along with surface facilities, are not engineered If the intended concept is "engineered barrier system", that term should be used with a clarification in the concept section. However, note that the control of release requirement which is placed on the engineered system would, in fact, become a requirement on the waste package. While we believe that the proposed 10^{-5} release rate criterion should be dropped or modified, in the event that the Commission chooses to retain this criterion, DOE would recommend that some acknowledgement be made of the isolation capabilities of the host rock The extent of the rock, or rocks, which will be included in the engineered system will be proposed in the license application related to a specific site.

Staff Response to Comment No. 179:

The staff recognizes that shaft, boreholes and their seals are engineered and agrees with the commenter that the term "engineered system" as used in the proposed rule might have introduced ambiguities. Therefore, in the final rule the term "engineered barrier system" as suggested by the commenter is used to mean the waste packages plus the underground facility. Since the performance objective for control of releases applies to the engineered barrier system it would not be appropriate to include boreholes, shafts and their seals within this system. Boreholes, shafts and their seals provide a potential pathway to the land surface (the accessible environment) and therefore are required to limit releases to meet the EPA standard, as expressed in the overall system performance objective.

The commenter's recommendation that a portion of the host rock be included in the definition of the engineered barrier system has not been adopted. The engineered barrier system is intended to include only man-made components, which is consistent with the provisions of the Nuclear Waste Policy Act of 1982 (Pub. L. 97-425). The provisions of 10 CFR 60.113(b), however, allow consideration by the Commission of the characteristics of the host rock in approving containment times for the waste package and release rates from the engineered barrier system. The staff considers that this provision accommodates DOE's underlying concern.

ON THE DEFINITION OF THE TERM "FAR FIELD":

Comment No. 180: C. Walske, Atomic Industrial Forum (50)

"Far field" means the portion of the geologic setting that lies beyond the geologic repository operations area. (AIF suggested new wording underlined)

Staff Response to Comment No. 180:

The definition of the term "far field" has been deleted from the rule. See Overview, Section-by-Section Analysis, Section 60.2 on deletion of "far field."

ON THE DEFINITION OF THE TERM "FLOODPLAIN":

Comment No. 181. Utility Nuclear Waste Management Group (44)

In the definition of the term "floodplain," the words "including flood prone areas of offshore islands" should be deleted as they are redundant.

Comment No. 182. National Association of Counties Research Inc. (1)

It should be noted, in the definition of floodplain, that this is meant to encompass the commonly termed "100 year flood."

Comment No. 183: R. H. Neill, State of New Mexico (78)

The floodplain definition could be more restrictive than a 1% chance of flooding per year since only a few percent of the total land area in a basin is typically inundated by a 100-year flood. Consideration should be given to defining the flood plain as the area inundated by a Standard Project Flood.

Staff Response to Comment Nos. 181-183:

The definition of the term "floodplain" used in the proposed technical criteria was derived from the definition set forth in Executive Order 11988--Floodplain Management. For further information see the U.S. Water Resources Council's Guidelines for Implementing E.O. 11988 (43 FR 6030). See also Overview, Section-by-Section Analysis, Section 60.2 on deletion of "floodplain."

ON THE DEFINITION OF THE TERM "GEOLOGIC REPOSITORY":

Comment No. 184. V. McIntyre (35)

Geologic Repository

Taken literally this definition would permit disposal in a shallow trench. Surely this is not what NRC intends.

Staff Response to Comment No. 184:

The staff can conceive of no way that HLW could be disposed in a shallow trench and still meet the overall performance requirements of the EPA standard.

Comment No. 185: U.S. DOE (48)

10 CFR 60.2 "Geologic Repository"

NRC Proposed Wording:

"Geologic repository" means a system for the disposal of radioactive wastes in excavated geologic media. A geologic repository includes (1) the geologic repository operations area, and (2) the geologic setting.

Recommended Revision:

Repository - the surface and sub-surface areas where waste handling activities are or have been performed.

Rationale:

The 10 CFR 60 definition as currently written would include the geologic setting which is generally considered to be distinct from the repository but part of the waste disposal system. The repository is designed to act in conjunction with the geologic setting and the waste packages to provide isolation of nuclear wastes and to permit the necessary waste handling operations associated with waste disposal. Note the recommended definition for "waste disposal system" on page B-15; this term should be used in place of "geologic repository" when the intent is to include the entire system.

Staff Response to Comment No. 185:

We consider the comment to be primarily semantic in nature in view of the accepted usage in Part 60, and we believe it would be inadvisable to make the suggested modification.

Comment No. 186: B. Blanchard, U.S. Department of the Interior (24)

Geologic repository

This term should be restricted to mean a place in excavated geologic media where radioactive waste is reposited, or laid away (see Webster's Third International Dictionary). The repository should not include the geologic setting, which may represent tens of square miles of systems that provide waste isolation. The repository should consist of the features included in the definition of "underground facility" in the proposed rule.

Staff Response to Comment No. 186:

See response to Comment No. 185

ON THE DEFINITION OF THE TERM "GEOLOGIC REPOSITORY OPERATIONS AREA".

Comment No. 187: C. R. Fisher, General Atomic Co. (16)

In order to avoid potential inconsistency of application, General Atomic suggests that the definitions of the term, "Geologic repository operations area," that appear in Sections 60.2 and 60 102, be revised so that they are identical.

Staff Response to Comment No. 187:

The discussion of the term "geologic repository operations area" set forth in Section 60.102 (Concepts) appears to be fully consistent with the definition of the term set forth in Section 60.2, and no change is deemed to be necessary.

Comment No. 188: Institute of Electrical and Electronics Engineers (28)

Confusion may be caused by defining a "geologic repository operations area" in terms of HLW. If a licensed repository were built for transuranic waste, this definition might not include such a repository.

Staff Response to Comment No. 176:

The term "geologic repository operations area" is defined in terms of HLW because of the language in the Energy Reorganization Act. Under existing law, a DOE repository for TRU alone would not be subject to NRC regulations. It should be noted, further, that references to TRU have been deleted from the rule. Any proposal to dispose of TRU at a geologic repository operations area would be considered on a case-by-case basis.

Comment No. 189: U.S. DOE (48)

10 CFR 60.2: "Geologic Repository Operations Area"

NRC Proposed Wording:

"Geologic repository operations area: means a HLW facility that is part of a geologic repository, including both surface and subsurface areas, where waste handling activities are conducted.

Recommended Revision:

Delete the term

Rationale:

Refer to our recommended revisions (page B-10) to the NRC term "geologic repository." It is suggested that "geologic repository operations area" be replaced by the term "repository." This would eliminate the need for defining an additional term which is not in general use, thereby increasing the clarity of the regulation

Staff Response to Comment No. 189:

See staff response to Comment No. 185.

Comment No. 190. C. Walske, Atomic Industrial Forum (50)

"Geologic repository operations area" means a HLW facility that is part of a geologic repository, including both surface and subsurface areas, where waste handling activities are conducted. It is an area which encloses the physically disturbed zone, and extends at least 0.5 km laterally beyond the limit of openings mined and developed for the repository operations. (AIF suggested new wording underlined)

Staff Response to Comment No. 190:

No change in the definition of the geologic repository operations area is necessary. However, the staff believes the intent of this comment is accommodated by the new definition of controlled area and the revised definition of accessible environment. The controlled area may have a greater area than that covered by the underground facility.

ON THE TERM "GEOLOGIC SETTING":

Comment No. 191: V. McIntyre (35)

Geologic setting, Site, and Candidates Area

These terms are leading to all sorts of confusion in the technical community. Guidance is needed from the Commission (in the supplementary information) as to how they are to be applied. For example, to cite one thing...most people think of the site as being a relatively small area which might be bounded by a fence. Obviously this is close to the Geologic Repository Operations Area. However according to the definitions it means the same thing as the Geologic Setting. But to my mind the geologic setting represents the regional picture. This hardly equates with the site.

The supplementary information should discuss what the Commission means by these terms and specific geologic examples should be given for the Basin and Range Province, the Columbia River Plateau, the Permian Basin of West Texas-New Mexico and the Gulf Coastal Plain.

Staff Response to Comment No. 191:

The staff agrees that the "site" connotes a smaller area than is intended by the term "geologic setting." The staff also recognizes the validity of arguments which suggests that the term "site" is more closely linked to a tract of land. The definition of the term site has been revised in the final rule to mean the location of the controlled area. The extent of the geologic setting for particular areas will be determined on the basis of the evidence presented in the licensing process. Obviously, however, the geologic setting must be sufficiently extensive to permit an evaluation of the relevant geologic, hydrologic, and geochemical factors.

Comment No. 192: U.S. DOE (48)

10 CFR 60.2: "Geologic Setting"

NRC Proposed Wording:

"Geologic setting" or "site" is the spatially distributed geologic, hydrologic, and geochemical systems that provide isolation of the radioactive waste.

Recommended Revision:

"Geologic setting" is the spatially distributed geologic, hydrologic, and geochemical systems at and around the site.

Rationale:

It is recommended that geologic setting not be synonymous with site. The term "site," while related to geologic setting, is sometimes applied in a broader sense than geologic setting, to mean a geographical location. An example of this appears in section 60.21(c)(1)(ii)(A) which refers to the meteorology of the site. (A recommended definition for site as a separate term is included later.) The geologic setting should be considered to be the geologic features of the site and the surrounding region. Note also that while some portions of the geologic setting provide isolation, other aspects of the geologic setting may have no role in providing isolation.

Staff Response to Comment No. 192:

See staff response to Comment No. 191.

Comment No. 193: B. Blanchard, U.S. Department of the Interior (24)

Geologic setting or site

These terms are synonymous as defined in the proposed rule. However, "site" is a very specific term and setting is much broader. "Setting" should be defined separately to be any one of several natural systems (i.e., geologic, hydrologic, geochemical, tectonic, or geomorphic) that provide isolation of radioactive waste. These settings do not necessarily coincide and they may be on a regional or local scale. For example, a large closed ground-water basin is a regional hydrogeologic setting; a smaller ground-water flow system is a local hydrogeologic setting. Neither of these necessarily conforms to the regional or local tectonic setting, for example.

"Site" should be a more specifically defined unchanging area, perhaps including the area underlain by the geologic repository (as redefined above) plus the disturbed zone.

Staff Response to Comment No. 193:

See staff response to Comment No. 191.

ON THE TERM "HLW":

Comment No. 194: R. I. Newman, American Institute of Chemical Engineers (46)

Regardless of what is done with it, spent fuel is not a "waste" by any generally accepted definition. In our opinion, spent fuel should be reprocessed not only for its energy value, but also through removal of plutonium to reduce the duration of hazard and the volume of high level waste.

Staff Response to Comment No. 194:

The proposed language has been retained. The Commission treats spent fuel as HLW for the reasons stated at 43 FR 53870.

ON THE TERM "HLW FACILITY":

Comment No. 195: UK Atomic Energy Authority (29)

Page 35286, column 1, 'HWL" is a printing error.

Comment No. 196: Utility Nuclear Waste Management Group (44)

"HWL facility" should be corrected to "HLW facility."

Staff Response to Comment Nos. 195 and 196:

Both commenters are correct. The printing error will be corrected in the final rule.

ON THE DEFINITION OF THE TERM "IMPORTANT TO SAFETY":

Comment No. 197: Bechtel National, Inc. (37)

The definition of "important to safety" uses the words "without undue risk to the health and safety of the public". Due to lack of specificity, this qualitative definition can cause considerable difficulty during the licensing review process.

It is recommended that the definition be quantified to specifically apply to items essential to the prevention or mitigation of the consequences of operational accidents that could result in exceeding some defined radiological release or exposure limit. Utilizing 1/10 of the "accident dose limit" stipulated in 10 CFR 72, 0.5 rem to the whole body at the site boundary may be appropriate for such a limit for a geologic repository.

In addition, the definition of "important to safety" should include engineered items and site characterization activities which are important for assuring the long term isolation of the waste from the human environment, e.g., the waste package and activities that are necessary to verify certain characteristics of the geologic setting.

Staff Response to Comment No. 197:

See Overview, Section 4.5, Important to Safety.

Comment No. 198: Utility Nuclear Waste Management Group (44)

The phrase "important to safety" is significant primarily to the extent that it serves to identify structures, systems and components subject to the design, construction and quality assurance requirements specified in §§ 60.130, 60.133 and 60.150. The definition in the proposed rule, however, is overly vague. To cure this, the meaning of "undue risk to the health and safety of the public," as used in the definition, should be specified in terms of a particular dose to a member of the public. In this regard, the UNWMG believes that use of dose of 0.5 rem to the whole body, or any organ, similar to that utilized in 10 CFR § 20.105(a) in connection with allowable, annual whole body doses to persons in unrestricted areas, would be appropriate.

Staff Response to Comment No. 198:

See Overview, Section 4.5, Important to Safety.

Comment No. 199: C. Walske, Atomic Industrial Forum (50)

"Important to safety," with reference to structures, systems and components, means:

a) those items essential to the prevention or mitigation of an accident that could result in a radiation dose to the whole body, or any organ, of 0.5 rem or greater at or beyond the nearest boundary of the controlled area during facility operations;

b) those features of the waste package that are necessary to control, within specified performance limits, the release of radioactive materials to the geologic environment after permanent closure; and

c) those aspects of the subsurface facility and the geologic setting that are necessary to assure that releases of radioactive materials to the accessible environment following permanent closure conform to the overall system performance objectives. (AIF suggested new wording underlined)

Discussion:

"Important to safety" is a designation used to identify those items and activities that provide reasonable assurance that the radioactive waste can be received, handled, and stored without undue risk to the health and safety of the public. Special design, procurement, construction and quality assurance requirements are applied to such items to assure that they retain their safety functions under all normal and abnormal conditions.

Features or aspects of the repository system that are needed to assure that the performance objectives for the system are satisfied after permanent closure are also considered "important to safety."

Staff Response to Comment No. 199:

See Overview, Section 4.5, Important to Safety.

ON THE DEFINITION OF TERM "ISOLATION":

Comment No. 200: V. McIntyre (35)

Isolation

What are the prescribed limits which are referred to? Are they those put forth by NRC or DOE?

Staff Response to Comment No. 200:

The prescribed limits are those referred to § 60.112.

ON THE DEFINITION OF THE TERM "MEDIUM":

Comment No. 201: C. Walske, Atomic Industrial Forum (50)

"Medium" or "geologic medium" is a rock type which could be used for a geologic repository. (AIF suggested new wording underlined).

Staff Response to Comment No. 201:

For the sake of clarity the term "medium" is now replaced by "geologic medium" throughout the final rule. The staff believes that since the term "geologic medium" is sufficiently clear to the professional community it is no longer necessary to define it. Therefore the definitic "medium or geologic medium" has been deleted from the rule.

ON THE DEFINITION OF THE TERM "OVERPACK":

Comment No. 202: U.S. DOE (48)

10 CFR 60.2: "Overpack"

NRC Proposed Wording:

"Overpack" means any buffer material, receptacle, wrapper, box, or other structure, that is both within and an integral part of a waste package. It encloses and protects the waste form so as to meet the performance objectives.

Recommended Revision:

The "overpack" is a component of the waste package to contain the waste during the containment period.

Rationale:

The recommended revision avoids listing the various possible configurations of the overpack and more clearly states the functions of that waste package component commonly referred to as a overpack.

Staff Response to Comment No. 202:

The term "overpack" has been deleted from the revised rule.

ON THE DEFINITION OF THE TERM "RETRIEVAL":

Comment No. 203: U.S. DOE (48)

10 CFR 60.2: "Retrieval"

NRC Proposed Wording:

This term is not defined in 10 CFR 60.

Recommended Revision:

Retrieval - The act of intentionally removing radioactive waste from the underground location at which the waste had previously been emplaced for disposal.

Rationale:

Some of the concerns over the retrieval requirements in 10 CFR 60 may be alleviated by providing a definition of the term and a discussion of the concept.

It should be noted in the discussion of the concept that retrieval is performed in the event that the specific waste isolation system has demonstrated an inability to meet its established performance objectives and that waste is considered to have been retrieved when it has been removed from the subsurface facility.

Staff Response to Comment No. 203:

The staff agrees with DOE's suggestion. This definition of the term "retrieval" has been adopted in the final rule.

ON THE DEFINITION OF THE TERM "SITE":

Comment No. 204: U.S. DOE (48)

10 CFR 60.2: "Site"

NRC Proposed Wording:

Defined as synonymous with geologic setting.

Recommended Revision:

Site - The location, both at and below the surface, where the repository is constructed.

Rationale:

(See previous comments on geologic setting). The proposed definition conveys the fact that the site is a tract of land to be characterized and controlled by DOE. The site would include surface features within the specified area and the geologic setting underlying this area. Note that site characterization, as defined in 60.2, would actually consist of geologic setting characterization for a particular site.

Staff Response to Comment No. 204:

In the final rule the term "site" is no longer synonomous with the term "geologic setting." As now defined "site" means the location of the controlled area.

ON THE DEFINITION OF THE TERM "STABILITY":

Comment No. 205: V. McIntyre (35)

Stability

This definition violates the common useage of stability. It implies a dull site however as written it would allow the siting of a geologic repository on top of the Great Glen Fault. Is this NRC's intent?

NRC should revise the definition and give abundant examples in the supplementary information of how features such as the San Andreas fault, Colorado Plateau, Columbia River Plateau, Ramapo Fault, and the Gulf Coast Salt Domes would be treated.

Comment No. 206: M.J. Fisher (39)

Provide a better definition of stability since it appears to be unenforceable in a licensing environment.

Comment No. 207: Utility Nuclear Waste Management Group (44)

Definition of "stability," without reference to a particular type of stability (e.g., structural stability, tectonic stability, hydrogeologic stability, geomorphic stability, etc.) is somewhat confusing. Accordingly, the term should be defined with reference to particular modifiers.

Comment No. 208: C. Walske, Atomic Industrial Forum (50)

"Stability" means that the geologic processes and their rates of operation during the Quaternary (or late Cenozoic) period have been identified and do not jeopardize containment or isolation when projected to future times. (AIF suggested new wording underlined).

Staff Response to Comment Nos. 205-208:

The term "stability" has been deleted. See Overview, Section 3.3, Siting Criteria.

ON THE DEFINITION OF THE TERMS "SUBSURFACE FACILITY" AND "UNDERGROUND FACILITY":

Comment No. 209: V. McIntyre (35)

Subsurface facility and Underground facility

Is it really necessary to distinguish between the two terms? I suggest that NRC drop one of them.

Staff Response to Comment No. 209:

The term "subsurface facility" has been deleted from the final rule.

Comment No. 210: B. Blanchard, U.S. Department of the Interior (21)

Subsurface facility and underground facility

To a layman these terms would seem to be synonymous, and certainly there is little basis for keeping in mind the distinction contained in the proposed rule. We suggest the term "subsurface facility" be retained as defined, and the term "underground facility" be dropped and replaced by the term "geologic repository," as redefined above.

Staff Response to Comment No. 210:

The term "subsurface facility" has been deleted from the final rule.

ON THE DEFINITION OF THE TERM "SYSTEM":

Comment No. 211: B. Blanchard, U.S. Department of the Interior (24)

System

The undefined term "system" is used extensively in the proposed rule. Because the meaning of system can be variously interpreted, a definition in the context of disposal of high-level radioactive wastes would be helpful. The definition should include the concept of a unit with interrelated, interacting, or interdependent parts or processes with well-defined boundaries.

Staff Response to Comment No. 211:

"System" is not a term of art and is not used as such in the technical criteria. The staff believes that there is no need to include a unique definition here.

ON THE DEFINITION OF THE TERM "TRANSURANIC WASTE":

General Staff Response to Comment Nos. 212-222:

References to transuranic waste have been deleted from the rule. Therefore, the definition of the term is also deleted. Applicable requirements must be satisfied for all forms of radioactive waste disposal in a geologic repository. See Overview, Section 3.2, Transuranic Waste (TRU).

Comment No. 212: Battelle Pacific Northwest Laboratories (2)

Under §60.2 Definitions, transuranic waste is defined as "Radioactive waste containing alpha emitting transuranic elements, with radioactive half-lives greater than five years, in excess of 10 nanocuries per gram." Technically, this implies that the total activity of any transuranic isotope emitting alpha particles, regardless of the alpha branching ratio, must be included in the total not to exceed 10 nCi/g. The classic example of this effect is ^{241}Pu which has a relatively short half-life (14.355y) and therefore a high specific activity but an alpha branching ratio of only $2.4 \cdot 10^{-5}$. The proposed rule as written technically requires the entire ^{241}Pu activity to be included in the transuranic concentration total, but the intent is to include only the alpha activity branch in the total.

This technical detail can be corrected with a minor rearrangement of the proposed definition of transuranic wastes to "Radioactive waste containing transuranic elements, with radioactive half-lives greater than five years, in excess of 10 nanocuries of alpha activity per gram."

Comment No. 213: Florida Power & Light Co. (25)

"Transuranic wastes" or "TRU wastes" as defined in 60.2 should be eliminated from the Rule. This type of waste is not a high-level radioactive waste and should not be included in 10 CFR 60.

Comment No. 214: Florida Power & Light Co. (25)

The criteria for transuranic wastes as defined in (60.2) is inconsistent with Table 1 of Proposed Rule 10 CFR 61 which provides that concentrations of Pu-241 up to 350 nCi/gm are allowed before the waste must be considered as class C intruder waste.

Comment No. 215: Florida Power & Light Co. (25)

It is not clear from the definition of transuranic wastes (60.2) if the criteria is based upon 10 nCi/gm per transuranic element or as a total. Further, as we understand it, the criteria which NRC adopted for transuranic wastes (10 nCi/gm) is arbitrary. We have seen other information to suggest this limit should be 50 to 100 times greater. We do not believe that transuranic wastes should be a part of this rule at all; however, we urge NRC to at least do an extensive technical evaluation regarding the hazards and alternative disposal methods associated with transuranic wastes in the proposed concentrations before adopting this part of the Rule. Relegating wastes with such low concentrations of transuranic elements to a geologic repository [60.102(b)(4)] may not be technically warranted and would have significant financial consequences. In addition, we would urge NRC to perform a critical evaluation of the sources and quantities of radioactive wastes in the United States that could be likely to contain transuranic elements in excess of the established criteria.

Comment No. 216: J. Adam (34)

The proposed amendments provide a definition for transuranic wastes. It would be more appropriate to have a definition of "Other than HLW." As now stated, there is an implication that TRU (as currently defined) will be disposed of in a HLW repository and that non-HLW, non-TRU will not be. There may be other wastes which are neither HLW nor TRU which may (or should) be disposed of in a HLW repository. The distinction should be made between HLW wastes and other wastes not between HLW and TRU.

The definition of container as included as part of the definition of waste package is not the same as that given in 60.102(e)(2). The latter definition is the better of the two.

Comment No. 217: Bechtel National, Inc. (37)

The definition of "TRU waste" should be more specific since if spent fuel was defined as a waste form, it could be classified either HLW or TRU waste in these proposed regulations. In addition, the activity level defined for TRU waste (10 nanocuries per gram of alpha radiation) is extremely low to require its disposal in the same manner as HLW (see e.g. 60.111) and, in fact, is a factor of 10 below the specific activity defined for TRU by the EPA in Draft 19 of 40 CFR 191. We recommend, therefore, that the TRU definition be reconsidered in view of the stringent requirements imposed by this rule. As an alternative, TRU disposal could be removed from the consideration by this rule and subsequently treated by future regulations.

Comment No. 218: B. R. McElmurry (38)

I cannot find any logic to support a 10 nanocurie/gram limit for the definition of TRU waste. As I understand it natural uranium or thorium may be 60-600, so that a limit of 100 might be reasonable. The limit maybe should be higher yet, because no one is restricted from entry into natural regions where soil activity is still higher. Furthermore, NUREG/CR-1005 suggests that shallow land burial of up to 22500 nanocuries per gram of PU^{239} is acceptable for shallow land burial. Severe restrictions of this sort must be based on toxicological data, not supposition. (Section 60.2)

Comment No. 219: Utility Nuclear Waste Management Group (44)

As presented in the proposed rule, the definition of "transuranic wastes" or "TRU wastes" is unduly restrictive. There is no technical justification for a 10 nanocurie per gram limitation. Further -- from a practical standpoint -- such a level is at the extreme low end of detectability. A limitation of 100 nanocuries per gram, as contained in the draft EPA standards for 40 CFR Part 191, would result in a more workable and technically sound definition.

In any event, as discussed below in connection with § 60.102(b)(4) the UNWMG is of the view that regulations pertaining to TRU should be developed in a separate document. Such an approach would, among other things, provide an opportunity for directing needed attention to the unique aspects of TRU waste disposal. In this connection, the UNWMG will be providing additional analysis of TRU waste disposal in its comments on the regulations currently being proposed for 10 CFR Part 61.

Comment No. 220: R. I. Newman, American Institute of Chemical Engineers (46)

We continue our strong objection to the unduly low transuranic content level in the definition of TRU wastes which we believe is in no way technically supportable for appropriate protection of the health and safety of the public. However, as the "justification" for this definition is published by the NRC in support of its proposed 10 CFR Part 61, we will provide further comments on TRU when we comment on Part 61 after reviewing the voluminous environmental impact statement.

Comment No. 221: P. J. Nickles and C. H. Montange, Covington and Burling (49)

Proposed § 60.2 defines transuranic wastes (TRU) to mean "radioactive waste containing alpha emitting transuranic elements, with radioactive half-lives greater than five years, in excess of 10 nanocuries per gram." Kerr-McGee objects to this definition to the extent that it suggests that deep repository disposal is required for all TRU waste with this activity or above or to the extent that it classifies TRU waste in excess of 10 nCi/gm as "high level" waste. The definition, if so applied, appears unjustified, unsupported, and unduly stringent.[1]

Based upon Kerr-McGee's current decommissioning experience with a mixed oxide fuel plant, Kerr-McGee estimates that NRC's proposed TRU definition, if applied to require deep repository disposal, would increase the need for geologic storage volume to hold high level waste from similar operations by at least a third over that which would be required if the definition specified a level of 100 nCi/gm. Requiring deep redepository disposal would unduly tax limited space in such repositories.

The "10 nCi/gm" limit appears to be totally arbitrary. The AEC Manual indicates that it was established without scientific support and is simply "derived from the upper range of concentration of radium-226 in the earth . . ." AEC Manual, Chapter 511 at p. 51 (Sept. 19, 1973). Indeed, the manual suggests that the 10 nCi/gm figure is subject to revision upon further study. Deep repository disposal, which will be very expensive ($200 per cubic foot or more) obviously should not be required on so flimsy a foundation. TRU waste which is in excess of 100 nCi/gm may be satisfactorily disposed in near surface facilities as low-level waste, at only a fraction of that cost (10% or less). Requiring deep geologic disposal for ordinary waste from a plutonium fuel operation would place an unnecessary burden on such operations.

Kerr-McGee's view is supported by the epidemiological investigation being conducted by the Los Alamos National Laboratory. The investigation examines the impact of low level exposure from internal deposition of and external radiation from plutonium. As reported by a press release from the Los Alamos National Laboratory dated October 15, 1981, considerably lower mortality was observed in the population of Los Alamos workers exposed to plutonium than would be expected from the mortality rate of white males in the United States. Kerr-McGee's view is further supported by the Department of Energy which reportedly does not believe that deep repository disposal is required for TRU waste in excess of 10 nCi/gm.

Kerr-McGee accordingly requests the Commission to make clear (1) that deep repository disposal is not required for TRU waste in excess of 10 nCi/gm and (2) that TRU waste in excess of 10 nCi/gm need not be disposed of as "high level" waste.

[1]Kerr-McGee also objects to the definition to the extent that it is intended to be a standard on the ground that NRC lacks authority to issue such standards. That authority was transferred to the Environmental Protection Agency (EPA) under Reorganization Plan No. 3 of 1970 (assuming arguendo the validity of the transfer of authority under that Plan).

Comment No. 222: U.S. DOE (48)

10 CFR 60.2 "TRU Waste"

NRC Proposed Wording:

"Transuranic wastes" or "TRU wastes" means radioactive waste containing alpha emitting transuranic elements, with radioactive half-lives greater than five years, in excess of 10 nanocuries per gram.

Recommended Revision:

Delete definition of TRU wastes in 10 CFR 60.

Rationale:

It is not appropriate to consider TRU wastes in the context of this regulation (see related comments in enclosure A, page 30). If the Commission should decide to keep TRU waste provisions in 10 CFR 60, DOE recommends that a common definition be adopted by EPA, NRC, and DOE for TRU waste and included in 60.2.

ON THE DEFINITION OF THE TERM "UNDERGROUND FACILITY":

Comment No. 223: U.S. DOE (48)

10 CFR 60.2: "Underground Facility"

NCR Proposed Wording:

"Underground facility" means the underground structure, including openings and backfill materials but excludes shafts, boreholes, and their seals.

Recommended Revision:

Delete the term and replace references to it with references to subsurface facility.

Rationale:

The necessity for using two terms, "underground facility" and "subsurface facility," is not obvious. The similarity between the two terms could be a source of confusion to the reader. Unless there is a specific need for both terms, DOE recommends deleting the term "underground facility."

Staff Response to Comment No. 223:

See response to Comment No. 209.

ONE COMMENTER SUGGESTED ADDING A DEFINITION OF THE TERM "WASTE DISPOSAL SYSTEM" TO 60.2:

Comment No. 224: U.S. DOE (48)

10 CFR 60.2: "Waste Disposal System"

NRC Proposed Wording:

This term is not defined in 10 CFR 60.

Recommended Revision:

Define Waste Disposal System as: "The configuration of man-made and natural features which provides for the handling, disposal, and isolation of nuclear wastes. This system includes: waste packages, the repository, the site, and those portions of the geologic setting which provide for isolation of the wastes." Replace references to geologic repository with references to the waste disposal system.

Rationale:

(See comments on Geologic Repository.) The term geologic repository is used in the draft 10 CFR 60 to refer to the entire waste disposal system. It is recommended that this new term be introduced to more clearly describe the system.

Staff Response to Comment No. 224:

The staff considers the term "geologic repository" appropriately descriptive.

ON THE DEFINITION OF THE TERM "WASTE PACKAGE":

Comment No. 225: V. McIntyre (35)

Waste Package

What is discrete backfill? I suggest that NRC define "indiscrete backfill."

Staff Response to Comment No. 225:

By discrete backfill, the staff meant backfill materials within an individual (i.e., discrete) waste package unit, as opposed to backfill used to fill drifts and emplacement rooms. However, because the term was unclear, it is no longer used in the definition of waste package in the final rule.

Comment No. 226: U.S. DOE (48)

10 CFR 60.2 "Waste Package"

NRC Proposed Wording:

"Waste package" means the airtight, watertight, sealed container which includes the waste form and any ancillary enclosures, including shielding, discrete backfill and overpacks.

Recommended Revision:

"Waste Package" means the waste form, canister. canister overpack, and any additional enclosure or materials (including backfill) that separate the radioactive waste from the unexcavated host rock.

Rationale:

The definition as currently stated in 10 CFR 60 is not consistent with the waste package concept used by the DOE program as the definition requires that the outer-most part of the waste package be airtight, watertight, and sealed (hole backfill would thus have to be within this enclosure). The components of the waste package, with the exception of the overpack and the waste form, should be optional at the discretion of the waste package designer. The recommended definition encompasses all material between the waste and the host rock, and hence by definition the waste package is in contact with the host rock. This raises concern that the 10^{-5} release rate criterion applies only to the waste package itself as it is not possible to take credit for the isolation capabilities of the host rock (see comments on the definition of engineered system). Obtaining agreement between DOE and the Commission on the definition of waste package is essential for rational discussion during the licensing process.

Staff Response to Comment No. 226:

The definition of the waste package has been revised in the final rule. However, we have not adopted DOE's recommended definition because it appears to be applicable to a specific design concept (a single canister placed in a hole in the floor of the underground facility) and not applicable to other concepts being considered (i.e., self-shielded packages placed in drifts). We have not used the term "backfill" in our definition because it is ambiguous. To the extent that absorbent materials or packing are placed around an individual container to protect it from corrosion by constitutents of groundwater, or to prevent the transport to the host rock of radioactive materials released following breach of a container, these materials would be considered part of the waste package. Backfill materials placed in openings primarily for structural support are

considered part of the underground facility. For the commenter's concern regarding the boundary of the engineered barrier system, see the response to Comment No. 179.

ONE COMMENTER REQUESTED CLARIFICATION OF SEVERAL EXISTING DEFINITIONS:

Comment No. 227: C. Walske, Atomic Industrial Forum (50)

Additional clarification is requested for the following:

"Biosphere" used in the definition of "Disposal" should itself be defined.

"Geologic setting or site" is not clear because the intended meaning of "Geologic system" and "Hydrologic system" is vague. Is a geologic system a topographic feature, structural features, structural or tectonic province, or region characterized by a particular assemblage of rock types? Is a "Hydrologic system" a groundwater basin or a single artesian aquifer?

Add the following definitions:

> "Containment period" means the prescribed period following repository closure, when the radiation and thermal levels of the waste are high, during which special emphasis is placed upon containing the waste by the waste package.

Staff Response to Comment No. 227:

The term "biosphere" has been replaced with the term "accessible environment" (which is defined in 60.2) in the revised definition of the term "disposal." Although the terms "geologic system" and "hydrologic system" are not precise, the context makes it clear that they must be interpreted in a manner that will take into consideration whatever may be significant in evaluating the isolation of radionuclides from the accessible environment. With respect to "containment period" see staff response to Comment No. 166.

ONE COMMENTER SUGGESTED THE INCLUSION OF DEFINITIONS OF HYDROLOGIC TERMS:

Comment No. 228: Capital Area Groundwater Conservation Commission (22)

Section 60.2 Definicions. Should include definitions of hydrologic terms such as groundwater, etc. Excellent sources of definitions are U.S. Geological Survey Water Supply Papers 1988 and 1541 A. U.S. Geological Circular 779 is an excellent "thinking document" when considering radwaste and earth science.

Staff Response to Comment No. 228:

See Response to Comment No. 152.

Comment No. 229: National Association of Counties Research, Inc. (1)

§ 60.2 - A paragraph should be included which requires the application to reflect the nature, extent, and proximity of current population centers, to the proposed site. (See comment on § 60.123.)

Staff Response to Comment No. 229:

See Overview, Section 2.4, Population-Related Siting Criteria.

THE FOLLOWING COMMENTERS ADDRESSED § 60.10:

Comment No. 230: Mississippi Dept. of Energy & Trans. (65)

Under Paragraph 60.10 Site Characterization, the requirement for active nuclear material to be tested at depth should be deleted. It is the general feeling that only major adverse conditions will cause the test facility not to become a permanent repository. The process for selecting a test location has been accelerated to the point that the evaluation is not adequate.

Staff Response to Comment No. 230:

The proposed amendments to § 60.10 would not require the use of radioactive material in site characterization. Neither would the present wording of § 60.10 prevent the use of such material. Whether radioactive material for site characterization will be used for characterization at a specific location will be particular to the site characterization program which DOE intends to employ at that location. Such use, it should be noted, would be limited to tests "needed to determine the suitability of the geologic setting for a geologic repository." (See the definition of "site characterization.")

Comment No. 231: Div. of Emergency Government, State of Wisconsin (77)

Page 35286, Paragraph 60.10 Site Characterization

In previous correspondence, the State of Wisconsin expressed concern that site characterization (which would include shaft sinking and other engineered activities) would not be subject to NRC licensing. We are still concerned that NRC has not reviewed and licensed many of the activities associated with site characterization.

Our particular concern relates to the mining laws of Wisconsin, in which site characterization including shaft sinking and in situ studies would require an environmental evaluation (and probably an environmental impact statement) and licensing. Significant environmental impact in shaft sinking will occur, and we are concerned that great effort can be expended in site characterization. A marginally acceptable site may become the ultimate repository because of the great amount of time, effort and funds expended to characterize and test.

We renew our request that some degree of licensing be imposed on DOE for at least some of the site characterization studies, so that such work would undergo proper regulatory scrutiny.

Staff Response to Comment No. 231:

See staff response to Comment No. 144.

Comment No. 232: Calif. Dept. of Conservation (62)

Site Characterization

Section 60.10, Site Characterization, subpart (b), states "Unless the Commission determines with respect to the site described in the application that it is not necessary, site characterization shall include a program of in situ exploration and testing at the depths that wastes would be emplaced."

No explanation is offered as to any set of conditions under which NRC would consider deleting the requirement of a thorough program of on-site exploration and testing for every potential HLW site. Even if a proposed site were in a geologic setting considered to be similar to a previously approved site, the site-specific conditions and their comparability with the approved site would still need to be tested to verify that the proposed site could indeed meet prescribed performance criteria. CDC believes strongly that in situ testing of geological conditions must be a mandatory element in any set of procedures required for selecting HLW sites, with no exception.

We recommend that subpart (b) of Section 60.10 be revised to unconditionally require an on-site exploration and testing program for every proposed potential site, as follows:

Section 60.10 Site Characterization

"(b) ~~Unless the Commission determines with respect to the site described in the application that it is not necessary,~~ Site characterization shall include a program of in situ exploration and testing at the depths that wastes would be emplaced."

Staff Response to Comment No. 232:

The Commission has expressed its belief that in situ testing at depth will be essential, but it has also stated that it is conceivable that necessary data could be obtained by other techniques (46 FR 13972-13973). The comment affords no basis for modifying this judgment. It should be noted that the Nuclear Waste Policy Act appears to contemplate that site characterization will always include in situ testing at depth.

Comment No. 233: Louisiana Dept. of Natural Resources (63)

Section 60.10 (b) Site Characterization. I agree with the requirement for in situ parameters--a prime requirement for the collection of hydrologic data.

Staff Response to Comment No. 233:

No response required.

Comment No. 234: Capital Area Groundwater Conservation Commission (22)

Section 60.10(b) Site Characterization. I agree with the requirement in situ parameters--a prime requirement for the collection of hydrologic data.

Section 60.10(d). The suggestion to limit adverse effects by limiting the number of subsurface "penetrations," indicates the need for the forementioned "State oversight" group and the interdisciplinary planning of penetrations or test holes for multipurpose data activities--geologic, hydrologic, etc. Current studies have not always been planned with this in mind but have had a "lack of data" syndrome and the need for "more holes" attitude.

Staff Response to Comment No. 234:

No response required to the commenter's first part. See General Response to Comment Nos. 19-23.

Comment No. 235: J. Adam (34)

§ 60.10 (c) Site Characterization.

DOE may have to characterize several sites in order to find one site which is licensable. It is also possible that DOE may be able to find a site which is likely to be suitable without using at depth, in-situ investigations. It is reasonable to require full characterization of the site once it has been selected as the subject of a license application. Given the cost of at depth testing and the difficulty of drawing quantitative conclusions about the relative merits of alternative sites, the requirement that DOE also characterize alternative sites using in-situ testing at depth is excessive. That DOE has identified one site which can satisfy NRC and EPA performance objectives and prescriptive criteria should suffice.

Staff Response to Comment No. 235:

DOE may request an exemption from the in situ testing at depth requirement. See the Commission's discussion of this issue at 46 FR 13973 and staff response to Comment No. 232.

Comment No. 236: U.S. DOE (48)

10 CFR 60.10(c)

NRC Proposed Wording:

As provided in section 51.40 of this chapter, ...

Recommended Revision:

None, but we wish to state our understanding of the intent of this section.

Rationale:

DOE believes that this section, when read together with the procedural provisions of Parts 51.40, 60.10(a) and 60.21(a), provides (1) that DOE is to include in its license application site characterization of alternative sites in accordance with NEPA and the requirements of Part 60.10; (2) that the information regarding the alternative sites, as identified in the Site Characterization Report, are to be described fully in the license application and accompanying environmental report, and are provided so that the NRC will be able to evaluate alternative sites in accordance with NEPA; and (3) that the standard by which the NRC will determine the adequacy of DOE's selection of alternative sites and its preferred site is whether the alternative site analysis was performed in accordance with NEPA.

Staff Response to Comment No. 236:

The commenter's understanding substantially conforms to that of the staff. See 46 FR 13972. There may also be grounds under the Atomic Energy Act for requiring multiple site characterization.

Comment No. 237: Louisiana Dept. of Natural Resources (63)

Section 60.10 (d). The suggestion to limit adverse effects by limiting the number of subsurface "penetrations," indicates the need for the forementioned "State oversight" group and the interdisciplinary planning of penetrations or test holes for multipurpose data activities--geologic, hydrologic, etc. Current studies have not always been planned with this in mind but have had a "lack of data" syndrome and the need for "more holes" attitude.

Staff Response to Comment No. 237:

See General Response to Comment Nos. 19-23.

Comment No. 238: U.S. DOE (48)

10 CFR 60.10(d)(1)

NRC Proposed Wording:

Investigations to obtain the required information shall be conducted to limit adverse effects on the long-term performance of the geologic repository to the extent practical.

Recommended Revision:

"Investigations to obtain the required information shall be conducted in a manner to limit adverse effects ..."

Rationale:

The NRC proposed language does not place the emphasis of the sentence properly.

Staff Response to Comment No. 238:

The paragraph has been revised for the reasons stated by the commenter.

Comment No. 239: Utility Nuclear Waste Management Group (44)

As currently worded the requirement contained in § 60.10(d)(2) is confusing. To the extent that the intent is to require that the number of exploratory boreholes and shafts be minimized, the section should be reworded to directly so state.

Staff Response to Comment No. 239:

The paragraph has been revised, for the reasons stated by the commenter.

THE FOLLOWING COMMENTER SUGGESTED ADDITIONAL WORDING TO 60.11(a):

Comment No. 240: Harmon & Weiss for NRDC (76)

§ 60.11(a)(5) should be amended to add the following language:

> "In addition, the description of the decision process by which the site was selected for characterization should contain sufficient information to allow the Director to determine (i) that the site was chosen primarily on the basis of consideration of geologic criteria and (ii) that the slate of sites are among the best that can reasonably be found, judged on the basis of geologic criteria."

Staff Response to Comment No. 240:

The staff declines to modify to language of § 60.11(a)(5). See staff responses to comment numbers 147, 241, and 477. See also Overview, Section 5.3, Geologic Conditions.

THE FOLLOWING COMMENTS ADDRESSED PROVISIONS FOR THE SAFETY ANALYSIS REPORT AS SET FORTH IN § 60.21:

Comment No. 241: Harmon and Weiss for the Natural Resources Defense Council, Inc. (76)

Section 60.21(c) requires the Safety Analysis Report to contain a description of the geologic characteristics of the site, phrased in the broadest and most general way. In addition, DOE is called upon to "analyze" 1) the degree to

which favorable and adverse site conditions may contribute to or detract from isolation, 2) the expected performance of the engineered systems that "bear significantly" on site suitability, and 3) the expected performance of the engineered systems that "bear significantly" on site suitability. The analyses called for will involve the use of extremely complex and unverifiable models and will necessarily incorporate great uncertainties, given the acknowledged difficulty inherent in predicting the behavior of the wastes and natural systems over the periods of time required.

These descriptions and analyses do not substitute for definitive site criteria and give NRC no tools by which to enforce the selection of an optimal site (or even one of the best).* Neither do they give DOE much useful guidance in conducting its own site selection process. Nor does any other section of the proposed rule provide either the needed guidance to DOE or criteria by which NRC can judge site suitability.

Staff Response to Comment No. 241:

Siting criteria are provided in § 60.122 and are as definitive as, in the judgment of the staff, are justified in light of current knowledge. With regard to the comment that the NRC has no tools to enforce the selection of an optimal site, the staff notes that a license to receive and possess radioactive material at a geologic repository operations area may be issued only if, among other things, the Commission has found that license issuance will not constitute an unreasonable risk to the health and safety of the public. The staff agrees with the commenter that geologic factors are very important factors in the site selection process, but believes that non-geologic considerations may also be important. See Overview, Section 5.3, Geologic Conditions and staff response to Comment No. 477.

Comment No. 242: UK Institute of Geological Sciences (29)

The contents of the Safety Analysis Report which is required to accompany the application for the siting of a repository provide a valuable resume of the types of information necessary to describe and assess the suitability of a site for the burial of HLRW but again this emphasizes the need for completion of the research before comprehensive mandatory rules are issued.

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*The issue of whether the rules should require selection of the "best" site is a red herring; no rule can ensure this. However, the rules should and do not ensure that site selection is based primarily on consideration of geologic factors.

Staff Response to Comment No. 242:

No response required.

Comment No. 243: T. H. Pigford (53)

In paragraph 60.21(c) NRC would require that the license application include data on expected releases of radionuclides to the accessible environment as a function of time. This is not sufficient. Assuming that the basic safety standard will be in the form of some radiation dose or dose rate to a maximally exposed individual or to a population, the application should include the evaluation of site-specific pathways for released radionuclides to reach humans and the radiation doses and dose rates therefrom.

Staff Response to Comment No. 243:

See Overview, Section 5.5, Population vs. Individual Dose.

Comment No. 244: Louisiana Dept. of Natural Resources (63)

Section 60.21(c)(I). Data needs should include absorptive and adsorptive properties and other clay properties. It should be recognized that clay is not impermeable.

Staff Response to Comment No 244:

See response to Comment No. 250.

Comment No. 245: Div. of Emergency Government, State of Wisconsin (77)

60.21(c)(1)(i)(B)	--	This section assumes that salt deposits will, in fact, be used for disposal.
60.21(c)(1)(i)(D)	--	Are these for each subsurface layer or an average over all layers between the surface and the bottom of the repository?
60.21(c)(1)(ii)(E)	--	Will models be openly discussed and reviewed so that "acceptable models" are defined in much the way they have been for air pollutant dispersion?
60.21(c)(3)(i)	--	Is there a word missing after "normal"?
60.21(c)(13)	--	Evaluation of natural resources will be very difficult for Wisconsin, particularly in areas now receiving intensive minerals exploration.

Staff Response to Comment No. 245:

The intent of paragraph 60.21(c)(1)(i)(B) was to identify the presence and characteristics of potential pathways from the geologic repository operations area to the accessible environment. Solution features, breccia pipes and other permeable anomalies were listed as examples of the types of potential pathways the staff envisioned could exist. This provision was not intended to apply to any specific rock type. The suitability of a particular site in a particular medium will be determined in the licensing process.

DOE will need to provide information on the hydrogeologic properties and conditions for each subsurface layer in the Safety Analysis Report.

Models will be openly discussed and reviewed as part of the licensing process.

The word "conditions" was omitted in paragraph 60.21(c)(3)(i). This omission has been corrected in the final rule.

The NRC staff cannot estimate the difficulty of a resource evaluation in the absence of site specific information. However, if a repository site were to be proposed for Wisconsin, an evaluation of natural resources would be required as specified by section 60.21(c)(13).

Comment No. 246: Utility Nuclear Waste Management Group (44)

The use of the term "bulk" with respect to geomechanical, hydrogeologic and geochemical conditions and properties in §§ 60.21(c)(1)(i)(C)-(F) differs from normal technical usage. The apparent reference is to the average of such properties and conditions over the disturbed zone. The language should be modified to so state.

With respect to § 60.21(c)(1)(ii)(E), it may be impossible to literally "confirm" models used to perform the required assessments. Rather, it would be more appropriate to require that assessments be supported by tests, data or studies. Further, it is not clear what would constitute "field-verified laboratory tests." Depending on the definition, field-verification may not be possible in some situations. A preferable approach would be to reference and require "appropriate laboratory and field tests."

Under § 60.21(c)(3), "a comparative evaluation of alternatives to the major design features that are important to radionuclide containment and isolation, with particular attention to the alternatives that would provide longer radionuclide containment and isolation" is required. For the reasons discussed in

the letter to which this Attachment is appended, however, such an open-ended, ALARA-type analysis is unnecessary. Simply stated, where projected doses are a small fraction of those which already result from variations in natural background radiation, further reductions cannot be justified. Accordingly, the requirement should be deleted.

In addition, the use of the expression "undiscovered deposits of natural resources" in § 60.21(c)(13) appears to be intended as a term of art (such as used by McKelvey in U.S.G.S. Professional Paper 820), meaning speculative resources, or those suspected but not actually found. If this is, indeed, the case, appropriate references or clarification should be provided to avoid any possible misinterpretations.

More basically, however, whatever the intended meaning of the expression, a prospective site would be explored in such detail during the characterization process that, as a matter of course, the presence or absence of resources should become well enough understood to accommodate the site selection process. Accordingly, § 60.21(c)(13) should be eliminated from the final rule as superfluous.

Finally, the word "sits" in § 60.21(c)(1)(ii)(A) should be "site."

Staff Response to Comment No. 246:

(a) In response to the first point concerning the use of the term "bulk", the NRC staff agrees with this comment and has deleted the term from 60.21(c)(i)(c), (d), (e) and (f). In addition, the language of 60.21(c)(i) has been modified to state that "the description shall, in all cases, include such information with respect to the controlled area." The NRC staff considers the revised language sufficiently clear for the purposes of the regulation. Because the level of detail needed is site specific, the staff declines to incorporate the word "average." This topic may be addressed in a regulatory guide.

(b) Since the analyses and models referred to in § 60.21(c)(1)(ii)(E) will be used to predict future conditions and changes in the geologic setting the following wording has been adopted:

"(F) An explanation of measures used to support the models used to perform the assessments required in paragraphs (A) through (D). Analyses and models that will be used to predict future conditions and changes in

the geologic setting shall be supported by using an appropriate combination of such methods as field tests, in situ tests, laboratory tests which are representative of field conditions, monitoring data and natural analog studies."

The staff recognizes that it would be impossible to literally "confirm" the models referred to in this part since they must take into likely future events and results of processes in the geologic setting.

(c) The required analysis now appears under §60.21(1)(ii)(D). See Overview, Section 5.1, Comparative Safety Analyses.

(d) With respect to "undiscovered deposits of natural resources" see response to Comment No. 252.

Comment No. 247: U.S. DOE (48)

10 CFR 60.21(c)(1)(i)(B)

NRC Proposed Wording:

The presence and characteristics of other potential pathways such as solution features, breccia pipes, or other permeable anomalies.

Recommended Revision:

Change last phrase "or other permeable anomalies" to "or other potentially permeable features".

Rationale:

An "anomaly" is a deviation from normal, an abnormality. The statement clearly refers to salt. Although they are deviations from the majority of the salt body, solution features and breccia pipes are not unusual features in salt bodies. They are neither necessarily anomalous nor permeable; some are less permeable than some other parts of the salt body. It is, of course, important and necessary to describe and assess the significance of these features--we just don't believe it proper for the rule to state the results in a prejudicial way (i.e., "permeable").

Staff Response to Comment No. 247:

The staff accepts the comment and has made the change.

Comment No. 248: J. M. de Montmollin (9)

Page 35287, Sec. 60.21 (c) (13)

The purpose of providing the assessment of mineral resources in the Safety Analysis Report is not clear. The wording infers that the only purpose is to show that the locations of the disturbed zone within a particular geologic setting was such that the mineral resources were no greater there than is characteristic of that geologic setting; that is, that mineral resources are a consideration in locating the disturbed zone but not the geologic setting. Whatever the intent, the treatment of the mineral resources problem does not provide sufficient assurance against inadvertent breaching of containment.

1. Sec. 60.21 (c) (13) implies that mineral deposits in the geologic setting outside the disturbed zone are of no concern; only that the resources in the disturbed zone should not be greater than is representative of the geologic setting. The geologic setting is defined (Sec. 60.2) as the "...systems that provide isolation of the radioactive waste." Since breaching of the geologic setting would compromise containment, it is not apparent why mineral resources only in the disturbed zone are to be evaluated or only their development restricted.

2. The definition of geologic setting does not include underlying formations that do not contribute to the system of isolation, and hence the rules do not require that they be considered. As the WIPP site illustrates, there may be substantial deposits well below the geologic setting, which would provide incentives to breach the containment. Sec. 60.133 (b) requires that boreholes be sealed. That apparently refers only to boreholes drilled in connection with the repository, although it could include pre-existing holes. It certainly does not include holes subsequently drilled to explore and develop mineral resources lying in or below the geologic setting at some future time. If boreholes are a threat to isolation, as the proposed rules indicate, there must be assurance that underlying mineral prospects do not lead to future drilling. It is difficult to gain such assurance, but as a minimum the rules should cover all mineral resources and prospects underlying the geologic setting, not just those in the disturbed zone.

Staff Response to Comment No. 248:

According to the final rule, the comparative evaluation will relate to the controlled area than to the disturbed zone. The controlled area includes formations underlying the underground facility, so resources there must be considered. Moreover, natural resources, whether identified or undiscovered must be evaluated throughout the entire geologic setting.

Comment No. 249: J. M. de Montmollin (9)

The apparent purpose of Sec. 60.21 (c) (13) is that the facility operator such as DOE would acquire mineral rights on the basis of current market values and withhold them from development, thereby resolving any conflict between resource development and repository isolation. There are three principal difficulties with that solution:

1. It assumes that such legal arrangements will remain effective for the 1000 years for which isolation is required.

2. Current market values have little meaning, even in the very short term. The price of gas in the Permian Basin of New Mexico, including that underlying the WIPP site, has increased from about 15 cents per 1000 cubic feet in the mid-1960s, about the time the site was first considered, to a regulated price of $2.84 today. Lease costs have risen from $5-15 per acre to more than $400*. Other gas, not regulated, sells today for more than $8. The corresponding values of the 35 billion cubic feet estimated to underlie the site are $5 million, $100 million, and over $300 million.

   These are not merely costs to the project; the last figure represents the resource value that society currently assigns to a badly-needed energy resource of that magnitude.

3. The market value of a mineral resource is a time-dependent variable, as the above example illustrates. The market value of a particular resource is a function of the technology available for development and the cost of alternative resources, both at a particular time. The incentives for future development of a particular deposit cannot be assessed in terms of current market prices and technology, beyond the certainty that resources will increase in value with time.

My concern is that the risks of breach of repository isolation by future mineral development are not adequately controlled by the proposed rules. A more immediate concern is that inadequacy will give rise to substantial public opposition to current efforts to arrange for disposal of nuclear wastes, leading to further delay and inaction.

The problem is particularly difficult since salt beds have assumed so much importance. Salt beds occur in sedimentary basins which also are the provinces associated with oil and gas, as well as other evaporite minerals such as potash. If salt beds are to remain under consideration, much more rigorous criteria beyond the estimation of current values only within the disturbed zone are needed. In view of the uncertainty as to what would constitute an attractive prospect to future generations, it may be necessary to require that the salt formation be at the bottom of the sedimentary series, underlain only by non-sedimentary basement rock. While that would greatly limit the availability of suitable salt-bed sites, there are other geologic media.

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*Oil and Gas Journal, Aug. 3, 1981, p. 64

Staff Response to Comment No. 249:

See Overview, Sections 2.6 and 3.1, Human Intrusion and Anticipated/Unanticipated Process and Events, respectively, and Section-by-Section Analysis, § 60.122(c)(16). No assumption is made that legal arrangements will remain effective for 1,000 years. The rule requires the assessment of natural resources without current markets, given credible changes in economic or technical factors. Also, see response to Comment No. 248.

Comment No. 250: Capital-Area Groundwater Conservation Commission (22)

Section 60.21(c)(I). Data needs should include absorptive and adsorptive properties and other clay properties. It should be recognized that clay is not impermeable.

Staff Response to Comment No. 250:

The data needs for adsorptive and absorptive properties of clay were included in the reference to geochemical properties in 60.21(1)(c)(i)(E).

The NRC staff recognizes that clay is not impermeable.

Comment No. 251: C. Walske, Atomic Industrial Forum (50)

Para. 60.21 Content of application

Item 60.21(c)(1)(i) If literally interpreted, these requirements could be a tremendous task to complete. More precise definition of "in the vicinity" and the multiplicity of required observations should be addressed.

Item 60.21(c)(3) The last sentence of this item requires that the SAR include a "comparative evaluation of alternatives to the major design features that are important to radionuclide containment and isolation." This is inappropriate in a Safety Analysis Report which should focus on the particular design being proposed. This type of comparative evaluation, which is really a cost/benefit analysis, should be in the repository Environmental Impact Statement if it is done at all. Furthermore, the way the requirement is stated puts no limit on the number of alternatives to be evaluated. Such a requirement should ask for a description of alternatives that have been considered.

Staff Response to Comment No. 251:

§ 60.21(c)(1) has been revised to require the information, if relevant and material, insofar as it pertains to subsurface conditions outside the controlled area that may affect isolation.

The commenter is correct in stating that a Safety Analysis Report should focus on the particular design being proposed. In the case of a geologic repository, however, the performance objectives are subject to modification, on a case-by-case basis, as needed to satisfy applicable EPA standards. An appreciation of alternative design features will provide the basis for determining which of the performance objectives might most appropriately be modified, and the extent of such modifications. Moreover, the requested information will facilitate the Commission's arriving at a judgment whether an alternative would so significantly increase its confidence that the performance objectives would be satisfied as to warrant the adoption of such alternative design features. See also Overview, Section 5.1, Comparative Safety Analyses.

Comment No. 252: V. McIntyre (35)

60.21 (c) (ii)(C) The analysis should carry through to the dose to an individual. This is the bottom line. If this can't be done we have no business burying waste.

60.21 (c) (13) The use of the term "undiscovered deposits" should be dropped since if they are undiscovered it is silly to speculate about them.

Staff Response to Comment No. 252:

See Overview, Section 5.5, Population vs. Individual Dose.

"Undiscovered deposits" are unspecified bodies of mineral-bearing material surmised to exist on the basis of broad geologic knowledge and theory. These are distinguished from "identified resources," which are specific bodies of mineral-bearing material whose location, quality, and quantity are known from geologic evidence supported by engineering measurements (see U.S. Geological Survey Bulletin 1450A, "Principles of the Mineral Resource Classification System of the U.S. Bureau of Mines and U.S. Geological Survey, 1976).

We consider the estimation of undiscovered deposits to be a reasonable approach to site investigations for a geologic repository. Because of the large area that could be relied on to provide isolation (the controlled area could approach approximately 150 square miles) and realizing that the geologic setting itself could cover hundreds of square miles, it would be unreasonable

to require identification of resources in the sense of the above definition of identified resources. However, given the NRC's approach to selection of sites of little resource value in order to reduce the likelihood of future human intrusion, the resource potential of this large area must be considered in the licensing process.

Therefore, we have retained the requirement to estimate undiscovered deposits in the final rule.

Comment No. 253: Bechtel National, Inc. (37)

60.21 (c) (3) - This paragraph requires the Safety Analysis Report to include "a comparative evaluation of alternatives to the major design features that are important to radionuclide containment and isolation, with particular attention to the alternatives that would provide longer radionuclide containment and isolation". Comparative evaluations of this type are not appropriate for safety analyses which should be directed at the specific design being proposed and the safety requirements it must satisfy. Furthermore, on what basis would such an evaluation be assessed by the NRC -- cost, safety, reliability, environmental impact? We recommend this requirement be deleted.

Staff Response to Comment No. 253:

See Overview, Section 5.1, Comparative Safety Analyses, and staff response to Comment No. 251.

Comment No. 254: Bechtel National, Inc. (37)

60.21 (c) (13) - This paragraph requires an evaluation of resources, including "undiscovered deposits, for the disturbed zone and for areas of a similar size in the geologic setting. The determination and specificity of "undiscovered deposits" is a complex and highly variable process for different prospective sites, and estimates by "reasonable inference based on geological and geophysical evidence" present an argumentative situation at best. What is the purpose of considering "areas of a similar size", how many should be considered, and at what depths? We recommend this paragraph, 60.21 (c) (13), be removed.

Staff Response to Comment No. 254:

See staff response to Comment No. 252.

The purpose of comparing the estimates of resources within the site with those of similar size within the geologic setting is to avoid selecting sites with higher resource potential than average for the region that would make

attractive targets for future exploration. The number of areas and depth to be considered would be site specific and would depend on the types of minerals likely to exist within the geologic setting based on geologic and geophysical evidence.

Comment No. 255: B. R. McElmurry (32)

The resource evaluations called for in 60.21.13 are not justified in the extent called for. Any resources discovered in the extensive testing should be reported, but it is futile to burden such a program with requirements for developing acceptable methodology for projecting the presence of unknown resources and unknown uses. Since repositories will occupy such an incredibly small portion of the land area of the United States, we should accept the small risk associated with the simpler approach.

Staff Response to Comment No. 255:

See response to Comment No. 254.

Comment No. 256: H. Ross (14)

60.21 (ii) (E)

Is the intent to verify the numerical model programs used to predict long term aspects of the geologic repository, or is the intent to prove the correctness of the combined model-plus-site data combination?

Proof of performance for long time intervals is impossible to demonstrate ahead of time. Should the word confirm be replaced with evaluate?

Sensitivity analyses should be included as a means to "confirm" the predictions of future performance.

Staff Response to Comment No. 256:

See Overview, Section-by-Section Analysis, § 60.21(c)(1)(ii)(F). The required support concerns not only the reliability of the codes themselves, but also the representativeness of the models with respect to the physical conditions of the site.

Comment No. 257: Harmon and Weiss for NRDC (76)

§ 60.31 should be amended to add the following:

(d) Site Selection

(1) That the site was chosen from among a slate of characterized sites that are among the best that can reasonably be found judged on the basis of geologic criteria.

(2) That among the sites characterized, the chosen site provides the highest reasonably achievable degree of enhancement of the waste isolation capabilities of the repository.

Staff Response to Comment No. 257:

See Overview, Section 5.3, Geologic Conditions and the staff response to Comment No. 477.

THE FOLLOWING COMMENTERS ADDRESSED 60.51:

Comment No. 258: National Association of Counties Research, Inc. (1)

§ 60.51 (a)(2)(ii) - To assure complete recording of the location of the repository, the wording of this section should be changed by adding, after "archives" in line 4, and "and land record systems," and inserting "state" after the word "local" in line 5.

Staff Response to Comment No. 258:

The staff agrees with the comment and has made the changes as suggested.

Comment No. 259: U.S. DOE (48)

10 CFR 60.51(a)(2)(ii)

NRC Proposed Wording:

Placement of records of the location of the geologic repository operations area and the nature and hazard of the waste in the archives of local and Federal Government agencies, and archives elsewhere in the world that would be likely to be consulted by potential human intruders.

Recommended Revision:

Replace "geologic repository operations area" with "repository".

Rationale:

Consistency with recommended revisions to Section 60.2.

Staff Response to Comment No. 259:

See staff response to Comment No. 185.

Comment No. 260: B. R.McElmurry (38)

The requirements of 60.51 relative to providing permanent markers are unnecessary, especially the part about providing foreign governments (Russia, No. Viet Nam?) detailed records. After 500 years or so, the waste is essentially harmless, so that should suggest the design life of a suitable marker.

Staff Response to Comment No. 260:

The staff disagrees with the characterization of the waste as "essentially harmless" after 500 years or so. See Part C, Rationale for Performance Objectives in 10 CFR Part 60, Chapter II. The purpose of markers (as well as other measures) is to discourage intrusions which could result in releases to the accessible environment of radionuclides at levels exceeding those established by EPA.

The rule sets out an adequate standard to specify the foreign archives in which records are to be deposited.

Comment No. 261: Div. of Emergency Government, State of Wisconsin (77)

60.51(2) -- What is the expected duration of these measures?

Staff Response to Comment No. 261:

Monuments must be designed, fabricated, and emplaced to be as permanent as practicable. Existing technology will readily allow for the establishment of monuments that can be expected to survive for many thousands of years.

We consider it reasonable to anticipate that relevant records will be preserved and remain accessible for at least several hundred years after permanent closure. The existence of archives and land record systems, the deliberate efforts that would be made to assure that the long-term significance of the information is recognized, and the development of current data handling technology, fully justify this assessment.

The concepts are reflected in the definition of "unanticipated processes and events" that is contained in the final rule.

THE FOLLOWING COMMENTERS ADDRESSED 60.101:

Comment No. 262: Utility Nuclear Waste Management Group (44)

Section 60.101 presents the purpose and nature of findings relevant to technical criteria. Pursuit of the barrier performance objectives approach, however, has resulted in a lack of flexibility. Proposed numerical standards do not accommodate the wide range of variations available for allocating safety functions among separate system components when designing to meet overall performance criteria for repositories in various geologic media. In short, single-value criteria that attempt to cover all options are appropriate for none of them. The use of such criteria, as currently prescribed in the regulation, could bias site selection and design; quite possibly to the extent that achieving required performance would be both more difficult and costly.

In addition, the UNWMG cannot agree with what appears to be the major NRC motivation for the inclusion of such criteria (see page 35,284) that the inclusion of individual component requirements facilitates a showing of compliance with overall system performance requirements (EPA standards). Such a showing will necessitate the use of numerical models, independent of specific, individual component requirements.

To provide an efficient, practical regulatory framework for repository licensing the Commission should assure that the regulations afford sufficient flexibility to both take advantage of new developments, and effectively utilize the specific characteristics of individual sites. Such flexibility could be provided through the addition of a new paragraph (c) in § 60.101 as follows:

(c) Sections 60.111 and 60.112 contain performance objectives concerning the containment of waste in the waste packages; the control of releases from the engineered system; and pre-waste emplacement groundwater travel times through the far field to the accessible environment. The ability to meet specific performance objectives, however, will vary from site to site, particularly as a function of the host rock involved. Accordingly, variations from and/or alternatives to the specific performance objectives are equally acceptable, provided that there is reasonable assurance that the overall system performance objective embodied in the environmental radiation protection standards referenced in § 60.111(b)(1) will be met.

Staff Response to Comment No. 262:

See Overview, Section 2.1, Single vs. Multiple Performance Standards.

THE FOLLOWING COMMENTERS ADDRESSED THE TERM "REASONABLE ASSURANCE":

GENERAL RESPONSES TO COMMENT NOS. 263-268:

See Overview, Section 5.4, Reasonable Assurance, for a general discussion of the issues raised in these comments. Where appropriate, additional discussion is provided in individual responses to these comments.

Comment No. 263: Div. of Emergency Government, State of Wisconsin (77)

Page 35288, second column, "reasonable assurance" and where else it appears in the proposed rule.

"Reasonable assurance" is a non-legal term that has evolved from the Waste Confidence Rulemaking. We are concerned that this phrase is a very subjective value judgment on the part of the Commission. This value judgment is not clearly amenable to review, except in courts by litigation. The competence of the Commission will change with time, and what constitutes "reasonable assurance" thus will also change, and not necessarily to more or less stringent evaluations.

Staff Response to Comment No. 263:

In dealing with risk assessments, such as those required when licensing HLW facilities, it is appropriate to provide a "reasonable assurance" standard. This indicates that the decisionmaker will not demand rigorous step-by-step proof of cause and effect, but may apply expertise to draw conclusions from imperfect data. See Ethyl Corp. v. EPA, 541 F.2d 1, 28 (D.C.Cir. 1976). Although "subjective value judgments" will be made, the Commission will nevertheless have an obligation to take relevant facts into consideration and arrive at conclusions that are rationally justified. Ibid. Contrary to the implication of the comment, the proposed language provides a properly rigorous test for the review of license applications.

Moreover, the term "reasonable assurance" has a long history of use by the Atomic Energy Commission and the Nuclear Regulatory Commission. Over 20 years ago, the "reasonable assurance" findings specified in the Commission's reactor licensing regulations (10 CFR § 50.35) were reviewed by the Supreme Court, and they were found to be in compliance with the requirements of the Atomic Energy Act. Power Reactor Development Co. v. Electrical Union, 367 U.S. 396, 407 (1961).

There is no reason to believe that the reasonable assurance provisions would be legally infirm in the context of repository licensing.

Comment No. 264: Westinghouse Corp. (54)

Westinghouse considers it appropriate to specify a time period over which reasonable assurance of satisfactory repository performance must be predicted. A time period of 10,000 years after permanent closure of the repository seems reasonable, based on the realization that prediction of processes and events beyond 10,000 years tends to become increasingly speculative.

Staff Response to Comment No. 264:

Long-term performance of a repository must be evaluated against the EPA standard. If the EPA standard were to specify environmental radioactivity levels over a period of 100,000 years, for example, then it would be necessary to predict performance over that period. We recognize that the degree of uncertainty may increase over time, at least as to some processes and events, but this should not preclude the making of required findings with reasonable assurance.

Comment No. 265: Sierra Club (66)

In general the degree of proof called for by the NRC is "reasonable confidence" that the public health is protected whereas the Sierra Club would wish a "high degree of confidence." The proposed rule still allows for a large amount of radioactivity to enter the environment and therefore a large number of cancers to be caused per kwh of electricity produced. We believe there should be a limit.

Staff Response to Comment No. 265:

The comment presumably refers to the provisions dealing with the making of findings with "reasonable assurance" (rather than "reasonable confidence"). By deliberately adopting "reasonable assurance" in this context, the Commission calls into play the same conservative approach to licensing that it employs in connection with reactors. If different words (e.g., "high degree of confidence") were chosen, there would be room for dispute as to whether the Commission intended a departure from its customary regulatory approach. Since that is not the intent, it is best to employ the established term of art. With respect to the amount of radioactivity entering the environment, EPA will establish generally applicable standards limiting the amount of radioactivity entering the environment. See also Overview, Section 5.4, Reasonable Assurance.

Comment No. 266: National Radiological Protection Board, UK (29)

The requirement for reasonable assurance (Section 60.101 (a) (2), P. 35288) that performance objectives and criteria will be met does not provide sufficient guidance for applicants. Since the performance objectives and criteria in the proposed rule are arbitrary (see general comments) it is obviously difficult to define clearly how compliance is to be demonstrated. However "reasonable assurance" could be statistically defined, taking into account the increase in the uncertainty of predictions with time.

Staff Response to Comment No. 266:

The factfinding process is an administrative task for which the terminology of law, not science, is appropriate. The degree of certainty implied by statistical definition has never characterized the administrative process. It is particularly inappropriate where evidence is "difficult to come by, uncertain, or conflicting because it is on the frontiers of scientific knowledge." See Ethyl Corp. v. EPA, 541 F.2d 1, 28 (D.C.Cir. 1976).

Comment No. 267: V. McIntyre (35)

60.101 (a) (2) I am supportive of NRC's statement of "reasonable assurance'

Staff Response to Comment No. 267:

The commenter's support is noted.

Comment No. 268: Sierra Club (66)

Reasonable Assurance

The proposed rule indicates (60.101) that complete assurance concerning protection of the public health can never be met and that the Commission will only require "reasonable assurance" based on the record. Instead, the Club believes that under conservative assumptions, there should be "high confidence" that concentrations of radionuclides in waste materials should not be allowed to appear in the Earth's biosphere before they have decayed to innocuous levels.

Staff Response to Comment No. 268:

See response to Comment No. 265.

Comment No. 269: C. Walske, Atomic Industrial Forum (50)

Para. 60.101 Purpose and nature of findings

To be consistent with proposed changes to Paragraph 60.111, it is suggested that Item 60.101(a)(2) be changed to read as follows:

(new section in quotes)

Item (a)(2) While these performance objectives and criteria are generally stated in unqualified terms, it is not expected that complete assurance that they will be met can be presented. .....For 60.111 and other portions of this subpart that impose objectives and criteria for repository performance over long times into the future, "it is recognized that proof of performance of engineered systems and geologic media during such long time periods is not available in the ordinary sense of the word. However, even though less than perfect performance of individual components of the repository system might occur, collectively they provide a degree of redundancy such that there can be a high level of confidence that satisfactory repository system performance will be achieved. Thus reliance is not placed on any single system component at the risk of compromising the performance of the overall system. Therefore, these objectives should be viewed as design guidance rather than rigid requirements. The general standard should provide reasonable assurance, based on the record before the Commission, that these objectives will be met, making allowances for the time period and hazards involved. These objectives provide flexibility to permit appropriate system trade-offs and allow for incorporation of future technological development. Such changes will be acceptable provided that it is shown that a comparable level of repository system performance is predictable.

Staff Response to Comment No. 269:

The comment suggests that the performance objectives be rewritten to provide greater flexibility. This has been accomplished through the revision of the performance objectives. This modification appears to accommodate the concerns identified in the comment.

THE FOLLOWING COMMENTERS ADDRESSED 60.102:

Comment No. 270: V. McIntyre (35)

This section is a nice addition to the technical criteria. It aids in understanding the regulation by showing how things are done and what they mean in a functional way.

Staff Response to Comment No. 270:

No response required.

Comment No. 271: M. J. Fisher (39)

Provide an illustrative time scale and spatial diagrams in your "Concepts" section.

Staff Response to Comment No. 271:

There is merit in the suggestion. However, it would be difficult to implement because of the many variables that ought properly to be taken into account. Therefore the staff declines to make the suggested change.

Comment No. 272: Utility Nuclear Waste Management Group (44)

Section 60.102(b)(4) addresses waste form requirements for TRU. Because of the special factors relevant to transuranic waste disposal, however, we believe that regulations pertaining to the management of such material should be developed in a separate document, and that this section of the regulations should so note. If this approach were followed, some of the complexity of the currently proposed rule would be eliminated. This approach would also provide an opportunity for directing needed attention to the unique aspects of TRU waste disposal.

Comment No. 273: C. Walske, Atomic Industrial Forum (50)

Para. 60.102 Concepts

Item (b)(4) Addressing TRU waste in this rule is inappropriate since the Commission has not yet established regulations dealing with the disposal of TRU. Furthermore, the requirements for TRU in this rule could set inappropriate precedents with respect to future TRU regulations that might be proposed. Therefore, it is strongly recommended that all reference to TRU waste in this rule be deleted. Accordingly, it is recommended that paragraph 60.102(b)(4) be changed to read as follows:

> "Item (b)(4) HLW includes irradiated reactor fuel as well as reprocessing wastes. However, if DOE proposes to use the geologic repository operations area for storage of radioactive waste other than HLW, such as transuranic-contaminated waste (TRU), the requirements pertaining to the storage of such radioactive waste will be established on a case basis and/or in accordance with such other applicable regulations as may be promulgated by the Commission."

It is noted that HLW is also TRU waste, especially following the 1,000 year containment period. That is, it contains more than 10 nanocuries per gram of transuranic elements. Clearly, the term "TRU waste" is not intended to include HLW. Therefore, a more quantitative definition of TRU waste is needed.

Staff Response to Comment Nos. 272 and 273:

Consideration of TRU wastes has been deleted from the rule and accordingly from the Concepts section. See Overview, Section 3.2, Transuranic Waste (TRU).

Comment No. 274: Capital-Area Groundwater Conservation Commission (22)

Section 60.102(c). Last sentence should read, "...particular attention must be given to the characteristics of host rock, material surrounding the host rock, regional hydrologic setting, and the past, present and predicted future effects of manmade and natural stresses on the hydrologic system." (Underlined material added).

Staff Response to Comment No. 274:

The staff agrees that the hydrologic parameters are equally important to characteristics of the host rock. There was no intent to imply otherwise. The sentence directing that particular attention be given to the host rock has been deleted.

Comment No. 275: Institute of Electrical and Electronics Engineers (28)

The first sentence implies that it is more difficult to predict the consequences of events early in the repository life than it is later. The opposite would seem to be true; i.e., it is more difficult to predict consequences later in the repository life.

Staff Response to Comment No. 275:

See Overview, Section-by-Section Analysis, § 60.102.

Comment No. 276: Lousiana Dept. of Natural Resources (63)

Section 60.102 (c). Last sentence should read, ". . . particular attention must be given to the characteristics of host rock, material surrounding the host rock, regional hydrologic setting, and the past, present and predicted future effects of manmade and natural stresses on the hydrologic system." (Underlined material added)

Staff Response to Comment No. 276:

See response to Comment No. 274.

Comment No. 277: J. Adam (34)

§ 60.102(e)(3) Concepts.

The last sentence of the definition of overpacks should read; "It encloses and protects the container and waste form so as..."

Staff Response to Comment No. 277:

The term "overpack" has been deleted from the revised rule.

THE FOLLOWING COMMENTERS ADDRESSED THE PERFORMANCE OBJECTIVES - 60.111:

RELATION TO EPA STANDARD:

Comment No. 278: National Radiological Protection Board, UK (29)

The rule has been developed in the absence of radiological protection criteria (environmental standards), for disposal of high-level wastes; the proposed technical criteria are, therefore, arbitrary. It leads to criteria which are inflexible because, since they have no clear basis, there can be no basis for changing them. In addition the approach is very likely to lead to criteria which are too restrictive, thus causing more expenditure on high-level waste disposal than is warranted by radiological protection considerations.

The rule does not define in any detail the means by which compliance with performance objectives is to be demonstrated. As a consequence the proposed performance objectives have little meaning and it is very difficult to decide whether they are appropriate or achievable.

One of the main purposes of the rule is to reduce uncertainties in predicting the performance of geologic disposal systems. While this is a reasonable objective it is over-emphasised. This leads to technical criteria which may be too restrictive, particularly for TRU wastes. It also down-grades the "geologic barrier" to an extent which is incompatible with the reasons for selecting the geologic disposal option.

For the reasons outlined above, the proposed rule is unsatisfactory and should not be adopted in its present form. It would be preferable to leave the rule in "proposed" form until the EPA standards have been published and until there is sufficient information available to derive technical criteria from these standards. The rule should then be revised.

Staff Response to Comment No. 278:

See Overview, Section 2.1, Single vs. Multiple Performance Standards; also, Part C, Rationale for the Performance Objectives in 10 CFR Part 60,

For discussion of means of demonstrating compliance, see Overview, Section 5.4, Reasonable Assurance.

Reference to TRU wastes has been deleted from the rule.

The significance of the geologic barrier is discussed in the Overview, Section 5.3, Geologic Conditions.

See Overview, Section-by-Section Analysis, § 60.112.

Comment No. 279: T. H. Pigford (53)

In analyses of long-term repository performance referenced in NRC's rationale performance is measured in terms of future radiation doses to individuals, which has been the practice in existing NRC licensing of fuel-cycle facilities. The numerical technical criteria in the NRC's proposed rule were originally evolved earlier under a similar assumption that the radiation performance standard would be in the form of a radiation dose limited to an individual.[3] Even so, there is no showing in NRC's rationale that its technical criteria would be either necessary or sufficient to meet the individual dose limits assumed in these studies referred to by NRC.

The new EPA radiation standard may be proposed as a limit on the integrated radiation exposure of some future population. This would depart markedly from individual radiation dose limits that have been implemented in the past by NRC in its regulations and guides. From descriptions of the low level of population dose being considered by EPA, it is evident that the corresponding dose to future individuals could be orders of magnitude below those which would be assumed from existing regulatory practice. The form in which the EPA standard is finally adopted can have a large effect upon how, and with what means, the standard is to be met. Foreseeing what may be a very large departure from previous practice in radiation standards, NRC's assumptions of the content and form of the EPA standard must be highly tentative.

An NRC representative[4] has stated that in developing its rationale for its proposed technical criteria NRC has adopted a set of release limits of radionuclides to the accessible environment, which is identified as the "EPA standard" referred to in the proposed rule 10 CFR 60. These limits are said to appear in an unpublished internal draft regulation by EPA. EPA derived these release limits on the basis of its tentative overall performance goal, expressed in terms of integrated radiation effects to a future population. These limits apply for release during a period of 10,000 yr after the wastes are emplaced in a repository.

We find nothing in NRC's notice of rulemaking nor in its rationale document which refers to these release limits assumed by NRC or which shows how NRC's proposed numerical technical criteria relate to meeting these release limits. There is no mention of these assumed release limits in any of the supporting references quoted by NRC. Repository performance analyses[5,6,7] referred to in NRC's technical rationale[2] are all in terms of radiation dose to future individuals, rather than curie releases or doses to future populations. Even NRC's assumptions of the "EPA standard," there is no showing by NRC that proposed technical criteria are either necessary or sufficient to meet or support this assumed standard.

Staff Response to Comment No. 279:

See Overview, Sections 5.5 and 2.1, Population vs Individual Dose and Single vs Multiple Performance Standards, respectively. See also Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Comment No. 280: T. H. Pigford (53)

NRC relies upon three references[5,6,7] for predictions of the long-term performance of the waste isolation system. These performance analyses predict the effect of repository and site parameters upon the long-term release of radionuclides to the environment, the concentrations of these radionuclides in the aquifer to which they are released, and the radiation doses to future individuals maximally exposed from these releases. The times under consideration extend to millions of years, when some of the important environmental release of actinides and their decay daughters, e.g., uranium-238 and radium-226, are predicted to occur. The long delay in such releases is caused by the adsorption

[2]U.S. Nuclear Regulatory Commission, Rationale for Performance Objectives and Required Characteristics of the Geologic Setting: "Technical Criteria for Regulating Geologic Disposal of High-Level Radioactive Waste," June, 1981.
[3]U.S. Nuclear Regulatory Commission, Proposed Rule 10 CFR 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," Federal Register, 60-11, May, 1981.
[4]M. J. Bell (U.S. Nuclear Regulatory Commission), Meeting of Board on Radioactive Waste Management, National Research Council, September 17, 1981.
[5]H. C. Burkholder, "Management Perspectives for Nuclear Fuel Cycle Wastes," Nuclear Waste Management and Transportation Quarterly Report, Jan.-Mar., 1976, Battelle Pacific Northwest Laboratories, Richland, WA.
[6]M. O. Cloninger, "A Perspective Analysis on the Use of Engineered Barriers for Geologic Isolation of Spent Fuel," Proc. NWTS Info. Mtg., Oct. 30 - Nov. 1, 1979.
[7]U. S. Department of Energy, Draft Environmental Impact Statement on the Management of Commercially Generated Radioactive Waste, DOE/EIS-0046-D, 1979.

of these radionuclides on the rock media, thereby reducing their transport velocity. Similar analyses of radiation doses to future individuals over such long time periods have appeared in reports for other waste isolation projects.[9,10]

However, the draft EPA standard, adopted by NRC as the "EPA standard" for the purpose of this proposed rulemaking, would require a different kind of performance analysis. Rather than dealing with radiation doses to future individuals, where the concentration of released radionuclides in the accessible environment will determine the radiation dose to an individual, the EPA draft standard deals instead with a total dose to a future population, integrated over time. It therefore emphasizes a cumulative release of radionuclides over a long period of time, rather than the concentration in water at the time of release. Whereas the performance analyses relied upon by NRC calculates doses to maximally exposed individuals at times extending to millions of years, the "assumed EPA standard" requires the calculation of total cumulative release of radionuclides up to a time of 10,000 yr after the wastes are emplaced in a repository. There is nothing in NRC's notice of rule,[1] in its rationale,[2] or in its draft environmental impact assessments,[11] relating to this EPA approach towards performance analysis of the geologic waste isolation system.

Here we do not address the questions of whether waste isolation performance should be evaluated in terms of individual or population dose and whether future radiation doses should be discounted if they incur after some set time period like 10,000 yr. Even though these questions are relevant to the unissued EPA draft standard which NRC has adopted as its "assumed EPA standard," NRC has presented no data or discussion concerning population dose of a 10,000 yr cutoff. Therefore, we have before us no basis for considering these issues. These questions are to be dealt with when the EPA standard is issued for review, assuming that it emerges in the form now assumed by NRC.

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[1]U.S. Nuclear Regulatory Commission, Proposed Rule 10 CFR 60, Disposal of High-Level Radioactive Waste in Geologic Repositories," Federal Register, 60-11, July 24, 1981.

[2]U.S. Nuclear Regulatory Commission, Rationale for Performance Objectives and Required Characteristics of the Geologic Setting: "Technical Criteria for Regulating Geologic Disposal of High-Level Radioactive Waste," June, 1981.

[5]H. C. Burkholder, "Management Perspectives for Nuclear Fuel Cycle Wastes," Nuclear Waste Management and Transportation Quarterly Report, Jan.-Mar., 1976, Battelle Pacific Northwest Laboratories, Richland, WA.

[6]M. O. Cloninger, "A Perspective Analysis on the Use of Engineered Barriers for Geologic Isolation of Spent Fuel," Proc. NWTS Info. Mtg., Oct. 30 - Nov. 1, 1979

[7]U.S. Department of Energy, Draft Environmental Impact Statement on the Management of Commercially Generated Radioactive Waste, DOE/EIS-0046-D, 1979.

[9]F. W. Bingham and G. E. Barr, "Scenarios for Long-Term Release of Radionuclides from a Nuclear-Waste Repository in the Los Medanos Region of New Mexico, "SAND 78-1730, 1979.

[10]National Research Council, "Review of the Criteria for the Site Suitability, Design, Construction, and Operation of the Proposed Waste Isolation Pilot Plant (WIPP)," Progress Report: July 1, 1978 - December 31, 1979, DOE/NE/93023-2 1981. National Academies of Science and Engineering.

[11]U.S. Nuclear Regulatory Commission, "Environmental Impact Assessment in Support of Proposed Rulemaking: Disposal of High-Level Radioactive Wastes in Geologic Repositories: Technical Criteria 10 CFR Part 60:," Draft NUREG-0806, July, 1981.

Staff Response to Comment No. 280:

The cited references contain information that would be relevant whether a population-dose or individual-dose value were selected as the basis for the EPA standard. These references have been used only to the extent appropriate. The relationship of the EPA approach and the NRC's performance objectives is fully explained in Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Comment No. 281: National Research Council (45)

The BRWM recognizes the difficulty of formulating an NRC rule for disposal of high-level radioactive waste in geologic repositories before the establishment by the Environmental Protection Agency (EPA) of generally applicable standards for radiation exposure from such repositories. The BRWM also recognizes that the NRC rule may be more, but not less, demanding than would be required by the EPA standards. The difficulty is exacerbated by the great disparity to be expected between a standard based on dose to individuals and one based on dose to populations, an important question that must be addressed before any standard can be set. In any event, neither the EPA standard nor the type of dose to which the standard will be keyed has yet been determined by EPA. The Board believes it is not good practice, in the absence of compelling reasons, to base a rule on tentative standards. If compelling reasons exist in this case, they should be explained.

Although a generally applicable standard has not been established, NRC found it necessary to assume a standard in formulating the proposed rule. We were informed by an NRC representative that the provisional standard adopted, but not explicitly stated in the rule, was a set of curie release limits of radionuclides to the environment that appears in an unpublished internal draft regulation by EPA, but seems not to be available to the general public. In our comments on the rule we assume that this is the "EPA standard" frequently referred to in supplementary material accompanying the rule and that it is the standard on which the rule itself is based.

NRC proposes to achieve adherence to this "EPA standard" by requiring minimum performance standards for each of the major elements in the geologic isolation system, including the following numerical criteria: 1000-year containment by the waste package; a fractional release rate of 10^{-5}/year or less of radionuclides from the engineered system after the first 1000 years; and a minimum time of 1000 years for travel of water from the repository to the accessible environment. NRC states four purposes for these criteria, the first purpose appearing in the proposed rule and the other three in the accompanying Supplementary Information:

1. To specify site and design criteria which, if satisfied, will support a finding of no unreasonable risk to the health and safety of the public.

2. To enhance NRC's confidence that the EPA standard will be met.

3. To simplify NRC's review of DOE's application to construct a licensed repository.

4. To guide DOE in siting, designing, and constructing a repository in such a manner that public health and safety will be protected.

The BRWM questions the adequacy of the proposed numerical criteria to accomplish these purposes. We appreciate the difficulty of devising numerical criteria and we commend NRC on its attempt to arrive at a reasonable set of numbers. In our view, however, it is premature to formulate a rule at this time, especially a rule containing such numerical criteria. Specifically, our conclusions regarding the proposed numbers are as follows:

1. NRC has not presented adequate evidence that these numerical criteria can "support a finding of no unreasonable risk to the health and safety of the public."

2. NRC has not shown that these numerical criteria are either necessary or sufficient to meet the "EPA standard." Such a showing would require an analysis, including the effect of uncertainty, to demonstrate that meeting these criteria would satisfy the "EPA standard" and that failure to meet the criteria would make compliance with the standard doubtful.

3. It has not been shown that adoption of the numerical criteria will simplify the licensing process; the opposite may well be true. Unless the numerical criteria are shown to be adequately founded, verifiable, and related to an overall performance goal, a licensing review based on them would be at least as difficult to carry out and as subject to challenge as a review focused simply on the long-term radiation safety of the waste isolation system.

4. No attempt has been made to demonstrate the technical validity of the proposed criteria. To show that a criterion is technically valid requires critical analysis of the current state of knowledge and of the problem of extrapolation to the long periods needed for waste isolation.

5. NRC has not shown how the proposed numerical criteria for the waste package can be verified. Such criteria serve little purpose unless a method can be described for demonstrating compliance or noncompliance.

6. The criterion of water transport time may be verifiable and is probably not verifiable in some geologic media. Because flow of water in some media is complex and poorly understood, transport time may be verifiable only within broad limits. Difficulties in verification should be discussed and acceptable limits should be specified.

7. These numerical criteria are not appropriate as a guide for DOE. Attempting to satisfy particular technological constraints may deflect DOE's attention from the more important goal of complying with an overall performance standard for the safety of the waste disposal system.

8. Adopting such criteria risks steering research and development by DOE and other agencies in unproductive directions. For example, if these criteria prove to be invalid and unnecessarily restrictive, much time and money may be wasted in attempting needless refinements of waste packages and repository designs.

On the basis of these conclusions, the BRWM considers the proposed NRC rule premature at this time. We recognize, however, that there may be compelling reasons for NRC to issue a rule in the near future. In this case we recommend that the rule state that it is based on an assumed single overall performance standard (alternative 1 of the three listed in the rule) with the understanding that this standard will be the EPA standard, yet to be promulgated; and we recommend that precise numerical criteria for major elements of the repository system be eliminated. A critical qualitative analysis of the goals to be sought in long-term containment of radionuclides, in low leach rates, and in slow ground-water movement, including other methods of attaining these goals and trade-offs among them, will provide adequate guidance for DOE's current investigations as well as for NRC's activities in a licensing procedure. The difficulty of establishing technically valid and verifiable numerical criteria on the basis of current knowledge should be stressed in the analysis, as should the unavoidable uncertainty in such standards even at a later time when actual numbers may have some significance. When and if numerical criteria are used in the future, we strongly recommend that they appear in regulatory guides rather than as part of the rule itself, so that they can be more readily adjusted to the results of continuing research and to the specific conditions of particular repository sites. NRC has used such guideline to promulgate most of the vast body of its technical requirements in other licensing procedures.

Staff Response to Comment No. 281:

See Overview, Section 2.1, Single vs. Multiple Performance Standards; also, Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

With respect to the numbered conclusions presented in the comment, the following references to these documents are appropriate:

1. The staff believes that the performance objectives and site and design criteria, if satisfied, will support a finding of no unreasonable risk to the health and safety of the public. The basis for the numerical criteria is fully explained in Part C.

2. See Part C.

3. See Overview, Section 2.1, Single vs. Multiple Performance Standards.

4. See Part C.

5. See Overview, Section 5.4, Reasonable Assurance.

6. If the groundwater flow performance objective is not verifiable in some medium, DOE may propose some other value so long as the overall performance objective could be shown to be met. The Commission must, in any event, be able to find with reasonable assurance that the overall system performance objective will be achieved.

7. See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards.

8. See Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 282: C. Walske, Atomic Industrial Forum (50)

Although the EPA has been developing standards for offsite protection of public health and safety, these standards have not yet been issued for comment. In the several years during which they have been under development, the system performance criteria have been changed. There is no certainty that they will not be changed again. While there is every expectation that EPA standards will be met within the framework of the NRC proposed rule, it would be premature for NRC to promulgate 10 CFR Part 60 in final form until EPA standards have been issued and adopted.

Comment No. 283: Bechtel National, Inc. (37)

It is strongly recommended that the Commission substantially revise the proposed Part 60. As partial fulfillment of such revision, the specific numerical values proposed for subsystem performance standards should be withdrawn and a single, overall repository performance standard substituted in their place. With the preceding in mind, we would urge the Commission not to finalize this proposed rule until the EPA standard for geologic disposal of high-level radioactive waste, or a similar standard by some other regulatory authority, is promulgated.

Staff Response to Comment Nos. 282 and 283:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section-by-Section Analysis, § 60.112.

Comment No. 284: R. I. Newman, American Institute of Chemical Engineers (46)

At 46 FR 35231, the Commission's supplemental information notes that the Environmental Protection Agency has the authority and responsibility for setting radiation standards but has not yet done so for high level waste. In this supposed regulatory vacuum, the Commission's proposed criteria would establish a requirement for zero release for a period of at least 2,000 years, as demonstrated below. (See Comment No. 389).

We feel that this is not only totally unrealistic in itself, but also is in marked contrast to the EPA's published standard of 25 millirem per year to the public from most nuclear activities (40 CFR Part 190).

Staff Response to Comment No. 284:

The staff believes the proposed criteria are appropriate to meeting the assumed EPA standard. Whether that standard is in "marked contrast" to 40 CFR Part 190 is a question that more appropriately should be addressed to, and considered by, EPA when it formally establishes a standard.

Comment No. 285: Institute of Electrical and Electronics Engineers (28)

Questions can be raised about the logic of issuing the NRC technical criteria before the Environmental Protection Agency (EPA) "Environmental Standards on Federal Radiation Protection Guidance" are issued. On the one hand, the function of the NRC, in this instance, is to enforce the EPA standards which have not yet been finalized. Furthermore, the NRC criteria are not consistent with the current draft of EPA's 40 CFR 191. These factors would argue for not issuing the NRC criteria at this time. On the other hand, DOE needs at least preliminary criteria on which to base their efforts to develop a suitable repository for high-level waste, or unnecessary delays could result. Furthermore, the EPA standards have been delayed repeatedly, and the outlook for their being issued in the near future is not promising.

Staff Response to Comment No. 285:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section-by-Section Analysis, §60.112.

Comment No. 286: F. L. Parker (80)

In closing, I believe that the current NRC approach, in light of no EPA standards, has much to recommend it. It requires defense in depth. It should be amended to indicate a range of acceptable numerical values dependent upon local conditions and manmade barriers. It requires adherence to EPA's as-yet unissued standards. NRC should develop guidelines on "verification" of input data to mathematical models and for the models themselves. NRC should set a reasonable dollar value on expenditures for dose reductions. I believe the criteria reduce but do not eliminate the uncertainty in the licensing procedure.

Staff Response to Comment No. 286:

This is a summary statement of the commenter's concerns. A staff response to each is provided for the detailed comments as they appear elsewhere in this document.

Comment No. 287: F. L. Parker (80)

An issue in the mind of many scientists and engineers is the timing of the regulations. I agree that in the best of all possible worlds, EPA would have issued its standard and NRC's criteria could be based on and responsive to EPA's standard. EPA has been trying for years to issue its standard and with the advent of a new administrator and a new philosophy, we are liable to see still further delays. Yet DOE needs to know what will be required of it in the licensing procedure. NRC has, in my opinion, tried to fill that gap while still requiring that any disposal system must eventually satisfy EPA's standard. NRC has also indicated the procedure it intends to follow to license such a repository. I agree with the Board on Radioactive Waste Management that the precise numbers chosen may not be the best choices, but reasonable numbers can be selected that put upper bounds or limits on the doses to maximally exposed individuals or to populations while still allowing tradeoffs among the components.

Staff Response to Comment No. 287:

See Overview, Section-by-Section Analysis, § 60.112.

Comment No. 288: Calif. Dept. of Conservation (62)

EPA Standard

The section on Authority (FR p. 35281), states "Although no EPA standards for disposal of HLW yet exist, these proposed technical criteria for regulating geologic disposal of HLW have been developed to be compatible with a generally applicable environmental standard. Specifically, the performance objectives and criteria speak to the functional elements of geologic disposal of HLW and the analysis required to give confidence that these functional elements will perform as intended." CDC is concerned both with toxicity and radioactivity of the radionuclides emplaced as HLW, and which may later be released into the environment. At such time as the EPA standards have been prepared, we recommend that the proposed rules be reevaluated to make sure that the performance criteria will indeed provide the calculations necessary to assure that repositories meet EPA standards.

Staff Response to Comment No. 288:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section-by-Section Analysis, § 60.112.

Comment No. 289: Union of Concerned Scientists (59)

Should minimum performance standards for major elements by combined with an overall EPA standard? (p 15)

The combination proposed by the NRC (Alternative 2) is satisfactory. However, some of the proposed performance standards should be altered (see comments below).

As a sequence of two engineered barriers and a natural barrier is required in the proposed rule, it is appropriate to set standards for each barrier in addition to standards for the overall combination of barriers.

Comment No. 290: C. Walske, Atomic Industrial Forum (50)

The proposed rule calls for minimum performance criteria for each of the major components of the repository system in addition to meeting as yet unissued EPA standards for the system. The Working Group (AIF) believes the proposed rule should permit a systems approach where the designer has the latitude to adjust each of the components to meet the overall performance requirement set by EPA. The NRC approach could unnecessarily eliminate adequate geologic sites, does not allow alternate solution to meeting overall requirements and could result in a poor cost-to-benefit ratio. By using the NRC criteria as guides rather than requirements, we believe that the prescribed safety goals can be achieved in the most cost effective manner.

Staff Response to Comment Nos. 289 and 290:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Standards.

Comment No. 291: U.S. DOE (48)

We have noted the Commission's discussion with the NRC staff relative to the cut-off of the EPA's regulation at 10,000 years. We concur with those expressed opinions and suggest that it would be appropriate to make the Commission's position a matter of record in the rule.

In its discussion of the role of the site the staff has indicated their desire to have the Safety Analysis Report contain a projection of the expected performance of the repository, giving the rates and quantities of the expected releases as a function of time. Given this additional requirement we question the necessity of precisely specifying the performance of subsystems of the waste disposal system.

Within the discussion on the major features of the rule we note that the repository depth was required to be 300 m below the surface. This appears inconsistent with the intent of section 60.122 - Favorable Conditions and, if an editorial oversight, we trust it will be rectified.

Staff Response to Comment No. 291:

The issue of an appropriate cut-off (10,000 or 100,000 years, for example) must in the first instance, be resolved by EPA. However, we have assumed for purposes of developing performance objectives for particular barriers, the EPA standard will provide a 10,000 year cutoff.

See Overview, Section 2.1, Single vs. Multiple Performance Standards.

There was an error in the supplementary information accompanying the proposed rule which referred to the favorable condition of emplacement at a minimum depth of 300 meters as a requirement. The proposed rule (and the final rule) specify the condition which permits emplacement of the waste at a minimum depth of 300 meters from the ground surface to be a favorable condition.

Comment No. 292: U.S. DOE (48)

At various meetings on this rule, the Commission has discussed with the staff the proposed cutoff of the draft EPA regulation (draft 19, 40 CFR 191) at 10,000 years. We concur with the Commission's judgement that a 10,000 year cutoff is appropriate and request that the Commission's position be made a matter of record in the rule.

Staff Response to Comment No. 292:

The issue of an appropriate cut-off (10,000 or 100,000 years, for example) must in the first instance, be resolved by EPA. However, we have assumed for purposes of developing performance objectives for particular barriers, the EPA standard will provide a 10,000 year cutoff.

Comment No. 293: New York State Energy Office (83)

In addition to requiring compliance with the yet to be established EPA "generally applicable environmental radiation standard," NRC proposes to prescribe minimum numerical performance standards for each of the major repository elements (i.e., waste package, underground facility, and site). NRC indicates that such criteria provide a means of compensating for some of the uncertainty in the assessment of overall repository performance, provide confidence that the wastes will be isolated for the period of greatest hazard, will enhance confidence that the final EPA environmental standards will be met, and will simplify the licensing process.

While we sympathize with NRC's desire for quantitative benchmarks to judge the acceptability of a specific proposed geological repository, the establishment of minimum numerical performance standards is at best premature and probably not desirable in a generic sense. In particular, the technical bases of the proposed performance standards and their relationship to the EPA environmental standard have not been demonstrated. At this stage, it is not clear whether meeting the minimum performance standards is either necessary or sufficient to meet the EPA standards. More generally, the wisdom of setting specific numerical standards for such a first-of-its-kind facility is not clear. NRC admits that such criteria will restrict DOE's flexibility in designing a repository and may inhibit the incorporation of new technological developments or knowledge gained during site characterization. Further, it is not clear to what degree DOE would be able to verify its compliance with these criteria or what level of assurance NRC would require.

For the purpose of codifying technical criteria for a geological repository for high-level nuclear waste, New York recommends that NRC utilize the suggested single overall performance standard approach. When a sufficient basis for developing performance criteria for the various major elements of the repository is established, such as when EPA's general environmental standard is finalized and further experience in repository development (i.e., siting, construction, operation) is obtained, such criteria would be most appropriate and useful as design objectives in a Regulatory Guide format.

Staff Response to Comment No. 293:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards; also, Section 5.4, Reasonable Assurance, on the question of verification.

Comment No. 294: M. I. Lewis (11)

Performance Objectives

The supporting document Draft NUREG 0806 shows how nebulous and "assumed" the performance objectives really are. Para 60.111 is discussed at Page 4-1 in the supporting document.

The entire Performance Objective is based on the phrase, "and assuming anticipated processes and events." This is totally inadequate in that there is little or no experimental data to base these "anticipated processes and events" upon. This dearth of experimental data is evident from the Paragraph on the bottom of Page A-12 in the supporting document.

"Although the scientific community is beginning to study the problem in more detail, data in the leaching of spent fuel under repository conditions are relatively spare. In this assessment, we have used the data obtained for KBS from studies done at Studsvik Sweden(10) which indicate that the leaching process occurs relatively rapidly at first and then decreases. For uranium, 137 Cs, and 90 Sr, a leach rate (expressed as fraction leached per year) approximately 4×10^{-4} yr^{-1} was obtained. For the calculations we have assumed the following leach values:

Fission Products: 4×10^{-4} yr^{-1}
Actinides: 4×10^{-5} yr^{-1} "

This demonstrates that the so-called long-term leach rates are based on 100 day data that would probably not be accurate for the millenia that this material needs to be kept from humanities' nostrils and stomache. Further there are many processes which would increase the leach rate with time: alpha recoil aging of glass, chelation of nuclides with other material in the waste or in the emplacement nonhuman intrusion by animals and plants.

There are many other errors or omissions in this proposed rule. Page A 3 "far field" is defined in such a manner as to be meaningless. Page 4-4 "Period of greatest" hazard is not defined. Page 4-6 "Hydrogeology ...assumed to be representative." Is it or is it not representative.

Staff Response to Comment No. 294:

A determination of the "anticipated processes and events" for a specific repository will depend on the features of the particular site and on the design of the repository. The DOE is required by Section 60.10 of the Commission's regulations to conduct a program of site characterization prior to submitting a license application. This program would include surface exploration, borings, construction of exploratory shafts and in situ testing at the repository depth to provide site-specific data. This information, combined with an examination of the geologic record, will allow a determination of the events and processes anticipated to occur following disposal of HLW at the site.

The leaching data referenced in this comment were used by the NRC staff to estimate an upper limit on the non-radiological impacts of licensing a HLW repository. This does not reflect the level of detail that would be considered in a review of a design proposed for licensing, and the quoted numbers should not be considered to represent the NRC's estimate of actual waste form leach rates. This comment correctly notes that section 60.135 of the final rule requires that the design of the waste package take into account, among other things, radiolysis, radiation damage, and interactions with the emplacement environment.

With respect to intrusion by plants and animals, the staff notes that a favorable condition for site selection is the ability to locate a repository

300 meters or more below ground. At such depths, intrusion by plants and animals is not anticipated. The commenter's other observations relate to the supporting documents for the proposed rule. These have been substantially revised for the final rule. (See Part C, Rationale for the Performance Objectives in 10 CFR Part 60.)

Comment No. 295: UK Atomic Energy Authority (29)

Performance Objectives. This is the most critical section and we would question the justification for most of the numbers quoted e.g.:

- retrievability 50 years after emplacement is complete.
- 1,000 years containment by the waste package.
- 1 in 100,000 annual release of any radionuclide. Also this definition is not totally clear, is it 1 in 100,000 of the amount of the radionuclide present after 1000 years or 1 in 100,000 in any year of that which is present at the start of that year.

Staff Response to Comment No. 295:

See Overview, Sections 2.1 and 2.2, Single vs. Multiple Performance Standards and Retrievability, respectively. See also Part C. The release rate provision is now clearly stated to refer to the amount of the radionuclide present after 1,000 years.

Comment No. 296: F. L. Parker (80):

Absolute Magnitude of the Performance Criteria

If one looks at the Rationale Document for the three key performance criteria - package life, leach rate, and water travel time - it becomes obvious that this is what NRC thinks is the best available technology (BAT). The two words that are attached to BAT in the EPA water pollution documents are "economically achievable." Such words should be added to the NRC criteria. The fact that NRC thinks this is the "best available technology" can easily be seen in the case of the leach rate for borosilicate glass. Using the data in DOE's Draft Environmental Impact Statement on Management of Commercially Generated Radioactive Waste, Vol. 2, p. J.6, Table J.4, one finds that the characteristics of borosilicate glass are density, 3.0-3.6 gm/cm^3, the leach rate of 10^{-4} to 10^{-7} gm/cm^2-day. Making the necessary transformations, this leads to leach rates of 7×10^{-2} to 6×10^{-5} per year (for a cubic centimeter cube); making the more realistic assumption of a waste package of 0.5 m x 3.0 m and with no selective leaching, leads to a leach rate of 10^{-3} to 8×10^{-7} per year. The lowest leach rate is less than the limit that NRC says is achievable.

Though the dollar amounts are large for the waste package, I think that the overall costs are still small relative to the nuclear program and a sense of perspective should be maintained. Certainly for the first set of repositories, economic efficiency should not be the primary goal, but rather licensability and the overall safety and confidence of the public.

The Rationale Document states for the waste package: "containment for 1,000 years has the effect of delaying releases until temperatures in the underground facility are past their peak and are decreasing and until thermal gradients in the underground facility and surrounding rock have decreased substantially from the first few hundred years. Lower temperatures and temperature gradients allow release rates and radionuclide migration to be predicted with greater confidence under these conditions" (p. 18). DOE can argue that they can reduce the temperature of the rock formations by increasing the distance between waste packages and/or decreasing the waste content of the packages or by additional aging of the waste. Since mining is likely to be considerably cheaper than the costs of the waste packages, it seems to me that it might be well worth while for DOE to choose extra excavation to achieve lower temperatures. In such case, the formations then would be perturbed thermally by only an insignificant amount and not affect the confidence with which one can predict release rates of nuclide migration. If one can show that this is economically more desirable than going to the higher temperatures, the higher cost packages and the concomitant uncertainty in rock changes, chemical interactions, and water flow, then that requirement should be relaxed.

The thousand-year groundwater travel time in an undisturbed environment is directly related to the thousand-year containment period. The first 1,000 years in the repository are dominated by the fission products. One would like to be certain that, in fact, all the fission products have decayed substantially before releases to man's environment would occur. The thousand years is not necessary; a shorter time would be adequate for decay. Therefore, the thousand-years travel time is determined by the actinides, as stated in the Rationale Document. The thousand-year travel time is also coupled with assumptions of sorption equilibrium coefficients of 100 ml/g for actinides and other principal nuclides that contribute to dose, which would prevent most of the principal isotopes of concern from reaching the accessible environment. This, of course, does not affect the transport of those materials which are not easily absorbed, such as Iodine 129.

The other key item is the release rate of 10^{-5} per year. Again, according to the Rationale Document, this would result in a "significant reduction in the fraction of several environmentally significant long-lived isotopes" (p. 20). So basically, we see that NRC is using BAT and is slightly "forcing technology" by its requirements. The results seem to be extremely large under the system.

A misleading aspect of the discussion is the reference to the Burkholder and Cloninger papers, which indicate that the maximum individual dose will not be decreased even if the hold-up times are increased up to a million years, rather than 1,000 years. This is based upon the assumption that a dose 50 years from now is equivalent to a dose a million and fifty years from now. I am afraid that neither I nor the general public buy that. It is obvious that discounting dosages as one discounts money is very difficult to do. On the other hand, it

is equally obvious that a dose to some unspecified individual a million years from now is very different from a dose to children or grandchildren a hundred years from now, or even a thousand years from now. There are people who can trace their ancestry a thousand years, but a million years seems a little bit beyond most people's comprehension.

Staff Response to Comment No. 296:

The commenter is not correct that NRC has simply based its requirements on what it considers to be best available technology. The NRC numerical criteria for the barrier performance also contribute to have confidence that the overall system performance objectives (the EPA standard) will be met. The contribution of the individual barrier requirements to overall performance is analyzed in some detail in the rationale document. In the staff's analysis, it can be seen that a range of combinations of engineered barrier performance and groundwater travel times will lead to similar overall system performance. However, the staff then considered several factors in identifying its numerical criteria; an important consideration was to require a combination of engineered and natural barriers that would have the capability to mitigate the failure of one of the barriers. The staff also considered achievability and reasonableness in specifying the numerical criteria, but added flexibility to the final rule to allow DOE to better optimize its design.

The staff recognizes the points the commenter makes concerning the possibility of compensating for the effects of temperature by design features. The final rule includes the flexibility to accommodate such design features.

The commenter is correct that the staff is considering a different time period from the referenced papers as the period for assessment of performance. The period considered by the staff is based on the assumed EPA standard is 10,000 years.

Comment No. 297: B. Hafner (12)

Among the key provisions proposed for establishing technical requirements for permanent disposal of radioactive waste materials, two items (1) a guaranteed 1000 year containment period, and (2) that radioactive material be held to one part in 100,000 of the amount of radioactive waste in the repository deserve full support. In terms of the nature of the material being handled and public safety, the need for these two provisions are obvious.

A third recommendation--that a 50-year retrieval period after emplacement for wastes be required--receives conditional support. I agree with the Commission for the need for such a requirement but there are questions as to whether or not this time allotment is adequate (depending on the geological medium selected).

However, there are strong objections to the proposal which would allow the Department of Energy to select a geologically unfit site if conditions may be "remedied." This seems to be a complete contradiction to the principle and rationale behind geological disposal. Furthermore, by establishing such a policy it tends to reinforce the allegations that (1) permanent and safe disposal of high-level wastes may not be so feasible (technically and/or economically) after all, (2) that the Commission is more interested in finding an expedient political solution to the matter than seriously solving the problem once and for all. Clearly, additional clarification on this issue is called for.

Staff Response to Comment No. 297:

See Overview, Sections 2.1 and 2.2, Single vs. Multiple Performance Standards and Retrievability, respectively.

The staff does not intend that the DOE be permitted to select a geologically unfit site. Section 60.122(a) as revised in the final rule specifies how favorable and potentially adverse geologic conditions must be considered. Also see Part C, especially Chapters III - V, which describe the NRC staff's view of the role of particular barriers in a geologic repository, the uncertainties in their performance, and how the engineered barriers can compensate for uncertainties associate with the geologic setting.

An example of a "remedy" of unfavorable condition would be the construction of civil structures on the surface sufficient to prevent flooding of the underground facility.

Comment No. 298: B. R. McElmurry (38)

In section 60.111, the retrievability requirement is undesirable. see Paragraph 1 above. Specification of performance requirements beyond 1000 years is unwarranted, and probably unfeasible. Much data already shows the waste toxicity to be below that of natural ore somewhere around 500 years. Therefore, we should not be concerned if the waste is dispersed hundreds of meters below ground after 500-1000 years.

Staff Response to Comment No. 298:

See Overview, Sections 2.1 and 2.2, Single vs. Multiple Performance Standards and Retrievability, respectively. See also Part C, Chapter II, which discusses the hazards of HLW.

Comment No. 299: U.S. DOE (48)

Our major concern with the proposed rule is related to the fundamental philosophy used in its preparation. The Department feels that the primary emphasis should be placed upon meeting an overall system performance objective. The final determination concerning levels of performance required of individual subsystems should be made during the preparation of an overall system analysis for a specific site and design. We have long recognized the need for a multi-barrier approach and the objectives which the Commission is seeking to achieve. However, as mentioned above, the Department considers that a more appropriate way of accomplishing the objectives expressed by the Commission would be to propose specific subsystem performance goals which are clearly distinguished from requirements by providing the flexibility to select numerical subsystem criteria on a case-by-case basis. As currently written, the performance objectives provide no such flexibility and preclude maximum utilization of engineering ingenuity in meeting the goal of assuring the public's health and safety. Essentially, we believe that 1) the regulation should be based on achieving an overall system performance requirement, in the manner of the EPA standard; 2) a multiple-barrier system should be proposed by the Department; 3) the performance of intermediate subsystems (barriers) of the system should be proposed by the Department and should support the overall system performance criterion; 4) the numerical criteria should be justified by engineering principles and proven site specific data; and 5) the methods by which compliance is to be demonstrated should be clearly defined.

Staff Response to Comment No. 299:

See Overview, Sections 2.1 and 5.4, Single vs. Multiple Performance Standards, and Reasonable Assurance, respectively.

Comment No. 300: J. L. Cohen (27)

No definitive goal or objective for the regulation (other than meeting a non-existent EPA standard) is presented or discussed. What is the nature of the radioactive waste problem? How serious could be the consequences if the waste is not properly managed? What degree of control is justified? Specifically, what purpose is the proposed rule supposed to accomplish?

Related to the previous questions, it should be noted that a significant body of scientific literature indicates the problem of geologic disposal of radioactive waste is relatively minor in terms of actual danger to present or future public health. (The references appended to this letter provide a small sample

from this literature). The stringent degree of control proposed in 10 CFR 60 indicates that the NRC rejects this information. If this is the case, what basis is used to justify the proposed degree of control?

Staff Response to Comment No. 300:

See response to Paragraph 1 of Comment No. 281. The appropriateness of the EPA standard will be assessed by EPA in the supporting rulemaking and environmental documents. Also see Part C, which discusses the hazards associated with HLW and the relationship of the performance objectives to an assumed EPA standard.

Comment No. 301: J. L. Cohen (27)

How does NRC justify the proposed duration of controls (1000 years, 10,000 years, etc.) for radioactive wastes considering that stable toxic wastes (Lead,Arsenic, Mercury, etc.) are disposed of with no requirement for long-term isolation despite the fact that: (1) These wastes are more toxic than radioactive wastes in terms of lethal doses, toxicity indices, or most any objectively determined hazard evaluation, and (2) Since they are stable, their potential for hazard will persist forever.

Staff Response to Comment No. 301:

See response to Comment No. 300.

Comment No. 302: UK Atomic Energy Authority (29)

We feel that too many firm numbers are being laid down without sufficient experimental and theoretical justification. Particularly if disposal will not take place for many years it is better to set overall dose limits to define the required performance of the multiple barrier. It is then up to designers to optimise the individual elements in the system as models and experimental data are improved over the years. The proposed rule would freeze options too soon. Most of the numbers quoted are probably reasonable but at this stage they should be examples not rules.

Staff Response to Comment No. 302:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 303: Mr. and Mrs. D. W. Willoughby (72)
Mr. and Mrs. M. F. Vega (73)
Mr. and Mrs. J. Johnson (74)

We understand that you are accepting comments from the public on the proposed rule regarding nuclear waste.

We would like to see the most stringent guidelines imposed on the nuclear power industry as to waste disposal.

We believe your proposal to require nuclear waste to be stored in canisters that should last for at least 1,000 years; the canisters buried in solid, stable and groundwater free rock formations; and the ability to remove the canisters for up to 50 years after storage, is the bare minimum that should be adopted.

In addition, we would like to see the nuclear power industry carry the full cost of its waste disposal.

No amount of regulation regarding safety and health in resp. . to waste disposal can be too strict as far as we are concerned.

For the sake of our world and all our children's future, plea . dopt the most safety and health conscious rules possible.

Staff Response to Comment No. 303:

The staff considers that compliance with Part 60 will support a finding of no unreasonable risk to the health and safety of the public.

Assignment of the burden of paying for disposal of HLW is outside the scope of 10 CFR Part 60, but the staff notes that the Nuclear Waste Policy Act of 1982 deals with this subject. See Overview, especially Section 2.1, Single vs. Multiple Performance Standards; also Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

10 CFR 60.111:

Comment No. 304: U.S. DOE (48)

We have noted several concerns relating to the requirements of this section in our Issue Commentary on retrievability, TRU waste, and the alternative approach. Because these concerns are so fundamental, we believe that significant revision to this section is in order. This revision could take the form of alternative language and/or the insertion of major qualifying statements. We believe that

the details of alternative language might well be the topic of further interagency staff discussions and are providing revised language for portions of 60.111 for your consideration.

Staff Response to Comment No. 304:

See Overview; also responses to individual comments by DOE.

Comment No. 305: National Association of Counties Research, Inc. (1)

The essence, of course, in creating an adequate rule in this regard, is gaining the recognition that our technical and institutional inabilities to deal with disposal of HLW, over the term of 1,000 years and beyond, are very real constraints. Because of those natural constraints, the procedures and standards present in this kind of rule must offer a kind of automatic protection--one that will work and exist on its own, independent of a particular government regulatory structure or a complex technical system or mechanism. In simpler terms, once established, depositories should "run themselves." The combination of design/prescriptive and performance standards should be constructed toward that end.

Staff Response to Comment No. 305:

See Overview; also responses to individual comments by National Association of Counties Research, Inc.

Comment No. 306: Penberthy Electromelt International (61)

Column 1 on page 60-15 refers to permanent closure with the restriction that the repository must perform so that releases are within the limits prescribed. It should be kept in mind that releases depend on a transport mechanism. If the repository is built in such a way that the waste is kept dry, a lot of problems are completely avoided. This performance objective is met by such a system because there is no transport mechanism.

Staff Response to Comment No. 306:

The staff agrees that an underground facility which is completely dry will be unlikely to release any waste. However, to assure satisfactory performance of a repository, many factors must be addressed, and the staff considers that prohibition of all geologic media and underground facility depths in which water is likely to occur would overly restrict the applicant and could rule out many potentially good sites. The staff's analysis in Part C, illustrates that sites in saturated media can be expected to meet the assumed EPA standard when the criteria of 10 CFR Part 60 are also met.

GENERAL RESPONSE TO COMMENT NOS. 307-323:

ALARA

The notice of proposed rulemaking requested comment on "whether an ALARA (as low as reasonably achievable) principle should be applied to the performance requirements dealing with containment and control of releases." Some commenters felt that ALARA should be applied to all licensed activities, and that no exception should be made for geologic repositories. Other commenters argued against incorporating ALARA, since the allowable releases under the EPA standard would already be so low as to eliminate any significant risk to public health and safety.

Although NRC cannot predict with certainty the form that an EPA standard may take, we do anticipate that the permissible amounts of radioactivity in the general environment will be established at such a low level that efforts to reduce releases further would have little, if any, demonstrable value. Accordingly, the ability of a repository to perform at levels superior to the EPA standard should not be the issue in licensing proceedings. The central issue with respect to the EPA standard is whether DOE's proposal, and the data presented in its support, will enable the Commission to determine with reasonable assurance that the established EPA standard will be met. NRC may insist upon the adoption of a variety of design features, tests, or other measures in order to be able to conclude with confidence that the EPA standard is met. The result may be the same as if we were to impose similar requirements in the name of keeping releases as low as reasonably achievable. But when we find that certain measures are needed to improve our confidence in dealing with uncertainties, we are making a substantial safety judgment.

The same kinds of balancing that are undertaken in ALARA determinations may be appropriate. That is, if the performance of the repository is sensitive to a particular source of uncertainty, it will be in order for the Commission to take into account both the significance of the factor involved and the costs of reducing or eliminating it.

In short, the staff has concluded that the long-term performance requirements should not be tied to an ALARA principle, and the rule remains as it was when proposed. We believe the concerns of the commenters in support of the ALARA approach will be largely accommodated in connection with our treatment of uncertainties in the course of the licensing process. See also Overview, Section 2.5, ALARA.

Comment No. 307: J. Carson Mark, Advisory Committee on Reactor Safeguards (10)

Although it is appropriate that the ALARA criterion be applied to the overall safety goal for the repository, we believe it is not appropriate to apply it to the individual performance criteria for every major subelement.

Staff Response to Comment No. 307:

See General Response to Comment Nos. 307-323.

Comment No. 308: Bechtel National, Inc. (37)

The Commission seeks comments on whether an ALARA principle should be applied to the performance requirements dealing with containment and control of releases.

> We believe the ALARA principle should not be applied to these requirements and that the discussion of ALARA should be removed from the Supplementary Information.

Staff Response to Comment No. 308:

See General Response to Comment Nos. 307-323.

Comment No. 309: National Radiological Protection Board, UK (29)

ALARA - NRC specifically seeks comments on whether an ALARA principle should be applied to the performance objectives for containment and control of releases (Section 60.111, p. 35289). It is difficult to see the logic in applying ALARA to particular parts of the disposal system while omitting it when specifying criteria for other parts. The ALARA principle should be a major feature of the overall performance objective for the whole disposal system. The principle should then be applied both in decisions on whether the whole system is acceptable and in setting performance objectives for system elements. In the latter case it will be necessary to show that performance objectives are not over-restrictive, in the sense that they entail more financial expense than is warranted by the reduction in total risk. It seems likely to us that application of ALARA to containment risk. It seems likely to us that application of ALARA to containment criteria would show than containment for 10^3 years is not a reasonable requirement for either HLW or TRU wastes.

Staff Response to Comment No. 309:

See General Response to response to Comment Nos. 307 through 323.

For a discussion of the merit of containment for 10^3 year, see Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Reference to TRU waste has been removed from the final rule.

Comment No. 310: Utility Nuclear Waste Management Group (44)

UNWMG is of the view that, with respect to high-level waste repositories, the application of an ALARA principle is superfluous. Projected doses are a small fraction of those resulting from variations in natural background radiation. Further reductions cannot be justified. In addition, the inclusion of an ALARA principle would add nothing to the certainty of performance of any individual component or the overall repository system. Thus, application of ALARA would make no sense and, indeed, could lead to confusion. Accordingly, its use should be avoided.

Comment No. 311: C. Walske, Atomic Industrial Forum (50)

We believe it is unnecesssary to apply an ALARA principle to the performance requirements dealing with containment and control of releases from a geologic repository. If the overall system performance criteria are satisfied, the risks to the health and safety of the public from high-level waste disposal will be so low as to be inconsequential. Thus, expenditure of additional effort to further reduce the risk would be unwarranted. Furthermore, it is not evident that exceeding the performance requirements for waste-package containment and control of releases would have any significant effect on further enhancing overall system performance. Finally, since there would be

no basis for determining whether ALARA had been achieved, individual judgment would have to apply which could lead to endless and futile debate between the regulator, applicant and intervenors. We conclude, therefore, that ALARA should not be applied to the performance requirements, and that reference to ALARA should be removed from the discussion of performance objectives in the Supplementary Information.

Comment No. 312: R. H. Neill, State of New Mexico (78)

We believe the ALARA principle should not be applied to containment and control of release performance requirements. The principal reason for this position is the belief that ALARA is best applied to predictable releases and doses, rather than to unlikely accidents whose probability of occurrence is difficult to accurately estimate.

Comment No. 313: Union of Concerned Scientists (59)

Should ALARA be applied to performance requirements dealing with containment and releases? (p 40)

These requirements should use ALARA wording as outlined in the footnote on p. 40, together with quantitative minimum criteria such as those now in the proposed rule.

The ALARA approach is consistent with the requirement in (c) (3) of section 60.21 that the safety analysis shall include a comparative evaluation of design alternatives. There may be several design alternatives at a given site which each meet the quantitative minimum criteria.

As in other regulatory areas, there is likely to be an association of higher costs with the pursuit of higher standards. ALARA is appropriate to this situation.

Staff Response to Comment No. 310 through 313:

See General Response to Comment Nos. 307 through 323.

Comment No. 314: Calif. Dept. of Conservation (62)

The Commission has requested (FR p. 35289) comments on the ALARA principle, which as it relates to containment, reads, "...as long as reasonably achievable," and as it relates to releases "...as low as reasonably achievable." CDC recognizes that unavoidable uncertainties are inherent in the engineering design, and in human prediction and control of future geologic processes, and on their impacts on the engineered systems. However, CDC believes strongly that all evaluations of HLW containment and releases should be based on probabilistic data which uses the worst-case scenario in failure analysis.

In application to the ALARA principle, CDC's concern is that any process of determining what degree of containment or release is "reasonably achievable" be required to follow a rigorous procedure that applies probabilistic, worst-case reasoning.

Staff Response to Comment No. 314:

See General Response to Comment Nos. 307-323. See also Overview, Sections 3.1 and 5.4; Anticipated/Unanticipated Processes and Events and Reasonable Assurance, respectively.

Comment No. 315: Northeast Utilities (79)

With respect to high-level waste repositories, NU believes that the application of an ALARA principle is superfluous. Projected doses are a small fraction of those resulting from variations in natural background radiation and further reductions would be hard to justify. In addition, the inclusion of ALARA would not improve the performance of an individual component or the overall repository system. Thus, application of ALARA does not seem reasonable and could possibly lead to confusion. Accordingly, we believe its use should be avoided.

Comment No. 316: J. A. Adam (34)

My first observation concerns the application of ALARA to a HLW repository. (The Commission also asked for comments on the application of ALARA to performance objectives.) The traditional applications of ALARA requires the quantitative definition of the relationship between incremental costs and incremental benefits. For a HLW repository such a definition may not be possible.

If the proposed performance objectives are satisfied, the impacts of a HLW repository will be small as measured by any reasonable standard. The real question is not whether the performance objectives are sufficiently restrictive but how much confidence exists that the performance objectives will be met. That is, the question is the degree of confidence not the level of performance. Rather than applying ALARA in the usual sense, the Commission ought to prefer those features which provide higher confidence in the performance of the repository to those which promise higher levels of performance without an increase in confidence. Likewise, DOE seeking approval of its license application should provide repository features in which the Commission can have a high level of confidence. As an example, the Commission should prefer a waste package design which will provide containment for an adequate period of time under a wide range of conditions to a waste package which promises containment for a longer period of time, but under a more narrow range of conditions.

Comment No. 317: E. Nemethy, Ecology/Alert (41)

Re: the proposed ALARA standard ("as low - or as long - as is reasonably achievable"). This sounds very much like a semantic cop-out. What's "reasonable" in situations like this? Only near-perfection! We propose/THUSS - To highest uncompromising scientific standards.

Comment No. 318: Mississippi Dept. of National Resources (65)

An ALARA principle should be applied to the performance requirements dealing with the containment and control of releases since post-closure data may not be available to confirm whether or not the requirements are being met. Setting given values for containment and releases would not be verifiable. Implementation of an ALARA principle based on state-of-the-art technologies and materials would be more appropriate, as long as the utmost care is taken.

Comment No. 319: Commonwealth Edison (17)

ALARA is a concept that applies to operations. It has no place in repository design or design criteria. The fact is that radiation dose for workers and for the public will really be one of the smallest and most carefully controlled impacts in the entire project. It is unrealistic to give it featured treatment by suggesting that ALARA should be a criterion of design.

Comment No. 320: H. Koss (14)

The adoption of the ALARA Principle requiring containment for "as long as reasonably achievable" and a release rate "as low as reasonably achievable" ignores the realities of additional costs (which could be enormous), the negative aspects of offsetting delays, and the evaluation of incremental improvements in containment and public health and safety. Performance criteria which specify design goals and invoke reasonable assurance, or those based on some form of cost/benefit analysis are certainly more realistic to fund and to verify and implement.

Staff Response to Comment No. 315 through 320:

See General Response to Comment Nos. 307 through 323.

Comment No. 321: F.S. Feates, Department of the Environment, UK (29)

Comment has been invited on a number of specific issues and those on which we can comment are dealt with in the paragraphs above. Those remaining relate to matters of national concern and do not call for any comment from the UK. There are, however, two matters which should be considered as needing clarification:

(a) the ALARA principle, mentioned as a footnote on p. 35289, might perhaps be explained more fully in relation to the approach adopted by the ICRP; in particular the need to take social and economic factors into account;

(b) on the same page, in column 2 /_ A_/ it is not made clear whether "one part in 100,000" refers to the activity in the year in question or to that which was originally emplaced. This seems to be a critical matter which must be unambiguous.

Staff Response to Comment No. 321:

See General Response to Comment Nos. 307-323.

The final rule makes it clear that the 1:100,000 ratio refers to the activity at 1,000 years after permanent closure.

Comment No. 322: U.S. DOE (48)

We agree with NRC's position not to apply ALARA to performance requirements dealing with containment and control of releases. Calculated releases of radionuclides from a repository are made far into the future. Good estimates of regional populations in the distant future cannot be made, and thus population doses cannot be calculated and the benefit of making changes to the engineered system cannot be quantitatively evaluated. Also the natural features of a site, the geologic setting, cannot be modified once a site is chosen. Therefore, we agree with NRC's position that ALARA requirements should not be applied to repository performance requirements.

Staff Response to Comment No. 322:

See General Response to Comment Nos. 307 through 323.

Comment No. 323: Calif. Dept. of Conservation (62)

The general proposed performance objective for all HLW disposal sites is to provide an engineered waste package system (including waste form, container, and overpacks) which will retain all the radionuclides during a 1,000-year containment period following permanent closure. After this period, the general performance objective would allow the engineered system to release the radionuclides at a maximum prescribed rate to the geologic setting.

A weakness in the performance objectives is their apparent reliance on the geologic setting to protect against possible failure of engineered systems during the 1,000-year containment period, but at the same time, having no rational way to specify the maximum expectable releases of radionuclides, heat, and radiation from the engineered system, if it should fail during that period.

CDC recommends additional tightening of the performance objectives in Subsection 60.111, to emphasize the importance of stringent criteria for the geologic setting, to assure its reliability under all failure conditons, to be able to mitigate a possible maximum level of radionuclide releases from the engineered system. As we discussed under General Comments, above, under the ALARA principle, CDC believes it is important that the engineering and geologic containment criteria be expressed in as definite and stringent manner as is feasible in the context of the Rules for Disposal. We believe that specific reference to the need to apply probabilistic failure analysis, and the worst-case scenario will provide a significant degree of additional assurance of safety, in the redundant systems.

Staff Response to Comment No. 323:

See Overview, Sections 3.1 and 5.4, Anticipated/Unanticipated Processes Events and Reasonable Assurance, respectively. It should be noted that provisions of the safety analysis report as modified in the final rule require an assessment of performance that takes into account the occurrence of unanticipated processes and events.

Comment No. 324: T. C. Gustavson (71)

The performance objectives and site criteria outlined in Subpart E -Techical Criteria are very generalized. Because it is generalized, it is highly inclusive and there are no pertinent issues that have not been mentioned. The proposed rule, however, is so nonspecific that the objectives and criteria of site-characterizaton work are not well defined.

Phrases such as " . . . description and assessment of . . .," " . . . characteristics of . . .," "potentially adverse conditions . . .," etc. are so ill-defined that almost anything could be done and still satisfy the guidelines.

Staff Response to Comment No. 324:

The staff regards the cited terms as adequately described in the context in which they are used.

Comment No. 325: R. H. Neill, State of New Mexico (78)

TRU Wastes (§60.111)

Little separate attention is given to transuranic waste in the proposed rule. TRU wastes are treated as a subset of HLW, although they have unique characteristics. There are two fundamental questions that need to be addressed about TRU wastes:

(1) What is the justification for classifying alpha emitting transuranic elements with concentrations greater than 10 nanocuries per gram as TRU wastes, rather than greater than 100 nCi/g (as EPA is considering) or some other number?

(2) Is it necessary to dispose of TRU wastes in deep geological formations; especially where concentrations are in the order of 10-100 nCi/g?

Because of these fundamental concerns we believe consideration should be given to writing separate regulations for TRU waste disposal, either in this rule or in a separate one.

Staff Response to Comment No. 325:

See Overview, Section 3.2, Transuranic Wastes (TRU).

Comment No. 326: Bechtel National, Inc (37)

60.111 (a) (1) - This section specifies exposure or release limits during normal operation but does not specify limits for operational accidents. To be consistent with 10 CFR 72, the following "accident dose limit" is suggested for inclusion in this section:

> "The dose to any individual located at or beyond the site boundary during the facility operations period shall not be greater than 5 rem to the whole body, or to any organ, from any design basis accident."

Comment No. 327: C. Walske, Atomic Industrial Forum (50)

Para. 60.111 Performance objectives.

Item (a)(1) Add a paragraph on accident dose limit, as follows:

> "The dose or dose commitment to any individual located at or beyond the site boundary during the facility operations period shall not be greater than 5 rem to the whole body, or to any organ, from any design basis accident".

This definition is based upon and is consistent with the definition of accident dose limit in 10 CFR 72.

Staff Response to Comment Nos. 326 through 327:

See Overview, Section 4.5, Important to Safety.

Comment No. 328: V. McIntyre (35)

60.111 (a) (1) Can NRC state at this moment what applicable environmental standards established by EPA are in effect and which relate to this regulation?

Staff Response to Comment No. 328:

There is no EPA HLW radiological standard in effect at this time.

Comment No. 329: J. A. Adam (34)

I am also concerned about the imposition of two distinct sets of performance objectives; those of NRC and those of EPA. I understand the rationale for using the two sets of performance objectives, but I also believe that doing so places an unnecessary burden on the design and analyses processes. In a sense,

it also places the application for a repository in double jeopardy. I believe that the NRC staff should go one step further and incorporate the EPA performance objectives into their own performance objectives. That is, the NRC performance objective should reflect NRC's understanding of what is required to satisfy the EPA's performance objectives and to also achieve the level of confidence that the NRC desires. Specifically, the NRC performance objectives for containment, isolation and groundwater travel time should be at least those which the NRC believes to be necessary to achieve the EPA performance objectives. This may require that the performance objectives be nuclide specific.

Staff Response to Comment No. 329:

See Overview, Section-by-Section Analysis, § 60.112.

Comment No. 330: J. Hamstra, Netherlands Energy Research Foundation (6)

The proposed rules require that the repository design should be such as to permit retrieval of waste packages for a period of up to 110 years (bottom middle column page 35282).

The point is to be stressed that this retrievability requirement limits the possibilities for the repository designer to optimize the overall repository system. Relative easy access because of retrievability may well increase the consequences of major accident during the operational period, such as a flooding of the disposal mine.

There is no rationale in depriving the repository designer the possibility of clearly improving the engineered parts of the overall disposal system to a point that both the short and long term hazards become minimal only because of a lack of confidence in our technical capabilities.

It is realistic to assume that in situ performance tests can demonstrate in a period of years the adequacy of the engineered components to the point that their reliability will be established. A non-retrievable disposal system recommends itself through the benefits of a better containment and isolation.

No underground disposal should be allowed unless there is a sufficient basis for confidence in the overall system of disposal. It is far more practical to continue an adequately controllable engineered surface storage than to replace that storage by a retrievable system of underground disposal. This because the consequences of a retrieval operation may well put quite an extra exposure burden on the workmen.

A nonretrievable disposal system should become acceptable once the performance demonstration of the essential engineered component(s) has provided its reliability.

Just as an example, the disposal of a stack of HLW canisters in a deep disposal borehole in rock salt is a typical example of a very safe disposal system that can hardly be developed in a retrievable way. It is, especially during the operational period, dependent on the reliability of the sealing of that borehole.

It thus should be required to demonstrate that the plugging of the borehole can be made such that it will withstand a hydrostatic pressure equal to that caused by the flooding of the disposal mine.

Staff Response to Comment No. 330:

See Overview, Section 2.2, Retrievability.

Comment No. 331: Commonwealth Edison (17)

The concept of retrievability is not a proper part of good repository design. The materials can be retrievable until the portion of the repository in which they are placed is closed. After that no retrievability criterion should be applied.

Staff Response to Comment No. 331:

See Overview, Section 2.2, Retrievability.

Comment No. 332: Utility Nuclear Waste Management (44)

UNWMG is of the view that requiring, as a parameter of repository design, the ability to maintain retrievability for a period of up to 110 years is excessive and without adequate supporting rationale. In addition, a design allowing for retrieval over a 50 year period following waste emplacement could, in and of itself, motivate extended and unnecessary delay in final repository closure, i.e., shaft sealing.

A more reasonable and appropriate approach might be to base design requirements for retrievability, if any, on the period of repository operation. Assuming the first waste packages to be loaded into the repository could be in place for about 30 years before all emplacement was complete, and allowing another 30 years (the same time as for original construction and emplacement) for retrieval, would lead to a retrievability design requirement for a total of 60 years. Such a period would be reasonable since any difficulties which are likely to be apparent at any time in the near future will probably manifest themselves quickly. In addition, it would tie retrievability to the period of the waste package monitoring program, which must extend as long as practical up to the time of permanent repository closure.

In any event, the rule, itself, should make clear that the requirement for retrievability does not preclude the back-filling of emplacement rooms and drifts when the operator deems it appropriate. From the discussion at page 35,282 of the Federal Register it is clear that, as the rule is now written, it is not the intent of the Commission to preclude such back-filling. However, to avoid any possible misunderstanding, the wording of the rule, itself, should be clarified.

Staff Response to Comment No. 332:

See Overview, Section 2.2, Retrievability.

Comment No. 333: National Research Council (45)

Finally, NRC proposes to require that the engineered system be designed so that waste can be retrieved, if necessary, for up to 50 years after the last waste is emplaced. The BRWM believes that any inclusion of a retrievability requirement must be studied further because the need to provide for any type of retrievability after emplacement may preclude the use of some otherwise desirable repository designs and some otherwise desirable geologic media.

Staff Response to Comment No. 333:

See Overview, Section 2.2, Retrievability.

Comment No. 334: R. V. Wyman, University of Nevada (5)

Particular comments concern retrievability requirements: (page 35282 Col. 3 par. 1 and 2). The requirement for retrievability dominates the design process and multiplies the cost. This is particularly compounded by the requirement on page 35293 (h)(2) on subsurface ventilation:

> "Permit continuous occupancy of all excavated areas during normal operations through the time of permanent closure."

Several of us have calculated this as requiring energy for ventilation comparable to that required by a large city. It will also require an enormous increase in access and sealing problems on the order of two orders of magnitude greater than would otherwise be required.

Staff Response to Comment No. 334:

See response to Comment No. 612.

Comment No. 335: C. Walske, Atomic Industrial Forum (50)

The 50-year period established for retrievability cannot be justified on either cost-effective or institutional grounds. If, as we understand from the NRC staff, the 50-year period is intended as guidance rather than as a mandatory requirement that would foreclose backfilling at an earlier date, the rule should so indicate.

Staff Response to Comment No. 335:

See Overview, Section 2.2, Retrievability.

Comment No. 336: J. Carson Mark, Advisory Committee on Reactor Safeguards (10)

We believe that more discussion of retrievability requirements should be made a part of the text of the rule as opposed to including it primarily in the background information. The NRC should indicate the conditions under which retrieval would need to be performed, perhaps by postulating illustrative circumstances. The type of waste to be inserted could influence the retrievability requirements as well as the performance of the repository. Although we did not explore the question of the impact of the retrievability option on design, it appears that it could be significant in certain cases, such as a repository located in salt. The 50-year time span appears more than adequate for preserving the retrievability option, but other criteria might be considered such as the time needed to demonstrate stability of thermal conditions, structural movement, or containment effectiveness.

Staff Response to Comment No. 336:

See Overview, Section 2.2, Retrievability.

Comment No. 337: Sierra Club (66)

We concur with the comment of the ACRS on this point, that the NRC should indicate the conditions under which retrieval would need to be performed, perhaps by postulating illustrative circumstances. The type of waste to be inserted could influence the retrievability requirements as well as the performance of the repository.

Without knowing under what conditions the high-level waste would be retrieved, we oppose the insertion of high-level wastes in a repository, even for test purposes. The promise of retrievability gives local citizens a false sense of security. Citizens feel that if there is a problem at the repository, the wastes will be retrieved and they will be protected. However, in our experience, the worse the situation, the less likely that wastes would be removed. Why? Because a balancing would take place: the environmental impact of leaking radionuclides would be weighed against occupational exposures incurred in removing the waste materials. Because it is more difficult to predict future health effects compared to health effects to workers involved in a retrieval operation, the result can be predicted now: DOE would do nothing. This scenario has already occurred with the West Valley burial ground. Thus there is a need to produce guidelines for retrieval, demonstrate the capability for retrieval and estimate the occupational dose which could be incurred during retrieval.

Again, this issue is well illustrated by the burial ground at West Valley. A radiation finger now extends 1 1/2 miles from the reprocessing plant/burial ground complex due to migration of radionuclides along a sand lens underground. Material is buried at the NRC-licensed burial ground in 50-foot deep holes which, we believe, have pierced a sand strata. The sand strata is cut by Cattaraugus gorge. Cattaraugus Creek empties into Lake Erie, the water supply for 1.8 million people. In spite of this danger to the health of the general

population, there is tremendous resistance to exhume the burial ground and to place the material in above-ground bunkers. The arguments center on whether the occupational exposures plus the economic costs are greater than the number of health effects which could be caused by the leakage of the radionuclides into drinking water. Of course, had the information concerning this potential leakage appeared in an initial safety analysis report, perhaps the wastes would not have been located at West Valley in the first place, with no leakage taking place into Cattaraugus Creek.

Staff Response to Comment No. 337:

For the commenter's concerns with respect to the conditions under which retrievability would be required, see the Overview, Section 2.2, Retrievability.

For the commenter's point regarding the waste burial ground at West Valley, we are taking a fundamentally different approach to disposal in 10 CFR Part 60. In the West Valley case, the buried radioactive materials were considered to be disposed of when buried, with no provisions for retrievability. In Part 60, we are taking the approach that the retrievability option must be preserved until completion of a performance confirmation program and a Commission decision regarding permanent closure. The Commission has the authority to order DOE to retrieve the wastes if necessary to protect public health and safety. Therefore, we consider the situation that the commenter describes will not occur under the provisions of Part 60.

Comment No. 338: Mississippi Dept. of Natural Resources (55)

Conservative practice requires that choices of options, specifically including retrieval, should be maintained as long as possible. However, NRC should be more specific on the objectives of maintaining the retrievability option. For example, there is no list of those possible conditions under which retrieval would be initiated.

Staff Response to Comment No. 338:

See Overview, Section 2.2, Retrievability.

Comment No. 339: Sierra Club (66)

The proposed rule has no retrievability criteria, i.e., conditions which specify when buried wastes would be retrieved. Finally, certain technical and procedural details regarding human intrusion, long-term controls, population criteria etc., need strengthening and are mentioned specifically in the comments below.

Staff Response to Comment No. 339:

See Overview, Section 2.2, Retrievability.

Comment No. 340: Stone & Webster Engineering Corp. (26)

The subject of Retrievability described on page 35282 requires some reconsideration. In response to the NRC's interest in alternate times and requirements, it is proposed to defer final closure/sealing of the repository for a limited period of time until adequate analysis of the pre-emplacement testing and post-emplacement monitoring is completed. Then, with the confidence resulting from the data developed from these tests, finally seal the repository with no design provisions for retrieval. This appears to be a more logical approach and would give greater total confidence in the repository's isolation from the biosphere goal which is the primary objective of this program.

Staff Response to Comment No. 340:

See Overview, Section 2.2, Retrievability.

Comment No. 341: U.K. Atomic Energy Authority (29)

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If waste is to be disposed of on an experimental basis it is reasonable to insist on retrievability in the early stages. We do not, however, believe that 110 year retrievability should be a condition for all future repositories. We favor the alternative of storing the solidified waste for many years and then disposing of it with no intention of retrieval.

Staff Response to Comment No. 341:

See Overview, Section 2.2, Retrievability.

Comment No. 342: Institute of Electrical and Electronics Engineers (28)

The discussion on retrieval of waste packages up to 110 years after construction begins can be construed to be in conflict with the EPA guidance (40 CFR 191, draft 19, p. 39) of not relying on institutional control for more than 100 years after disposal.

Staff Response to Comment No. 342:

The staff does not construe the provision as being in conflict with the draft EPA guidance, the adoption and applicability of which are in any event uncertain.

Comment No. 343: National Radiological Protection Board, UK (29)

The retrievability requirement (p. 35282 and Section 60.111 P. 35289) is poorly defined. It is not clear whether retrieval is regarded as an extreme measure and the intention is only to ensure that wastes can be located and could be retrieved at great cost, or whether a repository should be designed and operated so that retrieval would be relatively simple.

Staff Response to Comment No. 343:

See Overview, Section 2.2, Retrievability.

Comment No. 344: New York State Energy Office (83)

The proposed requirement that the "geologic operations area" be designed to allow retrieval of all wastes for a specified period following completion of emplacement has been addressed by several New York reviewers. While there is general consensus that a retrievability requirement provides needed compensation for the uncertainty that must be accepted in the initial development of a repository, some question has been raised about the admittedly arbitrary "50-year" retrievability period proposed by NRC. New York believes that the period of designed retrievability would be more appropriately determined on a case-by-case basis taking into consideration the specific characteristics of the geological setting and planned performance confirmation program.

In addition, the overall concept of retrievability requires clarification. Since the ultimate determinants of the retrievability of the waste appear to be the integrity of the waste package and the stability of the geological medium, wastes could conceivably be retrieved (albeit at great expense) for some significant period, possibly two or three hundred years, following closure of the repository. The concept of retrievability should not necessarily preclude backfilling or decommissioning portions of the repository prior to the expiration of the designated retrievability period. NRC should provide further guidance, possibly in the "Regulatory Guide" format, on the meaning and purpose of the retrievability requirement and what NRC would consider acceptable in terms of designed retrievability.

Staff Response to Comment No. 344:

See Overview, Section 2.2, Retrievability.

Comment No. 345: Bechtel National, Inc. (37)

The Commission seeks comments on the degree to which 110-year requirement for retrieval will govern thermal and mechanical design of the repository and on whether some shorter period would be adequate or whether there are other ways than an overall retrievability requirement to preserve options before permanent closure.

While the concept of retrievability may have merit for some geological settings and waste form descriptions, it is not necessary to specify a retrievability

time period. Instead, a retrievability time period for a given set of circumstances should be based upon the time needed to verify repository performance, which will be site and design specific.

Staff Response to Comment No. 345:

See Overview, Section 2.2, Retrievability.

Comment No. 346: B. D. Withers, Portland General Electric Co. (82)

The requirement to be able to retrieve wastes 110 years after implacement (30 years of operation, 50 years to final decision, 30 years to retrieve) is excessive. The 50-year decision period following cessation of operation and sealing of the shaft is after the maximum thermal output has been reached for the first-placed canisters. It is at this point that problems resulting from excessive heat would manifest themselves. The 50-year period is also after the canister-monitoring program in operation during implacement has been terminated. As geologic and groundwater considerations would not allow transport of radionuclides to the biosphere within 50 years of shaft sealing (assuming complete canister failure), the 50-year decision period is unnecessary. Retriveability design criteria, if any, should be based on the time of operation of the facility plus the time to remove all waste if a problem in the first canisters were found when the last canister was implaced, a total of no longer than 60 years.

Staff Response to Comment No. 346:

The commenter has misinterpreted the performance confirmation program in relation to the retrievability requirement. See Overview, Section 2.2, Retrievability, to see how these two concepts fit together.

Comment No. 347: B. R. McElmurry (38)

The requirement for retrievability beyond the filling of the repository is superfluous. The containers and the geology are designed to immobilize the waste, and it can always be recovered by mining techniques. In the interest of security the repositories should be sealed as soon as possible.

Staff Response to Comment No. 347:

See Overview, Section 2.2, Retrievability.

Comment No. 348: C. R. Fisher, General Atomic Company (16)

Some experts believe that the risk associated with allowing a repository to remain unclosed while the validation process continues is greater than the risk associated with closing the repository before validation is complete. These beliefs are based on preliminary probabilistic risk assessments (PRAs)

which support a conclusion that, in general, disposal (closed repositories) has a much lower risk than storage (unclosed repositories). General Atomic suggests that an alternative method by which to determine the time to close a repository would be to require closure when the risk from the closed repository operated using partially validated processes is equal to the risk due to potential enviornmental releases and human errors at an unclosed repository.

Staff Response to Comment No. 348:

See Overview, Section 2.2, Retrievability.

The staff would not consider it acceptable for permanent closure to be undertaken before the completion of a performance confirmation program that would enable the Commission to determine, with reasonable assurance, that the performance objective related to isolation will be achieved. Indeed, we note that the views referred to in the comment may not have taken into account the provision for backfilling which is now explicitly stated in the final rule.

Comment No. 349: R. I. Newman, American Institute of Chemical Engineers (45)

Retrievability should be made possible only to the extent that it does not, in any way, compromise the integrity of the repository or the ability to monitor the repository. Every opening to the environment left for retrievability is a potential pathway for escape of radionuclides as well as for ingress of water. Most importantly, open shafts and tunnels will significantly distort the heat transfer pathway which will exist after complete closure. This will cause thermo-mechanical monitoring during the period before complete closure to have a reduced value related to the long-term life of the repository.

Staff Response to Comment No. 349:

See Overview, Section 2.2, Retrievability. The backfilling of openings, permitted by the final rule, should accommodate the commenter's concerns.

Comment No. 350: U.S. DOE (48)

We have provided revisions that we believe are needed in the requirement for extending retrievability beyond the operational life. The requirement for a long retrievability period could compromise the primary objective of isolation. Furthermore, we expect a high degree of confidence to result from performance confirmation data taken over 30 or more years of operation. This plan for performance confirmation testing should be available as part of the license application and should provide sufficient basis for an early decision by the Commission on backfilling and decommissioning. Also, it is desirable to have some portions of the repository available for low-heat wastes and to allow an early decision on non-retrievable emplacement of such wastes, without waiting for the decision on high level wastes. We have not been able to quantify the

cost impact of maintaining the capability to defer a retrieval decision for 50 years after operation ceases, since a design is highly site-specific, but we believe additional costs will occur in the area of shaft and tunnel maintenance and from provisions for operator safety.

Staff Response to Comment No. 350:

See Overview, Section 2.2, Retrievability.

Comment No. 351: C. Walske, Atomic Industrial Forum (50)

The Commission seeks comments on the degree to which the 110-year requirement for retrieval will govern thermal and mechanical design of the repository, on whether some shorter period would be adequate and on whether there are ways other than an overall retrievability requirement to preserve options before permanent closure.

The AIF Working Group on 10 CFR 60 accepts the principle of retrievability. However, we feel strongly that regulations should not preclude closing shafts or drifts in sections of a repository that have been filled after a reasonable assessment has been completed of the performance characteristics of that section of the repository. It is our understanding from discussions with NRC staff that the rule will not require that drifts be kept open. The specific retrievability period is meant to be a design criterion rather than an operational one. A technical paper* by the Office of Nuclear Waste Isolation notes that the period of retrievability will depend on the length of time to demonstrate performance and will be site and design specific. The paper shows that a test period of about 3 - 5 years is needed to reach a decision point. We believe that adequate monitoring can be maintained throughout the emplacement period. Thus a 50-year observation time following waste emplacement is excessive. However, a reasonable retrievability period would not be a major problem if sections of the repository can be partially or entirely backfilled prior to the end of the retrievability period.

Staff Response to Comment No. 351:

See Overview, Section 2.2, Retrievability.

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*Wayne A. Carbiener, "Retrievability: The NWTS Position:, Battelle, Office of Nuclear Waste Isolation, "Waste Management '81", ANS Topical Meeting, Tucson, Arizona, February 23-26, 1981.

Comment No. 352: F. L. Parker (80)

As is pointed out in the Rationale Document, on page 27, "We only require that the design of the repository preserve the option to retrieve the waste for future decision makers. The persons in charge at the time emplacement is complete will have the opportunity to decide whether to decommission and seal up the repository or to continue to monitor its performance. We only require that the design be such that they will have this option." Consequently, it would be possible to actually backfill and decommission the repository immediately after filling. This statement from the Rationale Document should be included in the rule.

Staff Response to Comment No. 352:

See Overview, Section 2.2, Retrievability.

Comment No. 353: Virginia Electric and Power Co. (64)

The requirement to maintain retrievability for a period of up to 100 years is excessive, without any adequate support, and could unnecessarily delay the final closure of the respository. A more reasonable approach might be to base design requirements for retrievability, if any, on the period of repository operation. Assuming that the first waste packages will have been in place for about 30 years before the repository becomes filled and allowing for another 30 years (the same times as for original construction and emplacement) for retrieval, would result in a design requirement of 60 years. This time perio is reasonable because any problems involved with the storage will probably become apparent quickly.

Staff Response to Comment No. 353:

See Overview, Section 2.2, Retrievability.

Comment No. 354: Union of Concerned Scientists (57)

The proposed schedule is satisfactory. It should not be shortened.

Requirements for retrieval may have a significant effect on the thermal and mechanical design of a repository, particularly one located in salt. Nevertheless, the advantages of the proposed retrieval schedule are such that it should be retained.

Section 60.21 (Content of Application) should stipulate the information on retrieval which should be included in DOE's application.

Staff Response to Comment No. 354:

See Overview, Section 2.2, Retrievability. Information on retrieval is required to be included in DOE's license application. See § 60.21(c)(12).

Comment No. 355: Mississippi Dept. of Energy & Trans. (65)

The requirement for 110 years of retrievability should not be shortened. Technology 110 years from now based on historical evidence will probably either utilize the waste material or at least provide better techniques for disposal. Monitoring of material can be more accurate if retrievability is maintained. Problems with the nuclear waste tanks at Hanford provide a good historical case.

Staff Response to Comment No. 355:

See Overview, Section 2.2, Retrievability. The purpose of the requirement to design for retrievability is to protect public health and safety in the event the site or design proves unsuitable. It is not intended to facilitate recovery for resource value.

Comment No. 356: Northeast Utilities (79)

We believe that the proposed rule's requirement to maintain retrievability for a period of up to 110 years is unnecessary and without adequate supporting rationale. A design allowing for retrieval for a 50 year period following waste emplacement could motivate extended and unnecessary delay in final repository closure.

A more appropriate approach would be to base design requirements for retrievability on the period of repository operation. Assuming the first waste packages loaded into the repository could be in place for about 30 years before all emplacement was complete, allowing another 30 years for retrieval would lead to a retrievability design requirement of 60 years. Such a period appears reasonable because any problems are likely to manifest themselves within this time frame.

Staff Response to Comment No. 356:

See Overview, Section 2.2, Retrievability.

Comment No. 357: Penberthy Electromelt International (61)

If the Commission really wants to have retrievability, then the concept of "deep geologic" for a repository should be abandoned in favor of repositories above the flood plain. This kind of repository was proposed by Winograd (1974). There are many advantages over the deep mined repositories.

A repository of this kind can be made by a tunnel boring machine at a cost much lower than is expected for deep repositories. Such a tunnel might be 12 to 20 feet in diameter, entering the side of a mountain, mesa, butte or hill

about 100 feet above the surrounding flood plain. The tunnel is bored slightly uphill, so that the repository is self draining. Concrete sleds are placed in the tunnel to form a platform for storage and a passageway underneath for drainage if any. The tunnel itself is lined with reinforced concrete.

In use, the canisters of glassified waste are simply stacked on the concrete platform. If the wastes are high enough in self-heating, a chimney can be provided for cooling by escape of heated air.

A chimney of sufficient diameter 100 feet high will remove a great deal of heat. In this way, the selected limitation of 100 kw of self-heating for a sealed deep repository can be avoided. Instead of canisters 12 feet on centers they can be placed fairly close to each other.

The concept of putting canisters in sockets in a tunnel should be discarded. Not only is there extra expense for boring the sockets in the floor, there is added expense for making a drift (tunnel) which is high enough to accept the drilling machine.

The concept of retrievability must necessarily include the factor of economics. Certainly repository actions can be reversed, but not necessarily at an expense affordable to society.

One of the reasons for considering retrievability is to be able to reprocess the waste in case the first packaging system is not good enough. I believe this is a false objective. Alumino-silicate glass used as a radwaste host has centuries of successful history which makes prediction for the future completely reasonable. Glass objects have been recovered in good condition after several thousand years in tombs and after 2,000 years from immersion in the Aegean Sea.

An advanced waste form is available which has a cladding say 6 mm thick on the outside which is made of totally inert glass. Thus, any alteration of the surface will take place on the inert glass for some thousands of years, even under total immersion conditions.

Another argument for retrievability is the recovery of the resource of the wastes themselves. If heavy stainless steel canisters are used, the metal may be valuable a thousand years hence. But it won't be economic to recover it if the repository is very deep and the backfill has solidified and the repository is flooded. We should not make a conscious, collective societal decision to thwart the future recovery of the wastes, including the canisters. The residual uranium and plutonium may be valuable at a future time.

The alumino-silicate glass as made is very resistant to leaching due to the low soda and high alumina content. However, they can be rendered soluble in the future by remelting the glass with 20% added soda. This will not be costly if the overall activity has decayed nearly to the background.

Staff Response to Comment No. 357:

This comment deals primarily with the selection of an overall disposal concept and with development of waste form materials. Both these decisions are the responsibility of the Department of Energy. The NRC will review these decisions only to the extent they have a bearing on protection of the public health and safety and, in the absence of a specific license application, it is inappropriate for the Commission to try to judge the merits of the proposals presented in this comment.

See Overview, Section 2.2, Retrievability, and staff response to Comment No. 355.

Comment No. 358: H. Ross (14)

60.111(a) Retrievability

The duration of the period during which retrieval capability should be maintained is properly related to "the expected time needed to execute the performance confirmation program." However the proposed period of "50 years after waste emplacement operations are complete" is arbitrary, without technical justification, and would result in additional engineering and unnecessary costs in restricting backfilling, maintaining cooling in open shafts and rooms, etc. Studies indicate peak near field temperatures should be reached in 10 to 30 years after emplacement, depending upon the host rock, and that the performance confirmation period should be no more than 10 years after emplacement. Knowledge gained prior to and during repository excavation, and monitoring during post emplacement years should permit confirmation of long term extrapolations of the near field response. Costs and safety hazards associated with retrievability increase rapidly with time after emplacement. The retrievability period should not be prolonged to 50 years after emplacement, and should be related to the performance confirmation period for sequential portions of the completed repository, rather than for the entire repository.

Staff Response to Comment No. 358:

See Overview, Section 2.2, Retrievability.

Comment No. 359: V. McIntyre (35)

60.111 (a) (2) The geologic repository should be designed so that the waste can be permanently disposed of. You take your best shot and that should be it. The added cost and the hazard of retrieving waste may not be worth it. By the time NRC is ready to issue a license to emplace waste enough will be known so that this requirement would be superfluous.

Staff Response to Comment No. 359:

See Overview, Section 2.2, Retrievability.

Comment No. 360: American Nuclear Society (20)

Section 60.111(a)(2) states a requirement for a waste retrievability period for up to 50 years after waste emplacement operations are completed. NRC's concept of retrievability and the states' arguments concerning related time periods are inappropriate.

NRC decision to require a final licensing step prior to decommissioning or permanent closure provides the opportunity for examination of the repository performance up to that time. Since the repository is planned to be operational for more than 30 years, the first waste emplaced will have been in monitored storage for this time period when the last waste is emplaced. If the applicant can demonstrate safety based on these data, no furtner period of retrievability should be necessary.

We understand that the 50-year retrievability period is designated to assure the retrieval option remains open during repository operation and is not precluded by repository design. This objective can be achieved without defining an artificial time frame if the rule is so worded to set forth this objective. The retrieval option can be easily exercised, for one of the distinguishing features of deep geologic disposal is that the waste inventory and location is well documented. Technologically there should be no problem, for what can be emplaced can also be removed. The design and engineering of such retrieval are well within current state of the art. This concept is reflected in the current National Waste Terminal Storage (NWTS) position* which we believe presents a logical approach for satisfying the retrievability objective.

Staff Response to Comment No. 360:

See Overview, Section 2.2, Retrievability.

Comment No. 361: Capital-Area Groundwater Conservation Commission (22)

Section 60.111(a)(2). This section (July 3, 1981 in Federal Register) gives the retrievability time of starting "at any time up to 50 years after waste emplacement" not 110 years as mentioned in Dr. Heath's memorandum. As I recall, a 50-year period is considered to be temporary storage time. Is this intended to be a "safety feature" for a permanent storage facility? Regardless if it is to be permanent radwaste facility, the emplacement should be designed for an infinite period of time.

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*W.A. Carbiener, Retrievability: The NWTS Position, Proceedings of the Symposium on Waste Management in Tucson, Arizona (February 23-26, 1981).

Staff Response to Comment No. 361:

See Overview, Section 2.2, Retrievability.

Comment No. 362: T. H. Pigford (53)

NRC proposes to require that the engineered system be designed so that wastes can be retrieved, if necessary, for up to 50 yr after completion of all emplacement. It is understood that the method of retrievability is to be left to DOE, subject to final review by NRC, and that retrieval could include mining of emplacement rooms that have previously been backfilled and sealed. NRC has not justified the numerical requirement of 50 yr of retrievability after the last emplacement. The general concept of the retrievability option is more complex than revealed in NRC's rationale, and it should be more thoroughly evaluated.

Staff Response to Comment No. 362:

See Overview, Section 2.2, Retrievability.

Comment No. 363: Utility Nuclear Waste Management Group (44)

As stated in the letter to which this Attachment is appended, the UNWMG is of the view that the provision of § 60.111(a)(2) requiring, as a basis for repository design, the ability to maintain retrievability for a period of up to 110 years is excessive and without substantial rationale. In addition, a design allowing for retrieval over a 50 year period following waste emplacement could, in and of itself, motivate extended and unnecessary delay in final repository closure.

A more reasonable and appropriate approach might be to base design requirements for retrievability, if any, on the period of active repository operation. Assuming the first waste packages to be loaded into the repository could be in place for about 30 years before all emplacement was complete, and allowing another 30 years (the same time as for original construction and emplacement) for retrieval, would lead to a retrievability design requirement of 60 years, total. Such a period would be reasonable because retrievability, if it is to be designed for at all, should be tied to a concept of performance confirmation, and any difficulties which are likely to be apparent at any time in the near future will probably manifest themselves quickly. Further, such an approach would tie retrievability to the period of the waste package monitoring program, which must extend as long as practical up to the time of permanent repository closure.

In any event, the rule, itself, should make it clear that the requirement for retrievability does not preclude backfilling of the emplacement room and drifts when the operator deems it appropriate.

Staff Response to Comment No. 363:

See Overview, Section 2.2, Retrievability. Backfilling is permitted.

Comment No. 364: UK Atomic Energy Authority (29)

We believe that over-emphasis on designing for retrievability could distort the design of a repository. For heat-emitting waste it is better, therefore, to aim for a period of retrievable storage followed by disposal with no intention of retrieval. After this, retrieval is always possible as a last resort but it should never be necessary and should not be allowed to distort the design. This problem might be eased by having separate rules for spent fuel and other high-level waste since waste should be eventually disposed of but fuel is a resource which may need to be retrieved.

Staff Response to Comment No. 364:

See Overview, Section 2.2, Retrievability. The purpose of the requirement to design for retrievability is to protect public health and safety in the event the site or design proves unsuitable. It is not intended to facilitate recovery for resource value.

Comment No. 365: U.S. DOE (48)

Issue

The requirement proposed by the NRC in section 60.111(a)(2) that DOE design for a retrievability capability that extends for 50 years beyond completion of waste emplacement appears excessive in view of the site-specific considerations involved, as well as the extensive performance confirmation program to be conducted throughout the period of repository operations.

DOE Position

The duration of the period during which retrieval capability should be maintained should, as the Commission correctly states, be linked to "the expected time needed to execute the performance confirmation program." Studies conducted by DOE[1] have indicated that performance confirmation programs similar to that suggested in 10 CFR 60.137-143 are:

a. Achievable in substantially less time than the period suggested by the Commission.

b. Definable only on a site-specific basis.

Having an upper bound number in the rule, as proposed, will very likely compel the Commission to wait that full period before deciding to decommission the repository, even if there would be no objective technical basis for delay beyond the completion of waste emplacement. Further, the Commission may be excessively pessimistic in its statement that "neither the specific nature nor the period needed for execution of the performance confirmation program will be certain until construction of the repository is substantially complete." The scope and timing of such a program can and should be defined as part of the license application process for specific repositories, while maintaining reasonable options for decision-making prerogatives subsequent to the completion of waste emplacement. Moving towards non-retrievability should occur with the Commission on a step-by-step basis including possible early decisions to backfill, to decommission part or all of the repository, and to determine that the retrievability period is over. Closure of portions of the repository should be permissible prior to closure of the entire respository.

Discussion

Our position on retrievability is derived from several considerations:

- It is unlikely that emplaced wastes will need to be retrieved. A conservative step-wise site selection program should provide reasonable assurance that the repository will function to provide long-term isolation. We presume that NRC will authorize construction and waste receipt only if this premise is substantiated. Nonetheless, it is prudent and necessary to plan for the retrieval contingency.

- Confidence in the as-designed, as-constructed disposal system increases with time. As repository development and operations proceed, understanding of the host rock and the natural system, as well as the waste package and near-field performance, will improve. It should also be recognized, however, that the cost and hazards associated with retrieval operations may also increase with time.

- An initial period of time will be required after waste emplacement is initiated to verify the performance of the specific site and the design for isolation of the wastes. During this period, performance confirmation can be achieved by direct measurement of critical parameters and phenomena. Parameters and phenomena whose effects are measurable generally reach their critical values early in the process, e.g., peak rock temperatures occur fairly early, and the actual values can be accurately extrapolated once the initial gradients and rock response are determined.

- Parameters and phenomena to be measured in a performance confirmation program will vary from site to site. For example, creep closure response may be an issue in salt but not in crystalline rock. Conversely, fracture permeability phenomena may be of little concern in salt.

- The results from the performance confirmation program should support a decision to backfill storage rooms, with such a decision acknowledging the intent to truly dispose of the waste. Backfilling and sealing of storage rooms makes retrieval more difficult but does not rule out retrieval as a future option. As backfilling represents a true disposal condition, monitoring of a representative backfilled area is appropriate as part of performance confirmation.

- The capability to retrieve does in fact exist as long as access to the repository horizon is maintained. Thus, retrieval can be accomplished at any time up until authorization for full decommissioning and sealing of the repository.

This basic approach to retrievability seems compatible with the approach taken by the NRC in the regulation. Both regard retrievability as a planned contingency. Both acknowledge the value of a performance confirmation program yielding the earliest possible results.

However, the proposed regulation deviates from this approach by stipulating that the repository must be designed so that retrieval capability is maintained for an additional period of 50 years following the last emplacement of wastes. To this the NRC suggests adding 30-year allowances for both emplacement and retrieval operations, for a total of 110 years. (This latter figure presumably would increase if emplacement activities extended for longer than 30 years.)

The staff's rationale for the 50-year increment has been presented in the Supplementary Information. It is based on an anticipation that little will be known about specifics of the performance confirmation program before operations commmence and seeks to compensate by preserving flexibility in decision-making options regarding repository closure. We note that within the body of the regulation, no linkage is made between the 50-year period and the performance confirmation program.

We have several concerns relative to the 50 year period and believe the supporting rationale to be unduly pessimistic, since the NRC proposed rule includes a requirement that a performance confirmation program be under way during early stages of construction (sections 60.141 and 60.142). We have always assumed that the performance confirmation program, specifically as provided in Subpart F, would be the subject of much of the NRC review of the license application.

Second, the type of information required in Subpart F can be obtained during the period of waste emplacement. Table 1 (See PDR letter 48, p. A-6), which provides summary results from one DOE study[1], is an example of how one could establish a time frame for performance confirmation. The bases for the time periods are contained in reference (1). Most of the required data can be obtained in less that one decade of repository operation. We recognize that while the time required will vary from site to site, it is highly improbable that measurements would be needed beyond the waste emplacement phase. Sufficient data will be available from the ongoing verification studies to support the closure decision at that time.

The basis for this position on the time required for performance confirmation stems from analyses of phenomena and conditions that, if developed, would warrant retrieval. Such conditions, leading to a decision to retrieve, can be categorized as follows:[1]

- Natural Events and Processes. The occurrence of totally new, unknown, and unexpected natural phenomena in the environment of an operating repository which could render it unusable.

- Geologic and Hydrologic Response to Excavation and Waste Emplacement. The design of the repository will be based on data obtained from sampling and testing and on accepted thermal, mechanical, and hydrologic models. Designs will incorporate margins of safety to accommodate reasonable assumptions of inaccuracies in such design bases. Nevertheless, abandonment of the repository, or a portion of the repository, could conceivably be dictated if performance characteristics indicate that the required degree of confidence in the predicted performance could, for some reason, no longer be provided.

- Predicted Waste Package Performance. Post-emplacement evaluations could indicate that an excessive number of waste packages have defects or that the engineered barrier design is not performing as predicted. Retrieval of some defective waste packages or of all emplaced waste could be dictated in this event.

- Repository System Operation. The repository system could be judged not operable due to either an uncorrectable inadequacy of the design basis or small but chronic inadequacies that, with time, would build to an intolerable level.

- Malicious or Inadvertent Human Intrusion and Repository Disruption.

Performance confirmation programs should address these conditions wherever feasible. However, direct measurements and observations that can be made during repository construction and operation can only contribute to assessments of performance by one of the following approaches:

- Direct observation or measurement of unacceptable phenomena.

- Observation or measurement of precursors to unacceptable phenomena; that is, observation of environments or repository system response that could cause unacceptable phenomena sometime in the future.

- Observation or measurement of repository environments and responses to define more representative input values for predictive models, thereby improving confidence in performance predictions.

These measurements and observations, and the resulting confirmation of performance (and the time required for this confirmation) will vary from site to site. However, many phenomena and conditions may not be amenable to direct measurement or observation. The following criteria should be used to exclude phenomena from performance confirmation programs following the emplacement of waste:

- The phenomenon has a very low probability of occurrence, e.g., volcanism, or glaciation, during the operational period.

- The phenomenon has very little or no significance on repository long-term performance; e.g., small movements of canisters in salt.

- The phenomenon is of such a nature that its behavior can be satisfactorily evaluated prior to the beginning of waste emplacement. This is the case for the effects of mining on rock integrity.

- There is a very high degree of confidence that the phenomenon can be eliminated through active institutional controls during the period prior to decommissioning or that decommissioning will substantially reduce the probability of impact, e.g., human intrusion or alteration of surface or near-surface utilization.

Using this approach, DOE will identify, as part of the license application, phenomena that should be addressed in a performance confirmation program.

A final argument for requiring a decision on closure of the repository much earlier than the proposed 50-year time period is to put the decision in the hands of those directly involved with the regulation and operation of a specific repository. We propose that those concerned with the initial licensing and operation of the repository are the best qualified to judge its suitability, and permitting delays for the 50-year observation period may in effect preclude these individuals from making such a decision.

However, NRC correctly notes in the Supplementary Information that DOE is now, and will be making, critical decisions regarding the design of repositories which will have a direct effect upon how long the option to retrieve wastes can be reasonably maintained. We recognize the need to maintain these options on behalf of the NRC in their decisionmaking role regarding final repository closure. Therefore, we agree that fixing an upper limit on the retrievability period sufficient to provide some degree of flexibility in closure decisions is a reasonable approach at this time and this limit should be considered on a case-by-case basis during the license application review process.

Recommended changes to sections 60.2 and 60.111 to reflect these comments are included in the detailed section by section comments on the proposed rule (enclosure B, pages 12 and 21).

Staff Response to Comment No. 365:

See Overview, Section 2.2, Retrievability. See also, Overview, Section-by-Section Analysis, §§60.140-60.143.

[1]ONWI-203, Retrievability: Technical Considerations, Science Applications, Inc., September 1980.

Comment No. 366: U.S. DOE (48)

10 CFR 60.111(a)(2)

NRC Proposed Wording:

(2) The geologic repository operations area shall be designed so that the entire inventory of waste could be retrieved on a reasonable schedule, starting at any time up to 50 years after waste emplacement operations are complete. A reasonable schedule for retrieval is one that requires no longer than about the same overall period of time that was devoted to the construction of the geologic repository operations area and the emplacement of wastes.

Recommended Revision:

"The repository shall be designed so that any of the emplaced waste could be retrieved on a reasonable schedule, starting at any time up to 50 years after waste emplacement operations are initiated. This time period may be considered on a case-by-case basis for each repository consistent with the planned performance confirmation program. This requirement shall not preclude a decision by the Commission to allow backfilling or decommissioning part or all of the repository prior to the use of the designated retrieval period."

Rationale:

The discussion of the DOE position on retrievability, including the rationale for our recommended revision, is included in the enclosure labeled Issue Commentary.

Comment No. 367: C. Walske, Atomic Industrial Forum (50)

Item (a)(2) A number of commentators have expressed concern about the specified length of the retrievability period, thinking that the requirement implies that all mine openings must be maintained for the length of the retrievability period. Although we do not believe that this was the NRC intent, for clarity, it is suggested that Item 60.111(a)(2) be reworded as follows:

> "The geologic repository operations area and the waste package shall be designed so as not to foreclose the option of retrieving the entire inventory of waste on a reasonable schedule starting at any time during a designated retrievability period that follows completion of waste emplacement operations. The design objective for the retrievability period should be 50 years unless it is established that a shorter period is justifiable. This design objective is not to be construed as prohibiting the closure or backfilling of all or part of the underground structure during the retrievability period, nor is it intended to preclude decommissioning during this period. A reasonable schedule for retrieval is one that requires about the same overall period of time as was devoted to the original construction of the repository operations area and the emplacement of wastes."

Comment No. 368: Stearns-Roger (51)

The proposed 50-year retrievability period (60.111(a)(2)) should be approached with caution and deliberation. Considerable thought and detailed analysis must be applied to the negative impacts of long-term retrieval upon long-term isolation. Establishing an arbitrary 50-year retrieval requirement at this time appears to be based upon little logical rationale to support the general concept or the specific time interval. Until such rationale is thoroughly explored, the possibility exists that a long-term retrieval requirement might actually increase the risk to the health and safety of present and future generations.

- What is the rationale for 50 years versus shorter or longer intervals? The logical interval should be a function of the uncertainties concerning the site geologic system, the waste form and package, and their interactions. Thus, the retrieval interval could and should vary, dependent upon the chosen site and waste form and package.

- Longer retrieval intervals require numerous facility design features and operating procedures that tend to degrade the repository's long-term isolation capabilities. For example, considerable additional support structure would be required which certainly would make backfill and natural closure less reliable sealing processes. Also, much more material would be removed from underground openings as they attempt to creep and close, and the consequent degree of surface subsidence and geologic deformation would be somewhat greater. The long-term isolation confidence would thereby be reduced.

- A 50-year interval might very well preclude a given material as a viable host rock even if that material should prove to be the best choice for long-term isolation. Therefore, retrieval options must be balanced against long-term isolation requirements. Much more study is required in this area before long-term retrieval can be accepted as the best approach. For example, retrieval in a period of time about equal to that during which the waste was emplaced would require that all the underground shafts, main corridors, and ventilation ducts be kept open for over 100 years before retrieval ends. This long period of access may be possible in highly plastic salt but would be very costly and could increase risk both to workers operating the repository and to the public.

- Considerable funds, manpower, and material would be devoted to keeping a long-term retrieval repository open and oprable. Those limited resources would possibly be better allocated elsewhere in the repository.

- Again, the length of the retrieval interval should be weighed carefully against the overall functional requirements of a repository before establishing arbitrary and unvarying criteria.

Staff Response to Comment Nos. 366-368:

See Overview, Section 2.2, Retrievability.

Comment No. 369: Dr. Roy (52)

I support the NAS CRWM study on geologic criteria in its criticism of the 50 (-110) yr retrievability concept. This is bound to damage the final quality of the repository. It may exclude salt altogether. Most importantly, it eliminates the grouting concept which may be the safest procedure (including worker exposure).

I believe an alternative can be a demonstration phase to prove out the area, and the procedures, etc., on site using cold nuclides in a full scale pilot demonstration of any mined or grouted repository. This could be monitored for 20 years before NRC approval for the real version go-ahead. The latter would then use the optimum technological situation instead of compromising the technology for the regulation.

Comment No. 370: Westinghouse Corp. (54)

The 50-year retrievability requirement specified in paragraph 60.111(a)(2) has stirred considerable controversy. This paragraph as well as language in the supplementary information imply that tunnels can be backfilled prior to the end of the 50 years, but some of the detailed design criteria imply that the tunnels must be designed to remain open during the retrievability period. If, as we believe the NRC intended, the requirement to maintain the option to retrieve does not preclude the backfilling of underground openings or decommissioning during the retrieval period, then we believe the 50-year retrieval requirement will not have a significant impact on repository design.

However, this must be clarified in the rule. With respect to the waste package, the designs currently under development by Westinghouse for the Office of Nuclear Waste Isolation are impacted very little by the retrievability requirement. Based on the preceding considerations, Westinghouse has no strong objection to the retrievability requirement. However, the specified 50-year period is very arbitrary, and the actual time required to confirm repository performance and reach a decision to decommission is dependent on a number of factors and, while the 50-year requirement may not have a foreseeable impact today, that may not always be the case (e.g., waste package requirements and designs could possibly change). Therefore, we recommend that the specified 50-year period be identified as a design objective and that the rule state that a shorter period will be considered if suitable justification is provided.

Comment No. 371: Louisiana Dept. of Natural Resources (63)

Section 60.111(a)(2). This section (July 3, 1981 in Federal Register) gives the retrievability time of starting at any time up to 50 years after waste emplacement" not 110 years as mentioned in Dr. Heath's memorandum. As I recall a 50-year period is considered to be temporary storage time. Is this intended to be a "safety feature" for a permanent storage facility? Regardless if it is to be a permanent radwaste facility, the emplacement should be designed for an infinite period of time.

Comment No. 372: Bechtel National Inc. (37)

60.111(a)(2) - This performance objective requires that the repository be designed so that the entire inventory of waste can be retrieved starting at any time up to 50 years after waste emplacement operations are complete. Enclosure (J) to SECY-81-267 makes it clear that this requirement does not preclude backfilling or sealing the mined openings during the retrievability period; however, this is not made clear by the body of the proposed rule. This clarification should be added.

Furthermore, we believe it is preferable to delete the retrievability time period since this period should be based upon the time needed to verify repository performance, which will be site and design specific. In this regard, we support the NWTS position on retrievability as described by W. A. Carbiener at the ANS Topical Meeting, Waste Management '81, in Tucson, Arizona, February 23-26, 1981.

Comment No. 373: B. Houston, Hamilton & Assoc. for The American Ceramic Society (75)

The requirement of retrievability of the waste for long period [60-111(a)(2)] would appear excessive, except in the case of spent fuel. It seems likely that spent fuel would be retrieved if buried, however the value of reprocessed waste will be much lower and its risk is also lower. Tests will be carried out before normal repository operations are started and should significantly reduce the possibility of retrieval. Short term retrieval, i.e., 10-20 years for the first waste may be wise, but the cost of this requirement should also be reviewed with a view to potential hazards and risks.

Staff Response to Comment Nos. 369-373:

See Overview, Section 2.2, Retrievability.

Comment No. 374: V. McIntyre (35)

60.111 (b) Has the NRC given thought to what it will do if the EPA does not promulgate a 40 CFR 191? Do you have the authority to go forward?

Staff Response to Comment No. 374:

NRC's authority was confirmed by Section 121 of the Nuclear Waste Policy Act.

Comment No. 375: Bechtel National, Inc (37)

60.111 (b) - The EPA draft regulations contained in 40 CFR 191 and the assessments on which they are based are limited to releases of radionuclides to the accessible environment for a period of 10,000 years after disposal. During deliberations on 10 CFR 60 prior to its release for public comment, the Commissioners indicated that this same limitation should apply to the performance requirements of 10 CFR 60. This limitation should be stated explicitly within the body of the final rule. Furthermore, if consequence analyses are to be performed for periods beyond 10,000 years, this requirement should also be stated and the time frame for such analyses should be indicated.

Staff Response to Comment No. 375:

The required analyses of performance "as a function of time" must be sufficient to take into account features that might affect performance, i.e., that might affect the achievement of the performance objectives (See § 60.21(c)(1)).

If the EPA standard has a 10,000 year cutoff, the analyses must be adequate to permit assessment of performance over that period of time.

Comment No. 376: Utility Nuclear Waste Mangement Group (44)

In addition, § 60.111(b)(2) imposes, as design objectives: (1) that the waste packages contain all radionuclides for at least the first 1,000 years after permanent closure, and (2) that, after the first 1,000 years following permanent closure, the annual release rate of any radionuclide from the engineered system into the geologic setting -- assuming anticipated processes and events -- is at most one part in 100,000 of the maximum amount of the radionuclide calculated to be present in the underground facility (assuming no release from the underground facility) at any time after 1,000 years following permanent closure. It is obvious that literal proof of compliance with these objectives is neither intended nor possible. To avoid any potential confusion in either the licensing review or hearing process, however, these provisions should be redrafted to emphasize that the specifications are only design objectives; i.e., that the intent is to provide for the application of pertinent field, laboratory and analytical information in accordance with good engineering practice.

In particular, with respect to the 1,000 year containment requirement, the rule should specifically provide for a determination based on reasonable input parameters, derived from acceptable field and laboratory data and analyses, for a nominal (not first-to-fail) waste package. Similarly, the one part in 10^5 release rate requirement should be prescribed in terms of being demonstrable by means of analysis based upon reasonable input parameters. This portion of the rule, too, should specifically provide for analysis based upon typical waste package performance, and reasonable inputs with respect to the underground facility. A period of consideration, i.e., out to 10,000 years as is

being utilized by EPA in the case of its draft radiation protection standards, should also be specified.

In addition, § 60.111(b)(2)(i) imposes an assumption of "all or partial saturation of the underground facility." Under certain circumstances, however, (e.g., disposal in salt) such an assumption may not be reasonable. Accordingly, the rule should provide that the waste package design basis may reflect site specific conditions.

Staff Response to Comment No. 376:

See Overview, Sections 2.1 and 5.4, Single vs. Multiple Performance Standards and Reasonable Assurance. See also staff response to Comment No. 375.

For disposal in the saturated zone, we consider that a number of pathways for groundwater to enter the underground facility could be created due to rock damage during construction of the underground facility, deterioration of shaft and borehole seals, and as a result of the thermomechanical stresses caused by the heat generated by the waste. Further, salt deposits contain brine inclusions that will migrate toward the waste canister under the thermal gradients in a repository. Bedded salt will also contain interbeds that could provide pathways for groundwater to enter the underground facility. Hard rocks such as basalt, welded tuff and granite contain fractures that are potential pathways for groundwater ingress. The distribution of natural fractures, the formation of fractures due to construction and thermomechanical stresses and the effect of such fractures on resaturation of the repository will be extremely difficult to assess. We consider that these conditions must be considered and analyzed in designing the engineered barrier system, and if it cannot be shown that full or partial saturation of the underground facility will not occur, then the design of the waste packages must take these conditions into account.

For disposal in the unsaturated zone, assumption of full or partial saturation of the underground facility is not required in the final rule, since it is possible to design the underground facility to be drained of groundwater. Features of the design for controlling groundwater will be reviewed and the design of the engineered barrier system will be evaluated in light of the adequacy of such features. Criteria for disposal in the unsaturated zone are expected to be the subject of future amendments to the technical criteria.

Comment No. 377: United Nuclear Waste Management Group (44)

Finally, the specific requirements pertaining to TRU waste should be removed from § 60.111(b)(2) for the reasons discussed above in connection with § 60.102(b)(4).

Staff Response to Comment No. 377:

See Overview, Section 3.2, Transuranic Wastes (TRU).

Comment No. 378: J. Vadas (4)

I support 2 portions of the proposed rule; these are, a guaranteed 1,000 year containment period and that the radioactive releases be held to one part in 100,000 of the amount of radioactive waste in the repository. However, another section of the proposed rule, I strongly criticize, the section which would allow a geologically unfit site to be used if it could be "remedied." I am opposed to this because of the extra cost for doing so and because it is nearly impossible to remedy a geologically unfit site. The results of using an unfit site would be leakage and contamination of the environment.

Staff Response to Comment No. 378:

See response to Comment No. 297.

Comment No. 379: T. H. Pigford (53)

Rather than make a value judgment now on unissued EPA standard, we instead restrict our consideration here to the performance evaluation adopted by NRC in its rationale for its proposed criteria, i.e., the predicted radiation dose to future maximally exposed individuals over the long term to millions of years after emplacement in a geologic repository.

NRC references such performance analyses[5,6,7] in its rationale for selecting numerical criteria for three parameters of the waste-isolation system: (1) the time delay from waste emplacement until the onset of dissolution of the waste by groundwater, (2) the fractional rate of release of radionuclides from the waste to the groundwater, and (3) the time for groundwater to travel from the repository to the accessible environmet. The authors of two of these references[5,6] have dealt quantitatively with the effect of these and other parameters upon overall repository performance, with performance measured in terms of radiation dose to future maximally exposed individuals. However, NRC has not utilized the results of the primary studies by these authors.[12,13] NRC refers instead to a progress report[5] and to an unpublished paper[6] presented at an information meeting. In order to develop a better understanding of the basis and importance of NRC's proposed numerical criteria, we have reviewed the more thorough studies by these authors[11,12] on the effects of these parameters on waste isolation performance, supplemented by additional data[14-20] on radionuclide adsorption, solubility, and hydrology for rock media not considered specifically in these published analyses. The results of such performance analyses, showing the likely importance of each of the three above-mentioned numerical criteria to overall long-term waste isolation are discussed in subsequent sections.

1,000-yr Containment by the Waste Package

1. NRC's Purpose for proposing the 1,000-yr Containment

NRC proposes to require containment of the radionuclides within the high-level waste package for at least 1,000 yr following repository closure. NRC justifies this requirement as necessary to avoid the uncertainties of predicting release and hydrogeologic transport of radionuclides when affected by elevated temperatures of waste, rock, and groundwater. NRC is concerned with "severe" effects of temperature, which could accelerate the leaching of wastes exposed to groundwater and could affect groundwater transport of radionuclides by perturbing the motion of groundwater and by causing mineral phase changes of backfill and near-field rock. These phenomena are more relevant for host rocks which are permeable to groundwater.

Some of NRC's considerations of temperature effects are qualitatively reasonable, but there is no showing that the numerical criterion of 1,000 yr containment is important in attaining a safe overall performance. As is shown in the following sections, existing technical knowledge of repository heating and effects therefrom have not sufficiently entered into the NRC considerations. NRC's 1,000-yr containment requirement will not avoid the need to reduce uncertainties in predicting effects of heating on repository performance. Meeting NRC's proposed numerical criterion may introduce more technical uncertainty than exists in the problem which NRC seeks to avoid.

2. The Importance of 1,000-yr Containment to Overall Performance

Some of the temperature effects identified by NRC could increase the time for released radionuclides to reach the environment; others could decrease the transport time. It is the uncertainties from such effects that is NRC's concern. However, for typical repository sites under DOE consideration, the time for released radionuclides to travel through the heated zone of the repository is predicted to be small compared to the total travel time for radionuclides through the adjacent unheated rock media, so local changes in the water flow rate and nuclide transport rate in the heated zone do not necessarily cause large changes in the overall travel time. The references[12,13] show that future radiation doses from long-term releases of radionuclides to the environment are not appreciably affected by perturbations in radionuclide travel time, for typical values of repository and site parameters, and they show that delaying the onset of dissolution of the waste has little or no effect upon long-term overall waste isolation performance. Those radionuclides which are essentially completely attenuated by decay will not emerge for even much shorter water travel times. The few that do emerge are so long-lived that they will still emerge even for much longer water travel times or waste-containment times. These considerations further question the importance of NRC's proposed 1,000-yr containment in helping achieve suitable overall waste isolation performance.

The extent to which temperature affects radionuclide release and transport will depend in part upon the rock medium in which the waste is emplaced. To the extent that such effects are important, temperature effects should

enter into the selection of the rock medium for emplacement. However, such considerations would have little import under the mandated 1,000-yr containment criteria.

Although having questioned here whether or not possible uncertainties in predicting repository performance during the first 1,000 yr are important in predicting the release of radionuclides to the environment, we turn next to a more specific evaluation of NRC's discussion[2] of the uncertainties introduced by "severe" effect of temperature during the first 1,000 yr.

3. Temperatures Assumed by NRC

NRC assumes much higher repository temperatures than will necessarily exist. Repository temperature rises quoted by NRC are as much as 60% greater than those in current DOE reference designs.[25] There are several design options available to DOE to relax temperatures and to decrease the uncertainty of repository performance analysis, should it become necessary. These alternatives should be left as a DOE responsibility in the design process.

NRC does not show its basis for concluding that temperatures after 1,000 yr are low enough to allow release and transport of radionuclides to be predicted with greater confidence. However, NRC's graphs[2] show that after 1,000 yr the maximum rock temperature of a bedded-salt repository will have decreased to about 160°C. Evidently it is the uncertainty of prediction at temperatures greater than this 1,000-yr value that NRC's proposed 1,000-yr containment is intended to avoid. In DOE's current reference design for a bedded-salt repository the maximum rock temperature at any time during the first thousand years of emplacement or thereafter is less than NRC's 1,000-yr value. Therefore, the temperatures of current designs of bedded-salt repositories are evidently already low enough to satisfy NRC's concern, so NRC's justification of the 1,000-yr containment would not apply. This is another example of why a uniform and numerical containment criterion should not be mandated.

4. Temperature Effects Must Still Be Considered

Even assuming a repository with temperatures in the range which NRC considers to be severe, NRC's proposed 1,000-yr containment criterion would not eliminate the need to consider temperature effects. Many of the temperature-induced changes in the rock and backfill are likely to be irreversible and will remain and affect radionuclide transport well after the 1,000-yr period. Many of the temperature-induced mineralogical changes in basalt, granite, and tuff are likely to be permanent, and these will affect radionuclide transport for the much longer period of releases and transport after the 1,000-yr containment period. Data from field tests in heated rock indicate that if thermally induced fracturing of the rock occurs, increased porosity and permeability for water flow may not become important until well after the 1,000-yr containment period, when compressive stress due to temperature have subsided. These are two reasons why the effects of temperature upon the properties that affect radionuclide transport must still be considered, regardless of the existence of a 1,000-yr containment.

Even with a 1,000-yr container for the high-level waste, thermally-induced flow, due to heating repository rock containing groundwater, will continue beyond the 1,000-yr period and must still be considered in repository design and analysis. Heating groundwater decreases its density and viscosity and includes vertical flow, but such thermal convection is slow to develop. Analyses[26] for conceptual repositories with groundwater flow through hard-rock fractures show that, for the assumed constant-aperture fractures, the maximum water flow rate in the repository will not occur until well after 1,000 yr for spent-fuel waste, and the increased vertical flow will persist beyond 10,000 yr. For reprocessed high-level waste the magnitude of the thermally induced flow is considerably less than for the high-level waste, but near-maximum flow persists well after 1,000 yr. Therefore, for such repositories the 1,000-yr container does not necessarily avoid the need to consider the effects of repository heating upon groundwater flow and upon radionuclide transport from the high-level waste.

NRC's proposed 1,000-yr containment would not eliminate the need to consider the effects of temperature upon radionuclide transport even during the 1,000-yr period. Recognizing that transuranic wastes are also in the repository, NRC has proposed that a 1,000-yr container not be required for such wastes if they are not emplaced close enough to high-level wastes that the release rate from the transuranic waste can be significantly affected by the heat generated by the high-level waste. However, radionuclides can still be released by the relatively cool but uncontained transuranic wastes, and some of the transuranic radionuclides, especially americium-241, are of potential concern even during the first thousand years.[27] Even if the released transuranic radionuclides do not themselves transport through the heated rock, their transport will be governed in part by the flow of groundwater. As has been demonstrated by analyses of thermal convection flow of water in heated and unheated zones in conceptual repositories,[26,23] repository heating can markedly perturb the flow paths and velocities of groundwater, if groundwater is present in the repository. These flow perturbations occur not only in the heated regions where high-level waste is emplaced, but they also extend to the cooler regions where transuranic wastes may be emplaced. Therefore, the effect of repository heating on the transport of radionuclides even during the first 1,000 yr must still be considered, regardless of the existence of the 1,000-yr container for heated wastes.

NRC has not addressed the question of the importance of these thermally induced effects to the long-term transport of radionuclides in the environment. NRC's assumption that such thermal effects are important to long-term isolation performance remains in question.

5. Extrapolation From Current Knowledge

In considering other possible time periods for waste-package containment, NRC has ruled out waste-package containment time as long as 10,000 yr on the grounds that design of such a package requires a considerable extrapolation beyond DOE concepts and because costs are uncertain and may not be justified by the reduction in uncertainty that might be achieved. NRC should also apply such criteria to its proposed 1,000-yr container, which

it justifies on the basis of a single report[29] that suggests, with some reservation, that a titanium alloy may be sufficient for a 300-yr containment in a brine solution. The report provides no adequate basis for NRC's conclusion that 1,000-yr containment requires only a small extrapolation.

6. Can Compliance With the 1,000-yr Containment Requirement be Verified?

NRC has not addressed the question of whether or not compliance with the 1,000-yr containment requirement can be verified. Meaningful experiments involving accelerated corrosion to simulate long-time behavior are difficult to design and interpret, and the complex phenomena involved in the many different types of corrosion mechanisms which must be considered do not lead to reliable theoretical models for long-term extrapolation of performance or to verification of expected performance. This is an important area to be considered in the uncertainty analysis of repository performance, and it does not seem to have entered into NRC's consideration of proposing a 1,000-yr containment criterion.

A regulatory requirement that is not subject to meaningful verification of compliance is of dubious value. Even if sufficient laboratory data were to exist to predict that the designed waste package would contain radionuclides for 1,000 yr, it is likely that the 1,000-yr containment would not be met by all of the waste packages. Manufacturing tolerances are almost certain to result in some defective packages. The NRC criterion seems to require that all packages perform as specified, even though it has not been shown what fraction of the waste packages could undergo partial failure without resulting in a significant release of radionuclides to the environment. The NRC requirement is unrealistic and may be impossible to implement.

Even more difficult will be the problem of verifying compliance with a numerical EPA standard for overall performance of the waste isolation system, whether the standard be in terms of maximum radiation dose or curie release, unless guidance is provided as to how to comply with the standard. The only means of demonstrating compliance at such long times in the future is through predictive analysis of long-term performance, accompanied by best estimates of uncertainties in that performance estimate and by safety margins to provide for those uncertainties. Recognizing the reality of uncertainties in predictive analysis and providing flexibility and guidance so that compliance can be reasonably verified must be an essential ingredient in whatever overall performance standard is issued by EPA and implemented by NRC. Similar flexibility and guidance for compliance must necessarily accompany any numerical criteria for long-term future performance, but it does not appear in NRC's proposed rule.

7. NRC's Estimate of Cost

To support its conclusion that the cost of incorporating titanium in a waste package would be reasonable, NRC should review what is actually involved in constructing and verifying the performance of such a waste package, and NRC should describe its frame of reference for what costs

are "reasonable." The vague cost estimate by Magnini and Braithwaite[9] for a 300-yr waste package of unspecified design shows that NRC's proposed containment criterion could add several billion dollars to the cost of a repository. Such a cost may well be justified if it achieves a significant and necessary increase in public safety. However, there is no basis for such determination at this time.

It would be appropriate for NRC to rely more upon the DOE program that is developing the waste package and costs thereof. It would be appropriate for NRC to clarify to what extent costs will be a consideration in repository licensing.

8. Summary

The above analysis shows that NRC's proposed criterion that the radionuclides be confined within the waste package for 1,000 yr is without adequate or valid technical foundation, is based upon questionable assumptions, and may not be important to long-term public health and safety. There is no showing by NRC that the proposed criterion is necessary or sufficient for NRC's stated purposes.

Footnotes

[2]U.S. Nuclear Regulatory Commission, Rationale for Performance Objectives and Required Characteristics of the Geologic Setting: "Technical Criteria for Regulating Geologic Disposal of High-Level Radioactive Waste," June, 1981.
[5]H. C. Burkholder, "Management Perspectives for Nuclear Fuel Cycle Wastes," Nuclear Waste Management and Transportation Quarterly Report, Jan.-Mar., 1976, Battelle Pacific Northwest Laboratories, Richland, WA.
[6]M. O. Cloninger, "A Perspective Analysis on the Use of Engineered Barriers for Geologic Isolation of Spent Fuel," Proc. NWTS Info. Mtg., Oct. 30 - Nov. 1, 1979.
[7]U.S. Department of Energy, Draft Environmental Impact Statement on the Management of Commercially Generated Radioactive Waste, DOE/EIS-0046-D, 1979.
[11]U.S. Nuclear Regulatory Commission, "Environmental Impact Assessment in Support of Proposed Rulemaking, 'Disposal of High-Level Radioactive Wastes in Geologic Repositories: 10 CFR Part 60'," Draft NUREG-0806, July, 1981.

[12]H. C. Burkholder, M. O. Cloninger, D. A. Baker, G. Jansen, "Incentives for Partitioning High-Level Waste," Nuclear Tech.: 31, pp. 202-217, November 1976.
[13]M. O. Cloninger, C. R. Cole, J. F. Washburn, "An Analysis on the Use of Engineered Barriers for Geologic Isolation of Spent Fuel in a Reference Salts Site Repository," PNL-3356, December, 1980.
[14]B. H. Allard, H. Kipatsi, B. Torstenfelt, "Sorption of Long-Lived Radionuclides in Clay and Rock, Part 2, KBS Technical Report 98.
[15]L. L. Ames, "Low-Temperature Radionuclide K Values for Basalt, Heulandite and Notromite, PNL-2817, 1978.
[16]G. S. Barney, "The Kinetics and Reversibility of Radionuclide Sorption Reactions With Rocks," Progress Report for Fiscal Year, 1978.
[17]R. E. Gephart, et al., "Hydrologic Studies Within the Columbia Plateau, Washington; An Integration of Current Knowledge, RHO-BWI-ST-5, 1979.
[18]J. Rennerfeld, "Composition of Ground Water Deep Down in Granitic Rock:, KBS Technical Report 36, 1977.
[19]D. Rai, R. J. Serne, D. A. Moore, "Solubility of Plutonium Compounds and Their Behavior in Soils," Soil Sci. Soc. Amer. Jour.: 44, pp. 490-495, 1980.
[20]D. Rai, R. G. Strickert, "Maximum Concentration of Actinides in Geologic Media," Trans. Am. Nucl. Soc.: 35, 185, 1980.
[21]D. Rai, R. G. Strickert, D. A. Moore, R. J. Serne, "Influence of Solid Phases on Americium Concentrations in Solutions," PNL-SA-1906, 1981.
[22]B. J. Wood and D. Rai, "Nuclear Waste Disposal: Actinide Migration From Geologic Repositories," PNL-SA-9549, 1981.
[23]International Nuclear Fuel Cycle Evaluation, "Release Consequence Analysis for a Hypothetical Geologic Radioactive Waste Repository in Hard Rock," INFCE/DEP/WG.7/21, December, 1979.
[24]E. A. Bondietti and C. W. Francis, "Geologic Migration Potential of Technetium-99 and Neptunium-237," Science: 203, a1337-40, March 20, 1979.
[25]Office of Nuclear Waste Isolation, The Reference Repository Conditions Interface Working Group, "Interim Reference Repository Conditions for Commercial and Defense High-Level Nuclear Waste and Spent Fuel Repositories in Salt" (Draft), NWTS-3, December, 1980.
[26]J. S. Y. Wang and C. F. Tsang, "Buoyancy Flow in Fractures Intersecting a Nuclear Waste Repository," Heat Transfer in Nuclear Waste Disposal, HTD-Vol. 11, 105-109, ASME, November, 1980.
[27]B, K, Cohen, "Effects of ICRP Publication 30 and the 1980 BEIR Report on Hazards Assessment of High Level Wastes," Trans. Amer. Nucl. Soc., pp. 38, 84-85, 1981.
[28]J. S. Y. Wang, C. F. Tsang, N. G. W. Cook, P. A. Witherspoon, "A Study of Regional Temperature and Thermohydrological Effects of an Underground Repository for Nuclear Wastes in ard Rock," LBL-8271, October, 1979.
[29]N. J. Magnani and J. W. Braithwaite, "Corrosion Resistant Metallic Canisters for Nuclear Waste Isolation," Scientific Basis for Nuclear Waste Management, 2., C. J. Northrup, Jr., Ed., Plenum Press, New York.

Staff Response to Comment No. 379:

See Overview, Section 1.3, Purpose of the Technical Criteria, and Section 2.1, Single vs. Multiple Performance Standards; also, Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

The commenter has incorrectly assumed that NRC based its proposed criteria on predicted radiation doses to future maximally exposed individuals over times of millions of years after emplacement in a geologic repository. As stated in the rationale document, and as noted by a number of other commenters, the overall performance standard is the EPA standard, which we assumed will be similar to draft 19, and therefore based on cumulative releases of radioactivity to the accessible environment over a 10,000 year period. The NRC referenced the earlier studies by Burkholder, Cloninger, Hill and others in specific contexts to support its selection of the principal barriers and to identify nuclides that were important in the transport analyses. The rationale document for the final rule shows how the NRC criteria contribute to meeting the assumed EPA standard, and an appendix to the rationale document considers the EPA standard proposed on December 29, 1982.

With respect to the commenters eight numbered points we have the following responses.

1. The staff continues to be concerned about the effect of temperature on control of releases from the underground facility and considers that containment within a waste package can be an effective way to deal with this uncertainty. We recognize that factors such as the age of the wastes, the characteristics of the host rock and repository design can compensate for the effects of temperature and have allowed in the final rule for consideration of them on a case-by-case basis. (See § 60.113(b).)

2. The commenter has apparently misunderstood NRC's concern that containment time and release rate are coupled parameters that should not be varied independently as has been done in the earlier referenced studies. The NRC staff considers containment an important factor in achieving

controlled release. The importance of controlled release to overall performance is analyzed in the rationale document. (Part C of this document.)

3. In this instance the commenter references a draft working group report as a source for repository temperatures. NRC considered the DOE GEIS and its supporting documents to be more appropriate references for its purposes. In any event the final rule incorporates flexibility to allow for lower temperatures in repository designs.

4. The commenter has misinterpreted the staff's intent with regard to the benefit of the waste package containment requirement. NRC does not claim that containment for 1,000 years will eliminate the need to consider temperature effects. NRC's statement in the rationale that accompanied the proposed rule was that "Lower temperature and temperature gradients allow release rates and radionuclide migration rates to be predicted with greater confidence under these conditions." The staff agrees with the commenter that the effects of temperature on the disturbed zone will remain a factor to be evaluated. Also note that requirements for disposal of transuranic wastes have been deleted from the final rule.

5. In the rationale document for the final rule (see Part C), the staff has re-examined the state of waste package technology and considers that a waste package design for containment in the range of 300 to 1000 years is reasonably achievable, particularly in view of the clarification that absolute proof of zero release is not intended. (See Overview, Section 5.4, Reasonable Assurance, and Part C.)

6. In this point the commenter fails to recognize that DOE is already committed to designing a waste package that lasts for several hundred years and therefore would need to conduct accelerated corrosion tests taking into account the various corrosion mechanisms and would need to develop appropriate theoretical models for long term extrapolation. Also note that the proposed rule did not require complete assurance of zero release and the final rule has been further clarified on this point.

Finally, the final rule includes provisions for flexibility in the numerical criteria while the criteria provide guidance as to what combination of engineered and natural barriers will give the Commission confidence in overall performance.

7. Again, the commenter should take note of the fact that DOE is already committed to designing a waste package that will last for the period of the fission product pulse. DOE therefore will already need to perform the necessary tests develop the designs and carry out a quality assurance program to achieve this goal. The staff does not consider the incremental cost of its requirement unreasonable. (See Part C, Chapter VII.)

8. The staff has addressed the commenter's principal points in Part C.

Comment No. 380: U.S. DOE (48)

10 CFR 60.111(b)

NRC Proposed Wording:

(Not repeated here due to length.)

Recommended Revision:

(b) Performance of the geologic repository after permanent closure.

(1) Overall system performance

The geologic setting shall be selected and the engineered system shall be designed so as to provide reasonable assurance that, following permanent closure, the release of radionuclides into the accessible environment is within the limits defined by the generally applicable environmental standards established by the Environmental Protection Agency.

(2) Performance of the engineered system

(i) Containment of waste

The engineered system shall be designed so that there is reasonable assurance that containment of the HLW will be virtually complete during the period when the radiation and thermal output are dominated by fission product decay. As a performance objective, this period of containment will be a nominal 1,000 years after permanent closure of the repository unless it is established to the satisfaction of the Commission that an

acceptable level of overall system performance can be achieved with a shorter containment period. Among the factors that may be taken into account in proposing an alternative containment period are the radionuclide content and the thermal output of the waste. The capability of the engineered system to meet the performance objective after permanent closure shall be evaluated on the basis of anticipated processes and events and the assumption, where appropriate, that the nominal annual fractional rate of release of radionuclides from the engineered system need not be zero but should be less than one part in 100,000 or 1×10^{-5} of the inventory at the time of release. Those radionuclides whose contribution is less than 0.1% of the curie inventory at the time of release need not be included in any consideration or calculation relative to this objective. This requirement shall not be construed to mean that there shall be no releases during the containment period; the standard of compliance will be "reasonable assurance".

(ii) Control of releases

The engineered system shall be designed so that there is reasonable assurance that any release should be a gradual process which results in small fractional release rates extending over long times, and will not cause the overall performance standard on releases at the accessible environment to be exceeded. As a performance objective this annual fractional release rate shall not exceed one part in 100,000 of the inventory after the containment period unless it is established to the satisfaction of the Commission that an acceptable level of overall system performance can be achieved at other expected release rates. Among the other factors that may be taken into account in proposing an alternate release rate are the radionuclide content and the thermal output of the waste. The capability of the engineered system to meet the performance objective after the containment period shall be evaluated on the basis of anticipated processes and events and the assumption, where appropriate, that available void spaces in the underground facility are filled with groundwater. Those radionuclides whose contribution is less than 0.1% of the curie inventory at the time of release need not be included in any consideration or calculation relative to this objective.

(3) No change recommended.

Rationale:

The rationale for these changes is presented in the Issue Commentary enclosure to this response, under "Alternative Approach."

Staff Response to Comment No. 380:

This comment raises a variety of issues that are dealt with in various parts of the Overview, Section 2.1, including especially Single vs. Multiple Performance Standards, and Section-by-Section Analysis of the performance objectives. The commenter's principal point, that other containment periods

and release rates should be acceptable so long as the overall system performance objective can be achieved, has been adopted in the final rule. A further response is provided in connection with the Issue Commentary enclosure referred to by the commenter.

Comment No. 381: Div. of Emergency Government, State of Wisconsin (77)

60.111 -- Performance Objectives (b)(i) Containment Period

The last sentence indicates that "the ability of the geologic setting to isolate wastes during the isolation period, in accordance with paragraph (b)(3)(ii) of this section shall be deemed to satisfy this requirement." Assumptions are being made through positive statements that the suitability of a geologic respository is a given fact following final NRC site approval. However, due to limited scientific knowledge on geologic repositories to date, the adequacy and more importantly, the suitability of a proposed repository will be dependent on how well the variables are integrated into the final evaluation.

Staff Response to Comment No. 381:

The wording quoted in this comment has been deleted from the final rule. It was not, and is not, the Commission's intention to make a final finding of site suitability until a performance confirmation program has been completed and the results of this program have been evaluated. The NRC's retrievability criterion permits such a program to be conducted while providing for retrieval of the emplaced waste if necessary.

Comment No. 382: Bechtel National, Inc (37)

60.111 (b) (2) - In a footnote to this paragraph, the Commission requests comments on whether an ALARA principle should be applied to the performance requirements dealing with containment and the control of releases. We believe the ALARA principle should not be applied to these requirements and that the discussion of ALARA should be removed from the Supplementary Information for the following reasons:

(a) It is not evident that improving upon the stated performance requirements for waste-package containment and control of releases would have any significant effect on further enhancing overall system performance,

(b) If the currently proposed overall system performance requirements are met, the risks to public health and safety will be so low as to be inconsequential, and thus, expenditure of additional effort to further reduce the risk would be unwarranted, and

(c) There is no basis for determining whether ALARA has been achieved, consequently, individual judgement would have to apply which could lead to endless and futile debate between the parties concerned.

Staff Response to Comment No. 382:

See Overview, Section 2.5, ALARA.

Comment No. 383: Bechtel National, Inc (37)

60.111 (b) (2) - The engineered system performance requirements of this section are applied in an almost equal manner to TRU wastes as they are to HLW. This does not seem appropriate based upon the very large difference in hazard potential between these two waste forms. We recommend, therefore, that TRU be removed from consideration in this proposed rule, and handled separately by future regulations.

Staff Response to Comment No. 383:

See Overview, Section 3.2, Transuranic Wastes (TRU).

Comment No. 384: Bechtel National, Inc (37)

60.111 (b) (2) - Based upon the detailed ONWI studies of engineered barrier reported in PNL-3356 and PNL-SA-9826, it is not evident that the subsystem performance objectives specified in this paragraph do much, if anything, to enhance overall repository performance. These studies show that, even in view of the uncertainties inherent to the analyses,

(a) There is, in effect, no change in repository performance when the waste package release rate is reduced from 10^{-3}/yr to 10^{-5}/yr,

(b) A containment period of 1000 years has no significant effect on dose reduction; rather, a containment period of greater than 100,000 years would be required to accomplish this, and

(c) For a properly chosen deep repository site, any radionuclide release to man's environment is expected to take in excess of 10,000 years.

As pointed out by the authors of PNL-3356, these results should be viewed with the "realization that the analysis tends to maximize both the incentive for, and the resultant effectiveness of, the engineered barriers in the context of the overall repository system".

In addition, the NRC does not provide a valid justification for these subsystem performance objectives with the arguments presented in Enclosure (J) to SECY-81-267. For example, the NRC states that the 1000-year containment requirement is necessary to protect against the possibility of an accelerated

release from the disturbed zone into the far field due to elevated temperatures in proximity to the waste package during the first 1000 years after waste emplacement. However, no analyses are provided to show that a zero release from the waste package during this time period is necessary, or even beneficial, to meeting the overall system performance objectives. Furthermore, the NRC does not appear to recognize that temperature effects, should they be important, will be a function of waste emplacement density, repository design, and host rock characteristics, and thus, are site and design specific.

For these reasons, we believe the numerical subsystem performance objectives given in this section of the proposed rule should be deleted.

Staff Response to Comment No. 384:

See response to Comment No. 379.

Comment No. 385: F. L. Parker (80)

Statistical criteria need to be provided so that when the regulations say all material must be contained at the 10^{-5} level, it specifies what fraction of the material that is - 95% of the material or 99% of the material - and at what level of confidence. Once that is specified, testing can proceed to indicate whether or not these design goals are reachable. I think, also, that NRC needs to indicate what validation it will accept for these numbers. How will they allow DOE to prove that the package will last for 1,000 years, or that the travel time is 1,000 years, etc.? These items are crucial to planning a waste package and a repository and to obtaining a license.

Staff Response to Comment No. 385:

See Overview, Section 5.4, Reasonable Assurance.

Comment No. 386: C. Walske, Atomic Industrial Forum (50)

Proposed changes to Item (b)(2) Performance of the engineered system.

As indicated in the comment on alternative approaches, if NRC believes it necessary to define specific performance criteria for the various components of a repository, we recommend that these be in the form of "design guidance" and not fixed criteria. To accomplish this, it is suggested that parts of Paragraph 60.111 be changed to read as indicated below. The proposed revisions include the EPA proposed 10,000 year time period over which performance is to be evaluated, as well as the recommendation that reference to TRU waste be deleted. Also incorporated are proposed performance objectives for subsurface facility seals that would replace those in Item 60.132(i), 60.133(a) and 60.133(b).

Item (b)(2)(i) Containment of wastes

> "The waste package shall be designed to provide containment of radionuclides during the time period when the potential hazard from the short-lived radionuclides and the effects of the waste thermal loadi[illegible] on the geologic setting are significant so as to provide added assur[illegible] hat the overall geologic repository system performance objective wi[illegible] met. As design guidance, the containment period should be * years after permanent closure of the repository, unless it is established that an acceptable level of geologic repository system performance can be achieved with a shorter containment period. The design basis con[illegible]ainment period shall be evaluated on the basis of anticipated [illegible]ses and events and the assumption that the quantity of groundwater [illegible]able to interact with the waste package, following permanent closure [illegible] the maximum predicted under anticipated conditions. This evaluati[illegible] need not consider unlikely processes and events."

Staff Response to Comment No. 386:

The NRC will apply the EPA standard to whatever interval the EPA finally establishes. It would not be appropriate for our rule to specify an interval, but we have used 10,000 years in our analyses.

References to TRU wastes have been deleted from the final rule.

The provisions with respect to borehole seals have been revised. See Overview, Section-by-Section Analysis, § 60.134.

Comment No. 387: N. D. Lewis, State of Washington Energy Facility Site Evaluation (36)

While representatives of several state agencies have participated in discussions concerning the disposal of high-level radioactive waste, we do not feel qualified to comment on the technical aspects of much of the proposed regulation. However, we are confident that the provision for a package to last for 1,000 years is proper and acceptable.

Staff Response to Comment No. 387:

See Overview, Section 2.1, Single vs. Multiple Performance Standards; also, Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

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*To be established by the NRC on the basis that this time period (designated in the 7/8/81 draft rule as 1,000 years) provides confidence that the overall system performance objective will be met.

Comment No. 388: C. R. Fisher, General Atomic Co. (16)

Sections 60.111(b)(2)(i) and (ii)

General Atomic supports the use of an "as long as reasonably achievable" approach to specifying requirements for HLW containment, and an "as low as reasonably achievable" approach to requirements for the control of releases. The arbitrary imposition of 1000 years and 10 ppm limits may be in some cases too lenient while in others overly restrictive. For example, some preliminary estimates indicate that in all geologic media except salt, unacceptable consequences might result if the HLW were not contained for more than 1000 years, and subsequently released at rates less than 10 ppm/yr. Because of estimates such as these and the fact that repository technology is in the early stages of development, it would be unwise to use approaches to design and operation which do not maximize flexibility and the opportunity for innovation.

Staff Response to Comment No. 388:

See Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 389: R. I. Newman, American Institute of Chemical Engineers (46)

Section 60.111(b)(2)(i) of the proposed regulation would require that the nuclear waste be in such form and so packaged that, "even if full or partial saturation of the underground facility were to occur, and assuming anticipated processes and events, the waste packages will contain all radionuclides for at least the first 1,000 years after permanent closure." After this initial 1,000 years, Section 60.111(b)(2)(ii) would limit releases from the package to not more than one part in 100,000. Moreover, pursuant to Section 60.112(c), the repository must be such that water travel time to the accessible environment is longer than 1,000 years. Thus, overall, the zero release requirement from the repository is not only for required 1,000-year package containment time, but also for the 1,000-year travel time -- a total of 2,000 years of zero release.

The following factors should lead to the conclusion that the proposed 2,000-year zero release criterion is not only unnecessary but also contrary to rational protection of the health and safety of the public:

(1) No scientific basis related to radiological protection (the domain of the NRC) is presented in the proposed regulation. Indeed, in related documents (Draft NUREG-0805 and Draft NUREG-0806), the radiological exposure to the public resulting from the waste disposal operation is not quantified, but only addressed in general terms.

(2) The proposed regulation seems to make a mockery of the principle of "as low as reasonably achievable" (ALARA). For quite some time, we have understood that the implementation of ALARA involved the weighing of costs and benefits of reducing radiation exposures below a well-defined exposure guideline or limit. For the NRC to query commenters as to the

appropriateness of applying such a principle to a mandated 2,000-year zero release would seem to be a moot question. This is even more the case when, taking into account 2,000 years of radioactive decay, natural retardation of nuclides, and dilution (especially if the release is from a body of salt), the potential exposure to the population or any individual resulting from escape from a reasonable selected, designed, and constructed repository would be but a small fraction of normal background exposure as well as being far below the 40 CFR Part 190 standard or 25 mrem/yr.

(3) We believe that although compliance with the requirements of the proposed regulation can be accomplished, it would be at a cost increase which would be shown to be unwarranted if NRC had done the usual cost/benefit analysis.

(4) Licensing under these proposed criteria would require that DOE provide absolutely zero release -- not one atom. This is virtually an impossible task, and would lead inevitably to lengthy licensing delays.

(5) Adoption of the proposed regulation would increase the misconception of many who incorrectly perceive nuclear waste to be much more hazardous than a number of frequently encountered and accepted non-radioactive toxic materials.

Staff Response to Comment No. 389:

See Overview, Sections 2.1 and 2.5, Single vs. Multiple Performance Standards and ALARA, as well as the Section-by-Section Analysis, §60.113.

Zero release from the waste package is not required. (See Overview, Sections 3.4 and 5.4, Containment and Reasonable Assurance and also Section 60.113.) For the bases of the numerical criteria see the rationale document. With respect to the five numbered points:

1. The radiological protection standard underlying the technical criteria is expected to be published by EPA. The relationship between the numerical criteria and the assumed EPA standard considered by the staff is analyzed in the rationale document (Part C).

2. The EPA Fuel Cycle standard, 40 CFR 190, is not applicable to disposal of HLW. The draft EPA standard considered by the NRC staff in the rationale document is not based on dose to the maximum individual, but limits cumulative release to the accessible environment over 10,000 years. In

light of the time periods involved in disposal of HLW, the Commission considered it reasonable to request comment on application of ALARA to design the engineered barrier system. (See Overview, Section 2.5, ALARA.)

3. For the commenters point with respect to cost, see response to Comment Nos. 379 and 401 and the rationale document.

4. Again, zero release is not required. See response to Comment No. 379.

5. On the contrary, the NRC staff considers that adoption of the final rule will increase public confidence that HLW is being disposed of safely.

Comment No. 390: C. Walske, Atomic Industrial Forum (50)

The proposed rule specifies containment of all radionuclides for the waste package for a period of 1,000 years following permanent closure of the repository; and, after the first 1,000 years, an annual release rate of not more than one part in 100,000 of the inventory of any radionuclide present. The NRC staff has failed to justify these requirements either by modeling or by other calculational techniques. Therefore, these performance criteria should only be used as guides.

Staff Response to Comment No. 390:

See Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Comment No. 391: UK Atomic Energy Authority (29)

We are doubtful about specifying 1000 year transit time.

Staff Response to Comment No. 391:

See Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Comment No. 392: Union of Concerned Scientists (59)

The performance objectives governing control of releases (paragraph (b)(2)(ii) of section 60.111) do not specifically stipulate that the underground facility should be assumed to be saturated. That stipulation should be included.

Release requirements should be applied to all radionuclides. The proposed exemption for radionuclides contributing less than 0.1% of annual release should be removed.

The proposed release objectives do not address the capacity of the underground facility to inhibit releases if waste packages fail during the first 1,000 years. Requirements for inhibition of such releases should be included in this rule.

Staff Response to Comment No. 392:

The staff agrees that the underground facility should be considered to be resaturated. The final rule requires that both partial and complete filling of available void spaces with groundwater be taken into account for disposal in the saturated zone.

Radionuclides which contribute less than 0.1% to annual releases are exhibiting annual release rates of less than one part in 10^8 of the inventory of the repository at 1000 years. The staff considers that such releases do not constitute a sufficient risk to public health and safety to justify the extremely difficult and complex testing needed to demonstrate compliance since, in any case, compliance with the EPA standard for releases to the environment will also be required.

It is anticipated that some waste packages may fail during the first 1000 years. Should this occur, the underground facility must inhibit releases to the extent necessary to meet the 1 part in 100,000 performance objective. Thus, the rule does address the inhibition capacity of the underground facility.

Comment No. 393: H. Ross (14)

60.111 (b)(2)(ii)(A) Control of Releases

The one part in 100,000 release requirement for the engineered system again will be impossible to verify and ignores the positive features of a good geologic site to contain or delay transport of radionuclides. The requirement as stated requires engineering overkill for a single component of the system which will be unnecessarily costly and still impossible to verify. Sorption, long travel paths, and dilution all tend to offset the effects of release from the engineered system.

The combined engineering barriers and geologic setting should be considered as an interactive system, and long term performance requirements should apply to the system rather than its individual components.

Staff Response to Comment No. 393:

See Overview, Sections 2.1 and 5.4, Single vs. Multiple Performance Standards and Reasonable Assurance, respectively.

Comment No. 394: Institute of Electrical and Electronics Engineers (28)

Use of the systems approach in evaluating repository performance is recommended on page 35281, column 3. Multiple barriers are a feature of the system. Yet, in Section 60.111(b), each barrier is generally required to provide total performance capability for the system, independent of the performance of the other barriers. We do not consider this to be a systems approach, but rather a "defense-in-depth" approach. A systems approach is recommended by these reviewers.

Staff Response to Comment No. 394:

Contrary to the comment, total performance capability is not required to be provided by each barrier. See Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 395: H. Ross (14)

60.111(b)(2)(i) Containment of Wastes

The 1,000 year containment period for the waste packages is arbitrary and will be impossible to prove. The behavior to this length of time must be a numerical projection including some site specific uncertainty. The term 1,000 years after closure could mean 1,110 years for the first waste package emplaced and 1,001 years for the last waste package. A 1,000 year requirement for the waste package is unnecessarily long in view of the long term isolation provided by any acceptable geologic site. The engineering overkill required to meet a 1,000 year waste package containment will result in unnecessarily costly waste packages and may place other unnecessary requirements on handling facilities. A minimum containment period would include packaging, shipping, emplacement, and retrieval times, perhaps a total of 100 to 200 years. A design goal of twice this would be more appropriate.

Staff Response to Comment No. 395:

See Overview, Section 2.1, Single vs. Multiple Performance Standards and Section-by-Section, Analysis, § 60.113.

Comment No. 396: American Nuclear Society (20)

Section 60.111(b)(2)(i) requires that the waste packages contain all* radionuclides for the first 1,000 years after permanent closure.

NRC claims that the basis for the choice of 1,000 years is mainly that the heat induced by the waste in the geologic medium will increase the waste package leachability and reduce the near-field transport time, with the net result that the radiological source term from the "disturbed zone" increases. NRC does not argue that the 1,000-year containment period is necessary to reduce the overall radiological release to man's environment to an acceptable level.

It is agreed that the postulated release from the underground facility would be accelerated due to resulting higher temperatures in the geologic medium but, generally, the calculational models used do not take credit for any holdup or delay of radionuclides in the region of relatively higher temperatures. Rather, the radiological source term for the farfield transport models are derived directly from the waste package release rate as if the heated geologic medium region or "disturbed zone" did not exist. Thus, any acceleration of release from the underground facility due to temperature effects has already been discounted and, therefore, should not be used to penalize the waste package design.

Furthermore, heat or high temperature does not make waste-package containment more necessary, only more difficult to achieve. The waste-package containment requirement during any period should be based on the acceptable release quantity during that period, not on changes in nearby or adjacent conditions. A relatively higher temperature environment and the presence of water in a repository will make the waste package more difficult to design, but these factors should not influence the required waste-package performance, particularly when no credit is taken for near-field or "disturbed zone" retardation.

In addition, analyses have shown that NRC's stipulated 1,000-year containment period for waste packages or an engineered barrier would not have the suggested effect of supposedly reducing the release of radionuclides via hydrogeologic transport to man's environment. For example, Cloniger, et al.,** have shown that a waste-package containment period between 0 and 100,000 years does not contribute to reducing radiological consequences to man's environment; instead, this reduction is satisfied through the regional geology or natural barriers.

Thus, the 1,000-year containment period results in relatively no benefit for reduction in radionuclide releases, as compared to that for the natural barriers. It should also be noted that NRC's implied "zero leakage" criterion in the proposed 1,000-year containment period is impossible to prove.

Using somewhat different models, an almost identical conclusion is reached by Pigford, et al.*** Their results indicate that in varying waste package containment times from 1 to 10,000 years makes no difference to release rates for a spectrum of important long-lived isotopes.

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*The use of "all" could be interpreted that no waste package failure could be allowed in 1,000 years. Using probabilistic design analyses, it must always be concluded that some chance of failure exists. Consequently, percent of failure allowed must be defined if any fixed life is to be required for the waste package. Therefore, the proposed wording is unrealistic.

**M.O. Cloniger, et al., An Analysis on the Use of Engineered Barriers for Geologic Isolation of Spent Fuel in a Reference Salt Site Repository, PNL-3356 (December 1980).

***F. H. Pigford, et al., Migration of Radionuclides Through Sorbing Media, Analytical Solution, - II, LBL-11616, UC-70 Vol. 1 (October 1980).

For the above reasons, the 1,000-year containment period by engineered barriers provides no added safety and is unsupported by scientific evidence.

Staff Response to Comment No. 396:

See Overview, Section 2.1, Single vs. Multiple Performance Standards; Part C, Rationale for the Performance Objectives in 10 CFR Part 60, and staff response to Comment No. 379; also, Overview, Section 3.4, Containment, for use of the word "all."

Comment No. 397: S. J. Goodman (3)

The provision which calls for a guaranteed 1000 year containment period is grotesquely inadequate. Toxins like plutonium 239 remain dangerous for more than 250,000 years. Toxins like iodine 129 remain dangerous for 160 million years. This is considerably longer than 1000 years.

The radioactive containment should be held to much better than one part in 100,000 since even this small amount of release would still have a very serious health impact due to the astronomical amounts of radioactivity produced by the nuclear power program and the weapons effort.

The omission of any mention of population related requirements needs clarification, as does the proposed rule which allows the DOE to pick a geologically unfit site if conditions can be "remedied."

Staff Response to Comment No. 397:

Chapter II of the rationale document (Part C) contains a discussion of the hazards associated with HLW in either the form of spent fuel or the residue from reprocessed spent fuel. As shown in Chapters VII and VIII of that appendix, the commenter is correct that containment of HLW for 1,000 years alone or limitation of release rates to one part in 100,000 per year alone provides insufficient protection for the public. However, Chapters VII and VIII also show that these objectives, which apply to the engineered barrier system, when added to the requirements for the geologic setting, will substantially enhance confidence that the assumed EPA standard will be met.

The commenter's concerns would be more appropriately addressed to EPA to the extent that they involve establishment of acceptable levels of radioactivity in the environment.

See also, Overview, Section 2.4, Population-Related Siting Criteria and staff response to Comment No. 297.

Comment No. 398: Dr. Roy (52)

I believe that the rule is overly cautious in not permitting any credit for the linear sum of containment and isolation especially for fission product ions. Surely as long as no nuclides reach the biosphere in 1000 years it is enough. Risk analysis on catastropic repository failure can be factored in, but credit for the adsorption and isolation should not be excluded.

Staff Response to Comment No. 398:

The staff did not intend to deny credit for the combination of containment and isolation, nor to exclude credit for adsorption or isolation. The staff does consider that during the period when radiation and thermal conditions in the underground facility are dominated by fission product decay, containment of HLW should be substantially complete. This action protects the waste from groundwater contact until the temperature and radiation levels have decreased to the point where technically supportable predictions of radionuclide releases to the host rock can be made, and serves to mitigate the consequences of unanticipated failures of other components of the repository. The specific methods by which the DOE accomplishes this containment are left to its discretion.

Comment No. 399: Div. of Emergency Govt., State of Wisconsin (77)

Page 35281 - Containment and isolation, 2nd Paragraph - A requirement providing for a thousand years of waste package containment is commendable, although it may not be feasible. Two recent Science articles indicate that if the waste is incorporated into glass, the leach rates are likely to increase substantially past 2,000 years due to a-recoil effects (J. C. Dran, M. Maurette and J. C. Petit (1980) Science 209 1520-22). Existing knowledge coupled with computer models cannot accurately predict events for that time period. Thus, technical criteria cannot be required, but can only be established given best estimates of known factors. Either a shorter period of engineered protecton or more study is needed.

Staff Response to Comment No. 399:

See Overview, Section 5.4, Reasonable Assurance.

Comment No. 400: Institute of Electrical and Electronics Engineers (28)

The rationale for the 1,000-year period (as opposed to say, a 500-year period or a 10,000-year period) should have been summarized in the Supplementary Information.

The 1,000-year requirement for waste package integrity would probably be unduly restricted in cases where engineered barriers are available and/or groundwater travel times are longer than 1,000 years. In addition, it may be prohibitively difficult and expensive to fabricate waste packages that will remain intact for 1,000 years, and impossible to provide assurance that the requirement will be met.

The severe requirement for waste-package performance may result in the use of expensive materials as containers. These containers may represent a large mineral or precious metal deposit. Such a concentration of valuable materials could lead to the potential mining of the repository in the distant future, counteracting the intent of the regulations to protect future generations.

Staff Response to Comment No. 400:

See Overview, Section 2.1, Single vs. Multiple Performance Standards; also, Section 2.6, Human Intrusion, on resource value of emplaced waste.

Comment No. 401: T. H. Pigford (53)

1. NRC's Proposal

NRC proposes that the maximum annual release of any radionuclide after 1,000 yr from the engineered system, which includes the waste package and backfill, be at most one part in 100,000 of the maximum amount of that radionuclide calculated to be present in the underground facility (assuming no release from the underground facility) at any time after 1,000 yr following permanent closure. Taken literally, this means at any and all times after the 1,000 yr period.

2. Effect of Release Rate Upon Long-Term Performance

NRC refers to overall performance analyses[5,6,7] of conceptual repositories, which include parametric studies of the effect of release rate upon long-term performance. These analyses include projections to millions of years. NRC's release rate requirement is not supported by the results of these and more detailed parametric studies[12,13] for groundwater transport, which show that for

[5]H. C. Burkholder, "Management Perspectives for Nuclear Fuel Cycle Wastes," Nuclear Waste Management and Transportation Quarterly Report, Jan.-Mar., 1976, Battelle Pacific Northwest Laboratories, Richland, WA.

[6]M. O. Cloninger, "A Perspective Analysis on the Use of Engineered Barriers for Geologic Isolation of Spent Fuel," Proc. NWTS Info. Mtg., Oct. 30 - Nov. 1, 1979.

[7]U.S. Department of Energy, Draft Environmental Impact Statement on the Management of Commercially Generated Radioactive Waste, DOE/EIS-0046-D, 1979.

[12]H. C. Burkholder, M. D. Cloninger, D. A. Baker, G. Jansen, "Incentives for Partitioning High-Level Waste," Nucl. Tech.: 31, 202-217, November, 1976.

[13]M. O. Cloninger, C. R. Cole, J. F. Washburn, "An Analysis on the Use of Engineered Barriers for Geologic Isolation of Spent Fuel in a Reference Salts Site Repository," PNL-3356, December, 1980.

some typical sites the calculated future radiation doses to the maximally exposed individual from long-term releases to the environment are insensitive to the release rate from the waste package, for fractional release rates in the range of 10^{-3} to 10^{-5}/yr.

This insensitivity to release rate via groundwater transport occurs because of the contribution of radium-226 to the radiation dose. Radium-226 is not initially present in the waste but grows slowly from the decay of the long-lived precursors uranium-234, uranium-238, and thorium-230. A slow fractional rate of dissolution of the waste material allows greater amounts of thorium-230 to build up in the waste before the waste is all dissolved. This buildup, together with a "reconcentration effect"[30] due to simultaneous arrival of radium-226 at a discharge location from earlier decays of a broad band of absorbed thorium-230, results in the long-term radiation dose varying little with fractional release rate over the range indicated above and for the ranges of other parameters considered in the analyses.

3. NRC's assumption of demonstrated technology and cost

In discussing other possible numerical values for the release rate from the engineered system, NRC rejects the more stringent release rate of 10^{-1}/yr on the grounds (a) that DOE has not yet demonstrated whether such a release rate is achievable and (b) that the costs for a waste package with such a low release rate are very uncertain. At the other extreme, NRC rejects borosilicate glasses in current DOE programs as insufficient because of too high a release rate estimated by NRC to be in the range of 10^{-2} to 10^{-3}/yr. For materials to meet its 10^{-5}/yr release-rate criterion, NRC proposes nepheline syenite glasses, ceramic and composite materials, and clay backfill. However, there are not sufficient data on these materials proposed by NRC to meet NRC's requirements of demonstrated technology and reasonable cost. In fact, the technologies have not been developed, and the costs are not known.

4. Uncertain extrapolation from laboratory data

We question the validity of NRC's prediction of a long-term fractional release rate for any of these materials in a repository on the basis of existing laboratory data. NRC has adopted laboratory leach data, expressed as dissolution rate per unit surface area and based largely upon 30-day experiments, and has multiplied by the surface-to-mass ratio for repository waste to obtain a fractional leach rate assumed to be applicable to the long-term fractional release of all the important radionuclides contained in the waste packages emplaced in a repository. Members of the Waste Isolation System Panel of the National Research Council, who have reviewed the current knowledge for predicting long-term performance of wastes in a repository, have concluded that such extrapolation of laboratory leach data for repository performance estimates is not valid. This casts doubt on the validity of NRC's conclusion that the new materials suggested by NRC are necessary and sufficient to achieve a fractional

[30] H. C. Burkholder and M. O. Cloninger, "The Reconcentration Phenomenon of Radionuclide Chain Migration," The American Institute of Chemical Engineers Symposium Series, No. 179, 74, 1978.

release rate of 10^{-5}/yr, and it casts doubt on NRC's conclusion that waste forms under development in current DOE programs, such as borosilicate glass, will not meet NRC's proposed release rate.

5. Can release-rate performance be verified?

Verification of the expected release rate performance, whether at 1,000 to 10,000 yr after emplacement, or whether at millions of years later as would be suggested by NRC's quoted performance analyses, is even more difficult than that of verifying the 1,000-yr containment. The predicted performance depends much upon the local chemistry of the groundwater and upon the long-term failure modes of several of the components of the waste package, and it requires a validated theory of long-term release rate that does not now exist. Until the uncertainty of prediction and verification of waste-package performance is better understood, specification of a fractional release rate as a numerical criterion to be complied with has little meaning.

As has been pointed out before in connection with the 1,000-yr containment criterion, it is likely that not all of the low-release waste packages and backfill will perform as designed, because of statistical imperfections in manufacturing and emplacement. Although some degree of local imperfection will not significantly affect overall performance of the waste isolation system, NRC's release-rate requirement does not seem to allow for such departures from required and expected performance. This is another reason why this NRC requirement is unrealistic and may be impossible to implement.

6. Summary

The numerical specification of a fractional release rate of 10^{-5}/yr is of questionable importance to long-term safety and is proposed without a technical valid basis and with invalid assumptions of existing technology and cost if such a numerical criterion were adopted, compliance could probably not be verified. It would be more appropriate for NRC to state the considerations which may help guide DOE in its development and proof of the waste package as one of the possible barriers that may aid in meeting whatever safety standard that emerge. One of the important considerations is for DOE to continue work on developing a means of predicting the long-term performance of waste packages.

Staff Response to Comment No. 401:

In response to the commenters six numbered comments:

1. The performance objectives of Part 60 will be applied to whatever time period is appropriate to implement the EPA standard in its final form. The assumed standard considered by the staff in its evaluations limits releases over 10,000 years.

2. See response to Comment No. 379. The staff's analyses in the rationale document show that performance is strongly influenced by release rate when the assumed EPA standard is considered as the overall system performance objective.

3. The commenter has incorrectly concluded that NRC has rejected borosilicate glass as a waste form and has proposed nepheline syenite glass as a preferred alternative. The staff considers that the release rate criterion can be satisfied by a combination of various waste forms, absorbent backfill materials and geochemical retardation processes within the underground facility. There are a variety of combinations of materials that DOE could propose that could satisfy this requirement, particularly in light of the provisions for flexibility in the final rule.

4,5. See response to point No. 3. The commenter is correct that prior to licensing, longer term tests of integrated waste package designs and theoretical models for extrapolating test data to long times will be needed. Such information would be required even in the absence of NRC's numerical criteria. Also, the release rate requirement applies to the total engineered barrier system and therefore allows for local variations.

6. The staff's analyses indicate that the release rate requirement is important to overall system performance. (See the rationale document.) Also, for the commenter's concern regarding verification of compliance, see the Overview, Section 5.4, Reasonable Assurance.

Comment No. 402: American Nuclear Society (20)

The Long-Term Release Rate is Unsupported by Analyses and Studies

Section 60.111(b)(2)(ii) requires that the engineered system design shall provide the annual release of any radionuclides not exceeding one part in 10^5 of the waste inventory after 1,000 years. Three alternatives for the criterion for the release rate from the engineered system after the containment period were proposed (see Footnote No. 2, Enclosure J).

"(i) a range of 10^{-3} to 10^{-4}/year, which is typical of leach rates of many borosilicate glasses at low temperature;

(ii) a release rate of 10^{-5}/year;

(iii) a release rate of 10^{-7} year."

Alternative No. (i) states that the borosilicate glass "is expected...to crack into fragments 10 cm on a side." The section goes on to state that the 10^{-5} to 10^{-6} g/cm^2/day leach rates of the glass in conjunction with the expected cracking results "in a range of annual release rates of 10^{-3} to 10^{-4} of the waste inventory." The basis for this conclusion is not clear since the dissolution rate of the waste inventory will depend on waste matrix parameters, groundwater flow rates and properties, local geochemistry characteristics, and local temperature, as well as fragment size and leach rate. Thus, the annual release rate is expected to be a strong function of the repository system design, the selected geologic medium, and local hydrogeologic characteristics.

EPA rationale expressed for leach rates appears to be more appropriate. The leach rates of various waste forms must be cast in the role of contributing to confinement in conjunction with the repository. Borosilicate glass has excellent low leach rates over the long term. NRC-quoted high rates of 10^{-5} gm/cm^2/day are usually for shorter term tests for 90 Sr and 137 Cs leaching, which are likely to be chemically retained in quantity in the near-field or "disturbed zone;" longer term tests with actinides fall in a much lower range of values. The setting of annual release rates would be better handled through the establishment of an overall repository release limit by incorporating this limit in an overall system performance standard.

NRC has chosen the annual release rate of waste of 10^{-5}/year as the long-term performance objectives for the engineered system or barriers. In arriving at this number, NRC argues that a larger number, such as 10^{-3}/year, would require relying almost entirely on the geology and the far-field geochemistry while the selected number of 10^{-5}/year would contribute to reducing doses and substantially reduce reliance on geochemical retardation. This argument is provided without reference to supporting analyses or studies.

As an example, the preceding argument by NRC is contrary to an analysis by Cloniger, et al. (see Footnote No. 3) who concludes:

> "While the need for and the effectiveness of a release rate limiting barrier function is somewhat dependent on the sorption properties of the geologic media, generally a release rate of less than 10^{-3} yr^{-1} (fractional) is necessary to reduce the potential dose from 14C, 99Tc, and 129I to a baseline level below that of the actinides. Beyond that, a release rate of less than 10^{-5} yr^{-1} is required before the potential dose from the actinide chain members in time and space, due to their different sorption properties and the characteristics of the groundwater flow field, has the same effect as a release rate reduction of between 10^{-5} to 10^{-6} yr^{-1}.

Only in extreme cases of the intrusion water well scenario is there a direct relationship between release rate from the repository and release to the biosphere."

Staff Response to Comment No. 402:

See response to Comment No. 401.

Comment No. 403: C. Walske, Atomic Industrial Forum (50)

Item (ii)(A) Control of releases

> "For HLW the engineered system shall be designed so that, in the time interval from the end of the containment period to 10,000 years following permanent closure, the release rate of radionuclides to the geologic setting, will assure that the repository system performance objective is met. As design guidance, the annual release rate of any radionuclide should be at most one part in * of the maximum amount of that radionuclide calculated to be present in the waste deposited** in the underground facility (assuming no release from the underground facility) at any time during the specified time interval, unless it is established that an acceptable level of geologic repository system performance can be achieved with a higher release rate. The design basis release rate shall be evaluated on the basis of anticipated processes and events and the assumption that all available void spaces in the underground facility, following permanent closure, are filled with groundwater. This evaluation need not consider unlikely processes and events nor radionuclides that constitute less than 0.1% of the total inventory of radionuclides predicted to be present in the waste at the end of the containment period."

Staff Response to Comment No. 403:

The NRC will apply the EPA standard to whatever interval the EPA finally establishes. It would not be appropriate for our rule to specify an interval, but we have used 10,000 years in our analyses. The flexibility provision added to this performance objective in the final rule accomplishes substantially the same objective as the wording suggested in this comment.

*To be established by the NRC on the basis that the release rate (designated in the 7/8/81 draft rule as one part in 100,000) provides confidence that the overall system performance objective will be met.

**Control of releases should be limited to those from the wastes alone. As it is presently written, the language could be interpreted to include radionuclides naturally occurring in the medium.

Comment No. 404 B. Houston, Hamilton & Assoc. for The American Ceramic Society (75)

A requirement of the engineered facility to have a release rate of no greater than one part to 10^5 may have some merit. However, it is not clear, from what we have read (e.g., PNL-3356) that there is a significant difference in risk with low release rate packages to justify the requirement. It will also be technically difficult to demonstrate that after 1000 years of storage a waste package will have the desired behavior.

It also seems technically inappropriate to require that the waste packages have increased durability with time. The increasing durability with time results from the requirement that the release be 10^{-5}/year based on the presence of the isotopes at that time. It would be much easier to demonstrate that the release was 10^{-5}/year based on the amount present at 1000 years (or 500 years). This would allow durability to decrease with radioactivity and provide a constant risk, rather than a declining risk.

Staff Response to Comment No. 404:

The release rate performance objective applies to the underground facility and not, as suggested by the comment, to the waste package. Neither the proposed rule nor the final rule based the release rate on the inventory at the time of release. It should be noted, however, that in the final rule the inventory at 1,000 years is used as a reference, and provisions have been incorporated for approval of an alternative release rate by the Commission.

Comment No. 405: Capital-Area Groundwater Conservation Commission (22)

Section 60.111(b)(ii) A and B. In regard to a 1 to 10^5 part release rate, the fallibility of man and the unpredictability of nature and man's activities may consider this release rate to be unacceptable. However, if nuclear physicists can assure that the risk, if any, will be minimal and that the rate of release will not endanger the biosphere and geosphere, then the release should be satisfactory.

Staff Response to Comment No. 405:

See Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Comment No. 406: Dr. Roy (52)

Comment on "Control of Releases" (60.11, b(2) ii)

I appreciate the fact that it is extremely difficult to word such regulations. The annual release of 10^{-5} of the total α-radionuclide content strikes me as awkward.

Can this be attained by the technologies available now or likely to be developed in the next 50 years - the minimum time we have? On the basis of very extensive research in our laboratories such levels could be attained in partitioned wastes with present technology. That is not the most significant question. The technology can, with increased costs, simply add layers of protection of many kinds. For example, the Belgian Pamela process (glass beads in a lead matrix) would certainly add some orders of magnitude of actinide insolubility to any waste package if substituted for bulk glass. But is it worth it? Why not put the funds saved by going to a much more cost effective technology - grouting or in-can solidification in a cement matrix composite - in improving other parts of the N-waste or hazardous waste, or radiation hazards, threats to health.

Staff Response to Comment No. 406:

For the reason stated in Part C, the staff considers a 10^{-5} annual release rate, with allowance for flexibility on a case-by-case basis, to be appropriate as a means of achieving the overall system performance objective. The staff is not prescribing any particular technology by the requirements of the regulations.

Comment No. 407: California Department of Conservation (62)

CDC recommends the following changes to the proposed rules:

1. Subsection 60.111(b)(2)(ii)(A): Control of releases

   "(A) For HLW, the engineered system shall be designed with sufficient redundancies and with probabilistic failure analysis using the worst-case scenario so that, after the first 1,000 years following permanent closure, the annual release rate of any radionuclide from the engineered system into the geologic setting, assuming anticipated processes and events, is will be at most one part in 100,000 of the maximum amount of that radionuclide calculated to be present in the underground facility (assuming no release from the underground facility) at any time after 1,000 years following permanent closure..."

2. Subsection 60.11(b)(3)(i): Containment Period

   "(i) Containment period. During the containment period, the geoloic setting shall mitigate the impacts of the worst-case scenario including a complete premature failure of the containment barriers provided by the engineered system. The ability of the geologic setting to isolate wastes during the isolation period, in accordance with paragraph (b)(3)(ii) of this section, shall be deemed to satisfy this requirement."

Staff Response to Comment No. 407:

See Overview, Sections 3.1 and 5.4, Anticipated/Unanticipated Processes and Events and Reasonable Assurance, respectively.

Comment No. 408: Louisiana Dept. of Natural Resources (63)

Section 60.11(b)(ii)A and B. In regards to a 1 to 10^5 part release rate, the fallibility of man and the unpredictability of nature and man's activities many consider this release to be unacceptable. However, if nuclear physicists can assure that the risk, if any, will be minimal and that the rate of release will not endanger the biosphere and geosphere, then the release should be satisfactory.

Staff Response to Comment No. 408:

See Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Comment No. 409: Institute of Electrical and Electronics Engineers (28)

The rationale for limiting the annual release to one part in 100,000 (as opposed to 10,000 or 1,000,000) should have been summarized in the Supplementary Information.

Use of the release-fraction approach allows a large repository to release a larger quantity of radionuclides than could a smaller repository. Other factors being equal, a larger radiological dose would result. No justification is given for this approach. Since the initial inventory is not considered, the criterion could lead to either safe or unsafe conditions, depending on the inventory.

The wording that involves specifying an "annual release rate" but "assuming no release from the underground facility" needs to be clarified.

The release fraction of 10^{-5} per year could be either higher or lower than the corresponding value derived from 40 CFR 191, Draft No. 19, page 43, depending on the radionuclide.

As written, the limiting release fraction applies to each major radionuclide, regardless of radiotoxicity. Consideration should be given to the use of different limits for different radionuclides, as is being done by the EPA. Release of a certain fraction of the tritium inventory is one thing, but release of the same inventory fraction of plutonium may be entirely another matter.

Staff Response to Comment No. 409:

The assumed EPA standard would establish limits for radioactivity in the accessible environment that would be directly proportional to the amount of specified radionuclides placed in the repository. The approach in the NRC regulation, which would allow a larger release from a larger repository, is, therefore, consistent with the assumed EPA standard.

The phrase "assuming no release from the underground facility" no longer appears in the rule.

See Part C, relative to meeting values in the assumed EPA standard.

Comment No. 410: U.S. Department of the Interior (24)

The rule, as presently written, requires that after the 1,000-year containment period the rate of release of major nuclides from the engineered system into the geologic setting be no higher than 1 part in 100,000 per year. Slow release rates coupled with natural dispersion and retardation would reduce the concentration and spread out a stream of radionuclides travelling to the biosphere so that any discharges to the biosphere would be below acceptable limits. A performance objective related to release rates is particularly important with respect to the actinides, especially plutonium, americium, and neptunium. DeMarsily and others (1977) showed that the release rate is important in controlling the discharge of plutonium to the biosphere in a system in which the plutonium moved at the same velocity as the ground water and the flow path was short. Considerable evidence suggests that plutonium and its compounds are relatively insoluble and that transport of plutonium species would be retarded in most ground-water environments (e.g., Isherwood, 1981). The geochemistry of plutonium in relation to actual ground-water systems is not well known, however, and a low release rate as required by the rule appears to be necessary to overcome uncertainties related to actinide geochemistry. An environment which provides a very long flow path or one in which the retardation of the actinides can be well established might permit a higher release rate.

We do not believe that an annual release of 1 part in 100,000 from the engineered system should be especially difficult to achieve under low temperature conditions. A succession of barriers to release could include: a host rock with low water content, low permeability and low hydraulic gradients; backfill around waste packages to inhibit water access to the waste package and sorb any released radionuclides, a waste package that will not degrade suddenly; and a waste form of low leachability. We also note that most credible scenarios for the evolution of the repository would not lead to simultaneous failure by all waste canisters.

Staff Response to Comment No. 410:

No response necessary.

Comment No. 411: U.S. Department of the Interior (24)

The performance objective for the waste package has generated some of the most heated discussion as to necessity and feasibility. Cloninger and others (1980) have produced models implying that the longevity of the waste package has very little influence on the long-term risk unless the package lasts for a million years or more. The present rule requires reasonable assurance that the wastes will remain contained within the waste package for at least 1,000 years following closure of the repository. Some level of early containment of the waste

is clearly needed to provide protection against possible short-circuiting of the natural ground-water flow system by new or unknown fractures, improperly plugged shafts and boreholes, or inadvertent human activities that might disturb the geologic system during the time when the wastes are most hazardous and uncertainties over thermal effects the greatest. Such protection could be provided by the waste containment objective stated by DOE in the Confidence Rulemaking Proceeding (DOE, 1980):

> "Waste containment within the immediate vicinity of initial placement should be virtually complete during the period when radiation and thermal output are dominated by fission product decay. Any loss of containment should be a gradual process which results in very small fractional waste inventory release rates extending over very long release times, i.e., catastrophic losses of containment should not occur" (p. II-7).

NRC is proposing a more specific period of waste containment of 1,000 years to prevent interactions between the waste and its immediate environment during the period when temperatures in the repository are above ambient. Geochemical models needed to predict the course of such interactions at elevated temperatures are only in the early stages of development (Worlery, 1980; Jenne, 1981). In addition, thermomechnical effects on the hydraulic conductivity of the host rock are highly uncertain during the period of elevated temperatures. A waste package that provides containment for 1,000 years--the duration of the thermal pulse--is therefore highly desirable but need not be required if other compensating conditions are present. One of the conditions under which a shorter lifetime might be allowable is cooler waste--either through aging or dilution of the waste or lowered thermal loading of the repository. An environment in which the ground-water flow time is confidently predicted to be 10^5 years or longer and in which disruptive events will in all likelihood not alter the flow time might also accommodate a waste package with a shorter lifetime. Furthermore, it is possible that over the next several years understanding of the geochemical system and advances in overpack and back-filling technology will increase to the point where a high degree of confidence will exist that releases from the waste package will be very slow, even at elevated temperatures.

Staff Response to Comment No. 411:

The revised performance objectives have incorporated much of the substance of this comment. See Overview, Section-by-Section Analysis, §60.113; and Section 2.1, Single vs. Multiple Performance Standards. See also, Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Comment No. 412: B. Houston, Hamilton & Assoc. for The American Ceramic Society (75)

We wish to commend the Nuclear Regulatory Commission for developing and publishing a proposed rule for nuclear waste disposal. The rule provides guidelines to those involved in waste management so that they may focus their attention and development on specific areas. This rule allows acceptability to be defined and establishes limits on the continually increasing need for "better" performance. The rule is comprehensive in that it addresses all major technical areas.

There are, however, some specific values and requirements which we feel should be modified.

First, the use of a 1000 year requirement for the barrier lifetime. One-thousand-years does not appear to correlate to any signficant change in the waste toxicity or other characteristics. There is, however, a major decrease in toxicity as Cs^{137} and Sr^{90} decay in the waste. This is in the 300-500 year time frame and a limit of 500 years would appear to be adequate and more technically defensible. Engineering designs will be conservatively based and may well use a 1000 year basis to meet a 500 year requirement. The requirement for 1000 year containment will greatly increase the cost and complexity of the engineered system.

Staff Response to Comment No. 412:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See also, Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Comment No. 413: B. Houston, Hamilton & Assoc. for The American Ceramic Society (75)

The requirement of sealed packages may create future problems. Some potential types of TRU and HLW wastes may, when considering time periods over a 100 year period, generate significant pressures within a container, from helium buildup in the case of LMFBR or recycled wastes, and from radiolysis in the case of water containing (e.g., cast cement) waste forms. Allowing a slow release could be beneficial without compromising integrity.

Staff Response to Comment No. 413:

All references to TRU waste have been deleted from the rule. Further, the definition of "waste package" no longer states that the waste package must be a sealed container. See Overview, Section-by-Section Analysis, §60.2, Definitions, "Waste Package."

Comment No. 414: Dr. Roy (52)

I believe the 10 CFR 60 rule is moving in the right direction, as compared to many earlier attempts to assure the maintenance of radionuclide levels below the EPA standards. The principal novelty in 10 CFR 60 is the dual reliance on:

(a) The waste package (= containment)
(b) The geologic isolation system (= isolation)
instead of exclusive reliance on the latter. The argument developed in the text (p. 35281, col. 3) that the waste package performance is more easily measured and guaranteed is very sound. The issue of what the precise wording (p. 35289, col. 2) ... "the waste packages will contain all radionuclides for at least the first 1000 years ... after permanent closure..." means, needs to be clarified. I have two comments on this:

a) There can, in principle, be no such thing as zero release of anything. Hence it would be better to provide some reasonable numerical or percentage limit.

b) Up to now there has been so little measurement of the total waste package effectiveness in retaining radionuclides that no one - DOE, NRC, or EPA - could possibly know whether these are reasonable or unreasonable limits.

The enormous DOE and smaller but regrettably parallel NRC effort in "leach testing" of waste forms is, of course, totally irrelevant to determining this value - release of radionuclides from the waste package. The rationale for any waste form-in-water evaluation has never been publicly presented mainly because it has never been clearly thought about. I append hereto one document relevant to the issue on how to evaluate waste packages and the danger of continuing leach tests. I note as additional evidence of the community swing to this view, that when I again presented by critique of the leach test concept at the Julich meeting in June 1981, the French and Belgian groups went much further than I, in criticizing the continued use of these absurd tests.

Can a well designed waste package "contain all radionuclides" for 1000 years in a water saturated repository? No one knows. It is my opinion many systems will be able to meet these specifications, provided that no catastrophic tectonic activity is around which could shear through the canister, and admit large volumes of flowing water. In a static water saturated repository with minor leaks in canister, etc. using a metal or concrete matrix waste form, a titanium canister, a cold Cs-Sr doped overpack in compacted clay or concrete, at a repository thermal limit of 250°C and 200 bars pH_2O, one can estimate that essentially all radionuclides will be contained within the package.

Since it will be at least 50 years before any commercial waste repository starts to function, DOE R&D on the waste package can reasonably be expected to meet these specifications. Furthermore, since so little research has been supported as compared to engineering, step function innovation is possible, indeed highly likely.

Staff Response to Comment No. 414:

The containment objective has been revised so that containment of radionuclides is "substantially complete." The staff, of course, agrees with the commenter's emphasis on the need for both containment and isolation. The staff, further believes that the performance objectives as a whole are consistent with the arguments the commenter has presented.

Comment No. 415: J. Hamstra, Netherlands Energy Research Foundation (6)

The proposed rules state the requirement that the engineered system is to be designed so that the wastes are contained within the waste package for the first thousand years following emplacement bottom (third column page 35281). The restrictive containment or confinement of the radioactive waste to its waste package is an irrational requirement. The boundary of confinement can easily be shifted more outward without any consequence from the point of view of radiologial hazard to man and his environment. As said before it is the overall system that should be considered in realizing a confinement within a boundary that clearly defines the radionuclides to remain outside the biosphere for at least 1000 years. Following this period the function of the overall system is to provide the required isolation, in that the return of waste nuclides into man's environment should be limited, in amounts and concentration, to prescribed acceptable levels.

Staff Response to Comment No. 415:

See Overview, Section 2.1, Single vs. Multiple Performance Standards; also, Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Comment No. 416: P. C. Cahill, U.S. EPA (68)

Although we strongly support the multiple barrier approach we think that the 1000 year waste package requirement may be excessive. Studies published by the Electric Power Research Institute (EPRI) and confirmed by EPA indicate that in almost all situations improvements in canister life are less important for reducing long-term risks than improvements in waste form or careful selection of site characteristics. If the waste package lasted only a few hundred years, it would guard against uncertainties during the period of greatest heat generation; however, the 1000-year-life requirement for the waste package could necessitate the use of very expensive or exotic materials (such as titanium) for waste canisters. The supporting documentation for the rule does not consider the potential cost of this requirement. In light of the relatively small benefits and possible high cost, we believe the Commission should reexamine this requirement.

Staff Response to Comment No. 416:

See Overview, Section 2.1, Single vs. Multiple Performance Standards; also, Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

In the final rule, the containment provisions have been modified to require containment for a period of 300 to 1,000 years, with additional provisions for flexibility as the case warrants. For the reasons described in Part C, the

staff considers the performance objectives to be appropriate and necessary measures that must be taken in order for the Commission to be able to determine, with reasonable assurance, that the assumed EPA standard will be achieved.

Comment No. 417: P. Sgriznoli (7)

High-Level Radioactive Waste Storage for 1000 years

Relative to the above, I understand there is a proposed rule as above; and in the interim it can be excavated for certain reasons.

The existence of radioactive waste for any amount of years in any part of the U.S. is dangerous beyond belief but for a proposed 1000 years is a very short time in lieu of the apparent real-life age.

I would like my opposition to be known to you.

Staff Response to Comment No. 417:

This commenter is apparently concerned that radioactive wastes remain hazardous for more than 1000 years, and that a 1000-year containment performance objective may not be sufficient. Part C, Rationale for the Performance Objectives in 10 CFR Part 60, which accompanies the final rule discusses the hazard of high-level wastes over time and presents the NRC's analyses in support of the performance objectives. The commenter should also take into account the requirements for isolation which would apply beyond the containment period.

Comment No. 418: D. Farris, Economic Survival Training (8)

I am writing about the proposed rule that high level radioactive waste be packaged for storage so that leakage is prevented for the first 1000 years.

I am in favor of at least this much precaution and any other measures to ensure our safety and that of future generations.

Staff Response to Comment No. 418:

This commenter is apparently concerned that radioactive wastes remain hazardous for more than 1000 years, and that a 1000-year containment performance objective may not be sufficient. Part C, Rationale for the Performance Objectives in 10 CFR Part 60, which accompanies the final rule discusses the hazard of high-level wastes over time and presents the NRC's analyses in support of the

performance objectives. The commenter should also take into account the requirements for isolation which would apply beyond the containment period.

Comment No. 419: R. A. Van Konynenburg, Lawrence Livermore Laboratory (15)

The zero-release containment limit as proposed by the Commission is not necessary because more reliance can and should be placed on the other barriers, namely the intrinsic leachability of the waste form itself, and the low flow conditions and ion trapping capacity of the repository and the geologic medium.

In addition, it should be recognized that small releases are not intolerable, in view of the vast inventory of naturally-occuring radionuclides in the earth's crust, the release of which occurs constantly and is not subject to the Commission's regulation.

The containment time proposed by the Commission is not reasonable because the function of the waste package should be to provide containment primarily during handling and shipping, including possible retrieval, not long-term containment.

The zero-release limit is not reasonable because the only way to satisfy such a release limit is by complete reliance on a sealed canister, which would have to remain leak-tight for 1000 years. If, instead, the limit were set at 99% containment, use could be made of the intrinsic resistance to leaching of the waste form itself in satisfying the limit. This is much more reasonable.

Comment No. 420: R. A. Van Konynenburg, Lawrence Livermore Laboratory (15)

Reasonable assurance of complete containment of all radionuclides for 1000 years is not possible for several reasons:

a. The fact that zero is an unmeasureably and impracticably small number to use in specifying the release of material from any real world, engineered system.

b. The fact that the entire known history of most engineering materials which could be considered for application to waste package construction spans less than 100 years, limiting our direct experience of their long-term durability. Metals which are found to exist in their uncombined state in nature (such as gold) must be avoided because of cost and because of their attractiveness for potential plunder.

c. The inability of competent and responsible scientists to confidently extrapolate corrosion experiments of achievable duration to a time period of 1000 years, given the degree of understanding of corrosion phenomena which presently exists. This is particularly true in view of the complex chemical, thermal, fluid flow, and radiation conditions which could prevail in a repository, and which will remain, to some degree, unpredictable.

In view of these considerations, I strongly urge the Commission to reconsider its proposed waste package containment limit, and to adopt a more reasonable and practicable standard, as described herein, which will still provide the

necessary protection to the environment and the public health and safety. I have not dealt with a more fundamental problem of the lack of a "generally applicable standard for radiation in the environment" upon which to base any NRC regulation in this area, since I realize this is not within the Commission's jurisdiction, but it does appear to be an example of "building one's house upon the sand." I would hope that sufficient coordination has been carried out with the Environmental Protection Agency to ensure compatibility with whatever "generally applicable standard" is forthcoming from that agency.

Staff Response to Comment Nos. 419 and 420:

The staff believes that containment should be provided beyond the time of permanent closure. See Part C. Under the final rule, containment need not be absolute, but only substantially complete. The staff does not anticipate that there will be a need to use metals having great intrinsic value.

Comment No. 421: Sierra Club (66)

Limit to radiation releases

The limits to yearly radiation releases are specified in 60.111(b)(2). According to the proposed rule, within the first 1,000 years following closure, the waste package must contain all radionuclides. Following this initial period, the annual release rate can be no more than one part in 100,000 of the radionuclides present at 1,000 years following closure, excluding radionuclides which are present in small quantities. Certain of these excluded radionuclides will produce the largest number of health effects in the long term. They include technetium-99, neptunium-237 and iodine-129. Further, it is not clear, without detailed calculations at specific sites, that this regulation is sufficiently stringent to protect the public health, or whether it would lead to a large number of cancers.

Staff Response to Comment No. 421:

For all radionuclides isolation limits must conform to the EPA standard. Health effects will be considered by EPA in establishing this standard.

Comment No. 422: J. Hamstra, Netherlands Energy Research Foundation (6)

From our safety assessment work for a HLW repository to be mined in a salt dome it was demonstrated that the waste package, once it is emplaced in a sealed disposal borehole, does not contribute to the confinement of the radioactive waste. Once the confinement should be disturbed the isolation of waste nuclides will so dominantly be controlled by other engineered barriers and by the natural barriers that the waste package can not play a role of any importance in the optimization process of overall system improvement. At least for a carefully designed HLW-repository in salt the waste package is therefore not

a key component of the overall engineered system (bottom first column page 35285). Its component requirements derive primarily from the solidification process, the intermediate storage prior to disposal and the handling prior and up to the emplacement of the waste package in the disposal borehole. Its dimensions will have to be a compromise between what the solidification process and what the disposal facility requires.

Depending on its specific fission product content and the intermediate storage time prior to disposal. the diameter of the canister plays an important role in controlling the thermal load on the host rock directly surrounding the emplaced packages.

The length of the waste package will primarily be determined by the limitations from underground handling of these packages in shielded casks.

This lengthy explanation is given to underline that the HLW package is an important engineered component, but that its importance lies elsewhere than meeting the containment and controlled release performance objectives for the overall system.

Staff Response to Comment No. 422:

See Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Comment No. 423: Institute of Electrical and Electronics Engineers (28)

The requirement that annual releases not exceed 10^{-5} of that present 1000 years after decommissioning is probably excessive. At 1000 years after removal from the reactor, HLW is only 10 to 100 times more toxic radiologically than the ore from which it was extracted. A release fraction of 10^{-3} or 10^{-4} would be more appropriate. (The same argument holds for TRU wastes.)

The limiting release rate from the repository should be based on the potential for release to the accessible environment. Without knowledge of the particular geologic environment, it cannot be concluded positively whether the limiting annual release rate is unduly conservative or too lenient.

Staff Response to Comment No. 423:

See Overview, Section 2.1, Single vs. Multiple Performance Standards; also, Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Comment No. 424: Institute of Electrical and Electronics Engineers (28)

Why is the release rate limit for transuranic waste stated as "from the underground facility into the geologic setting," whereas, for HLW, the limit is stated as "from the engineered system into the geologic setting?" The engineered system is the waste packages and the underground facility (page 35285, column 3). If radionuclides escape from the underground facility, have they

not escaped from the waste packages and also (by definition) from the engineered system?

Staff Response to Comment No. 424:

The comment is correct in observing that "engineered system" and "underground facility" had the same meaning in the context of the release rate performance objective. The different terms were used because the draft rule did not require waste packages for TRU wastes in all cases. In the final rule all references to TRU wastes have been deleted, and the release rate performance objective is stated in terms of the "engineered barrier system."

Comment No. 425: V. McIntrye (35)

60.111 Alara Principle

I believe there should be no Alara requirement. NRC should set a minimum standard and leave it at that. Alara means too many things to too many people. If it is retained the supplementary information should explain it with several good examples.

60.111 (b) (3) The time envisioned for the containment and isolation periods ought to be spelled out. Is it 1,000 years for HLW and 0 years for TRU?

60.111 (b) (3) (ii) How long is the engineered system supposed to function? It really isn't clear.

Staff Response to Comment No. 425:

See Overview, Section 2.5, ALARA. These provisions of proposed § 60.111(b)(3) do not appear in the final rule. The engineered barrier system is to function for whatever period of time is necessary to comply with the EPA standard; a period of 10,000 years is considered in the assumed EPA standard described in Part C.

Comment No. 426: C. Walske, Atomic Industrial Forum (50)

We recommend that Item (3) Performance of the geologic setting be changed as follows:

Item (i) Containment period

> "During the containment period, the geologic setting shall mitigate the impacts of postulated but credible failures of components of the engineered system. The ability of the geologic setting to isolate wastes during the isolation period in accordance with paragraph (b)(3)(ii) of this section shall be deemed to satisfy this requirement.

Comment No. 427: C. Walske, Atomic Industrial Forum (50)

Item (ii) Isolation Period

> "During the time interval from the end of the containment period to 10,000 years following permanent closure, the geologic setting shall be capable of inhibiting the transport of radionuclides released from the engineered system into the geologic setting to assure that the overall geologic repository system performance objective is met. The capability of the geologic setting to perform this function shall be evaluated based on the assumption that those processes operating on the site will be those that have been operating on it during the Quaternary Period, with perturbations caused by the presence of the emplaced radioactive waste superimposed thereon."

Staff Response to Comment No. 426 and 427:

The sections referred have been deleted from the final rule. See Overview, Section-by-Section Analysis, §60.113.

Comment No. 428: C. Walske, Atomic Industrial Forum (50)

We recommend that an Item (4) Performance of subsurface facility seals be added as follows:

> "Prior to or at the time of final closure, subsurface openings consisting of shafts, boreholes, and all or part of the underground excavation shall be sealed with a barrier system consisting of an appropriate combination of engineered structures and backfill. The functions of this barrier system are the inhibition of radionuclide transport through the pathway consisting of the interconnected network of subsurface openings with the objective of providing additional assurance that the overall geologic repository system performance objective is met; the inhibition of groundwater movement into and from the underground facility; and, where required, the reduction of creep deformation of the host rock that could adversely affect the performance of the geologic repository. The capability of this barrier system to perform these functions shall be evaluated considering the ambient geochemical and hydrological environments and anticipated changes thereto, anticipated changes in the geologic setting including anticipated rock deformations, and other applicable in-situ conditions."

Staff Response to Comment No. 428:

The design criterion for shaft and borehole seals accomplishes much the same purpose as the wording suggested in this comment although with less detail.

Comment No. 429: U.S. Department of the Interior (24)

Performance Objectives for Multiple Barriers (60.111, 60.112).

As was the case with the Advance Notice of Proposed Rulemaking for 10 CFR Part 60 (Federal Register, May 13, 1980) (letter from Director, USGS, to Secretary, NRC, dated July 10, 1980), we agree with the NRC that performance objectives are needed for each of the three major barriers within the waste isolation system. We recognize that trade-offs among the barriers will be possible and desirable and that DOE should be allowed considerable flexibility in overall system design. Further, a suitable combination of barriers for the system will depend strongly on the specific site chosen for a repository. Analysis of the effectiveness of various barriers, however, will depend strongly on models with inherent uncertainties in the models themselves, in the nature of the geologic and hydrologic environment in which the waste is placed, and in the future evolution of that environment as it interacts with the waste and is subject to natural perturbations. Specifying minimum performance objectives for the three main barriers can overcome these uncertainties to some extent. Redundancy among barriers is particularly important during the period when short-lived fission products (Sr and Cs) dominate the hazard and heat generation is greatest.

The form and wording of the minimum performance objectives are understandably difficult problems for the Commission. Future increases in technical knowledge of waste disposal systems can be expected to reduce the total uncertainty of models somewhat and lead to more cost effective and workable combinations of engineered and natural barriers. For example, efforts in the USGS are under way to find optimum combinations of natural features within one province of the country (Bedinger and Sargent, 1981). For these reasons, we feel that some performance objectives could be modified in the future, dependent on the environment of disposal as long as the governing EPA standard can still be met.

Staff Response to Comment No. 429:

See Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 430: J. L. Cohen (27)

Despite extensive verbage, the performance objectives still seem vague and arbitrary. They provide little definitive guidance to the designer of a disposal facility.

Staff Response to Comment No. 430:

Wording has been added to the performance objectives to clarify the intent in specifying levels of performance for individual barriers, and other wording formerly contained in the rule has been deleted. Part C, Rationale for the Performance Objectives in 10 CFR Part 60, demonstrates the relationship

between the performance objectives and a "working draft" of the EPA standard for overall repository performance.

THE FOLLOWING COMMENTERS ADDRESSED 60.112:

Comment No. 431: Capital-Area Groundwater Conservation Commission (22)

The regulations and the ongoing studies are oriented primarily toward geology and do not place hydrology in the proper perspective. Geology includes structure, stratigraphy, and lithology and provides knowledge of the framework BUT does not provide the needed hydrologic data required in major hydrologic decisions, such as that required in Section 60.112(c)-"the predicted travel time of groundwater." The rate and movement of groundwater are the most important processes relative to the potential impact on the containment of waste and therefore hydrology should be considered a unique discipline that requires equal emphasis in the regulation and in the studies.

Staff Response to Comment No. 431:

The required analyses must thoroughly consider hydrogeologic properties and conditions. See §60.21(c)(1).

Comment No. 432: Capital-Area Groundwater Conservation Commission (22)

Geology provides information on the "makeup of the container," whereas hydrology quantifies the hydrodynamics of the system. Thus, geologic studies alone do not provide information required to estimate the movement of fluids and answer questions pertaining to the rate of movement of radionuclides and water, especially in areas where the host rock is surrounded by saturated materials. Local and regional hydrologic modeling should be the prime prerequisite during the initial phase of a site study because it not only provides information on the effects of hydrologic stresses but indicates data needs and oftentimes indicates geologic unconformities. Unfortunately, the early stages of studies made in the Gulf Coast areas did not include enough emphasis on hydrologic studies. As a consequence, questions related to the interaction of hydrology to the shear zone, the sheath, the fissures in the caprock, the salt, and to the rate and direction of groundwater movement cannot be answered with a slight degree of confidence at this time and probably for some time into the future. Thus NRC proposed regulations should place equal importance on hydrologic studies to prevent omissions during the data-collection phase and provide for multidiscipline activities. Final determinations as to the suitability of a salt dome for radwaste storage will be unnecessarily delayed until the proper hydrologic data are collected and regional and local hydrologic models are started, calibrated, verified, and accepted.

Other subjects that need early consideration in the licensing processes are socioeconomics, archeological, and wildlife.

Staff Response to Comment No. 432:

See response to Comment No. 431.

Environmental factors will be considered by the Commission as required by the National Environmental Policy Act.

Comment No. 433: V. McIntyre (35)

60.112 Required Characteristics of the Geologic Setting

This is not a performance objective and it should not be included with them. I recommend that a separate section should be set up for GEOLOGIC REQUIREMENTS. This section should address TIME, SPACE, and SATURATED vs UNSATURATED MEDIA. The following outline was drawn up with this in mind:

GEOLOGIC REQUIREMENTS
60.... General Requirements
60.... Disposal in saturated media
(a) Requirements
(i) Requirements to be applied to the region
(ii) Requirements to be applied to the disturbed zone

(b) Requirements for the period following permanent closure
(i) Requirements for the period following permanent closure
(ii) Requirements to be applied to the disturbed zone

60.... Disposal in unsaturated media
(same as above)

Staff Response to Comment No. 433:

See Overview, Section-by-Section Analysis, §60.113 which discusses proposed §60.112.

Comment No. 434: Utility Nuclear Waste Management Group (44)

Section 60.112 specifies certain required characteristics of the geologic setting having to do with stability and groundwater travel times. As discussed above in connection with § 60.111 however, it is important that the rule note that a reasonable demonstration of the required characteristics is sufficient, and that a higher level of proof is not required.

Further, the requirement prescribed in § 60.112(c), which limits repositories to locations exhibiting pre-waste emplacement groundwater travel times through the far field to the accessible environment of 1,000 years or more, could be confusing insofar as disposal in media such as salt is concerned. To avoid

possible uncertainty, the 1,000 year groundwater travel time requirement should be worded as follows:

> The geologic repository shall be located so that the travel time of any groundwater flowing between the outermost waste container location and the accessible environment is at least 1,000 years.

Staff Response to Comment No. 434:

See Overview, Section 5.4, Reasonable Assurance, and Section-by-Section Analysis, §60.113. Travel time should be measured from the disturbed zone rather than from the underground facility because of the uncertainties involved in fully evaluating conditions within the disturbed zone.

Comment No. 435: T. H. Pigford (53)

NRC proposes to require that groundwater travel time from the waste to the environment be at least 1,000 yr, determined for conditions prior to waste emplacement. In justification, NRC states that this requirement "...avoids the need to model the thermal effect or the hydrologic system and the geochemical impacts of nuclide transport."

2. Effect on Overall Performance

NRC does not show that a 1,000 yr groundwater travel time is necessary to achieve an overall performance goal. As has already been discussed in Section 9.3, performance analyses[4,5] quoted in NRC's rationale, supplemented by more detailed performance analyses[12,13] and by typical and likely properties for other rock media[14-24], show that future radiation doses to maximally exposed individuals resulting from geohydrologic transport to the environment are relatively insensitive to perturbations in groundwater travel time.

3. Thermally Affected Radionuclide Transport Must Still Be Considered

As discussed in Section 9.4, the thermal effect on the hydrologic system must be considered, regardless of NRC's specification of 1,000 yr for waste containment and water transport to the environment.

4. Can Water Travel Time Be Verified?

NRC concludes that groundwater travel times of 1,000 yr are achievable, and travel times of this magnitude and longer are quoted for many locations potentially suitable for repositories. However, the NRC numerical criterion will present a difficult problem of verification. There is no single, unique water

[4] M. J. Bell (U.S. Nuclear Regulatory Commission), Meeting of Board on Radioactive Waste Management, National Research Council, September 17, 1981.

[See pp. 292-293 for remaining footnote references 5, 12, 13, 14-24.]

travel time for a site, even in the absence of emplaced wastes. The emplacement area will extend over considerable distance, and groundwater flow from the emplacement will follow nonuniform pathways before reaching the accessible environment, reflecting spatially nonuniform potentiometric and transmissivity fields and possible short-circuit pathways through conductive fractures. Each of these pathways can be characterized by its own water travel time, with considerable difference from one pathway to another. If NRC intends to apply its 1,000 yr criterion to that filament of water which arrives first at the environment after contacting the waste, it should so state. NRC should review what is known about the spectrum of water travel times for typical sites. It should consider to what extent localized radionuclide releases along the more direct and rapid pathways to the environment contribute releases that are significant in relation to the overall performance goal.

5. Summary

NRC has not shown need or adequate technical basis for its proposed numerical criterion for water travel time. It would be more appropriate for NRC to state its considerations of water travel time as a contributor to overall safety performance. It would be appropriate for DOE to have the flexibility to select sites with water travel times sufficient so that, in combination with the other properties of the site and of the engineering design, there will be reasonable assurance that a regulatory specified overall performance standard will be achieved.

Staff Response to Comment No. 435:

The rationale document (Part C) for the final rule demonstrates the impact of a 1000-year groundwater travel time on overall repository performance.

The commenter has misunderstood a statement in the NRC's rationale for the proposed rule that indicated that, by applying the requirement for the groundwater travel time to the volume of rock outside the disturbed zone, the need for thermal and geochemical modelling is avoided. Such modelling is avoided only in demonstrating compliance with the groundwater travel time criterion, whereas alternative criteria that the staff considered, such as radionuclide travel time or travel time between the underground facility and the accessible environment, would require more complex modelling to demonstrate compliance. The staff recognizes that thermal and geochemical effects will need to be considered in assessing overall performance.

This comment notes that determination of groundwater travel times is likely to be difficult, and the NRC fully agrees. However, the groundwater flow characteristics will significantly affect the performance of any geologic

repository, and must be well understood prior to any repository performance assessment. The NRC's 1000-year travel time criterion will not significantly affect the hydrologic investigations which must be conducted at a potential repository site. See also Overview, Section-by-Section Analysis, §60.113.

Comment No. 436: Harmon and Weiss, for the Natural Resources Defense Council, Inc. (76)

The Proposed Rules Contain Neither Site Suitability Criteria Nor Any Mechanism to Ensure that the Sites are Selected on the Basis of Geologic Considerations

While the Commission recognizes that at some point the ability of the engineered systems to contain waste will be lost and virtually complete reliance will have to be placed on the natural characteristics of the site to isolate the waste, (46 Fed. Reg. 35282) the proposed rules contain no definitive or enforceable geologic criteria for site suitability. Nor do the regulations require DOE to demonstrate that the three sites selected for characterization have been chosen on the basis of their geologic characteristics. Thus, there is no mechanism proposed in these rules to ensure that the critical decisions on site characterization and selection will result in the emergence of a site which is even among the best that could be found. Indeed, recent developments strongly suggest that political considerations have overridden rational geologic considerations in the selection of the first few sites to receive serious attention from DOE. The current rule would not prevent licensing of the "best" of three weak sites. At worst, it would allow DOE to characterize two clearly unsuitable sites and squeeze the Commission into accepting a third marginal one.

Staff Response to Comment No. 436:

Because of the variability in geologic parameters from site to site, the Commission has found it impossible to specify precise numerical criteria for most geological parameters. Nevertheless, under Part 60 a detailed examination and evaluation of candidate site will be required. See also Overview, Section 5.3, Geologic Conditions, and the staff response to Comment Nos. 147, 241, and 477.

Comment No. 437: Louisiana Dept. of Natural Resources (63)

Section 60.112 should be headed "Required characteristics of the geologic and hydrologic setting."

Comment No. 438: Capital-Area Groundwater Conservation Commission (22)

Section 60.112 should be headed "Required characteristics of the geologic and hydrologic setting."

Staff Response to Comment No. 437 and 438:

As the rule has been revised, there is no longer such a section.

Comment No. 439: Union of Concerned Scientists (59)

These requirements now stipulate ((c) of section 60.112) that pre-waste emplacement groundwater travel times be at least 1,000 years. This stipulation should instead demand that estimated post-waste emplacement travel times be at least 1,000 years.

At present, minimum repository depth (300 m) is merely one of the favorable conditions listed in section 60.122. Minimum depth should be a required characteristic.

Staff Response to Comment No. 439:

See Overview, Section 3.3, Siting Criteria and Section-by-Section Analysis, §60.113 and §60.122.

There is inadequate technical justification for selection of any particular depth as a fixed requirement.

Comment No. 440: Mississippi Dept. of Natural Resources (65)

This section is good, but not specific. How are the stabilities required in paragraphs (a) and (b) defined? Perhaps in paragraph (c) the 1000-year groundwater travel times required at a site should be specified for both pre- and post-waste emplacement.

Staff Response to Comment No. 440:

See Overview, Section-by-Section Analysis, §60.113.

Comment No. 441: Dr. T. C. Gustavson (71)

The proposed rule contains vague and frequently unrealistic criteria pertaining to structural stability. For example:

§ 60.112

a) "The geologic setting shall have exhibited structural and tectonic stability ..."; neither the geologic setting nor the phrase "structural and tectonic stability" are defined. Rigidly enforced, this would make both the Hanford Reservation and the Nevada Test Site unsuitable.

§ 60.122

"... appropriate combination of these conditions ..."; who is to determine what is and is not appropriate?

a) Reference is made to the rates of tectonic processes. This is essentially undeterminable for 99% of the regions under consideration.

b) Similarly for structural processes.

§ 60.123

a) 4) Reference is made to the historical earthquake record. In the midcontinent, where seismicity is diffuse and the historical record is so short as to be statistically non-existent, this criteria is not valid.

5) Fault activity is not defined.

b) This criteria requires investigation to 500 m below the repository level, yet the drill holes necessary for these investigations compromise the repository integrity.

6) "Fault activity" is not defined.

8) This criteria requires dating of fractures, which are certain to be present. This is undeterminable in 99.99% of the cases.

Staff Response to Comment No. 441:

The stability provisions of the geologic setting performance objective have been deleted.

The Commission will determine the appropriateness of the favorable and potentially adverse conditions at a site based on a proposal by the DOE. As noted in this comment, evaluation of many of the geological processes or features of a site will be judgmental and potentially controversial. For this reason, the Commission has adopted a multiple barrier approach which places considerable emphasis on engineered barriers during the period when wastes are most hazardous.

See also Overview, Section-by-Section Analysis, §60.113 and §60.122.

The provision for site investigation to 500 m. below the repository level has been deleted; under 60.21(c)(1) the Safety Analysis Report must reflect results of investigations extending to a depth sufficient to determine critical pathways for radionuclide migration.

We have not included a definition of "fault activity," but note that DOE must demonstrate that any such fault would not compromise the ability of the site to host a geologic repository.

Comment No. 442: T. C. Gustavson (71)

The proposed rule contains vague and unrealistic criteria pertaining to hydrogeologic and geomorphic stability. For example:

§ 60.112

b) "The geologic setting shall have exhibited hydrogeologic, geochemical, and geomorphic stability since the start of the Quaternary Period." What constitutes hydrogeology, geochemical and/or geomorphic stability is not defined.

§ 60.122

a-e) "The nature and rates of tectonic, structural, hydrogeologic, geochemical and geomorphic processes that have occurred since the start of the Quaternary period are such that, when projected, they would not affect, or would favorably affect the ability of the geologic repository to isolate waste." To make this determination a period of time over which the rate projection is to be made must be provided. A specific time period is not provided in section 60.111 Performance Objective and so the requirements of section 60.122 (a-e) cannot be obtained.

Staff Response to Comment No. 442:

See Overview, Section-by-Section Analysis, §60.113. The relevant time period is that for which isolation must be achieved.

Comment No. 443: U.S. Department of the Interior (24)

That section of the rule requiring stability of the geologic setting since the start of the Quaternary Period seems to us to be both vague and unnecessary. Stability is a relative matter. Movement has occurred on some faults in the Atlantic Coast Province in Quaternary time even though as a whole the province is more stable than the Basin and Range Province, with in turn is more stable tectonically than the Pacific Coast region. It would be unfortunate if the rule should be so interpreted that only the most stable parts of the continent came to be considered for repository locations. The vagueness could give rise to licensing problems. Furthermore, in some environments, instability such as tectonic subsidence and infilling may be a positive factor for waste isolation (Winograd, 1981). Also, the vagueness of this criterion is inconsistent with the greater specificity of other criteria.

A general requirement for stability seems superfluous if the EPA standard is projected to be met by the isolation system, the performance objectives now in

the rule for the individual barriers are projected to be met, and the favorable and potentially adverse conditions have been characterized and their consequences analyzed.

Staff Response to Comment No. 443:

See Overview, Section-by-Section Analysis, §60.113. It should be emphasized that contrary to the implication of the comment, the presence of a potentially adverse condition does not exclude the site from consideration.

Comment No. 444: C. R. Fisher, General Atomic Co. (16)

Section 60.112(a), (b) and (c)

As a result of the difficulty and uncertainty in assessing geologic parameters, General Atomic suggests that the word, "exhibited," be replaced by "inferred" in (a) and (b), and by the phrase, "inferred, calculated or measured," in (c).

Staff Response to Comment No. 444:

This provision of the proposed rule has been deleted from the final rule. See Overview, Section-by-Section Analysis, §60.113.

Comment No. 445: Institute of Geological Sciences, UK (29)

Section 60.112

Para. (a). Some quantitative statement of stability would be desirable if these mandatory characteristics are seen as significant but a stable geological setting has proved difficult to define in a generic sense. It will normally require definition in a regional rather than a global sense.

Paras. (a) and (b). "The start of the Quaternary" was probably chosen as a relatively arbitrary, but convenient time base (dated at about 2 million years ago in the United Kingdom) which was sufficiently far back in the geological record to provide a relevant time-base. However, there is little scientific basis for choosing that time period, rather than any other specified period.

Paragraph (b). In the land masses of the northern hemisphere there have been a series of glaciations during the Quaternary and it is totally unrealistic to speak of geologic and geomorphic stability since the start of the Quaternary.

Paragraph (c). The 1000 year time period appears to be related to assessments of the life-span of the engineered barriers. The pre-waste emplacement rates of groundwater movement, rather than travel times over an arbitrary period of time, are relevant as the base-line from which migration times can be judged. Any final nuclide migration models (of the types outlined in Section 60.21, p. 35287 and to be included in the Safety Analysis Report) will attempt to simulate the repository and its geological setting as an entity. Accordingly,

it is the groundwater travel times resulting from any perturbations caused by the repository and its waste which should be definitive. There is an inconsistency with respect to groundwater travel times between Section 60.112 para. (c) where the phrase ..... "at least 1000 years" is used, and Section 60.122 para. (f) (4) where the term ..... "substantially exceed 1000 years" appears.

Staff Response to Comment No. 445:

See Overview, Section-by-Section Analysis, §60.113; also, §60.122 with respect to groundwater travel times that substantially exceed 1000 years.

Comment No. 446: Div. of Emergency Government, State of Wisconsin (77)

60.112(a). How will tectonic stability be demonstrated? There is no U.S. historical record longer than 200 years?

Staff Response to Comment No. 446:

The reference to "tectonic stability" has been deleted. See Overview, Section-by-Section Analysis, §60.113.

Comment No. 447: V. McIntyre (35)

60.112 (a) and (b) Why weren't they combined? Is there some significance in splitting them. I can't see one.

Staff Response to Comment No. 447:

The referenced sections have been deleted from the final rule.

Comment No. 448: H. Ross (14)

60.112 (c)

No geologic site should be considered acceptable if numerical modeling of the site specific hydrologic properties (permeability, transmissivity) or other observable data (historical facts, age dates) suggests a ground water travel time substantially less than 10,000 years. This is one numerical criteria which, properly stated in terms of observable data and established numerical modeling techniques, should be more restrictive.

Suggested wording change -

The geologic repository shall be located so that pre-waste emplacement ground water travel times through the far field to the accessible environment are at least 10,000 years, as determined by the site specific physical properties and accepted numerical modeling procedures.

Staff Response to Comment No. 448:

The NRC agrees that a groundwater travel time substantially in excess of 1000 years would be desirable, and has stated so in the favorable conditions section of Part 60. However, favorable geochemistry and/or good engineered barriers could give acceptable performance with a 1000-year travel time. See Part C, Rationale for the Performance Objectives in 10 CFR Part 60.

Comment No. 449: Louisiana Dept. of Natural Resources (63)

Section 60.112(c). The requirement of 1000 years for isolation of the "waste package" when considering ground-water travel time cannot be predicted without some uncertainty because of the inability of the scientist to guarantee future hydrologic conditions, the stability and integrity of host rock, and the effects of manmade stresses. Although models may not be capable of giving a single unquestionable answer for 1000 years and changes may occur with time, it should be realized that a model may be able to provide a spectrum of alternatives based on (1) the geology and hydrology, (2) the historical stability and integrity of the host rock, (3) the regional and local hydrology of the materials surrounding the host rock, (4) the present and predicted long-term effects of manmade and natural stresses that have some degree of uncertainty, (5) the radwaste form, and (6) degree of accuracy of the in situ hydrologic parameters. In summary, it is satisfactory to assume, with all the uncertainties candidly discussed, that 1000 years predictions for ground water movement can be made but with an ever increasing degree of uncertainty and concern. The inability to predict long-term ground water movement can be offset by the adoption of a philosophy to avoid the possibility of "ground water interaction" by locating sites so that the host rock is not surrounded and overlain by water-saturated material.

Staff Response to Comment No. 449:

See Overview, Section 5.4, Reasonable Assurance.

Comment No. 450: Capital-Area Groundwater Conservation Commission (22)

Section 60.112(c). The requirement of 1000 years for isolation of the "waste package" when considering groundwater travel time cannot be predicted without some uncertainty because of the inability of the scientist to guarantee future hydrologic conditions, the stability and integrity of host rock, and the effects of manmade stresses. Although models may not be capable of giving a single unquestionable answer for 1000 years and changes may occur with time, it should be realized that a model may be able to provide a spectrum of alternatives based on (1) the geology and hydrology, (2) the historical stability and integrity of the host rock, (3) the regional and local hydrology of the materials

surrounding the host rock, (4) the present and predicted long-term effects of manmade and natural stresses that have some degree of uncertainty, (5) the radwaste form, and (6) degree of accuracy of the in situ hydrologic parameters. In summary, it is satisfactory to assume, with all the uncertainties candidly discussed, that 1000 years predictions for groundwater movement can be made but with an ever-increasing degree of uncertainty and concern. The inability to predict long-term groundwater movement can be offset by the adoption of a philosophy to avoid the possibility of "groundwater interaction" by locating sites so that the host rock is not surrounded and overlain by water-saturated material.

Staff Response to Comment No. 450:

See response to Comment No. 449.

Comment No. 451: American Nuclear Society (20)

Section 60.112(c) states a requirement that prewaste emplacement groundwater travel times through the far-field to the accessible environment are at least 1,000 years.

While the "water travel time" concept may have validity in assessing multiple barriers, the ambiguity of what constitutes the "accessible environment" can lead to a number of interpretative results for this factor, as applied to differing site-specific characteristics, It would be better to more clearly define the "accessible environment" as a surface or near surface water body or body of significant quantities of water that could conceivably realize extensive use. In the absence of analyses justifying 1,000 years for differing site-specific characteristics and a clear definition of "accessible environment," ANS recommends deleting this numerical value.

Staff Response to Comment No. 451:

See Overview, Section 4.1, Accessible Environment/Controlled Area.

Comment No. 452: State of Wisconsin (77)

60.112(c). How will groundwater travel time be estimated for cracked and fissured areas?

Staff Response to Comment No. 452:

Mathematical simulation of flow in fractured rock is currently approached by two techniques--(1) equivalent porous continuum models and (2) discrete models. These models are solved for two or three dimensional problems using either finite-element or finite difference techniques for either steady state or

transient flow. The staff believes that, at present, the better alternative is to employ an equivalent continuum porous medium approach.

Comment No. 453: V. McIntyre (35)

60.112 (c) Under heat loading the "1,000 year travel time" may be considerably less. Surely the water travel time can be modeled under thermal loads. This section ought to be modified accordingly.

Staff Response to Comment No. 453:

See Overview, Section-by-Section Analysis, §60.113.

Comment No. 454: Bechtel National, Inc (37)

60.112(c) - The acceptability of the requirement for a 1000-year groundwater travel time is strongly dependent upon the definition of "accessible environment". If the definition in 60.2 is interpreted to have the same meaning as the definition currently under consideration by the EPA in Draft 19 or 40 CFR 191 (which could locate the accessible environment at a potential well location 1 mile from the repository), then the 1000-year requirement is overly restrictive and could rule out many excellent sites. On the other hand, if "accessible environment" applies to only aboveground land or water surface areas and "large", "readily accessible" underground sources of drinking or irrigation water, then the 1000-year requirement may be appropriate, though this can only be determined by evaluation of the overall repository system. We recommend deletion of this requirement since, again, it represents a subsystem characteristic which needs to be considered in view of total system performance on a design and site specific basis. However, if this requirement is retained, a more precise definition for "accessible environment" is needed than is given in paragraph 60.2, and a justification for the 1000-year duration should be provided.

Staff Response to Comment No. 454:

See Overview, Section 2.1, Single vs. Multiple Performance Standards; and Section 4.1, Accessible Containment/Controlled Area.

Comment No. 455: U.S. Department of the Interior (24)

The present requirement that the geologic setting have prewaste-emplacement ground-water travel times through the far field to the accessible environment of at least 1,000 years is both reasonable and achievable. In many existing environments, actual prewaste-emplacement travel time can be expected to be much greater than that.

Staff Response to Comment No. 455:

No response required.

Comment No. 456: M. J. Fisher (39)

Paragraph 60.112 requires "the geologic repository shall be located so that pre-emplacement ground-water travel times through the far field to the accessible environment are at least 1,000 years". What does this mean? I would recommend changing pre-emplacement to ambient conditions and require DOE to analyze how their construction, testing, and waste emplacement has affected the ambient conditions.

Staff Response to Comment No. 456:

See Overview, Section-by-Section Analysis, §60.113.

Comment No. 457: Institute of Electrical and Electronics Engineers (28)

Requiring geologic stability during the entire Quaternary Period may be excessive.

Staff Response to Comment No. 457:

See Overview, Section-by-Section Analysis, §60.113, also Section 3.3, Siting Criteria.

Comment No. 458: C. Walske, Atomic Industrial Forum (50)

60.112 Required characteristics of the geologic setting

Item (c) should be deleted as a required characteristic as it is more properly included under "Favorable conditions", Item 60.122(f)(4). However, if Item 60.112(c) is retained, the meaning of "accessible environment" should be clarified as suggested earlier under 60.2 "Definitions".

Comment No. 459: Institute of Electrical and Electronics Engineers (28)

The rationale for requiring groundwater travel times of at least 1,000 years to the accessible environment should have been summarized in the Supplementary Information.

It is noted that the NRC definition of the "accessible environment" (Section 60.2) differs from that of the EPA in their 40 CFR 191, Draft No. 19, page 36. The EPA definition includes any underground sources of drinking water (e.g., a well) more than one mile away from the waste location.

Staff Response to Comment No. 458 and 459:

The significance of groundwater travel time is explained in Part C. See also, Overview, Section 2.1, Single vs. Multiple Performance Standards, and Section 4.1, Accessible Environment/Controlled Area.

THE FOLLOWING COMMENTERS ADDRESSED 60.121:

Comment No. 460: V. McIntyre (35)

60.121 Aren't these requirements procedural? I suggest that they be placed with NRC's licensing procedures.

Staff Response to Comment No. 460:

The NRC staff does not believe the provisions of 60.121 are procedural and therefore declines to include this section as part of the licensing procedures. The ownership and control provi ions are needed in order to permit NRC to find that the performance objectives will be met during the periods before and after permanent closure.

Comment No. 461: U.S. DOE (48)

10 CFR 60.121(a)

NRC Proposed Wording:

Requirements for ownership and control of the geologic repository operations area.

(a) Ownership of the geologic repository operations area. The geologic repository operations area shall be located in and on lands that are either acquired lands under the jurisdiction and control of DOE, or lands permanently withdrawn and reserved for its use. ...

Recommended Revision:

(a) Ownership of the site. The geologic site shall be located in and on ... .

Rationale:

DOE has substituted the term "site" for geologic repository operations area to be consistent with our recommended revision of the definition of "geologic repository operation area."

Staff Response to Comment No. 461:

The staff has modified the provisions of 60.121(a) to now refer to ownership of the land in and on which both the geologic repository operations area and the controlled area will be located. The staff believes that this revision will alleviate some of DOE's concerns.

Comment No. 462: Div. of Emergency Government, State of Wisconsin (77)

60.121 -- There is no requirement for present or future population density, nor for transportation access to the site? These issues should affect site suitability.

Staff Response to Comment No. 462:

See Overview, Section 2.4, Population-Related Siting Criteria. [Transport access is dealt with indirectly by requiring that surface facilities allow safe handling and storage (Section 60.131) and that emergency response capabilities be provided (Section 60.130). Transportation access is of concern to NRC only insofar as these health and safety issues are involved.] See also response to Comment No. 480.

Comment No. 463: N. K. Olson, S.C. Geological Survey (70)

Para 60.121, subpara (a), p. 35289

Some mention should be made concerning special legal considerations for State Water Rights in applicable states. This would show cognizance of a vital issue.

Staff Response to Comment No. 463:

The reservation of portions of the Federal domain implies that appurtenant unappropriated water will be reserved to the extent needed to accomplish the purpose of the reservation. U.S. v. New Mexico, 438 U.S. 696 (1978); Cappaert v. U.S., 426 U.S. 128 (1976). Accordingly, it was felt that no special mention of water rights was needed, at least as to reserved lands. However, because unappropriated water may be insufficient, it does appear to

be desirable to specify that needed water rights be obtained in every case. This would not require any separate action on the part of DOE if it appears that such needed water rights have been obtained, by implication, as a result of reservation or acquisition of lands.

Comment No. 464: Mississippi Dept. of Energy & Trans. (65)

The secure area, whether by land acquisition, land easement, or fencing, should be defined as part of the criteria. The protected land area should be large enough to provide people protection from handling accidents as well as interaction between nuclear materials and natural phenomena such as tornadoes.

Staff Response to Comment No. 464:

The geologic repository operations area must be sufficiently large that radiation levels and releases of radioactive material to unrestricted areas will at all times be maintained within standards applicable to other nuclear facilities. See § 60.111(a). Under the regulation, reliance may be placed upon conservative design features to assure an adequate measure of protection from handling accidents and natural phenomena.

THE FOLLOWING COMMENTERS ADDRESSED 60.122:

Comment No. 465: Commonwealth Edison (17)

The regulations should be cleaned up to eliminate any criteria that restrict site or repository selection to a particular medium or tend to rule out any medium.

Staff Response to Comment No. 465:

The regulations do not exclude any suitable geologic medium from consideration. A number of the revisions to the rule may result in broadening the range of geologic media that may in practice be considered for selection.

Comment No. 466: Louisiana Department of Natural Resources (63)

The regulations and the ongoing studies are oriented primarily toward geology and do not place hydrology in the proper perspective. Geology includes structure, stratigraphy and lithology and provides knowledge of the framework BUT does not provide the needed hydrologic data required in major hydrologic decisions, such as that required in Section 60.112 (c)-- "the predicted travel time of groundwater." The rate and movement of ground water are the most

important processes relative to the potential impact on the containment of waste and therefore hydrology should be considered a unique discipline that requires equal emphasis in the regulation and in the studies.

Staff Response to Comment No. 466:

The required analyses must thoroughly consider hydrogeologic properties and conditions. See §60.21(c)(1).

Comment No. 467: Hon. W. A. O'Neill, Governor, State of Connecticut (69)

The Rule provides acceptable geologic standards for the disposal of high-level radioactive waste in geologic repositories. Though we believe the Rule to be generic in nature, it does address the major requirements and criteria for such a facility. It should be stressed however, that each specific site should be considered on the specifics of the location and any circumstances which are unique to the area, town or state.

Staff Response to Comment No. 467:

No response required.

Comment No. 468: M. J. Fisher (39)

Finally, I highly suggest that NRC require DOE to complete all site investigations to include rock and water properties and conditions for all material between the surface and the host rock and laterally out for 1/4 mile prior to waste emplacement since retrieval may be compromised by naturally induced accidents i.e., flooding, roof collapse, and buckling of support pipes and supports.

Staff Response to Comment No. 468:

The staff believes that there is sufficient assurance that the information referred to in the comment will necessarily have been obtained by DOE either in the course of its site characterization plan or as part of the activities required with respect to updating the application prior to the emplacement of wastes. The extent of required investigations is defined more fully in the final rule. See §60.21(c)(1).

Comment No. 469: Div. of Emergency Government, State of Wisconsin (77)

Page 35282 - Role of Site - It is stated "The Commission also recognizes that isolation is, in fact, a controlled release to the environment which could span many thousands of years...". We question the use of the terms "isolation"

and "controlled release" within these contexts. Figuratively speaking, use of the word isolation assumes that the material is unavailable. However, isolation in this instance is admittedly only a temporary, and as yet unknown (in terms of time) variable. "Controlled release" presumes a mechanism which governs and regulates the amount of material available for release (ignoring any natural or man-made catastrophe or system failure). Once nuclear materials are emplaced, the engineered systems take over and all the variables that were previously considered in the design phase are now potential impacts. Thus, any unplanned or miscalculated variables may impact the total system. Decisions are being made and implemented based on the best technology and calculated impacts, despite the contention of a "controlled release." Both may or may not react as planned. While one can only design the system to the best of our ability, it should be recognized that a controlled release is not a given.

Staff Response to Comment No. 469:

The staff considers it appropriate to refer to "isolation" in terms of "controlled release" notwithstanding the existence of some uncertainty with respect to the actual level of isolation that will be achieved. See also Overview, Section 5.4, Reasonable Assurance.

Comment No. 470: M. J. Fisher (39)

The section entitled "Role of the Site" illustrates your lack of confidence in the site by not mentioning the "systems approach" you and DOE had discussed in the IRG report.

Staff Response to Comment No. 470:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. See also staff response to Comment No. 52.

Comment No. 471: National Radiological Protection Board, UK (29)

Interdependency of Site and Design - The NRC view that site and design are so interdependent that it is artificial and misleading to separate siting and design requirements (p. 35284, column 1, para. 3) is very realistic. Separation of the two types of requirement would inevitably lead to inconsistencies and difficulties in meeting criteria.

Staff Response to Comment No. 471:

The staff is unclear as to what is meant by the commenter's statement that separation of siting and design requirements could lead to inconsistencies in meeting criteria.

Comment No. 472: J. Hamstra, Netherlands Energy Research Foundation (6)

There may well be other than technical criteria that may influence a final site selection. Once a site is selected the overall system should be developed to meet the overall performance objectives. There is no hazard related requirement for a deep geological disposal to be located far from present-day population centers.

The geologic and geohydrologic conditions of the site are predominant over what conditions exist in the presence at the surface above the site. There is, however, one restriction and that is that the existing use of the land and physical planning will permit to lower the shafts at the proper places and to build the surface facilities directly next to the shafts.

Staff Response to Comment No. 472:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 473: Harmon and Weiss for the Natural Resources Defense Council, Inc. (76)

As noted earlier, it is already clear that political exigencies - most notably the current desire of DOE to show quick "progress" towards a waste disposal solution - have virtually dictated the selection of at least two of the first three sites which will receive serious DOE consideration for storage of commercial high-level waste. These are Hanford and the Nevada Test Site. The DOE apparently is also still pursuing the Savannah River Plant (SRP) as a site for high-level waste, although this may be for the purpose of storing defense waste only. These DOE sites are being pursued despite the fact that the National Academy of Science in 1966 stated: "Throughout the fabric of the 10-year history of the Committee's deliberations run some continuing threads of purpose and conviction. Prominent among them is the realization that none of the major sites [including Hanford and SRP] at which radioactive wastes are being stored or disposed of is geologically suited for safe disposal of any manner of radioactive wastes other than very dilute, very low-level liquids, with the probable exception of grout injection into fractured shale at Oak Ridge.* Those who have closely followed the nuclear waste issue over the past decade know full well that these sites surfaced and have been pursued by DOE because all are on government-owned reservations, pose no problems of site acquisition and are easily accessible to DOE. There can be no serious question that a site selection process based on geologic considerations would not have identified these three sites for characterization. Yet the proposed NRC rules would be fully satisfied by characterization of these three sites alone. This demonstrates the inadequacy of the proposed rules.

*National Academy of Science-National Research Council, Committee on Geologic Aspects of Radioactive Waste Disposal, Report to the Division of Reactor Development and Technology, United States Atomic Energy Commission (May 1966).

Staff Response to Comment No. 473:

See Overview, Section 5.3, Geologic Conditions. See also staff response to Comment Ncs. 231 and 436.

Comment No. 474: U.S. DOE (48)

Issue

The NRC proposed rule does not specify credit for site-specific factors.

DOE Position

DOE feels credit for site-specific factors should be specified.

In a DOE letter to NRC, dated May 29, 1981, concern was expressed that the DOE would be required to calculate exposures from radionuclide transport, with no assurance from NRC or the draft regulation regarding what assumptions and site-specific mitigating factors might be applied in the calculations. Consequently, DOE expressed concern that the licensing process may be unnecessarily protracted by debate over the related systems-safety objective, and how it might be achieved.

Section 60.21 adequately specifies what site conditions and assessments the DOE safety-analysis report should contain, and therefore largely alleviates DOE's concern. However, as in the case of nuclear-reactor facilities, DOE suggests that NRC develop, as part of its Regulatory Guide Series, guides for implementation of 10 CFR 60. The DOE would be pleased to assist NRC staff in the development of such guides.

Staff Response to Comment No. 474:

See Overview, Section 2.1, Single vs. Multiple Performance Standards. The NRC staff anticipates that regualtory guides will be prepared as appropriate. DOE will have an opportunity to comment on these guides in draft form.

Comment No. 475: F. L. Parker (80)

Site Specific Criteria

I believe that the regulation should be procedural rather than substantive since we shall license only one to three repositories in this century. Therefore, specific numbers will be determined for these few sites, provided they satisfy EPA's standard and NRC's defense in depth criteria. Consequently, though precise numbers are inappropriate at this stage, a range of acceptable numbers would give DOE some understanding of the types of sites that might be licensable.

Staff Response to Comment No. 475:

See Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 476: Mississippi Dept. of Natural Resources (65)

General Comments

In our reviews to date of work done by the U.S. Department of Energy (DOE) and Battelle's Office of Nuclear Waste Isolation (ONWI) in the National Waste Terminal Storage (NWTS) Program, the Bureau of Geology has been concerned constantly with the lack of specific guidelines and criteria for studies being done. Existing guidelines and criteria for the NWTS Program are so vague and generalized, and written using so many ambiguous or undefined terms, as to be almost worthless. Our experience with NWTS reports in Mississippi has been that widely differing interpretations of the significance of certain geologic findings can be made under existing criteria. These differing interpretations have been such that ONWI may find that a site satisfactorily meets a certain criterion as a suitable repository site, while the Bureau of Geology may have a different interpretation of the criterion and argue that the site is unsuitable based on the same data. Despite pleas for the promulgation of specific criteria, the NWTS Program continues with only vague and general rules available. We have found even that DOE's interpretation of the criteria, or at least the weight put on different criteria, changes with time.

The Bureau of Geology has looked to the NRC, as the repository licensing agency, for a definitive description of the geologic parameters of a suitable repository site, including a description of geologic features that would make a site unsuitable. We do not find such descriptions in the proposed rules for 10 CFR Part 60, Subparts E-H. Our primary complaint is with the lack of specificity. The rules are a good outline or list of goals to be achieved, but we need more definition of how these goals are to be achieved. We suspect that some of the goals cannot be met with present technology.

It is difficult to comment on these proposed rules for several reasons, but primarily because they are very general and in many cases not as specific as criteria outlined in ONWI-33(2). Difficulty also arises in differentiating the respective roles of DOE, NRC, and EPA. DOE is charged with the responsibility of siting, constructing, and operating a repository. EPA is responsible for developing performance standards with respect to radionuclide releases from a repository. NRC is responsible for developing rules by which they will receive and rule on license applications from DOE. If NRC rules become too rigid, they could in effect dictate exploration, design, and construction criteria for DOE. If the rules are too general, they become meaningless and would allow DOE to replace NRC licensing rules with their own criteria. The NRC rules are also dependent upon EPA standards which do not exist. It is possible that DOE and NRC could jointly dictate the EPA standards.

Although we find that the proposed rules are too generalized and non-specific, the Bureau of Geology has no complaints about the topics or subjects covered in the rules, except where mentioned below. We make no recommendations of

sections to be deleted or additional topics to be added; we only request the the "skeleton" of the proposed rules be given some "flesh."

Staff Response to Comment No. 476:

For reasons noted by the Commission, provisions that are unduly restrictive would be inappropriate at this stage of technological development (46 FR 35283). This principle is applicable with respect to siting questions as it is to matters of design. Greater specificity may be warranted at a later stage. See also Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 477: Harmon & Weiss, for NRDC (76)

Some mechanism must be created which will do the job which NRC has articulated as a goal: the development of a slate of candidate sites that are among the best that can reasonably be found. Since the Commission has chosen not to adopt definitive site suitability criteria, the only other option that we can see is to impose a requirement that the sites characterized and selected are chosen by a process based on consideration of geologic factors. NRDC recommends a two-stage demonstration. First, at the level of site characterization, DOE should be required to show that the three sites selected were chosen on the basis of geologic factors and therefore represent a slate of sites that are among the best that can reasonably be found. Second, at the stage of construction authorization, a concept similar to ALARA should be employed, requiring a demonstration that the geologic characteristics of the chosen site provide the highest reasonably achievable degree of enhancement of the waste isolation capabilities of the repository. This is consistent with the requirement for consideration of alternatives contained in §60.21(c)(3) and §50.40(c).

Staff Response Comment No. 477:

The process for the selection of sites for characterization is now prescribed by the Nuclear Waste Policy Act. Under the NRC rules, DOE can be required to adopt measures to enhance the performance of particular barriers where it appears that significant uncertainties will thereby be substantially reduced. See Overview, Section 2.5, ALARA.

Comment No. 478: M. I. Lewis (11)

Although no specific site suitability or exclusion requirements are given in the criteria, stability and minimum groundwater travel times are specified as required site characteristics." This quite sounds more like a criticism of this proposed rule than a criteria to be met.

Stability and ground water travel times are important. However, there are many other criteria which must be considered at this early time before the rule goes into effect.

There are social and economic considerations. If these are not mentioned in the rule, they will be difficult to bring up during licensing hearings. Further, the staff has been remiss in its duty if they have not looked at other problems generic to siting HLW repositories other than stability and ground water travel times.

Staff Response to Comment No. 478:

Social and related economic factors will be considered in connection with the Commission's environmental review (see 10 CFR Part 51). Generic geologic considerations are treated extensively in the siting criteria, §60.122.

Comment No. 479: Div. of Emergency Government, State of Wisconsin (77)

Page 35824 - Number 3 Siting Requirements, 1st Paragraph, Last Sentence

Does a decision to construct a test facility at a given location constitute repository approval? Will a decision to utilize a specific geologic media at a given location (through the use of an experimental drop shaft and tunnel) guarantee that site's use as a repository?

According to the rule, natural adverse conditions will be resolved through scientific engineering. Will experimental repositories receive adequate in-situ testing to enable scientific estimates of suitability? An important question when considering the time frames necessary for waste isolation is what constitutes adequate testing?

Emplacement of high radioactive wastes may cause an adverse condition. Increased use of engineered designs to compensate for natural adverse conditions could lead to complications in long-term predictions of suitable isolation.

Staff Response Comment No. 479:

As the staff understands the comment, it raises two issues: first, whether the undertaking of site characterization and/or construction implies any commitment with respect to approval of a facility at the particular location; and second, whether adverse effects related to waste emplacement will have been given adequate consideration.

With respect to the former, the licensing procedures make it clear that a final licensing decision is required prior to receipt of the HLW, and that no prior activities imply a commitment to issue a license.

As to the effects of the wastes these are required to be fully analyzed in the course of the license review.

Comment No. 480: R. H. Neill, State of New Mexico (78)

Siting Requirements (§60.122 and preamble)

We see no geologic reason why population related siting requirements should be included. However, transportation routes to the site should be considered in the overall site evaluation because it is possible that an otherwise acceptable site should be ruled out because of transportation considerations (such as inadequate highways or railroads or the necessity of moving wastes through hazardous or heavily populated areas).

No minimum area for DOE control adjacent to the geologic repository operations area is specified in 60.102(c). This should be considered.

Staff Response to Comment No. 480:

For a discussion of the issue of population-related siting requirements, see Overview, Section 2.4. Transportation-related impacts would be considered in the context of the evaluation of alternatives pursuant to the National Environmental Policy Act. The extent of the area subject to controls (see §60.121) can only be determined in light of the geologic, hydrologic and other conditions of the geologic setting.

Comment No. 481: M.J. Fisher (39)

The section on "Major Features of the Proposed Rule", 3. Siting Requirements, page 35284, discusses minimum groundwater travel times. From where to where? Does this have anything to do with the "accessible environment"? Why does the definition of "accessible environment" not mention groundwater and groundwater users?

Staff Response Comment No. 481:

See Overview, Section 4.1, Accessible Environment/Controlled Area.

Comment No. 482: Penberthy Electromelt International (61)

Ground Water Travel Time

The restriction on page 60-20 for travel time of ground water through the far field to the accessible environment of at least 1000 years is a quite unnecessary restriction. This will interfere with the drain repository concept, whereby flooding of the nuclear waste package is avoided. When the waste is kept dry, we don't care whether there is a trickle of water along the bottom of the repository tunnel.

Staff Response to Comment No. 482:

The significance of the groundwater travel time is explained in Part C, which contains the rationale document.

Comment No. 483: Mississippi Dept. of Energy & Trans. (65)

Attention to the protection of fresh water is necessary, especially since water is perhaps Mississippi's most valuable natural resource.

Comment No. 484: Mississippi Dept. of Energy & Trans. (65)

Criteria for future water needs and uses should be given particular attention since fresh water is projected to be a scarce commodity in the future. Minimum distances and barriers between the waste package and fresh water aquifers should be included in the criteria.

Staff Response to Comment Nos. 483 and 484:

A principal objective of the performance objectives is to establish criteria to be used in evaluating the isolation of radioactive materials from the accessible environment including fresh water aquifers. Effects of a project on future water needs and uses will also be considered in the NEPA review process. It should also be noted that proximity to water supplies and the effect upon the rights of users of water are among the factors that will be considered in DOE's guidelines for the recommendation of sites for repositories, to be issued under Section 112(a) of the Nuclear Waste Policy Act.

THE FOLLOWING COMMENTERS ADDRESSED THE EXCLUSION OF POPULATION-RELATED SITING CRITERIA

Comment No. 485: J. Carson Mark, U.S. NRC Advisory Committee on Reactor Safeguards (10)

We agree with the approach suggested in the proposed rule. We believe it is not necessary to include any siting criteria which relate to population density or the proximity of the waste repository to population centers.

Staff Response to Comment No. 485:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 486: T. H. Pigford (53)

NRC has requested comments on whether population-related siting requirements should be included in the final rule. The "EPA standard" assumed by NRC does not require population data or projections, even though it is intended to meet a specified integrated dose limit to future populations. Instead, it relies upon worldwide averages for consumption of food and water by populations and assumptions of worldwide population growth. However, if the finally adopted EPA standard is still based upon meeting some release limit derived from a population dose limit, the actual population-related features of proposed sites should be considered.

In any event, it is reasonable that geologic repositories for high-level waste be located in areas removed from dense population.

Staff Response to Comment No. 486:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 487: B. Hafner (12)

One also wonders why the Commission has neglected to mention any population-related requirements. Since someone is going to have a high-level repository "in their backyard" it seems logical that the NRC would establish suitable requirements in this area. However, as of yet such requirements have not yet been proposed. Since this is an area which will be brought up sooner or later it would seem to be in the Commission's best interest to do so as soon as possible. Once again, clarification on this matter is called for.

Staff Response to Comment No. 487:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 488: Commonwealth Edison (17)

There is no justification whatsoever for any population density criteria. All shipments will have to meet appropriate transportation safety requirements, and the handling of materials will be done on site subject to 10 CFR Part 20 and other appropriate requirements.

Staff Response to Comment No. 488:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 489: Committee on Armed Services, U.S. Senate (23)

Pursuant to the request for comments on the Commission's proposed technical criteria for the disposal of high-level nuclear waste, the undersigned urge that the Commission include population factors as criteria for siting a nuclear waste repository.

It is our belief that the nuclear material storage problem can be resolved by selecting sites in remote, uninhabited or sparsely populated areas which our scientific community believes to be absolutely safe. We urge that until it can be proven by extensive testing that nuclear waste can be stored safely, public anxiety will be justifiably high. By focusing on sites located as far away from populated areas as possible, public concern will be reduced.

Staff Response to Comment No. 489:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 490: Institute of Electrical and Electronics Engineers (28)

The NRC invited comments on whether population-related siting requirements should be included. Future locations of population centers are difficult to predict. Thus, no reliable projection can be made of the population dose from radionuclide releases that might occur in the distant future. However, the maximum individual dose, to a person living in the worst location in the accessible environment, can be projected with less uncertainty. The use of this calculated dose in connection with licensing should be investigated.

Staff Response to Comment No. 490:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 491: Honorable Trent Lott, U.S. House of Representatives (37)

I am writing to you in regard to the Nuclear Regulatory Commission's proposed rule governing high-level radioactive waste repository siting, published in the July 8 Federal Register. I am particularly concerned that the NRC has not included any siting requirements which directly deal with population density or proximity to population centers.

As you know, this proposed action goes against a quarter century of policy for the siting of nuclear facilities, including that for NRC's own standards for the siting of nuclear power reactors. Population has always been a governing factor in the location of a nuclear plant. I am aware that plans for the location of three such plants in the past have been withdrawn or abandoned because of the population factor: the Perryman site near the Aberdeen Proving Ground outside Baltimore, and the Newbold Island and Burlington plants planned by Public Service Electric and Gas of New Jersey.

I am very distressed that the single most important factor in the siting of a plant has disappeared from the NRC's proposed criteria. I would, therefore, like to meet with you to discuss this change which I believe directly affects the safety of the public and could unnecessarily delay our nuclear option.

Staff Response to Comment No. 491:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 492: B. R. McElmurry (38)

In all cases, the setting of a single overall performance standard for waste confinement is the preferred approach because it allows for future technological improvement (page 35283, alt. 1). Specifying criteria for each component will rule out any system with different and perhaps superior components.

Staff Response to Comment No. 492:

See Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 493: J. Vadas (4)

Finally, there is no mention of any population related requirements. I would like some clarification on the latter point.

Staff Response to Comment No. 493:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 494: National Radiological Protection Board, UK (29)

Siting Requirements (population density) - The decision not to include any siting requirements which deal directly with population density or proximity to population centres (p. 35284, column 3, para. 4) is both practical and realistic. Given the long time periods of concern in geologic disposal it would be impossible to ensure that any such requirements were met.

Staff Response to Comment Nos. 494:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 495: UK Atomic Energy Authority (29)

We agree that there is no point in invoking a population criterion.

Staff Response to Comment No. 495:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 496: Bechtel National, Inc. (37)

The Commission seeks comments on whether a population-related siting requirement should be included in the final rule and how they might be implemented.

> It is not necessary to include a population-related siting requirement in the final rule for 10 CFR Part 60. The relative risk to the public health and safety during the repository operational and decommissioning phases and beyond is likely to be substantially less than that for most types of nuclear facilities.

Staff Response to Comment No. 496:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 497: B. R. McElmurry (38)

Population siting requirements (p35284) are entirely superfluous. Geologic criteria should govern site selection, because no one knows what the population situation will be in 100 or 1000 years.

Staff Response to Comment No. 497:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 498: M. J. Fisher (39)

Again in the same section, the question of siting requirements for population density or proximity to population centers has been opted for resource considerations. This appears to be a wise choice, however the "Proposed Rule" does not provide water resource siting criteria in enough detail to allow evaluation of acceptable versus nonacceptable site conditions. For example, sole source aquifers such as the one designated by the EPA for the Spokane, Washington area and projected water withdrawals for irrigation purposes should be discussed.

Staff Response to Comment No. 498:

See Overview, Section 2.4, Population-Related Siting Criteria. See also responses to Comment Nos. 463, 483, and 484.

Comment No. 499: Utility Nuclear Waste Management Group (44)

UNWMG supports the approach taken in the proposed rule which does not include any siting requirements dealing directly with population density or proximity to population centers. Over the periods of time involved, such requirements would be virtually meaningless since, among other things, population projections into the far future would be completely speculative. Further, since overall system performance requirements will, presumably, be stated in terms of radioactive material release limitations, population-related siting requirements are unnecessary from a purely regulatory viewpoint.

Staff Response to Comment No. 499:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 500: U.S. DOE (48)

The Commission has invited comment on whether population-related siting requirements should be included in the final rule, and how any requirement might be implemented. The request did not distinguish between operational and postclosure population proximity considerations. These considerations for the operational phase surface facilities are distinctly different than for postclosure.

Because air pathways are the predominant mechanism for radioactive release from surface facilities during the operational phase, the objective should be to consider release mechanisms (and the consequences of release) to the same extent they are considered in licensing other fuel cycle facilities. The regulation requires DOE to meet 10 CFR 20 requirements and EPA standards for radiological exposures or releases, thereby accomplishing this objective. DOE believes no further requirements needed, especially given the practical considerations that:

- Low population density and distance from population centers would normally be viewed as favorable conditions.

- NRC will review each application on a case-by-case basis, and would critically analyze the proposed use of any site in close proximity to a large population or within a zone of high population density.

For the postclosure phase, population considerations do not provide a valid basis for regulation. After a repository is filled and sealed, the most likely mechanism for the escape of radionuclides to the biosphere is by dissolution and transport in groundwater. Such action is likely to occur only after the long-term decomposition of engineered barriers, thus permitting a slow rate of release into the host rock and surrounding geologic environment (the far-field) over periods of thousands of years. There, in the far-field, natural geochemical mechanisms of sorption and precipitation would work in concert with long groundwater travel time and radioactive decay to delay and reduce any releases to the accessible environment. Because potential future release points may be distant from the repository, and future population trends over hundreds or thousands of years also cannot be predicted, current population density near a repository has very little safety significance during the postclosure period. Release rates, or dose to a maximum individual, provide a more meaningful basis for judging the suitability of a proposed isolation system. While reference-sized populations may be useful for comparing sites or establishing limits on release, site-specific population factors should not be used as the critical basis for licensing a site.

We believe, therefore, the treatment of population in the proposed 10 CFR 60 is appropriate.

Staff Response to Comment No. 500:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 501: C. Walske, Atomic Industrial Forum (50)

Because of the inherent safety of the geologic repository, especially during the containment period, the distance between the repository and a large population center is immaterial from a safety standpoint. From a practical standpoint, political considerations will undoubtedly prevent a repository from being located near a larger population center. Furthermore, projection of population movements beyond the containment period would be highly speculative and would not be governed by any rule written in 1982. Therefore, we conclude that a population-related siting requirement is not needed.

Staff Response to Comment No. 501:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 502: C. R. Fisher, General Atomic Co. (16)

Because there is no strong motivation for locating a waste repository near a population center (as there is for nuclear plants), and because the chosen sites should have "little resource value," there is only a small probability that

future populations will be significantly affected by the site choice unless deliberate actions to move near the site are taken. These long term population considerations are probably impossible to control; therefore, including them in the proposed rule would most likely be futile. However, because the greatest threat to the general public exists during the early life of the repository when the emplacement (and possibly the retrieval) of the wastes is taking place, General Atomic believes it would be feasible and appropriate to impose population density or distribution criteria on the site selection.

Staff Response to Comment No. 502:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 503: Calif. Dept. of Conservation (62)

The Commission invited (FR 35284) commentary on whether population-related siting requirements should be included in the final rule, and if so, how. CDC feels this is a significant issue which needs further review. At a minimum, we suggest inclusion of the following criteria: "That the distance from the repository site to a point of human intrusion be based on the radius of contamination due to accidental release of radioactive material during the deposition of the HLW waste material."

Staff Response to Comment No. 503:

See Overview, Section 2.4, Population-Related Siting Criteria. The staff is unable to relate the suggested remoteness criterion (which pertains to the size of the controlled area) to the radius of contamination due to accidental release during the deposition of waste.

Comment No. 504: Mississippi Dept. of Natural Resources (65)

Population density and proximity to population centers should be given consideration since safe disposal should be the primary objective of the NWTS Program. Common sense should dictate that HLW be disposed of in a remote area with as low a population density as possible. Primary consideration should be given to the safety of the general population in the vicinity of the surface facility of the repository since that is where spent fuel and HLW will be processed for encapsulation into canisters and placed in the repository. Since the spent fuel and HLW will become progressively less hazardous with time, it would seem more logical to site the repository with more consideration given to present safety than to the safety of a repository at some future time.

Staff Response to Comment No. 504:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 505: Sierra Club (66)

Population density criteria must be included as part of the proposed rule. They are not included now. The Commission believes that the issue has been addressed indirectly through a consideration of resources in the geologic setting. The Commission believes that this is a more realistic approach over the long periods of time involved.

We disagree and believe there should be a population density criteria. As the proposed rules now stand, a high-level waste repository could be located in the South Bronx.

Resources apply to dollar value of goods and not human health effects. Any EIS, in a consideration of alternative sites, must weigh the resources in dollars and the human health effects separately in concluding where a repository should be located. The preferred site must minimize the total number of health effects.

We disagree with the Staff's reasoning on this point. The Staff claims that because of the long-lived nature of the wastes, population predictions are uncertain and thus an area which is sparsely populated today might not be so in the future. However, the greatest hazard from high-level wastes occurs during the first few hundred years. Highly populated areas, or those which are reasonably projected to be so, should be avoided in the time periods during which the high-level waste is most hazardous.

Staff Response to Comment No. 505:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 506: Mississippi Dept. of Energy & Trans. (65)

There are no siting requirements relative to population density or proximity to population centers. The fact that nuclear waste is located at the site causes severe apprehension and anxiety on the population whether the risk is real or imagined. This type of damage is further accented with news information about catastrophic possibilities. Criteria should be established to avoid this type of people problem by limiting the site to areas of very low population density.

Staff Response to Comment No. 506:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 507: Mississippi Dept. of Energy & Trans. (65)

There is no mention in the rule of population and/or proximity to population. Since the life of a repository could well exceed the institutional lifetime of the na , and as such the issue of population is critical and should be included in the technical rule.

Staff Response to Comment No. 507:

See also Overview, Sections 2.4 and 2.6, Population-Related Siting Criteria and Human Intrusion, respectively.

Comment No. 508: Union of Concerned Scientists (59)

Prior to closure of the repository, such siting requirements would reduce the risk to the public arising from transportation and other accidents.

Both prior to and after closure, such siting requirements would reduce the risk to the public arising from failure of the repository. It is likely that appropriate requirements would be effective in separating the repository from large populations for several centuries, during which period the radiation and heat loading of the repository would decline. The risk of repository failure would decline correspondingly.

Therefore, population-related siting requirements should be formulated.

Staff Response to Comment No. 508:

See Overview, Section 2.4, Population-Related Siting Criteria. Risk associated with transportation to alternative sites will be considered in connection with the Commission's review of alternatives under NEPA.

Comment No. 509: Hon. W. A. O'Neill, Governor, State of Connecticut (69)

We do have concerns that the Proposed Rule has not included any siting requirements which directly deal with population density or proximity to population centers. We believe this area should be considered in the overall siting requirement of a repository. In a state the size of Connecticut, population density would be a crucial factor in the siting of any facility for radioactive waste disposal. Our state made extensive comments regarding this issue to the Department of Energy on their study "Crystalline Intrusives in the United States and Regional Geologic Characteristics Important to Storage of Radioactive Waste." (Copy attached) (See PDR letter #69 for attachment.)

Staff Response to Comment No. 509:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 510: Div. of Emergency Government, State of Wisconsin (77)

Demographic evaluation should be required in the final licensing process. In particular, the total demographic evaluation should include a risk analysis that reflects the sources of high-level waste (power plants) and proposed routing to the repository. In our opinion, the transportation routing may be the most

hazardous part of high-level waste disposal. Certain sites in the continental United States may require such complex or difficult routes, that other sites may offer a better disposal alternative.

Staff Response to Comment No. 510:

See Overview, Section 2.4, Population-Related Siting Criteria. See also response to Comment No. 508.

Comment No. 511: Northeast Utilities (79)

We agree that population density or the proximity of a site to population centers should not be a siting requirement. Over the periods of time involved, such requirements would be meaningless since population projections are at best speculative. Further, since overall system performance requirements are stated in terms of limitations on the release of radioactive materials. population-related siting requirements are unnecessary.

Staff Response to Comment No. 511:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 512: B. D. Withers, Portland General Electric Co. (82)

As population estimates for the time periods in question are largely supposition, population considerations should not be made a part of the rule. Any population residing in the vicinity of a disposal facility would already be protected by the original design criteria limiting radioactive material release.

Staff Response to Comment No. 512:

See Overview, Section 2.4, Population-Related Siting Criteria.

Comment No. 513: National Association of Counties Research, Inc. (1)

§ 60.122 - Tectonic, structural, hydrogeological, geochemical, and geomorphic processes are listed here as, given favorable conditions, contributing to the ability of the geologic setting to meet performance objectives. A further characterization and analysis of these processes may be necessary in order to gain the best knowledge possible about the site. Soils, surface topography, uniformity/heterogeneity, permeability, porosity, attitude, weathering, fracturing, fault zones, karst zones, swelling, creep, and other deformation, may all be important elements of detail that can affect location and isolation analysis. Perhaps these are inherent in the processes set out above, but it would seem to make clearer to the site regulator and developer the evaluation that is necessary if these (and other like) elements are fully expressed.

Staff Response to Comment [illegible]

In the view of the staff, the [illegible] analysis Report will necessarily deal with items of concern such as those [illegible] ried by the commenter. (See § 60.21(c)) Those which represent potentia[illegible] verse conditions will need to be evaluated as provided in §60.122.

Comment No. 514: C. R. Fisher, G[illegible] al Atomic Co. (16)

Section 60.122 through 124

These sections list the considerations that any applicant can not avoid evaluating as part of the preparation of submittals for a license. In addition, the manner of presentation is tutorial and prolix, and in their present form the sections appear to be inappropriate for inclusion in a regulation. Therefore, General Atomic suggests that these sections be extensively edited to remove gratuitous information and unnecessary verbiage, and to focus more clearly on the guidance NRC intends to communicate to the user.

Staff Response to Comment No. 514:

Portions of Sections 60.122-60.124 have been revised to focus more clearly on the guidance NRC intends to communicate to the user.

Comment No. 515: Institute of Geological Sciences, UK (29)

The second general point leads directly from the ambiguity in the definitions and relates to consequential inconsistencies and variability in the degree of qualitative versus quantitative components in the technical criteria. From the geological viewpoint this can be seen, for example, in pages 35290 and 35291, Sections 60.122 and 60.123 in which the favourable and potentially adverse conditions of the geological setting are considered. Other examples are referred to below in relation to specific points. Some inconsistencies highlight admirably those aspects of the siting of a HLW repository about which there are insufficient technical data. It can be argued that these sections of the document illustrate the strength of the case for delaying the proposed rules until more technical data are available. The deficiency of data and the problem of the proof of the adequacy of a repository into the future is recognized throughout the text, for example at p. 35288 Section 60.101 paragraph 2. Statements of this nature are entirely valid and seem to negate the technical content of associated criteria.

Staff Response to Comment No. 515

NRC has revised the referenced portions of the rule. Even though some considerations are expressed in qualitative terms, the NRC believes that

they can serve as useful guidance in the licensing of a facility. See also Overview, Section 2.1, Single vs. Multiple Performance Standards.

Comment No. 516: Louisiana Dept. of Natural Resources (63)

Geology provides information on the "makeup of the container," whereas hydrology quantifies the hydrodynamics of the system. Thus, geologic studies alone do not provide information required to estimate the movement of fluids and answer questions pertaining to the rate of movement of radionuclides and water especially in areas where the host rock is surrounded by saturated materials. Local and regional hydrologic modeling should be prime prerequisites during the initial phase of a site study because it not only provides information on the effects of hydrologic stresses but indicates data needs and oftentimes indicates geologic unconformities. Unfortunately, the early stages of studies made in the Gulf Coast area did not include enough emphasis on hydrologic studies. As a consequence, questions related to the interaction of hydrology to the shear zone, the sheath, the fissures in the caprock, the salt, and to the rate and direction of ground-water movement cannot be answered with a slight degree of confidence at this time and probably for some time into the future. Thus NRC proposed regulations should place equal importance on hydrologic studies to prevent omissions during the data-collection phase and provide for multidiscipline activities. Final determinations as to the suitability of a salt dome for radwaste storage will be unnecessarily delayed until the proper hydrologic data are collected and regional and local hydrologic models are started, calibrated, verified, and accepted.

Other subjects that need early consideration in the licensing processes are socioeconomics, archeological, and wildlife.

Staff Response to Comment No. 516:

See staff response to Comment Nos. 431 and 432.

Comment No. 517: National Radiological Protection Board, UK (29)

Favourable and Potentially Adverse Conditions - This approach (Section 60.122 and 60.123, P. 35290-1) to specifying geologic criteria is a very reasonable and practical one. It allows considerable flexibility in selecting sites, making allowance for the wide variations in geologic environments. The inclusion of a minimum disposal depth of 300m as a favourable condition, rather than a strict criteria, is a particularly good feature of the approach.

Staff Response to Comment No. 517:

No response required.

Comment No. 518: M. J. Fisher (39)

In your paragraph "60.122 Favorable Conditions", you fail to mention geomechanical stability in the host rock to allow for long periods of open shafts and boreholes. The confining pressures at that depth must be analysed before workers are sent down. Also very low water flow conditions and capability against modest water flow conditions are necessary to prevent rock collapse and flooding in the shafts and tunnels.

Staff Response to Comment No. 518:

Section 60.122 concerns isolation capabilities of the geologic setting. The commenter's concerns have been appropriately addressed in the section dealing with design requirements. (§60.133).

Comment No. 519: U.S. DOE (48)

10 CFR 60.122

NRC Proposed Wording:

Each of the following conditions may contribute to the ability of the geologic setting to meet the performance objectives relating to isolation of the waste. In addition to meeting the mandatory requirements of section 60.112, a geologic setting shall exhibit an appropriate combination of these conditions so that together with the engineered system, the favorable conditions present are sufficient to provide reasonable assurance that such performance objectives will be met.

Recommended Revision:

Each of the following conditions are likely to enhance the ability of the geologic setting to meet the performance objectives of the geologic waste disposal system. The presence of one or more of any of these conditions will be considered as a favorable factor during the license application review. In addition to meeting the mandatory requirements of section 60.112, a geologic setting should exhibit one or more of these conditions so that together with the engineered system, the favorable conditions present are sufficient to provide reasonable assurance that such performance objectives will be met.

Rationale:

While we recognize the staff's intention is to enumerate conditions that would be considered as favorable attributes, we do not feel that the proposed language properly identifies the intent of the section.

Staff Response to Comment No. 519:

The principal change proposed by this comment would call for the site to exhibit "one or more"; rather than "an appropriate combination" of favorable conditions. The staff believes such a change would be misleading and inappropriate.

Comment No. 520: Utility Nuclear Waste Management Group (44)

In § 60.122 the proposed regulations require specified favorable conditions "so that, together with the engineered system, the favorable conditions present are such to provide reasonable assurance that . . . performance objectives will be met." In accordance with the discussion above in connection with §§ 60.111 and 60.112, however, the rule should specify that the indicated "favorable conditions" may be determined on the basis of a reasonable demonstration, and that additional certainty is not necessary.

In addition, §§ 60.122(a)-(e) involve the projection of past tectonic, structural, hydrogeological, geochemical and geomorphic processes into the future. Such projections, however, should not be left open-ended, and should be specifically limited to the period of analytical consideration; i.e., the 10,000 year period suggested above in the discussion of § 60.111(b)(2).

In this same general connection, UNWMG believes that the absence of groundwater travel times from the geologic setting to the accessible environment of less than 1,000 years should also be indicated as a favorable condition in this section. The 1,000 year flow time from the outermost waste container to the accessible environment, discussed above in connection with § 60.112(c) as a performance objective, is, of course, more significant. However, UNWMG believes that the lack of groundwater communication from anywhere in the entire geologic setting to the accessible environment within 1,000 years would offer an additional advantage sufficient for its identification as a "favorable condition."

Finally, in the tenth line of § 60.122, the word "engieered" should be "engineered."

Staff Response to Comment No. 520:

See Overview, Section-by-Section Analysis, §60.122. The staff recognizes that the presence of some favorable conditions, such as those requiring projections of geologic processes into the future, requires interpretation of geologic data and that "certainty" is not required. However, the staff considers this to be evident from the wording of the conditions themselves, so that there is no need to modify the language.

Comment No. 521: C. Walske, Atomic Industrial Forum (50)

Para. 60.122 Favorable Conditions

This paragraph contains language such as "...shall exhibit..." which could lead to the interpretation that these are mandatory requirements like the preceding ones. This is in conflict with the statement in the introduction (p. 35284) that these are not absolute requirements but merely considerations entering into a judgmental determination. This should be expressed in this paragraph, the heading should be deleted or changed from "requirements" to "considerations", and "shall" be replaced by "should" wherever it occurs.

The language concerning projections of tectonic, structural, hydrologic, geochemical, and geomorphic processes into the future (items (a) through (e)) should acknowledge that more stringent standards apply for the first 10,000 years than thereafter.

Item (f)(3) calling for "...inhibition of groundwater flow... along shafts, drifts or boreholes" is difficult to satisfy if taken literally. Instead of a positive effect (inhibition), it should merely say that rock types that facilitate establishment of preferential pathways along shafts, etc., are undesirable or require specific counter-measures. Therefore this item should be placed under Para. 60.123 Potentially Adverse Conditions.

The language in Item (f)(4) "...substantially exceed 1,000 years" is unnecessarily vague, and should be replaced by "...or at least 1,000 years".

Staff Response to Comment No. 521:

See Overview, Section-by-Section Analysis, §60.122, and staff response to Comment No. 520. The heading of Section 60.122 has been changed from "requirements" to "criteria" so as to convey more clearly the intent that these are conditions to be assessed.

Comment No. 522: U.S. DOE (48)

10 CFR 60.122(a) and (b)

NRC Proposed Language:

(a) The nature and rates of tectonic processes that have occurred since the start of the Quaternary Period are such that, when projected, they would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

(b) The nature and rates of structural processes that have occurred since the start of the Quaternary Period are such that, when projected, they would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

Recommended Revision and Rationale:

Reference is made to structural processes (in 60.122(b)) right after reference to tectonic processes in 60.122(a). The distinction between structural and tectonic processes is not clear to many, and could be interpreted differently. Therefore, we strongly urge that these terms be explained or defined clearly so that the intended distinction between structural and tectonic processes is clear to any reader or reviewer.

Staff Response to Comment No. 522:

Paragraphs 60.122(a) and (b) have been modified. The term "structural processes" has been deleted from the rule, as such processes are included in the more general term "tectonic processes."

Comment No. 523: Penberthy Electromelt International (61)

Tectonic Processes

The foregoing system of packaging the radwaste in a glass of high integrity and clad with an inert glass makes it quite unimportant whether there is a collapse of the tunnel due to an earthquake. Nothing will happen to the waste.

Staff Response to Comment No. 523:

For many, perhaps all, design concepts, the nature of the tectonic processes operating on the site can be an extremely important condition.

Comment No. 524: N. K. Olson, S.C. Geological Survey (70)

Para. 60.122, subpara. (a) and (b), p. 35290

"Tectonic processes" in (a) should be considered adequate as covering "structural processes" in (b), thereby eliminating the need for subpara. (b).

Para. 60.122, subpara. (a) through (e), p. 35290

For clarity, suggest changing "would not affect or would favorably affect" to "would not affect or would not decrease."

Staff Response to Comment No. 524:

Paragraphs 60.122(a) and (b) have been modified. The term "structural processes" has been deleted from the rule, as such processes are included in the more general term "tectonic processes." The staff does not consider the second recommended change to be a clarification.

Comment No. 525: New York State Energy Office (83)

The New York State Geological Survey advises us that the term "Quaternary Period" should either be replaced by a span of time in years or be specifically defined in the glossary. The survey indicates that there is no general agreement among geologists on its definition.

Staff Response to Comment No. 525:

Although there is still debate in the geological community concerning the precise age of the Quaternary Period, the staff believes that for regulatory purposes an age of 2 million years is appropriate. This is because most geologists would assign an age of approximately 2 million years to the lower limit of the Quaternary Period (Plio/Pleistocene boundary), based upon results of investigations on deep sea cores and on the Calabria, Italy, section. The staff considers that it is not necessary to quantify or define the term "Quaternary." However, in recognition of the lack of precision concerning the start of the Quaternary Period, staff has used the language "during the Quaternary Period" rather than "since the start of the Quaternary Period" in revised §60.122.

Comment No. 526: J. Adam (34)

§ 60.122 Favorable Conditions.

Given the other provisions of §60.122(f) the requirement of a low groundwater content appears unnecessary and may rule out some otherwise highly desirable sites.

The following favorable condition should be added:

"(k) A uniform and massive, in both depth and extent, geologic unit at repository depth.

The response of a uniform massive formation is easier to model with confidence than a formation which is either not massive or non-uniform. All else being the same, greater confidence can be placed in the predictions of the behavior of massive, uniform formations.

Staff Response to Comment No. 526:

See Overview, Section 3.3, Siting Criteria, and Section-by-Section Analysis, §60.122.

While the concept suggested by the commenter has merit and is similar to that of "stability" as used in the proposed rule, the staff has not adopted it. The terms "uniform" and "massive" suggested by the commenter are relative terms. All host rocks will exhibit some evidence of fracturing, faulting or other inhomogenieties that would make implementation of the suggested change unworkable in practice. Further, the term massive could be interpreted that the staff has a preference for domed over bedded salts. The staff has no basis for such a preference. Therefore, we decline to make the change. We consider, however, that a host rock which was identified to be relatively uniform and massive would be found to possess favorable characteristics already identified in other provisions of the final rule.

Comment No. 527: Institute of Geological Sciences, London (29)

Section 60.122

Paras. (a) to (e). The phrase "nature and rates of process" will prove difficult to define and quantify when applied to some of the processes referred to. The distinction made between the terms "tectonic processes" and "structural processes" in paras. (a) and (b) is fine. In most situations the two terms would be regarded as synonomous and the reason for the distinction is not clear.

Para. (f) (1). The term ..... "low groundwater content" is ambigous and without a rigorous definition as to its precise meaning this condition could preclude the inclusion of many argillaceous formations and crystalline rocks which current research indicates could be satisfactory as hosts.

Para. (j) This "catch-all" condition illustrates the generalised nature of conditions (a) to (i) and emphasises the problems of drafting criteria to cover all of the interactive factors in advance of completion of the necessary research. This point is well recognised in the text (p. 35284 3rd column)..... "The impact of these characteristics on overall performance would be site specific. Thus, the Commission has judged that these should not be made absolute requirements. Presence of all the favourable characteristics does not lead to the conclusion that the site is suitable to host a repository. Neither is the presumption of unsuitability because of the presence of an unfavourable characteristic incontrovertible". This valid concept should not be negated by earlier statements in the rules which are based on generalised concepts.

Para. (a) (5). The recognition of the timing of movements on fault planes is technically extremely difficult and in many situations it would be impossible to ascertain whether or not a fault had been active since the start of the Quaternary.

Para. (b) (1) and (2). In the cases of argillaceous and crystalline host the evidence available from opencast and sub-surface mines as well as from predrilling, may be advantageous in that they increase the amount and reliability of information and may in no way detract from the suitability of the site. This may not be so for evaporites, but the wording should reflect the distinction.

In addition the rules may well have implications on the use of existing cavities for the storage of waste.

Para. (b) (5). Nearly all rocks have, at some time or another, suffered dissolution - it is the degree and the nature of the processes involved which are important. Most rocks are soluble under specified conditions.

Para. (b) (6). Does this condition refer to only one fault - it is the nature of the fault which is important, not the mere fact that it exists. In some circumstances the identification of faulting in the disturbed zone may be regarded as advantageous in that the location(s) of the potential for future movement is known.

Para. (b) (8). Uplift and subsidence following isostatic readjustment after the last Ice Age is ubiquitous in the glaciated areas and is common in much of the rest of the world for various reasons. It is the degree, rate and causes of structural deformation which are important.

Para. (b) (10). No such correlations should be accepted as definitive as far as areas remote from plate boundaries are concerned.

Para. (b) (13). It is difficult to envisage that there are not zones within any potential host-rock in which there are not reducing conditions. Excavation and entry of air into the disturbed zone will change the conditions, at least in the near-field, and any such clause will need to recognise this.

Staff Response to Comment No. 527:

See Overview, Section 3.3, Siting Criteria, and Section-by-Section Analysis, §60.122. The considerations identified by the commenter with respect to potentially adverse conditions may be taken into account as provided in § 60.122(a)(2).

Comment No. 528: C. R. Fisher, General Atomic Co. (16)

Section 60.122(f)

The use of the word "substantially" is unacceptably imprecise. General Atomic requests that the NRC's intent be quantified.

Staff Response to Comment No. 528:

The travel time would be considered to "substantially exceed" 1000 years if it would demonstrably improve the ability of the geologic setting to meet the performance objectives related to isolation of the waste. The extent of improvement in performance that would result from an increase in travel time will be site specific, and it would be inappropriate to be more precise in the regulation. For an example of the dependence of performance of a geologic

repository on groundwater travel time for several geologic media, see Chapter VII of Part C.

Comment No. 529: V. McIntyre (35)

60.122 and 123. These sections should be organized to emphasize the temporal relationships--that is, when requirements apply--before decommissioning or after it.

60.122 (a) through (e) These requirements parallel one another. They ought to be combined into a list or table.

60.122 (f) (4) Suppose the host rock is not in contact with the accessible environment. What then?

60.122 (h) Since mineral assemblages apparently are the same thing as rocks why not call them that or "geologic media"?

60.122 (i) Rather than beating around the bush NRC should state a minimum depth. As written the regulation would permit disposal in shallow trenches. I am sure that is not NRC's intent.

Staff Response to Comment No. 529:

See Overview, Section-by-Section Analysis, §60.122.

Comment No. 530: H. Ross (14)

Section 60.122 (f)(4)

Suggested wording change -

"groundwater travel times under pre-waste emplacement conditions...that substantially exceeded 10,000 years."

Staff Response to Comment No. 530:

See response to Comment No. 528. As explained in Part C, groundwater travel time substantially in excess of 1,000 years (rather than 10,000 years) could greatly increase the Commission's confidence that the overall system performance objectives would be achieved.

Comment No. 531: UK Atomic Energy Authority (29)

Favourable conditions. (f) (4) We are doubtful about specifying this number at this stage since its significance is very dependent on (g) regarding radionuclide transport.

(i) as above we are concerned that 300 metres may be inappropriate at some sites.

Staff Response to Comment No. 531:

The 300 meter criterion is a favorable condition, the absence of which would not exclude a site from further consideration. See also response to Comment No. 528.

Comment No. 532: Penberthy Electromelt International (61)

There is no reason at all to require a minimum depth of 300 meters (1000 feet). A host rock thickness of 100 feet between the repository and the surface is quite sufficient to prevent casual entry into the repository.

Staff Response to Comment No. 532:

The 300 meter criterion is a favorable condition, the absence of which would not exclude a site from further consideration.

Comment No. 533: T. H. Pigford (53)

NRC specifies a minimum emplacement depth of 300 m as one of the favorable conditions which, in an appropriate combination, are sufficient to provide reasonable assurance that NRC's performance objectives will be met. NRC has not shown the basis for its conclusion of sufficiency, and no data and analyses have been presented in this regard. Once an overall performance objective of the waste isolation system has been established, it will be possible to analyze the effects on overall performance due to different emplacement depths for different rock media. Some technical considerations argue for deep emplacement; others argue against going too deep. Determination of emplacement depth should be a product of overall system analysis under DOE supervision, subject to final safety evaluation by NRC.

Staff Response to Comment No. 533:

The 300 meter criterion is a favorable condition, the absence of which would not exclude a site from further consideration.

Comment No. 534: UK Atomic Energy Authority (29)

Overall Description, we have grave doubts about the specification of 300 metres minimum depth which may be totally inappropriate at the specific site.

Staff Response to Comment No. 534:

The 300 meter criterion is a favorable condition, the absence of which would not exclude a site from further consideration.

Comment No. 535: Mississippi Dept. of Natural Resources (65)

Section 60.122

This section is no more specific than Section 60.112, unfortunately. Again, in paragraph (f)(4) pre-waste emplacement should perhaps be changed to include post-waste emplacement conditions. What is the meaning or significance of paragraph (j)?

Staff Response to Comment No. 535.

With respect to paragraph (f), see Section-by-Section Analysis, §60.122(b)(2)(iv). Paragraph (j) has been deleted as being too vague.

Comment No. 536: N. K. Olson, S. C. Geological Survey (70)

Para 60.122, subpara (f), p. 35290

Suggest adding an additional ground-water characteristic: "(5) ground-water flow paths leading away from the geologic setting."

Staff Response to Comment No. 536:

The flow paths are part of the geologic setting. A host rock will have flow paths leading both towards and away from the site, depending upon the spatial reference.

Comment No. 537: T. C. Gustavson (71)

On page 88 (Concepts, 60.102, Area Adjacent to the Geologic Repository, Operations Area) the statement is made that - Within the geologic setting, particular attention must be given to the characteristics of the Host Rock as well as any rock units surrounding the host rock. On page 90 (Favorable Conditions, 60.122) the statement is that "the host rock should provide the following ground-water characteristics: (1) low ground-water content, (2) inhibition of ground-water movement in the host rock, (3) inhibition of ground-water flow between hydrologic units or along shafts, drifts, and boreholes, and (4) ground-water travel times under pre-waste emplacement conditions between the underground facility and the accessible environment that substantially exceeds 1,000 years." With the exception of number 4, the Technical Rule is nonspecific with respect to characteristics of the host rock. The Technical Rule should detail the properties that a host rock (and bounding units) should possess, for example: composition, texture, bedding characteristics, moisture content,

impurities and inclusion, physical integrity. The characteristics of the host rock may inhibit flow between hydrogeologic units (see segment 3 above), but it will never inhibit flow or in any manner affect flow along shafts, drifts or boreholes.

Staff Response to Comment No. 537:

The favorable condition related to hydrogeologic conditions of the host rock has been revised in the final rule. Since the technical criteria are intended to apply to several geologic media and geologic settings, the staff does not consider it appropriate to specify in more detail the properties that a host rock should possess. In its license application, DOE is required to describe the subsurface properties and conditions of the site it has selected and to provide analyses to show that these properties and conditions are adequate for waste isolation (§60.21(c)(1)).

The provision of the proposed rule relating to flow along boreholes and shafts mentioned in this comment no longer appears in the final rule.

Comment No. 538: U.S. DOE (48)

10 CFR 60.122(h)

NRC Proposed Wording:

(h) Mineral assemblages that, when subjected to anticipated thermal loading, will remain unaltered or alter to mineral assemblages having increased capacity to inhibit radionuclide migration.

Recommended Revision:

"will remain unaltered, or if altered such alteration will not reduce their capacity to inhibit radionuclide migration to an extent that the overall system performance objective would not be met."

Rationale:

The text states that mineral assemblages, when subjected to anticipated thermal loading, should remain unaltered or altered so as to have increased capacity to inhibit radionuclide migration. While this sounds good, it may rule out some otherwise favorable sites which, upon thermal loading, might have a diminished capacity to inhibit radionuclide migration but which may still be acceptable in regard to radionuclide migration.

Staff Response to Comment No. 538:

10 CFR 60.122(h) is included in the set of favorable conditions. The purpose of including the favorable conditions is to give credit to those characteristics of a site which contribute to the ability of the geologic setting to meet the performance objectives relating to isolation of the waste.

Comment No. 539: N. K. Olson, S.C. Geological Survey (70)

Para 60.122, subpara (i)

Suggest for geodetic accuracy changing "deemed to be the elevation of the lowest point" to "deemed to be the altitude above mean sea level of the lowest point."

Staff Response to Comment No. 539:

The NRC considers the wording sufficiently precise.

Comment No. 540: Div. of Emergency Government, State of Wisconsin (77)

60.122 & 123 -- If the time scales discussed refer to the isolation rather than the containment period, the time periods should be 10,000 to 100,000 not 1,000 years (especially for 60.123(a)(8) which should include the next Ice Age).

60.122(f)(4) -- Has the ability to characterize groundwater behavior in crystalline rock improved?

Staff Response to Comment No. 540:

The relevant time period for projections shall be for whatever time period is necessary to comply with the EPA standard. The staff believes that the ability to characterize groundwater behavior in crystalline rocks has improved in recent years. NRC research contractors have already reported progress in characterizing and understanding groundwater behavior in crystalline rocks.

THE FOLLOWING COMMENTERS ADDRESSED 60.123

Comment No. 541: Institute of Geological Sciences, London (29)

Reference to geological criteria occur throughout the text but they are covered in some detail on p. 35289 Section 60.112, p. 35290 Section 60.122 and pp. 35290-1 Section 60.123 in which the required characteristics of the geological setting

are considered and the potentially favourable and adverse conditions are outlined. The generalised characteristics of Section 60.112 (mandatory) are amplified in Section 60.122 which is proceeded by the statement that ..... "a geological setting shall exhibit an appropriate combination of these (favourable) conditions so that, together with the engineered system, the favourable conditions present are sufficient to provide reasonable assurance that such performance objectives will be met". There is no indication of what combination of conditions would be regarded as appropriate and some of the associated statements are so generalised as to cause difficulties in interpretation of their meaning. Most of the criteria are interactive, although this is not emphasised in the text, and many of the specific conditions are the products of a number of interactive factors.

Staff Response to Comment No. 541:

An appropriate combination would be one that assured that the overall performance objective (the EPA standard) would be met. The requirement for a "combination" recognizes the interactive nature of geologic systems.

Comment No. 542: National Association of Counties Research, Inc. (1)

§ 60.123 - NACo believes it is necessary to make the existence of potentially adverse conditions less discretionary in the evaluation process for determining site suitability. The presence of two or more of these adverse conditions at a particular site should therefore trigger the site's rejection, unless the assessment envisioned in § 60.124 can clearly demonstrate that a favorable judgment should be made. Further, we would add several other potentially adverse conditions or expand upon those present. The presence of critical habitats, wetlands, coastal high hazard areas, permafrost areas (whose fragile ecosystems have significant potential for erosion and groundwater contamination), and/or proximate human populations, transportation corridors, or projected future human land uses should also be considered potentially adverse conditions. Additionally, adverse condition (a)(8) should be expanded beyond climatic change to include several climatologic conditions or factors such as winds, precipitation, or ambient temperatures.

Staff Response to Comment No. 542:

The presence of only one significant condition not adequately compensated by favorable conditions or capable of remedy by design would render the site unsuitable since the performance objectives would not be met. It should be understood that the incorporation of favorable and unfavorable conditions provides an analytical framework for applying the performance objectives. It is not the intention that the conditions be regarded as independent requirements, and for that reason it would be inappropriate to characterize them in the manner proposed. A number of environmental factors listed in the comment will be subject

to review under NEPA and other laws, but they have no direct effect upon the capability of the geologic repository to satisfy the performance objectives. Meteorological conditions would be of concern, after permanent closure if they were the cause of extreme erosion. But in that event, the phenomena would already have been identified as potentially adverse. Note also that a meteorological assessment is required to be included in the safety analysis report.

Comment No. 543: Mississippi Dept. of Natural Resources (65)

Section 60.123

Parts of this important section also need clarification, including but not limited to the following. In the case of a salt dome, the 2 km distance in paragraph (b), if sufficient, should be from the boundaries of the dome. In (b)(3), what would "representative areas" be at a salt dome site? In (b)(4), what is "extreme" erosion? Does (b)(5) apply to salt domes, all of which exhibit evidence of dissolutioning of soluble rocks? What is the definition of "complex engineering measures" in (b)(16)?

Staff Response to Comment No. 543:

The provisions of 60.123(b) as set forth in the proposed rule have been modified and no longer contain specified distances for the horizontal and vertical limits of investigations to be conducted. The investigations must include the controlled area and areas outside the controlled area that could affect isolation. The NRC agrees that some of the potentially adverse conditions should be considered further away from the geologic repository.

In 60.123(b)(3), representative areas would, as stated in the rule, be areas of similar size that are representative of and located in the geologic setting.

The staff has used the term "extreme erosion" to refer to the occurrence of substantial changes in land forms (as a result of erosion) over relatively short intervals of time.

In response to the comment on 60.123(b)(5), see response to Comment No. 544.

"Complex engineering measures" involve techniques and structures required to overcome difficult and hazardous conditions, such as wet ground and poor rock,

which would increase the uncertainty that the geologic repository would meet the performance objectives.

Comment No. 544: T. C. Gustavson (71)

In addition to being ambiguous, some requirements for the site (geologic setting) are phrased in such general terms so as to probably eliminate all known geologic settings. For example, Section 60.123 (p. 35290) indicates that "evidence of dissolutioning of soluble rocks" in the disturbed zone may "compromise site suitability." It is clear that in most geologic settings, some dissolution, in addition to salt dissolution (sometimes followed by reprecipitation) is to be expected especially in carbonates. Is the presence of dissolution of these "soluble rocks" really to be an important screening criteria? If so, a great deal more work will have to be done to determine the magnitude of this process.

Staff Response to Comment No. 544:

The staff recognizes that dissolution can be a common occurrence in certain rock types However, given the varying degrees to which dissolution can occur in rock, the staff considers it to be a factor that must be evaluated during siting. If the dissolutioning is not of a magnitude that could affect the suitability of a site to host a repository, DOE will be given the opportunity to so demonstrate in accordance with the provisions of paragraph 60.122(a) of the final rule.

Comment No. 545: U.S. DOE (48)

10 CFR 60.123(a)(5)

NRC Proposed Wording:

A fault in the geologic setting that has been active since the start of the Quaternary Period and which is within a distance of the disturbed zone that is less than the smallest dimension of the fault rupture surface.

Recommended Revision:

Add: Or, where the length of the smallest dimension is unknown, a fault in the geologic setting that has been active since the start of the Quaternary Period and whose active segment is within 1 km of the disturbed zone.

Rationale:

The potential structural condition described is unclear First, definition of the smallest dimension of the fault rupture surface is difficult. Does the Commission use last movement or total length as the critical dimension?

Secondly, there appears to be no direct correlation between the nature of the fault rupture surface (earthquake fault plane) and the magnitude of an earthquake. Once the magnitude of an earthquake is defined, the peak acceleration as a function of distance can be more credibly extrapolated. We are not sure that this adverse condition, as defined, is beneficial in defining the waste isolation characteristics of the repository.

Staff Response to Comment No. 545:

Paragraph 60.123(a)(5) has been deleted from the final rule because it was unclear. Faulting which could have an adverse effect on isolation will be reviewed under other provisions of the final rule.

Comment No. 546: N. K. Olson, S.C. Geological Survey (70)

Para 60.123, subpara (a)(5)

Last words, "that is less than the smallest dimension of the fault rupture surface" are somewhat confusing and too permissive. Compare with subpara (b)(8) which follows. Suggest rephrasing to avoid ambiguity.

Staff Response to Comment No. 546:

See response to Comment No. 545.

Comment No. 547: V. McIntyre (35)

60.123 (a) (5) This is obviously an attempt to define the near field of a fault. The determination of the extent of the smallest dimension of the fault rupture surface will require considerable effort. It will be difficult to implement and it may lead to a lot of unnecessary litigation by intervenors.

60.123 (b) (13) How about calling the conditions "oxidizing conditions"?

Staff Response to Comment No. 547:

In response to the comment on paragraph 60.123(a)(5), see response to Comment No. 545. The language "not reducing" is intended to identify neutral as well as oxidizing groundwater conditions as potentially adverse.

Comment No. 548: J. Adam (34)

§60.123(a)(8) Potentially adverse conditions.

Since the extent and nature of climatic changes, particularly those caused by man, can not be predicted over the long-term, this paragraph should read:

"Geologic, geochemical, or hydrologic characteristics which could be adversely effected by climatic changes."

Staff Response to Comment No. 548:

See Overview, Section-by-Section Analysis, § 60.122(c)(7).

Comment No 549: C. Walske, Atomic Industrial Forum (50)

Para. 60.123 Potentially adverse conditions

In Item (b), the demand for "investigation...to a depth of 500 meters below the limits of the repository excavation" without specifying the type of investigation, is excessive. Non-invasive techniques (i.e., seismic) are reasonable, but invasive techniques (drilling or shaft sinking) would unjustifiably degrade the integrity of the host rock.

Item (b)(2) is considered too restrictive since it may eliminate too many otherwise desirable sites. It would be illogical to preclude drilling--with appropriate precautions--for the purpose of site characterization, and pre-existing drillholes should be evaluated with consideration of depth, plugging and scaling, casing left in the hole and general care of execution (include documentation). It must also be recognized that there is a potential for the existence of undocumented drillholes within the operations area.

In Item (b)(3), the gross value of a resource, without regard to extraction cost, is a meaningless basis for comparison. Commercial potential is the only valid measure for judging the likelihood of future attempts at extraction.

Item (b)(8) is too stringent. Wide area uplift or subsidence are both very common and without effect on the integrity of the host rock. The real intent of this item, to the extent it is practical, is already expressed in (b)(7).

Staff Response to Comment No. 549:

The provisions of 60.123(b) as set forth in the proposed rule have been modified and no longer contain specified distances for the horizontal and vertical limits of investigations to be conducted. The NRC agrees that some of the potentially adverse conditions should be considered further away from the geologic repository.

The volume to be investigated is now described at § 60.21(c)(1)(ii)(B). Non-invasive techniques may be used so long as they will provide the needed information. Note, also, that the avoidance of unnecessary penetrations is addressed in the requirements for the site characterization set out at § 60.10.

The staff does not consider evidence of drilling for any purpose, as referred to in the commenter's second point, to be too restrictive because drillholes could constitute pathways to the accessible environment. Further, such provisions would not eliminate otherwise desirable sites if DOE can demonstrate that the condition does not compromise the ability of the site to host a geologic repository in accordance with paragraph 60.122(a) of the final rule. Regarding (b)(3), the staff believes that commercial potential alone is an inadequate basis for defining this potentially adverse condition. Over the period during which isolation may be required, resources may become economically recoverable even though they are not currently considered to have resource potential. To take this into account, it is important that the gross value of the resource be considered in relation to other deposits of the resource so as to form a basis for evaluating the future attractiveness of selecting the particular site as a location for recovery operations.

Although the staff recognizes that structural deformation is widespread we disagree with the commenter's final point. The staff considers structural deformation to be an important factor that should be evaluated during siting studies. Again, if the amount of structural deformation is not of a magnitude that could compromise the site's ability to host a geologic repository, DOE will be permitted to demonstrate this under 60.122(a).

Comment No. 550: U.S. DOE (48)

10 CFR 60.123(b)

NRC Proposed Wording:

Adverse conditions in the disturbed zone. For the purpose of determining the presence of the following conditions within the disturbed zone, investigations should extend to the greater of either its calculated extent or a horizontal distance of 2 km from the limits of the underground facility, and from the surface to a depth of 500 meters below the limits of the repository excavation.

Recommended Revision:

"... of 500 meters below the repository horizon. Within the limits of the engineered system such investigations will be made by non-invasive methods such as geophysical sensing, wherever possible, to reduce creation of potentially adverse conditions.

Rationale.

The NRC wording could be interpreted to suggest that these investigations would be made only by boreholes or other invasive procedures within the repository boundaries. We believe that such a requirement is too restrictive and inconsistent with other portions of the rule.

Staff Response to Comment No. 550:

See staff response to Comment Nos. 543 and 549.

Comment No. 551: Utility Nuclear Waste Management Group (44)

Again, the rule should specifically provide for a determination of the existence or non-existence of the potentially adverse conditions identified in § 60.123 on the basis of a reasonable analysis. In this regard, § 60.123(b) requires geologic investigation to a distance 500 meters below the repository. This appears excessive and, under some circumstances, could be counterproductive (as when a deeper aquifer is penetrated by an exploratory borehole). If a numerical value is deemed necessary, 100 meters would seem both more realistic and reasonable.

In addition, § 60.123(b)(14) identifies as potentially adverse "[g]roundwater conditions in the host rock, including but not limited to high ionic strength or ranges of Eh-pH, that could affect the solubility and chemical reactivity of the engineered systems." Any groundwater, however, will "affect" solubility and chemical reactivity. Accordingly, the proper issue is whether or not there will be a significantly adverse effect. The regulation should be revised to correctly reflect this concern, perhaps by adding

"adversely, in a significant way,"

after the word "affect" in the proposed text.

Staff Response to Comment No. 551:

See staff response to Comment Nos. 543 and 549. See Overview, Section-by-Section Analysis, 60.122(c)(8).

Comment No. 552: U.S. DOE (48)

10 CFR 60.123(b)(2)

NRC Proposed Wording:

(2) Evidence of drilling for any purpose.

Recommended Revision:

Add: "other than repository siting or construction."

Rationale:

The proposed languages fails to allow for exploratory activities.

Staff Response to Comment No. 552:

The staff considers that drilling, even for purposes related to repository development, is a potentially adverse condition. As in the case of other such conditions DOE may show (in accordance with § 60.122(a)) that the ability of the site to host a geologic repository is not compromised.

Comment No. 553: R. I. Newman, American Institute of Chemical Engineers (46)

In Section 60.123(b)(3), the gross value of resources should be omitted. There are many bodies of mineral resources so dilute that recovery is quite uneconomic, yet the total (gross) value of the contained resource could be considerable. Net value or commercial potential should be the only factors of consideration.

Staff Response to Comment No. 553:

Staff response to Comment No. 549.

Comment No. 554: Dr. T. C. Gustavson (71)

On p. 35283, column 2, paragraph 2, the statement is made that "the proposed technical criteria are written to direct site selection towards selection of sites of little resource value and for which there does not appear to be any attraction for future societies." This is probably the best approach to take to attempt to minimize human intrusion. Section 60.123(b)(3), however, states that an adverse condition exists only when the disturbed zone has resources that have a greater value than the average value for other areas of similar size located in the geologic setting. The intent of these two statements is not parallel. The first statement says to avoid areas of potential resources. The second says only that one adverse condition exists if the disturbed area can be shown to contain substantial mineral resources.

§§ 60.123

b) If the assessment of natural resources is limited only to a depth of 500 m below the repository, this will exclude recognition of most hydrocarbon resources in sedimentary basins. This excludes consideration of resources below 1500 m (5,000 ft) and most hydrocarbons are found at this depth or greater depths.

To conclude, the concepts and scope of the proposed rule are satisfactory, but the rule is vague and nonspecific in many areas. Because of the lack of specific or detailed requirements, the rule may not achieve its proposed objective, namely assurance that a waste repository does not become a safety and health hazard.

Staff Response to Comment No. 554:

See response to Comment No. 556. The provisions of 60.123(b) as set forth in the proposed rule have been modified and no longer contain specified distances for the horizontal and vertical limits of investigations to be conducted. The NRC agrees that some of the potentially adverse conditions should be considered further away from the geologic repository.

Comment No. 555: U.S. DOE (48)

10 CFR 60.123(b)(3)

NRC Proposed Wording:

(3) Resources that have either greater gross value, net value, or commercial potential than the average for other representative areas of similar size that are representative and located in the geologic setting.

Recommended Revision:

Delete "... that are representative of and located in the geologic setting."

Rationale:

The evaluation of the resource potential at a site by comparison with an equivalent potential in a larger geographic area is a valid approach. However, we are concerned that restricting the range of evaluation to "areas of similar size" located in the geologic setting (i.e., site) may be inappropriate because unique structured formations may be unnecessarily discriminated against. Specifically, we note that a salt formation is a unique feature in the geologic setting and may be considered a resource. But the ubiquitous nature of salt does not make a particular small body of salt an important resource. We do not believe that the Commission's intent is to eliminate salt from consideration as a potential host rock, given its many particular advantages.

Staff Response to Comment No. 555:

The staff is concerned that selection for a repository site of a formation that is unique within a particular geologic setting could lead to potential human intrusion in the unlikely event of failure of passive institutional controls. We consider this a potentially adverse condition that needs to be evaluated in accordance with the requirements of § 60.122(a).

Comment No. 556: P. C. Cahill, U.S. EPA (68)

We do not understand why your proposed section 10 CFR 60.123(b)3) includes the caveat that resources are to be compared with others "that are representative of and located in the geologic setting." We suggest that the resources also be compared with resources in other areas in different geological settings.

Staff Response to Comment No. 556:

As redefined in the final rule, a geologic setting is sufficiently extensive so as to assure that sites with potential resource value are recognized as such, and are appropriately evaluated. (See §60.21(c)(13) and §60.122(a)(2)). DOE would then need to show on the basis of the evaluation that the presence of the resources was not significant, (for example, because of the widespread presence of the same resources elsewhere, whether or not in the same geologic setting, much more favorable to exploitation or that there were compensating favorable conditions).

Comment No. 557: Div. of Emergency Government, State of Wisconsin (77)

60.123(b) -- The distance from the disturbed zone should be determined by rate of groundwater movement instead of 2 km.

60.123(b)(3) -- The exploitability of resources is a value judgment determined by industry. The standards for exploitation vary for each company, its location, the location of its clients, and the salability of the resource. Evaluation of resources should be given an in depth evaluation at any proposed site. The collapse of the salt mine near Lake Peigneur in Louisiana might be related to petroleum exploration nearby.

Staff Response to Comment No. 557:

The commenter's first point is well taken. This provision has been replaced by language which more closely ties the area of investigation to the performance objectives. See § 60.21(c)(1)(ii)(B).

On the second point, see response to Comment No. 556.

Comment No. 558: U.S. DOE (48)

10 CFR 60.123(b)(9)

NRC Proposed Wording:

More frequent occurrence of earthquakes of higher magnitude than is typical of the area in which the geologic setting is located.

Recommended Revision:

Delete the section.

Rationale:

Whether there is "more frequent occurrence of earthquakes" is irrelevant; what matters is whether the frequency and/or intensity of earthquakes is at an acceptable level.

Staff Response to Comment No. 558:

See Overview, Section 3.3, Siting Criteria. The staff considers "more frequent occurrence of earthquakes or earthquakes of higher magnitude than is typical..." to be a potentially adverse condition; whether or not their frequency or intensity is acceptable is the kind of judgment to be made as a result of the analyses required under § 60.122(a).

Comment No. 559: U.S. DOE (48)

10 CFR 60.123(b)(14)

NRC Proposed Wording:

Groundwater condition in the host rock, including but not limited to high ionic strength or ranges of Eh-pH, that could affect the solubility and chemical reactivity of the engineered systems.

Recommended Revision:

Change last clause to: "...that could increase the solubility of the radionuclides and chemical reactivity of the engineered system, thus increasing the rate of release and migration of radionuclides.

Rationale:

As written, the emphasis is on the engineered system. We suggest that the materials of concern are the radionuclides and that the section be reworded for clarity.

Staff Response to Comment No. 559:

Changes that would not increase the rate of release and migration of radionuclides could be shown not to have a significant effect, pursuant to §60.122(a)(3)(i)

Comment No. 560: Institute of Electrical and Electronics Engineers (28)

60.123(b)(12) Add the words "and adversely" before "affect."
60.123(b)(14) Add the words "and adversely" before "affect."

Staff Response to Comment No. 560:

See Overview, Section 3.3, Siting Criteria. Whether there is an adverse effect would be determined pursuant to §60.122(a)(3)(i).

Comment No. 561: H. Ross (14)

Section 60.123 (b)(15)

"Processes that would reduce sorption" are identified as a potentially adverse condition while sorption conditions themselves are seemingly given token recognition as a favorable condition in § 60.122 (g)(1). Both sorption and sorption reducing processes are site specific phenomena that can best be evaluated in the context of a systems analysis for the specific geologic site.

Staff Response to Comment No. 561:

In accordance with the regulations, both sorption, and sorption reducing processes will be evaluated in site-specific analyses.

Comment No. 562: U.S. DOE (48)

10 CFR 60.123(b)(15)

NRC Proposed Wording:

Processes that would reduce sorption, result in degradation of the rock strength, or adversely affect the performance of the engineered system.

Recommended Revision:

"...would reduce sorption of radionuclides, result in ..."

Rationale:

For clarity we suggest the insertion.

Staff Response to Comment No. 562:

Proposed paragraph 60.123(b)(15) has been modified, as suggested by DOE, and now appears as paragraph 60.122(c)(9).

THE FOLLOWING COMMENTERS ADDRESSED 60.124:

Comment No. 563: V. McIntyre (35)

60.124 This section is procedural in nature. It doesn't belong in Subpart E.

Staff Response to Comment No. 563:

The NRC does not share the commenter's view that the provisions of 60.124 are procedural in nature. On the contrary, these provisions provide some of the standards that will be used in arriving at findings about the ability of the geologic setting to meet the performance objectives relating to isolation of the waste. Therefore, NRC believes that these provisions are appropriately set forth in Subpart E.

Comment No. 564: J. Adam (34)

§ 60.124(b) Assessment of potentially adverse conditions.

This paragraph should be changed to read: "...evaluated using realistic analyses and assumptions,..."

The use of conservative analyses and assumptions in analyzing potential events can result in a lack of balance in the evaluation of a site and the rejection of, what is in fact, a good site.

Staff Response to Comment No. 564:

The wording "conservative analyses and assumptions" has been replaced with "assumptions which are not likely to underestimate its effect." The staff considers this change to alleviate the concern expressed in this comment.

Comment No. 565. U.S. DOE (48)

10 CFR 60.124(b)

NRC Proposed wording:

The effect of the potentially adverse human activity or natural condition on the geologic setting has been adequately evaluated using conservative analyses and assumptions, and the evaluation used is sensitive to the adverse human activity or natural conditions; and

Recommended Revision

"The effect of the potentially adverse human activity or natural condition on the geologic setting has been adequately evaluated using realistic yet conservative analyses and assuming anticipated processes and events, and the evaluation used is sensitive to the adverse human activity or natural conditions; and"

Rationale:

The term "conservative analyses and assumptions" could be construed to mean the speculative scenarios that have been used often in reactor siting. What is required in waste isolation is a realistic yet conservative analysis which assumes anticipated processes and events.

Staff Response to Comment No. 565:

See staff response to Comment No. 564. The provision has not been limited to anticipated processes and events because the overall system performance objectives also require consideration of unanticipated processes and events.

DESIGN AND CONSTRUCTION REQUIREMENTS [60.130-60.134]

General Discussion to Comment Nos. 566-654 on Design and Construction Requirements:

This section has been amended. A number of the detailed requirements which, upon review, would seem to presume or force a particular design have been deleted. However, in each case the health and safety objectives which were the subject of those specifications have been retained in a more general formulation. Specific design criteria are addressed below.

The staff does not believe that deleting specific design criteria will weaken the rule. All repository activities must comply with 10 CFR 20, which sets standards for protection against radiation in both restricted and unrestricted areas. Radiological protection can be achieved through a variety of design options that are currently being developed by DOE. At this early stage of repository development, however, specific design requirements could misdirect DOE's efforts.

Further, in response to several commenters, the staff has clarified the definition of "important to safety" to indicate that it applies to design of systems, structures and components the failure of which, during the preclosure period, could lead to offsite exposures in excess of 0.5 rem for any organ. The definition included in the final rule employs language similar to that proposed by several commenters, as it applies to the preclosure period.

A number of the same commenters expressed the opinion that the requirements for design of systems components and structures important to safety contained unnecessary detail and should be abbreviated. The staff declines to make these changes, since, for these systems determined to be important to safety, past Commission practice has been to provide general design criteria for such systems at a comparable level of detail. For example, 10 CFR Part 72 contains comparable requirements with respect to the design of systems, structures and components important to safety for an ISFSI.

Comment No. 566: Union of Concerned Scientists (59)

Should the design and construction requirements (sections 60.130 through 60.134) be abbreviated? (p. 20)

These requirements should not be abbreviated.

Furthermore, these requirements should address the monuments which are called for under section 60.51.

Staff Response to Comment No. 566:

With regard to the commenter's first point, see the general discussion above. With regard to the commenter's second point, a monument could be designed in many ways and still serve its purpose. The staff considers that design requirements for a monument would add excessive detail to 10 CFR 60. If deemed

desirable, however, they could be specified at a later date; they are not needed at this time. Nevertheless, in response to the comment, §60.21(c)(8) has been amended to require that the application include a conceptual design of the monuments. This will provide a basis for early review of the adequacy of DOE's plans as part of the licensing process.

Comment No. 567: Utility Nuclear Waste Management Group (44)

UNWMG believes that the level of detail required under the rule, as proposed, is excessive and should be greatly abbreviated. This comment is based upon what the UNWMG views of the basic desirability of maintaining flexibility with respect to design and construction wherever possible and minimizing unnecessary cost. It is difficult to identify any repository structure, system or component important to safety in terms of limiting accident doses to the public to levels such as the 0.5 rem prescribed in 10 CFR § 20.105(a) pertaining to allowable levels of exposure in unrestricted areas. Accordingly, the need to specify design and construction requirements, if any, is small.

Staff Response to Comment No. 567:

See general discussion preceding Comment No. 566.

Comment No. 568: U.S. DOE (48)

DESIGN/CONSTRUCTION REQUIREMENTS

The DOE comments on the Advance Notice of Proposed Rulemaking (ANPR), contained in a letter dated July 15, 1980, noted that in many cases design solutions to perceived problems were incorporated into the rule rather than technical criteria or performance objectives. We note that the proposed rule is substantially improved from the ANPR in this area. We believe that sections 60.130 through 60.134 are generally at an appropriate level of detail to allow the NRC to regulate design and construction while still giving DOE the necessary flexibility to provide the appropriate design. There are still a few areas where the level of specificity is unwarranted or the rule may otherwise deviate from past practice. These are presented in the detailed comments in enclosure B. (See PDR letter 48 for Enclosure B.)

Staff Response to Comment No. 568:

See the general discussion preceding Comment No. 566 as well as responses to specific comments by DOE.

Comment No. 569: C. Walske, Atomic Industrial Forum

The requirements given in the proposed rule are much too detailed. Many of them more properly belong in supporting documents such as NRC Regulatory Guides. Only those design and construction requirements which are important to safety should be included in the rule. A' "important to safety" needs to be defined. Our proposed definitio[illegible] [illegible]ven in Paragraph 60.2. Detailed recommendations are given in the comments [illegible] Section 60.130-60.135 under the heading "Design and Construct[illegible]on Requi[illegible]ements.

Staff Response to Comment No. 569:

See general discussion precedin[illegible] [illegible]ent No. 566.

Comment No. 570: Bechtel National, Inc. (37)

The Commission seeks comments on formulations for the design and construction criteria in the rule.

> There should be few, if any, components designated as "important to safety" related to the design and construction of the repository. Consequently, any formulations of such design and construction criteria should deal with safety principles and criteria to be incorporated in the design as opposed to design details that are more appropriately the subject of regulatory guides.

Staff Response to Comment No. 570:

See general discussion preceding Comment No. 566. It should be noted, however, that these criteria deal with design of systems important to waste isolation as well as important to safety. We believe the commenter may not have taken this concern into account.

Comment No. 571: Westinghouse Corp. (54)

The design and construction requirements contained in the proposed Technical Criteria are much too detailed, some are conflicting, some are unnecessarily restrictive, and some are completely unnecessary. The rule should contain only top level criteria and requirements and, where appropriate, they should clearly identify the concern being addressed. Details associated with the top level requirements are best contained in supporting documents such as Regulatory Guides.

Staff Response to Comment No. 571:

See general discussion preceding Comment No. 566.

Comment No. 572: Virginia Electric and Power Co. (64)

The level of detail required for design and construction of the repository is excessive and should be reduced. This comment is based on the desirability to maintain flexibility with respect to design and construction wherever possible and minimize unnecessary cost.

Staff Response to Comment No. 572:

See general discussion preceding Comment No. 566.

Comment No. 573: Sierra Club (66)

We support the inclusion of detailed design and construction criteria in the rule itself and not in supplementary Regulatory Guides. The proposed rule paints a much more technologically complex picture of waste disposal than the nuclear industry does and if honestly adhered to by the NRC staff and licensing boards will go a long way toward restoring public confidence in the Federal agencies and the process of siting a waste repository.

Staff Response to Comment No. 573:

See general discussion preceding Comment No. 566.

Comment No. 574: Westinghouse Corp. (54)

Many of the design and construction requirements refer to "structures, systems, and components important to safety." However, without a definition of "important to safety," there is no basis for determining what should be considered under this category. In reality, a repository operations area will have very few structures, systems, or components that are important to assuring the health and safety of the public. However, it is important to specify those components that are important because special design, procurement, construction, and quality assurance requirements will be applied to them.

Staff Response to Comment No. 574:

See general discussion preceding Comment No. 566. See also Overview, Section 4.5, Important to Safety.

Comment No. 575: Northeast Utilities (79)

We believe that the level of detail required under the proposed rule should be reduced. This comment is based on the desire to maintain flexibility with respect to design and construction and to minimize unnecessary cost. Further, the proposed rule does not identify a design basis accident with the result

that it is not possible to identify any repository structure, system or component important to safety in terms of limiting accident doses to the public, such as the 5 rem level prescribed in 10 CFR § 72.68. Accordingly, the need to specify design and construction requirements important to safety, beyond Part 20, needs clarification. Also, the imposition of quality assurance requirements contained in Part 50 Appendix B to systems that prevent or mitigate the consequences of events that cause undue risk to the public is meaningless without defining these events.

Staff Response to Comment No. 575:

See general discussion preceding Comment No. 566. See also Overview, Section 4.5, Important to Safety.

THE FOLLOWING COMMENTERS ADDRESSED 60.130:

Comment No. 576: National Association of Counties Research, Inc. (1)

§ 60.130 - Controlling access to the site is much more important than indicated by the twelve words accorded it here. The necessity of maintaining security over a long period may mean that both engineered and natural security systems should be employed. Strict personnel security approaches must be used. None of this is reflected in the general statement about controlling access.

Also in this section, a sub-section concerning "means to control infiltrating water and its migration through sub-strata" should be included.

Staff Response to Comment No. 576:

On the question of physical security, the important part of the design criteria is the provision (§60.132(a) of the final rule) that the design of surface facilities allow safe handling and storage of wastes. The adequacy of the security program is not otherwise a siting or design concern and is therefore not further addressed in Subpart E. It should be noted, however, that DOE will be required to include, in its license application, a description of the physical security plan for protection against radiological sabotage as well as a description of controls to restrict access. §§60.21(b)(4), 60.21(c)(8). This information will be evaluated by the Commission in making licensing determinations with respect to public health and safety. In addition to the issue of radiological safety, NRC will also need to determine whether DOE's proposed activities would be inimical to the common defense and security; in this regard, however, a DOE certification that it will provide such safeguards as it requires at

comparable DOE surface facilities will constitute a rebuttable presumption of nonimicality. §§60.31(b), 60.41(c). The NRC's general requirements for physical protection of plants and materials are contained in Part 73. Although Part 73 does not apply to facilities licensed under Part 60 (since the activities of DOE would not fall within any of the categories listed in the Scope definition, 73.1(b)), the staff anticipates that it will provide substantial guidance in determining whether or not adequate protection against radiological sabotage has been provided. On matters of physical protection, particularly insofar as issues of common defense and security are concerned, the staff considers it appropriate to give substantial weight to the expertise and independent statutory obligations of DOE. See also 46 FR 13975-13976.

Groundwater infiltration and migration are treated in part in the siting criteria. In addition, however, see § 60.133(d), which requires the design of water control systems to be of sufficient capability and capacity to reduce potentially adverse effects.

Comment No. 577: Institute of Geological Sciences, London (29)

Further geological aspects of the technical criteria, especially those concerned with geomechanical, geochemical and the nature and design of backfilling materials are contained in Sections 60.132, 60.133, 60.134 and 60.135 (pp. 35293-35295). These are concerned with the design and construction requirements of the repository and include some very definitive statements, such as the requirements of the backfill placed in a facility. It can be argued that it is neither proven, nor generally accepted, that such requirements are necessary and that, accordingly, these statements are premature.

Staff Response to Comment No. 577:

See general discussion preceding Comment No. 566.

Comment No. 578: Bechtel National, Inc (37)

During repository operations, there are expected to be few, if any, credible accidents that can result in significant radiological exposure to off-site personnel. Consequently, there should be few, if any, components designated as "important to safety". For this reason, it should not be necessary for Sections 60.130 through 60.134 to deal so extensively with design and construction requirements for items "important to safety" that will not be present or functional after the operations period has passed.

Furthermore, many of the proposed requirements for these sections tend to prejudge the final repository design and are presented at a level of detail that goes far beyond that which is normally included in Title 10 regulations. Some examples of requirements that fall into this category are contained in 60.130 (b)(4)(iii) and (iv), 60.130 (b)(1)(vi), 60.130 (b)(6)(iii) and (iv), 60.131 (a), 60.132 (c)(2), 60.132 (e)(1), 60.132 (e)(3)(v), 60.132 (f), 60.132 (g), 60.132 (h)(2) and (4), 60.132 (j)(1), and 60.133 (c).

For the reasons expressed above, we recommend that the design and construction requirements be considerably shortened and simplified. They should deal with safety principles and criteria to be incorporated in the design as opposed to design details that are more appropriately the subject of regulatory guides.

Staff Response to Comment No. 578:

See general discussion preceding Comment No. 566, and Overview, Section-by-Section Analysis of individual provisions.

Comment No. 579: Utility Nuclear Waste Managment Group (44)

Sections 60.130 to 60.134, inclusive, specify numerous requirements for the design of, and construction specifications for, the geologic repository operations area. As discussed in the letter to which this Attachment is appended, UNWMG believes that the level of detail prescribed is excessive and should be greatly abbreviated. This comment is based upon what the UNWMG views as the basic desirability of maintaining appropriate flexibility with respect to repository design and construction. Nevertheless, UNWMG is of the view that the rule will at least be generally practical if the suggested modification to the definition of "important to safety," discussed above in connection with § 60.2, is adopted. There are, however, several areas which are in need of particular attention.

Staff Response to Comment No. 579:

See general discussion preceding Comment No. 566.

Comment No. 580: C. Walske, Atomic Industrial Forum (59)

Para. 60.130 - 60.134 - General design requirements for the geologic repository operations area.

A HLW repository is expected to have few, if any, structures, systems or components which are designated as"important to safety" in order to assure protection of the public against undue radiological risk during the repository operations period. Thus, it should not be necessary for items 60.130 through 60.134 to deal so extensively with design and construction requirements for items "important to safety" that will not be present or functional after the following operations period has passed. For example, it is recommended that the

following sections be deleted as they provide unnecessary regulatory detail and may imply a level of design assurance not necessitated by the safety function of the items involved:

60.130(b)(2)(i), 60.130(b)(4)(iii), 60.130(b)(4)(iv), 60.130(b)(5)(i), 60.130(b)(6)(ii), 60.130(b)(6)(iii), 60.130(b)(6)(iv), 60.130(b)(7), 60.130(b)(9), 60.133(c), 60.134(a), and 60.134(g)

Item 60.130(b)(1) - Paragraphs (i) through (vi) of Item 60.130(b)(1) could be eliminated without significantly changing the regulatory content of the section since these requirements are implicit to meeting the requirements of Part 20.

Item 60.130(b)(1)(vi) - The type and extent of redundancy in the radiation alarm system should be specified if this requirement is retained. For example, is redundancy of the detection instruments sufficient or is it intended for the redundancy to include the annunciators and the electrical power supply? It is not apparent that any redundancy should be specified as this tends to prejudge the design and the extent of the hazards involved. (Note that 10 CFR 72 does not require redundancy for the radiation alarm system. If the wording of 10 CFR 72 is appropriate, it is recommended that it be used without change in 10 CFR 60.)

Staff Response to Comment No. 580:

See general discussion preceding Comment No. 566, and Overview, Section-by-Section Analysis of individual provisions. With respect to the radiation alarm system the staff agrees that the language contained in 10 CFR Part 72 is appropriate and has modified the rule accordingly.

Comment No. 581: V. McIntyre (35)

60.130 (a) Are the first two sentences really needed? If not, drop them.

60.130 (b) (3) This requirement was obviously lifted from reactory technology. It adds nothing to the technical criteria and it should be dropped.

60.130 (b) (6) Is this requirement necessary?

Staff Response to Comment No. 581:

Paragraph 60.130(a) has been rewritten to better indicate the scope of the paragraphs that follow. As for 60.130(b)(3), since mining operations will include large equipment and machinery the staff considers that it is important to require design to protect against dynamic effects. Hence, although the staff recognizes that loss of safety functions seems to be a remote possibility, it still seems to merit consideration in the design. However, the language has

been modified for clarity. Finally, with respect to 60.130(b)(6), the staff has reviewed the paragraph and has determined that subparagraph (i) should be limited to items important to safety, and that the provisions of subparagraph (iii) were dealt with under provisions for testing structures, systems and components important to safety (60.130(b)(7)).

Comment No. 582: U.S. DOE (48)

10 CFR 60.130(b)(1)(vi)

NRC Proposed Wording:

"The alarm system shall be designed with redundancy and in situ testing capability."

Recommended Revision:

"The alarm system shall be designed with high reliability and in situ testing capability."

Rationale:

Consistent with nuclear power plant practice, not all radiation alarms in the repository operations area need be redundant.

Staff Response to Comment No. 582:

In reviewing this comment, the staff has determined that it would be appropriate to follow the language of a similar design requirement in Part 72 in view of the comparability of the operations involved.

Comment No. 583: U.S. DOE (48)

10 CFR 60.130(b)(1)(vi)

NRC Proposed Wording:

"A radiation alarm system to warn of increases in radiation levels,"

Recommended Revision:

"A radiation alarm system to warn of increases approaching a safety set point value below maximum permissible levels,"

Rationale:

Increases in very low levels need not be alarmed.

Staff Response to Comment No. 583:

In reviewing this comment, the staff has determined that it would be appropriate to follow the language of a similar design requirement in Part 72 in view of the comparability of the operations involved.

Comment No. 584: C. Walske, Atomic Industrial Forum (50)

Item 60.130(b)(2) - The intended difference between Items (i) and (ii) is not clear. Both paragraphs deal with anticipated natural phenomena and environmental conditions for the design of structures, systems and components important to safety. Paragraph (i) applies to interference with normal operation during the period of construction and operations, while Paragraph (ii) applies to failure to achieve the performance objectives in any relevant time period. Therefore, Item (ii) would appear to encompass all of the requirements of Item (i).

Since an "anticipated event" is defined as one that is "reasonably likely to occur during the period the intended performance objective must be achieved", is it the NRC intent that important-to-safety items required for the operations period be designed to retain their safety function for a 100-year earthquake, and that the engineered barriers used for long-term protection be designed to withstand a 10,000-year earthquake? The NRC intent needs to be more clearly expressed.

Staff Response to Comment No. 584:

In response to the AIF comment, Sections 60.130(b)(2)(i) and 60.130(b)(2)(ii) have been combined into one paragraph. Also, the staff agrees that the period of applicability with respect to items important to safety was not clear in the proposed rule. In the final rule, "important to safety" is defined to be applicable prior to permanent closure of the repository.

Comment No. 585: U.S. DOE (48)

10 CFR 60.130(b)(2)(i)

NRC Proposed Wording:

"The structures, systems, and components ... shall be designed ... to accommodate the effects of environmental conditions so as to prevent interference with normal operation ... ."

Recommended Revision:

"The structures, ... to prevent interference with necessary safety functions during the entire period of construction and operation."

Rationale:

The goal of the design of safety systems should be the maintenance of the safety of the facility, not normal operations. It would be unnecessary to design the facility to operate normally through a tornado or an earthquake.

Staff Response to Comment No. 585:

The staff agrees with the thrust of DOE's comment. Paragraph 60.130(b)(2)(i) has been revised accordingly.

Comment No. 586: C. R. Fisher, General Atomic Co. (16)

Section 60.130(b)(4)

In order to add a necessary degree of precision, General Atomic suggests that the last part of paragraph (i) be altered to read "...during and after the maximum credible fire or explosion in the geologic..." In addition, General Atomic suggests that a criterion be added which excludes the use of explosive and flammable materials in the emplacement operations areas.

Staff Response to Comment No. 586:

Paragraph 60.130(b)(4)(i) has been modified in response to the suggestion in the comment. The word "credible" has been inserted before "fires" in the final rule. The NRC staff believes that it is desirable for similar concepts to be expressed consistently in different parts of the regulations. The term "maximum" does not appear in this context in Part 72 and hence is not included here.

With respect to the use of explosives in the emplacement areas, while it is a good point, it pertains to how operations are conducted rather than to design of the geologic repository operations area, and is not appropriate for inclusion in Subpart E.

Comment No. 587: R. J. Newman, American Institute of Chemical Engineers (46)

Section 60.130(b)(6)(iv) requires that "all systems important to safety shall be designed to permit them to be maintained at all times in a functional mode." This is contrary to NRC requirements in other facilities where redundant systems are required to permit one of two or more systems to be removed from service--in other words, be not "in a functional mode"--for maintenance while the other systems provide the required capability for safety.

Staff Response to Comment No. 587:

This section was intended to deal with emergency power only. The wording has been revised to clarify the intent of this requirement. See Overview, Section-by-Section Analysis, 60.131(b)(5).

Comment No. 588: C. Walske, Atomic Industrial Forum (50)

Item 60.130(b)(9) - The statement that "systems shall be designed with sufficient redundancy to ensure that adequate margins of safety are maintained" is vague. The statement should be deleted or if retained rewritten as follows;

> "When instrumentation and control systems are necessary to monitor and control the behavior of engineered systems 'important to safety', they shall be designed to cover anticipated ranges for normal operation and for accident conditions."

Staff Response to Comment No. 588:

The staff agrees with this comment, and has deleted this statement. In those cases where redundancy is appropriate to monitor safety functions, it is implicit in this and other requirements.

Comment No. 589: C. Walske, Atomic Industrial Forum (50)

Item 60.130(b)(10) - In the context of this paragraph, the statement that the repository operations area shall "include such provisions for worker protection as may be necessary to provide reasonable assurance that all structures, systems, and components important to safety can perform their intended functions" makes no sense. This paragraph should be rewritten with the intent clarified.

Staff Response to Comment No. 589:

The staff declines to modify the language. It should be noted, however, that this provision is not intended to assert NRC authority over mining safety

practices generally; but to the extent that the safety of workers is necessary for systems important to safety to perform their intended function, the relevant design features are of legitimate concern to NRC.

Comment No. 590: R. V. Wyman, University of Nevada (5)

Suggestion: Omit rule (h)(2) and rely on the design group to provide access in accordance with the general rule on 35282 Col. 3 par. 1 and 2.

Staff Response to Comment No. 590:

See response to Comment No. 612.

THE FOLLOWING COMMENTERS ADDRESSED 60.131:

Comment No. 591: J. Carson Mark, U.S. NRC Advisory Committee on Reactor Safeguards (10)

Specification of Design and Construction Criteria

We believe that detailed design and construction criteria should not be included in the rule. It would be better to incorporate information of this type in supplementary regulation guides.

Staff Response to Comment No. 591:

See general discussion on the design section preceding Comment No. 566.

Comment No. 592: Institute of Electrical and Electronics Engineers (28)

60.131(a) The applicant should be required to state where all the retrieved waste would be stored, either at the repository site or at other locations. This requirement would help ensure that advance planning takes place for dealing with this possibility.

Staff Response to Comment No. 592:

The safety analysis report (60.21(c)(12)) requires a description of plans for retrieval and storage of radioactive waste, should retrieval be necessary. This requirement seems to satisfy the intent of the commenter's suggestion.

Comment No. 593: C. Walske, Atomic Industrial Forum (50)

Item 60.131(a) - The waste package design may preclude the need for a decontamination facility for waste containers in the surface facility; e.g., if the self-shielded package design is used. Thus, this section of the rule is too design specific and should be modified accordingly. Furthermore, "wastes" cannot be decontaminated.

Item 60.131(c) - This section contains requirements that are very similar to those of Section 60.130(b)(1). It is recommended that these sections be combined in Section 60.130.

Staff Response to Comment No. 593:

The referenced sentence in section 60.131(a) has been deleted. The staff recognizes that the radiation control requirements in § 60.131(c) are very similar to those in 60.130(b)(1). It would not be appropriate to combine them, however, because 60.131(c) refers to offsite effluents and 60.130(b)(1) addresses worker protection within the geologic repository operations area.

Comment No. 594: Div. of Emergency Government, State of Wisconsin (77)

60.131(b) -- What processing is contemplated? How much manipulation will be required at the surface?

Staff Response to Comment No. 594:

The extent of processing and manipulation is dependent upon the operations which DOE proposes to conduct at the geologic repository operations area.

Comment No. 595: V. McIntyre (35)

60.131 (e) This is so elementary that it is hardly worth including as a requirement.

Staff Response to Comment No. 595:

Past experience with the difficulties of decontamination argues that this is a worthwhile requirement to include in the technical criteria.

THE FOLLOWING COMMENTERS ADDRESSED 60.132:

Comment No. 596: Mississippi Dept. of Natural Resources (65)

Section 60.132

This section is particularly vague and general. As one example, what is the meaning of "control of groundwater movement" in (a)(2)?

Staff Response to Comment No. 596:

As to the question of specificity, see general discussion preceding Comment No. 566.

With respect to 60.132(a)(2), the staff agrees that this paragraph was particularly ambiguous as well as redundant and has deleted it.

Comment No. 597: C. Walske, Atomic Industrial Forum (50)

Item 60.132(a)(1) - The Commission's intent for the additional design requirements for the underground facilities, listed as Item (1), is too broad. The NRC should define what is meant by "interactions among geologic setting, the underground facility, and the waste package."

Staff Response to Comment No. 597:

The staff agrees with the comment and has deleted Paragraph 60.132(a)(1).

Comment No. 598: C. R. Fisher, General Atomic Co. (16)

Section 60.132(b)

General Atomic believes that this paragraph is too non-specific to be of any use. In addition, the degree of design flexibility should be left to the designer. Therefore, unless the guidance NRC intends to communicate through this paragraph can be made more specific, the paragraph should be deleted.

Staff Response to Comment No. 598:

Paragraph 60.132(b) does not specify any degree of design flexibility other than whatever is necessary to accommodate site conditions as they may be identified during construction and operation. The NRC did not intend to communicate anything more or less specific than that.

Comment No. 599: C. Walske, Atomic Industrial Forum (50)

60.132(c)(1) - Delete "or retrieval" since if waste retrieval occurs, concurrent excavation activities would, in all likelihood, stop -- and would surely stop if retrieval operations were impaired. Even with this change, it is not clear why this separations criterion should be a regulatory requirement. Deletion of this section is recommended.

Staff Response to Comment No. 599:

See general discussion preceding Comment No. 602 and Overview, Section-by-Section Analysis, § 60.133.

Comment No. 600: U.S. DOE (48)

10 CFR 60.132(d)(2)

NRC Proposed Wording:

"Ensure sufficient structural stability of openings and control of groundwater to permit the safe conduct of waste retrieval operations,"

Recommended Revision:

"Ensure ... groundwater to permit the safe conduct of waste emplacement operations. Structural support shall be provided, as required to ensure structural stability of the openings upon removal of any backfill material which may have been emplaced, or upon preparation of the unbackfilled storage rooms prior to retrieval and for the duration of retrieval operations in each module;"

Rationale:

The regulation should not arbitrarily preclude backfilling emplacement areas prior to decommissioning.

Staff Response to Comment No. 600:

The Commission did not intend to place any requirements upon subsurface openings that would preclude their backfilling prior to permanent closure. Upon review, the staff has concluded that paragraphs 60.132(d)(2) and (3) are repetitive and adequately covered by §60.133(c).

Comment No. 601: C. Walske, Atomic Industrial Forum (50)

Item 60.132(d)(2) - If retrieval occurs, the regulations should be sufficiently flexible to allow for re-excavation of original openings, excavation of new openings, and the addition of new underground features for the control of groundwater. This paragraph should be revised accordingly or deleted.

Staff Response to Comment No. 601:

See response to Comment No. 600.

Comment No. 602: C. Walske, Atomic Industrial Forum (50)

Item 60.132(e)(1) - Since backfill may be added soon after waste emplacement, it may not be necessary to maintain stability for all subsurface openings throughout the operations period, but rather, for a much shorter period only and before local bulk temperatures have increased significantly. Thus, this paragraph appears to be overly restrictive in requiring all openings to be designed to maintain stability throughout the operations period.

Staff Response to Comment No. 602:

Upon review, the staff considers the cited paragraph to be overly detailed and has revised it as described in the general discussion preceding Comment No. 566. See also Overview, Section 2.2, Retrievability.

Comment No. 603: U.S. DOE (48)

10 CFR 60.132(e)(3)(v)

NRC Proposed Wording:

"The ability to construct the underground facility as designed so that stability of the rock is enhanced."

Recommended Revision:

"The ability to construct the underground facility as designed so that the stability of the rock is not significantly reduced."

Rationale:

It is impossible to "enhance" the stability of the natural formation while driving tunnels through it.

Staff Response to Comment No. 603:

The cited provision has been deleted. See general discussion preceding Comment No. 566.

Comment No. 604: C. Walske, Atomic Industrial Forum (50)

Item 60.132(e)(3)(v) - This is an impossible requirement. Creating any subsurface opening cannot enhance stability of the rock. The word "enhanced" should be replaced by the words "not unnecessarily diminished" or this item should be deleted.

Staff Response to Comment No. 604:

See response to Comment No. 603.

Comment No. 605: C. Walske, Atomic Industrial Forum (50)

Item 60.132(f) - This paragraph seems to preclude any method of excavation except continuous mining. The paragraph should be deleted since there is a more appropriate statement contained in 60.134(d) that deals with damage to and fracturing of rock.

Staff Response to Comment No. 605:

The paragraph has been revised to avoid an interpretation that would preclude any suitable excavation method. The design must nevertheless limit the potential for creating a preferential pathway.

Comment No. 606: C. Walske, Atomic Industrial Forum (50)

Item 60.132(g) - The extent to which water and gas control needs to be established for repository design is dependent upon the specific site and rock medium being used. For this reason, some of the requirements in this section may not be applicable or appropriate to a specific repository design. The section should state, therefore, that the requirements apply only where appropriate, or those requirements that are not generic to all sites and media should be deleted. Sections (g)(1) through (g)(6) should be replaced with the following:

> "Water and gas control shall be provided, as appropriate, to control and monitor the quantity of water or gas in the subsurface facilities during the construction and operation periods."

Staff Response to Comment No. 606:

The NRC staff agrees that the extent of water and gas controls would depend upon where the repository was constructed. In response to public comment, the staff has deleted the more detailed requirements of 60.132(g). All that remains is a general requirement which would be applicable to any geologic setting. The provision is not limited to the period of operations since control of groundwater intrusion is also important to waste isolation.

Comment No. 607: U.S. Department of the Interior (24)

Page 35293, column 1, item (g)(1). What is "service water?" Should this say "surface water?"

Page 35293, column 3, item (ii)(A). In view of the difficulty of placing backfill in the drifts of a mine, it is not reasonable to make the general statement that the backfill shall provide a barrier to ground-water movement into and from the underground facility. This may be feasible for specific rock types and conditions, but as a general requirement it would be difficult to comply with. We suggest the following: "To the extent possible, it shall minimize ground-water movement..."

Item (B). Change "reduce" to "minimize."

Item (C). See comments on item (A). We suggest the following: "To the extent possible, it shall minimize ground-water movement..."

Staff Response to Comment No. 607:

The requirement was for "service water," as stated. "Service water" was in reference to water used for cooling machinery, drilling fluids, or similar purposes. For clarity, however, the staff has revised Section 60.132(g). See staff response to Comment No. 606.

The detailed provisions set forth in paragraph 60.132(i)(3)(ii)(A)-(C) have been deleted.

Comment No. 608: N. D. Lewis, State of Washington Energy Facility Site Evaluation Council (36)

We do not believe that it is appropriate that a geological setting should be chosen which would require extensive gas and water control values, pipelines and similar features as stated in 10 CFR 60.132(g). Failure of such control devices may compromise package integrity.

Staff Response to Comment No. 608:

The staff does not anticipate any excessive or extraordinary means for controlling gas and water in the underground facility. However, the staff recognizes that in any underground excavation there may be water and gas inflow, and the requirement is therefore included as appropriate to consideration of the design of the repository. See also staff response to Comment No. 606.

Comment No. 609: Utility Nuclear Waste Management Group (44)

First, § 60.132(g)(4) states that "Water control systems shall be designed to include storage capability and modular layouts that ensure that unexpected inrush or flooding can be controlled and contained." This requirement is overly vague. It should be recast in terms of controlling and containing unexpected inrushes of water or flooding that can reasonably be hypothesized.

Second, § 60.132(j)(2) requires that handling systems be designed "to minimize the potential for operator error." The design of a handling system, however, is a function of a number of considerations (such as space availability, reliability, maintainability, etc.), and cannot have as a sole goal minimizing the potential for operator error. This section should be revised to reflect this fact.

Third, § 60.133(b)(1) should be deleted. The decision to seal shafts and boreholes is an operational one. Accordingly, it should be made by the operator on the basis of operational considerations.

Finally, § 60.133(b)(2) is unduly restrictive and, in fact, would discriminate against favorable media such as salt. The first sentence should be deleted.

A design aim for such seals would be more realistically and soundly based on a performance objective tied to overall system performance, e.g., if it prescribed that shaft and borehole seals be so designed and constructed as not to compromise the overall system performance objective.

Staff Response to Comment No. 609:

The cited paragraphs have all been deleted for reasons given in the Overview, Section-by-Section Analysis.

Comment No. 610: U.S. DOE (48)

The requirements placed on the sealing of boreholes and shafts appear to be excessive and undemonstrable. We have suggested that rather than requiring seals to match the performance of the native rock and not become preferential pathways for water flow that the requirement be stated in terms that would relate seal performance to the overall performance of the repository.

Staff Response to Comment No. 610:

The staff agrees that the proposed rule contained excessive detail regarding the design of seals for boreholes and shafts ahd has modified the final rule along the lines suggested by the commenter.