

Operations, or designee, the letter must contain the following statement:

"If you wish to have the above decision further reviewed, you may appeal in writing to (review officer/address) within 30 calendar days of the date of this letter explaining why you believe the decision is

incorrect. Your request for review should be submitted through this office. Since this review will be based on the record, including papers filed, FmHA files, notes, or transcripts of the appeal meeting, my decision, applicable statutes and regulations, and any additional written information you wish to

submit, you should include any additional information you think is important, including any changes you believe should be made on the attached hearing notes."

2. Exhibit D is revised to read as follows:

EXHIBIT D.—HEARING/REVIEW OFFICERS DESIGNATIONS

Decision maker or decision	Hearing officer	Review officer
County Supervisor	District Director or person designated by State Director	State Director or designee (who has not been significantly involved with the case).
County Committee	State Director or designee	Deputy Administrator, Program Operations or designee.
District Director	State Director or designee	Deputy Administrator, Program Operations or designee.
State Director	Deputy Administrator, Program Operations or designee	(No review)
Division Director or Assistant Administrator	Deputy Administrator, Program Operations or designee	Do
Deputy or Associate Administrator	Administrator or designee	Do
Decision to foreclose real estate	District Director	State Director or designee.
For accounts serviced in the county office	District Director from another district or other person not involved in the initial decision designated by State Director.	Deputy Administrator, Program Operations or designee.
For accounts serviced in the district office	Deputy Administrator, Program Operations or designee	(No review)

Notes.—

1. District Director also means Assistant District Director.
2. County Supervisor also means Assistant County Supervisor with loan approval authority.

3. Designee is the person designated by the Hearing/Review Officer to conduct a hearing or review. The designee signs the decision letter to the appellant without the concurrence of the original Hearing/Review Officer except:

a. For hearings on County Committee decisions. For these hearings the State Director or Acting State Director may designate other persons to act on his or her behalf in conducting the hearing; however, the State Director or Acting State Director must sign the hearing decision letter.

b. When the Hearing/Review Officer, designated by the Deputy Administrator, Program Operations, is not a member of the National Office staff, the complete case file, hearing notes, tapes recordings, and a recommended decision will be sent to the Deputy Administrator, for review and a final decision.

c. When the Hearing/Review Officer is a member of the National Office staff, after the decision is written, but prior to notification of the applicant, in all cases requiring corrective actions or training (e.g. reversals or other problems which may become evident) the Hearing/Review Officer will brief the Deputy Administrator, Program Operations, concerning the decision and will notify the State Director involved that the decision will be reversed or modified and will advise the State Director of what corrective action will have to be taken.

4. For decision not directly covered above, the Hearing/Review Officer is the person in the next higher level of FmHA authority.

(7 U.S.C. 1989; 42 U.S.C. 1480; delegation of authority by the Secretary of Agriculture, 7 CFR 2.23; delegation of authority by the Under Secretary for Small Community and Rural Development, 7 CFR 2.70)

Dated: June 1, 1983  
 Neal Sox Johnson,  
 Acting Administrator, Farmers Home Administration.

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NUCLEAR REGULATORY COMMISSION

10 CFR Part 60

Disposal of High-Level Radioactive Wastes in Geologic Repositories Technical Criteria

AGENCY: Nuclear Regulatory Commission.

ACTION: Final rule.

SUMMARY: The Nuclear Regulatory Commission (NRC) is publishing technical criteria for disposal of high-level radioactive wastes (HLW) in geologic repositories, as required by the Nuclear Waste Policy Act of 1982. The criteria address siting, design, and performance of a geologic repository, and the design and performance of the package which contains the waste within the geologic repository. Also included are criteria for monitoring and testing programs, performance confirmation, quality assurance, and personnel training and certification.

EFFECTIVE DATE: July 21, 1983.

FOR FURTHER INFORMATION CONTACT: Patricia A. Comella, Deputy Director of the Division of Health, Siting and Waste Management, Office of Nuclear Regulatory Research, U.S. Nuclear

Regulatory Commission, Washington, D.C. 20555, Telephone (301) 427-4816.

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Background

On February 25, 1981, the Nuclear Regulatory Commission published rules

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which established procedures for the licensing of geologic disposal, by the U.S. Department of Energy (DOE), of high-level radioactive wastes (HLW). 48 FR 13971. On July 8, 1981, NRC proposed technical criteria which would be used in the evaluation of license applications under those procedural rules (48 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 that are published here. No significant new issues were raised in the four letters received too late for consideration. The principal comments, and the Commission's responses, are reviewed in the discussion below. A more detailed analysis of the comments is contained in a NRC staff report (NUREG-0804) which is being distributed to all commenters on the proposed rule and which may be purchased by other interested parties from the NRC's GPO Sales Program, Washington, D.C. 20555. Upon publication, a copy will be placed in the Public Document Room (PDR), 1717 H Street NW., Washington, D.C. 20555. This staff report includes a technical rationale for the performance objectives in 10 CFR Part 60 as well as the comment analysis. The final rules contain a number of changes, explained in this statement, that reflect concerns addressed in the public comments.

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.

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.<sup>1</sup>

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.<sup>2</sup> In addition to the objective of assuring that licensed facilities will adequately isolate HLW over the long term, these provisions also address considerations related to health and safety during the operational period 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

<sup>1</sup> 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.

<sup>2</sup> 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.

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.<sup>3</sup> 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.

#### 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

<sup>3</sup> 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 212(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.)

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.

#### 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 times 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 will be contained in NUREG-0804. 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 provisions would not be controlling.

Similarly, the Commission may approve or specify a radionuclide release rate or a pre-waste-emplacment 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 principals 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.

#### 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 objective 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.<sup>4</sup>

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

<sup>4</sup>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)(E). 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.

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.

#### 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.

#### 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 those 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 could 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 is more realistic, as originally stated, to reduce the probability by avoiding sites with significant resource potential and by using records and monuments to caution future generations. Consequences of unanticipated releases would be greater if they occur in densely populated areas. Nevertheless, it is the view of the Commission that it make 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 express 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 area 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.

#### 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.

#### 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 its 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, but 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.

#### Other Principal Changes in the Final Rule 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 release 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.<sup>6</sup>

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

<sup>6</sup>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.

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.

#### *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.

#### *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 Quarternary 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 *Geologic Conditions*.

A detailed review of the siting criteria is contained in the Section-by-Section Analysis.\*

#### *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 adequacy of design to contain "all" radionuclides for long

\* 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.

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.

#### 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.

**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.

**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 repository operations area is or may be located.

**Site.** "Site" had been defined in the proposed rule as being equivalent to "geologic setting." This was appropriate where geologic setting referred to 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.

**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.

**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.<sup>1</sup> 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.

<sup>1</sup>10 CFR Part 60, 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.

(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."

#### Discussion of Other Comments

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

#### 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.

#### 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 saturations, 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.

#### Geologic 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 geologic 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 proved 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 an 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 approach.

#### *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 function 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).

#### *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.

#### *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.

#### *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.

#### *Section 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 § 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 Water Supply Paper 1988 (U.S.G.S., 1972).

#### *Section 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.

#### *Section 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)).

#### *Section 60.21 Content of application.*

##### *Section 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.

##### *Section 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.

##### *Section 60.21(c)(1)(ii)(A)*

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

##### *Section 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.

##### *Section 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.

##### *Section 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.

##### *Section 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.]

**Section 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."

**Section 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.

**Section 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.

**Section 60.21(c)(9) and § 60.21(c)(11)**

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

**Section 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.

**Section 60.21(c)(14)**

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

**Section 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.

**Section 60.21(c)(15)(ii)**

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

**Section 60.21(c)(15)(vi).**

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

**Section 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.

**Section 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.

**Section 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

**Section 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 operation area.

**Section 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 operation 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.)

**Section 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.)

**Section 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."

**Section 60.52 Termination of license.**

Conforming changes. See *Decommissioning*, above.

**Subpart D—Records, 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.

**Section 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.

**Section 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.

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

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

**Section 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.

**Section 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**

**Section 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.

**Section 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**

**Section 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.

**Section 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*.

**Section 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). § 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 *Single vs. Multiple Performance Standards*.

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 NUREG-0804 shows that the inventory of radioactive material in a repository containing 100,000 metric tons of spent fuel is  $1.7 \times 10^4$  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

*Section 60.121 Requirements for ownership and control of interests in land.*

The proposed rule set 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

*Section 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.

*Section 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.

*Section 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.

*Section 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 the place of "and").

*Section 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."

*Section 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 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)

*Section 60.122(b)(6).*

New. See *Population—Related Siting Criteria*, above.

*Section 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.

*Section 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).

*Section 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.

*Section 60.122(c)(3) [§ 60.123(a)(7)].*

No substantive change from proposed rule.

*Section § 60.122(c)(4) [§ 60.123(b)(8)].*

*[§ 60.123(b)(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.

*Section 60.122(c)(5) [§ 60.123(b)(12)].*

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

*Section 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.

*Section 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.

*Section 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.

*Section 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.

*Section 60.122(c)(10) [§ 60.123(b)(5)].*

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

*Section 60.122(c)(11) [§ 60.123(b)(8)].*

No substantive changes.

*Section 60.122(c)(12) [§ 60.123(a)(4)].*

*Section 60.122(c)(13) [§ 60.123(b)(10)].*

*Section 60.122(c)(14) [§ 60.123(b)(9)].*

*Section 60.122(c)(15) [§ 60.123(b)(11)].*

*Section 60.122(c)(16) [§ 60.123(b)(4)].*

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

*Section 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 on naturally occurring materials for which economic extraction is currently feasible or potentially feasible during the foreseeable 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.

**Section 60.122(c)(18) [§ 60.123(b)(1)].**

Extended from the disturbed zone to the site.

**Section 60.122(c)(19) [§ 60.123(b)(2)].**

Extended from the disturbed zone to the site.

**Section 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.

**Section 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****Section 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.

**Section 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. [Section 60.130(b)(3)]**

Editorial change, characterizing missile impacts as dynamic effects.

**(3) Protection against fires and explosives. [Section 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 [Section 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. [Section 60.130(b)]**

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. [Section 60.130(b)(7)]**

No change from proposed rule.

**(7) Criticality control. [Section 60.130(b)(8)]**

No change from proposed rule.

**(8) Instrumentation and control systems. [Section 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. [Section 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 of legitimate concern to NRC.

(10) Shaft conveyances used in radioactive waste handling. [Section 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.

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

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

No change from proposed rule.

(e) Consideration of decommissioning. [Section 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 design criteria for the underground facility. [Section 60.132]*

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

The only change, in punctuation, is editorial.

(c) Retrieval of waste. [Section 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. [Section 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. [Section 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. [Section 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. [Section 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. [Section 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. [Section 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. [Sections 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.

*Section 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.

*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*

*Section 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.

*Section 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.

*Section 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.

**Section 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."

**Section 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**

**Section 60.137 General requirements for performance confirmation.**

Unchanged from proposed rule.

**Subpart F—Performance Confirmation Program**

**Section 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.

**Section 60.141 Confirmation of geotechnical and design parameters.**

Unchanged from proposed rule.

**Section 60.142 Design testing.**

Unchanged from proposed rule.

**Section 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**

**Section 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.

**Section 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.

**Section 60.152 Implementation.**

Unchanged from proposed rule.

**[Section 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 requirement 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.

**Environmental Impact**

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.

**Paperwork Reduction Act**

This rule contains no new or amended recordkeeping, reporting, or application requirement, or any other type of information collection requirement, subject to the Paperwork Reduction Act (Pub. L. 96-511).

**Regulatory Flexibility Act Certification**

As required by the Regulatory Flexibility Act of 1980, 5 U.S.C. 605(b), the Commission certifies that this rule, if adopted, will not have a significant economic impact upon a substantial number of small entities. The only entity subject to regulation under this rule is the U.S. Department of Energy.

**List of Subjects in 10 CFR Part 60**

High-level waste, Nuclear power plants and reactors, Nuclear materials, Penalty, Reporting requirements, Waste treatment and disposal.

**Issuance**

For the reasons set out in the preamble and under the authority of the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, the Nuclear Waste Policy Act of 1982, and 5 U.S.C. 553, the Nuclear Regulatory Commission is

adopting the following amendments to 10 CFR Part 60.

## PART 60—DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES IN GEOLOGIC REPOSITORIES

1. The Table of Contents for Part 60 is revised to read as follows:

### Subpart A—General Provisions

- Sec.
- 60.1 Purpose and scope.
  - 60.2 Definitions.
  - 60.3 License required.
  - 60.4 Communications.
  - 60.5 Interpretations.
  - 60.6 Exemptions.
  - 60.7 License not required for certain preliminary activities.
  - 60.8 Reporting, recordkeeping, and application requirements; OMB approval not required.
  - 60.9 Employment protection.

### Subpart B—Licenses

#### Preapplication Review

- 60.10 Site characterization.
- 60.11 Site characterization report.

#### License Applications

- 60.21 Content of application.
- 60.22 Filing and distribution of application.
- 60.23 Elimination of repetition.
- 60.24 Updating of application and environmental report.

#### Construction Authorization

- 60.31 Construction authorization.
- 60.32 Conditions of construction authorization.
- 60.33 Amendment of construction authorization.

#### License Issuance and Amendment

- 60.41 Standards for issuance of a license.
- 60.42 Conditions of license.
- 60.43 License specification.
- 60.44 Changes, tests, and experiments.
- 60.45 Amendment of license.
- 60.46 Particular activities requiring license amendment.

#### Permanent Closure

- 60.51 License amendment for permanent closure.
- 60.52 Termination of license.

### Subpart C—Participation by State Governments and Indian Tribes

- 60.61 Site review.
- 60.62 Filing of proposals for State participation.
- 60.63 Approval of proposals.
- 60.64 Participation by Indian tribes.
- 60.65 Coordination.

### Subpart D—Records, Reports, Tests, and Inspections

- 60.71 General recordkeeping and reporting requirements.
- 60.72 Construction records.
- 60.73 Reports of deficiencies.
- 60.74 Tests.
- 60.75 Inspections.

### Subpart E—Technical Criteria

- Sec.
- 60.101 Purpose and nature of findings.
  - 60.102 Concepts.

#### Performance Objectives

- 60.111 Performance of the geologic repository operations area through permanent closure.
- 60.112 Overall system performance objective for the geologic repository after permanent closure.
- 60.113 Performance of particular barriers after permanent closure.

#### Land Ownership and Control

- 60.121 Requirements for ownership and control interests in land.

#### Siting Criteria

- 60.122 Siting criteria.

#### Design Criteria for the Geological Repository Operations Area

- 60.130 Scope of design criteria for the geologic repository operations area.
- 60.131 General design criteria for the geologic repository operating area.
- 60.132 Additional design criteria for surface facilities in the geologic repository operations area.
- 60.133 Additional design criteria for the underground facility.
- 60.134 Design of seals for shafts and boreholes.

#### Design Criteria for the Waste Package

- 60.135 Criteria for the waste package and its components.

#### Performance Confirmation Requirements

- 60.137 General requirements for performance confirmation.

### Subpart F—Performance Confirmation Program

- 60.140 General requirements.
- 60.141 Confirmation of geotechnical and design parameters.
- 60.142 Design testing.
- 60.143 Monitoring and testing waste packages.

### Subpart G—Quality Assurance

- 60.150 Scope.
- 60.151 Applicability.
- 60.152 Implementation.

### Subpart H—Training and Certification of Personnel

- 60.160 General requirements.
- 60.161 Training and certification program.
- 60.162 Physical requirements.

### Subpart I—Emergency Planning Criteria [Reserved]

2. The authority citation for Part 60 is revised to read as follows:

Authority: Secs. 51, 53, 62, 63, 65, 81, 161, 162, 163, 68 Stat. 929, 930, 932, 933, 935, 948, 953, 954, as amended (42 U.S.C. 2071, 2073, 2092, 2093, 2095, 2111, 2201, 2232, 2233); secs. 202, 206, 88 Stat. 1244, 1248 (42 U.S.C. 5842, 5846); secs. 10 and 14, Pub. L. 95-601, 92 Stat. 2951 (42 U.S.C. 2021a and 5851); sec. 102, Pub. L. 91-190, 83 Stat. 853 (42 U.S.C. 4332); sec. 121, Pub. L. 97-425, 96 Stat. 2228 (42 U.S.C. 10141).

For the purposes of sec. 223, 68 Stat. 958, as amended (42 U.S.C. 2273), §§ 60.71 to 60.75 are issued under sec. 161c, 68 Stat. 950, as amended (42 U.S.C. 2201(o)).

3. Section 60.2 is revised to read as follows:

#### § 60.2 Definitions.

As used in this part—

"Accessible environment" means: (1) The atmosphere; (2) the land surface, (3) surface water, (4) oceans, and (5) the portion of the lithosphere that is outside the controlled area.

"Anticipated processes and events" means those natural processes and events that are reasonably likely to occur during the period the intended performance objective must be achieved. To the extent reasonable in the light of the geologic record, it shall be assumed that those processes operating in the geologic setting during the Quaternary Period continue to operate but with the perturbations caused by the presence of emplaced radioactive waste superimposed thereon.

"Barrier" means any material or structure that prevents or substantially delays movement of water or radionuclides.

"Candidate area" means a geologic and hydrologic system within which a geologic repository may be located.

"Commencement of construction" means clearing of land, surface or subsurface excavation, or other substantial action that would adversely affect the environment of a site, but does not include changes desirable for the temporary use of the land for public recreational uses, site characterization activities, other preconstruction monitoring and investigation necessary to establish background information related to the suitability of a site or to the protection of environmental values, or procurement or manufacture of components of the geologic repository operations area.

"Commission" means the Nuclear Regulatory Commission or its duly authorized representatives.

"Containment" means the confinement of radioactive waste within a designated boundary.

"Controlled area" means a surface location, to be marked by suitable monuments, extending horizontally no more than 10 kilometers in any direction from the outer boundary of the underground facility, and the underlying subsurface, which area has been committed to use as a geologic repository and from which incompatible activities would be restricted following permanent closure.

"Director" means the Director of the Nuclear Regulatory Commission's Office of Nuclear Material Safety and Safeguards.

"Disposal" means the isolation of radioactive wastes from the accessible environment.

"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.

"DOE" means the U.S. Department of Energy or its duly authorized representatives.

"Engineered barrier system" means the waste packages and the underground facility.

"Geologic repository" means a system which is intended to be used for, or may be used for, the disposal of radioactive wastes in excavated geologic media. A geologic repository includes: (1) The geologic repository operations area, and (2) the portion of the geologic setting that provides isolation of the radioactive waste.

"Geologic repository operations area" means a high-level radioactive waste facility that is part of a geologic repository, including both surface and subsurface areas, where waste handling activities are conducted.

"Geologic setting" means the geologic, hydrologic, and geochemical systems of the region in which a geologic repository operations area is or may be located.

"High-level radioactive waste" or "HLW" means: (1) Irradiated reactor fuel, (2) liquid wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuel, and (3) solids into which such liquid wastes have been converted.

"HLW facility" means a facility subject to the licensing and related regulatory authority of the Commission pursuant to Sections 202(3) and 202(4) of the Energy Reorganization Act of 1974 (88 Stat 1244).

<sup>1</sup> These are DOE "facilities used primarily for the receipt and storage of high-level radioactive wastes resulting from activities licensed under such Act [the Atomic Energy Act]" and "Retrievable Surface Storage Facilities and other facilities authorized for the express purpose of subsequent long-term storage of high-level radioactive wastes generated by [DOE], which are not used for, or are part of, research and development activities."

"Host rock" means the geologic medium in which the waste is emplaced.

"Important to safety," with reference to structures, systems, and components means those engineered structures, systems, and components 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 unrestricted area at any time until the completion of permanent closure.

"Indian tribe" means an Indian tribe as defined in the Indian Self-Determination and Education Assistance Act (Public Law 93-638).

"Isolation" means inhibiting the transport of radioactive material so that amounts and concentrations of this material entering the accessible environment will be kept within prescribed limits.

"Permanent closure" means final backfilling of the underground facility and the sealing of shafts and boreholes.

"Performance confirmation" means the program of tests, experiments, and analyses which is conducted to evaluate the accuracy and adequacy of the information used to determine with reasonable assurance that the performance objectives for the period after permanent closure will be met.

"Public Document Room" means the place at 1717 H Street N.W., Washington, D.C., at which records of the Commission will ordinarily be made available for public inspection and any other place, the location of which has been published in the Federal Register, at which public records of the Commission pertaining to a particular geologic repository are made available for public inspection.

"Radioactive waste" or "waste" means HLW and other radioactive materials other than HLW that are received for emplacement in a geologic repository.

"Restricted area" means any area access to which is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. "Restricted area" shall not include any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area.

"Retrieval" means the act of intentionally removing radioactive waste from the underground location at which the waste had been previously emplaced for disposal.

"Saturated zone" means that part of the earth's crust beneath the deepest water table in which all voids, large and

small, are ideally filled with water under pressure greater than atmospheric.

"Site" means the location of the controlled area.

"Site characterization" means the program of exploration and research, both in the laboratory and in the field, undertaken to establish the geologic conditions and the ranges of those parameters of a particular site relevant to the procedures under this part. Site characterization includes borings, surface excavations, excavation of exploratory shafts, limited subsurface lateral excavations and borings, and in situ testing at depth needed to determine the suitability of the site for a geologic repository, but does not include preliminary borings and geophysical testing needed to decide whether site characterization should be undertaken.

"Tribal organization" means a tribal organization as defined in the Indian Self-Determination and Education Assistance Act (Public Law 93-638).

"Unanticipated processes and events" means those processes and events affecting the geologic setting that are judged not to be reasonably likely to occur during the period the intended performance objective must be achieved, but which are nevertheless sufficiently credible to warrant consideration. Unanticipated processes and events may be either natural processes or events or processes and events initiated by human activities other than those activities licensed under this part. Processes and events initiated by human activities may only be found to be sufficiently credible to warrant consideration if it is assumed that: (1) The monuments provided for by this part are sufficiently permanent to serve their intended purpose; (2) the value to future generations of potential resources within the site can be assessed adequately under the applicable provisions of this part; (3) an understanding of the nature of radioactivity, and an appreciation of its hazards, have been retained in some functioning institutions; (4) institutions are able to assess risk and to take remedial action at a level of social organization and technological competence equivalent to, or superior to, that which was applied in initiating the processes or events concerned; and (5) relevant records are preserved, and remain accessible, for several hundred years after permanent closure.

"Underground facility" means the underground structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals.

"Unrestricted area" means any area, access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, and any area used for residential quarters.

"Waste form" means the radioactive waste materials and any encapsulating or stabilizing matrix.

"Waste package" means the waste form and any containers, shielding, packing and other absorbent materials immediately surrounding an individual waste container.

"Water table" means that surface in a groundwater body at which the water pressure is atmospheric.

4. Section 60.10 is amended by revising paragraph (a) and adding a new paragraph (d) to read as follows:

**§ 60.10 Site characterization.**

(a) Prior to submittal of an application for a license to be issued under this part DOE shall conduct a program of site characterization with respect to the site to be described in such application.

(d) The program of site characterization shall be conducted in accordance with the following:

(1) Investigations to obtain the required information shall be conducted in such a manner as to limit adverse effects on the long-term performance of the geologic repository to the extent practical.

(2) The number of exploratory boreholes and shafts shall be limited to the extent practical consistent with obtaining the information needed for site characterization.

(3) To the extent practical, exploratory boreholes and shafts in the geologic repository operations area shall be located where shafts are planned for underground facility construction and operation or where large unexcavated pillars are planned.

(4) Subsurface exploratory drilling, excavation, and in situ testing before and during construction shall be planned and coordinated with geologic repository operations area design and construction.

5. Section 60.11 is amended by revising paragraph (a) to read as follows:

**§ 60.11 Site characterization report.**

(a) As early as possible after commencement of planning for a particular geologic repository operations area, and prior to site characterization, DOE shall submit to the Director a Site Characterization Report. The report

shall include: (1) A description of the site to be characterized; (2) the criteria used to arrive at the candidate area; (3) the method by which the site was selected for site characterization; (4) identification and location of alternative media and sites at which DOE intends to conduct site characterization and for which DOE anticipates submitting subsequent Site Characterization Reports; (5) a description of the decision process by which the site was selected for characterization, including the means used to obtain public, Indian tribal and State views during selection; (6) a description of the site characterization program including: (i) The extent of planned excavation and plans for in situ testing, (ii) a conceptual design of a geologic repository operations area appropriate to the named site in sufficient detail to allow assessment of the site characterization program, with respect to investigation activities which address the ability of the site to host a geologic repository and isolate radioactive waste, or which may affect such ability, and (iii) provisions to control any adverse, safety-related effects from site characterization, including appropriate quality programs; (7) a description of the quality assurance program to be applied to data collection; and (8) any issues related to site selection, alternative candidate areas, or other sites, or design of the geologic repository operations area which the DOE wishes the Commission to review. Also included shall be a description of the research and development activities being conducted by DOE which deal with the waste form and packaging which may be considered appropriate for the site to be characterized, including research planned or underway to evaluate the performance of such waste forms and packaging.

6. Section 60.21 is amended by revising paragraphs (c)(1), (c)(3), (c)(4), (c)(8), (c)(9), (c)(11), (c)(13), (c)(14), and (c)(15) to read as follows:

**§ 60.21 Content of application.**

(c) The Safety Analysis Report shall include:

(1) A description and assessment of the site at which the proposed geologic repository operations area is to be located with appropriate attention to those features of the site that might affect geologic repository operations

\*To the extent that the information indicated in Items 2 through 5 appears in an Environmental Impact Statement prepared by DOE for site characterization at the named site, it may be incorporated into DOE's Site Characterization Report by reference.

area design and performance. The description of the site shall identify the location of the geologic repository operations area with respect to the boundary of the accessible environment.

(i) The description of the site shall also include the following information regarding subsurface conditions. This description shall, in all cases, include such information with respect to the controlled area. In addition, where subsurface conditions outside the controlled area may affect isolation within the controlled area, the description shall include such information with respect to subsurface conditions outside the controlled area to the extent such information is relevant and material. The detailed information referred to in this paragraph shall include—

(A) The orientation, distribution, aperture in-filling and origin of fractures, discontinuities, and heterogeneities;

(B) The presence and characteristics of other potential pathways such as solution features, breccia pipes, or other potentially permeable features;

(C) The geomechanical properties and conditions, including pore pressure and ambient stress conditions;

(D) The hydrogeologic properties and conditions;

(E) The geochemical properties; and

(F) The anticipated response of the geomechanical, hydrogeologic, and geochemical systems to the maximum design thermal loading, given the pattern of fractures and other discontinuities and the heat transfer properties of the rock mass and groundwater.

(ii) The assessment shall contain—

(A) An analysis of the geology, geophysics, hydrogeology, geochemistry, climatology, and meteorology of the site;

(B) Analyses to determine the degree to which each of the favorable and potentially adverse conditions, if present, has been characterized, and the extent to which it contributes to or detracts from isolation. For the purpose of determining the presence of the potentially adverse conditions, investigations shall extend from the surface to a depth sufficient to determine critical pathways for radionuclide migration from the underground facility to the accessible environment. Potentially adverse conditions shall be investigated outside of the controlled area if they affect isolation within the controlled area.

(C) An evaluation of the performance of the proposed geologic repository for the period after permanent closure, assuming anticipated processes and events, giving the rates and quantities of

releases of radionuclides to the accessible environment as a function of time; and a similar evaluation which assumes the occurrence of unanticipated processes and events.

(D) The effectiveness of engineered and natural barriers, including barriers that may not be themselves a part of the geologic repository operations area, against the release of radioactive material to the environment. The analysis shall also include a comparative evaluation of alternatives to the major design features that are important to waste isolation, with particular attention to the alternatives that would provide longer radionuclide containment and isolation.

(E) An analysis of the performance of the major design structures, systems, and components, both surface and subsurface, to identify those that are important to safety. For the purposes of this analysis, it shall be assumed that operations at the geologic repository operations area will be carried out at the maximum capacity and rate of receipt of radioactive waste stated in the application.

(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.

(3) A description and analysis of the design and performance requirements for structures, systems, and components of the geologic repository which are important to safety. This analysis shall consider—(i) The margins of safety under normal conditions and under conditions that may result from anticipated operational occurrences, including those of natural origin; and (ii) the adequacy of structures, systems, and components provided for the prevention of accidents and mitigation of the consequences of accidents, including those caused by natural phenomena.

(4) A description of the quality assurance program to be applied to the structures, systems, and components important to safety and to the engineered and natural barriers important to waste isolation.

(8) A description of the controls that the applicant will apply to restrict access and to regulate land use at the

site and adjacent areas, including a conceptual design of monuments which would be used to identify the controlled area after permanent closure.

(9) Plans for coping with radiological emergencies at any time prior to permanent closure and decontamination or dismantlement of surface facilities.

(11) A description of design considerations that are intended to facilitate permanent closure and decontamination or dismantlement of surface facilities.

(13) An identification and evaluation of the natural resources of the geologic setting, including estimates as to undiscovered deposits, the exploitation of which could affect the ability of the geologic repository to isolate radioactive wastes. Undiscovered deposits of resources characteristic of the area shall be estimated by reasonable inference based on geological and geophysical evidence. This evaluation of resources, including undiscovered deposits, shall be conducted for the site and for areas of similar size that are representative of and are within the geologic setting. For natural resources with current markets the resources shall be assessed, with estimates provided of both gross and net value. The estimate of net value shall take into account current development, extraction and marketing costs. For natural resources without current markets, but which would be marketable given credible projected changes in economic or technological factors, the resources shall be described by physical factors such as tonnage or other amount, grade, and quality.

(14) An identification of those structures, systems, and components of the geologic repository, both surface and subsurface, which require research and development to confirm the adequacy of design. For structures, systems, and components important to safety and for the engineered and natural barriers important to waste isolation, DOE shall provide a detailed description of the programs designed to resolve safety questions, including a schedule indicating when these questions would be resolved.

(15) The following information concerning activities at the geologic repository operations area:

(i) The organizational structure of DOE as it pertains to construction and operation of the geologic repository operations area including a description of any delegations of authority and assignments of responsibilities, whether in the form of regulations,

administrative directives, contract provisions, or otherwise.

(ii) Identification of key positions which are assigned responsibility for safety at and operation of the geologic repository operations area.

(iii) Personnel qualifications and training requirements.

(iv) Plans for startup activities and startup testing.

(v) Plans for conduct of normal activities, including maintenance, surveillance, and periodic testing of structures, systems, and components of the geologic repository operation area.

(vi) Plans for permanent closure and plans for the decontamination or dismantlement of surface facilities.

(vii) Plans for any uses of the geologic repository operations area for purposes other than disposal of radioactive wastes, with an analysis of the effects, if any, that such uses may have upon the operation of the structures, systems, and components important to safety and the engineered and natural barriers important to waste isolation.

7. Section 60.22 is amended by revising paragraphs (a) and (d) to read as follows:

**§ 60.22 Filing and distribution of application.**

(a) An application for a license to receive and possess source, special nuclear, or byproduct material at a geologic repository operations area at a site which has been characterized, and an accompanying environmental report, and any amendments thereto, shall be filed in triplicate with the Director and shall be signed by the Secretary of Energy or the Secretary's authorized representative.

(d) At the time of filing of an application and environmental report, and any amendments thereto, one copy shall be made available in an appropriate location near the proposed geologic repository operations area (which shall be a public document room, if one has been established) for inspection by the public and updated as amendments to the application or environmental report are made. An updated copy shall be produced at any public hearing on the application for use by any parties to the proceedings.

8. Section 60.31 is amended by revising paragraphs (a)(1) and (a)(2) to read as follows:

**§ 60.31 Construction authorization.**

(a) *Safety.* That there is reasonable assurance that the types and amounts of

radioactive materials described in the application can be received, possessed, and disposed of in a geologic repository operations area of the design proposed without unreasonable risk to the health and safety of the public. In arriving at this determination, the Commission shall consider whether:

(1) DOE has described the proposed geologic repository including but not limited to: (i) The geologic, geophysical, geochemical and hydrologic characteristics of the site; (ii) the kinds and quantities of radioactive waste to be received, possessed, stored, and disposed of in the geologic repository operations area; (iii) the principal architectural and engineering criteria for the design of the geologic repository operations area; (iv) construction procedures which may affect the capability of the geologic repository to serve its intended function; and (v) features or components incorporated in the design for the protection of the health and safety of the public.

(2) The site and design comply with the performance objectives and criteria contained in Subpart E of this part.

9. Section 60.32 is amended by revising paragraphs (b) and (c) to read as follows:

**§ 60.32 Conditions of construction authorization.**

(b) The Commission will incorporate in the construction authorization provisions requiring DOE to furnish periodic or special reports regarding: (1) Progress of construction, (2) any data about the site obtained during construction which are not within the predicted limits upon which the facility design was based, (3) any deficiencies in design and construction which, if uncorrected, could adversely affect safety at any future time, and (4) results of research and development programs being conducted to resolve safety questions.

(c) The construction authorization will include restrictions on subsequent changes to the features of the geologic repository and the procedures authorized. 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. These restrictions will fall into three categories of descending importance to public health and safety as follows: (1) Those features and procedures which may not be changed without: (i) 60 days prior notice to the Commission (ii) 30 days notice of

opportunity for a prior hearing, and (iii) prior Commission approval; (2) those features and procedures which may not be changed without (i) 60 days prior notice to the Commission, and (ii) prior Commission approval; and (3) those features and procedures which may not be changed without 60 days notice to the Commission. Features and procedures falling in paragraph (c)(3) of this section may not be changed without prior Commission approval if the Commission, after having received the required notice, so orders.

10. Section 60.43 is amended by revising paragraphs (b)(3) and (b)(5) to read as follows:

**§ 60.43 License specifications.**

(b) License conditions shall include items in the following categories—

(3) Restrictions as to the amount of waste permitted per unit volume of storage space considering the physical characteristics of both the waste and the host rock.

(5) Controls to be applied to restricted access and to avoid disturbance to the controlled area and to areas outside the controlled area where conditions may affect isolation within the controlled area.

11. Section 60.46 is amended by revising paragraphs (a)(3) and (a)(6) and adding (a)(7) to read as follows:

**§ 60.46 Particular activities requiring license amendment.**

(a) Unless expressly authorized in the license, an amendment of the license shall be required with respect to any of the following activities—

(3) Removal or reduction of controls applied to restrict access to or avoid disturbance of the controlled area and to areas outside the controlled area where conditions may affect isolation within the controlled area.

(6) Permanent closure.

(7) Any other activity involving an unreviewed safety question.

12. Section 60.51 is amended by changing the undesignated center heading immediately preceding the section from "Decommissioning" to "Permanent Closure" and by revising paragraphs (a)(1), (2), (4), (5) and (6), and paragraph (b).

**§ 60.51 License amendment for permanent closure.**

(a) DOE shall submit an application to amend the license prior to permanent closure. The application shall consist of an update of the license application and environmental report submitted under §§ 60.21 and 60.22, including:

(1) A description of the program for post-permanent closure monitoring of the geologic repository.

(2) A detailed description of the measures to be employed—such as land use controls, construction of monuments, and preservation of records—to regulate or prevent activities that could impair the long-term isolation of emplaced waste within the geologic repository and to assure that relevant information will be preserved for the use of future generations. As a minimum, such measures shall include—

(i) Identification of the controlled area and geologic repository operations area by monuments that have been designed, fabricated, and emplaced to be as permanent as is practicable; and

(ii) Placement of records in the archives and land record systems of local State, and Federal government agencies, and archives elsewhere in the world, that would be likely to be consulted by potential human intruders—such records to identify the location of the geologic repository operations area, including the underground facility, boreholes and shafts, and the boundaries of the controlled area, and the nature and hazard of the waste.

(4) The results of tests, experiments, and any other analyses relating to backfill of excavated areas, shaft sealing, waste interaction with the host rock, and any other tests, experiments, or analyses pertinent to the long-term isolation of emplaced wastes within the geologic repository.

(5) Any substantial revision of plans for permanent closure.

(6) Other information bearing upon permanent closure that was not available at the time a license was issued.

(b) DOE shall update its environmental report in a timely manner so as to permit the Commission to review, prior to issuance of an amendment, substantial changes in the permanent closure activities proposed to be carried out or significant new information regarding the environmental impacts of such permanent closure.

13. Section 60.52 is amended by revising paragraphs (a) and (c)(2) to read as follows:

**§ 60.52 Termination of license.**

(a) Following permanent closure and the decontamination or dismantlement of surface facilities, DOE may apply for an amendment to terminate the license.

(c) A license shall be terminated only when the Commission finds with respect to the geologic repository—

(1)

(2) That the final state of the geologic repository operations area conforms to DOE's plans for permanent closure and DOE's plans for the decontamination or dismantlement of surface facilities, as amended and approved as part of the license.

14. Subpart D is revised to read as follows:

**Subpart D—Records, Reports, Tests, and Inspections****§ 60.71 General recordkeeping and reporting requirements.**

(a) DOE shall maintain such records and make such reports in connection with the licensed activity as may be required by the conditions of the license or by rules, regulations, and orders of the Commission as authorized by the Atomic Energy Act and the Energy Reorganization Act.

(b) Records of the receipt, handling, and disposition of radioactive waste at a geologic repository operations area shall contain sufficient information to provide a complete history of the movement of the waste from the shipper through all phases of storage and disposal.

**§ 60.72 Construction records.**

(a) DOE shall maintain records of construction of the geologic repository operations area.

(b) The records required under paragraph (a) shall include at least the following—

(1) Surveys of the underground facility excavations, shafts, and boreholes referenced to readily identifiable surface features or monuments;

(2) A description of the materials encountered;

(3) Geologic maps and geologic cross sections;

(4) Locations and amount of seepage;

(5) Details of equipment, methods, progress, and sequence of work;

(6) Construction problems;

(7) Anomalous conditions encountered;

(8) Instrument locations, readings, and analysis;

(9) Location and description of structural support systems;

(10) Location and description of dewatering systems; and

(11) Details, methods of emplacement, and location of seals used.

**§ 60.73 Reports of deficiencies.**

DOE shall promptly notify the Commission of each deficiency found in the characteristics of the site, and design and construction of the geologic repository operations area which, were it to remain uncorrected, could: (a) Be a substantial safety hazard, (b) represent a significant deviation from the design criteria and design bases stated in the application, or (c) represent a deviation from the conditions stated in the terms of a construction authorization or the license, including license specifications. The notification shall be in the form of a written report, copies of which shall be sent to the Director and to the appropriate Nuclear Regulatory Commission Regional Office listed in Appendix D of Part 20 of this chapter.

**§ 60.74 Tests.**

(a) DOE shall perform, or permit the Commission to perform, such tests as the Commission deems appropriate or necessary for the administration of the regulations in this part. These may include tests of: (1) Radioactive waste, (2) the geologic repository including its structures, systems, and components, (3) radiation detection and monitoring instruments, and (4) other equipment and devices used in connection with the receipt, handling, or storage of radioactive waste.

(b) The tests required under this section shall include a performance confirmation program carried out in accordance with Subpart F of this part.

**§ 60.75 Inspections.**

(a) DOE shall allow the Commission to inspect the premises of the geologic repository operations area and adjacent areas to which DOE has rights of access.

(b) DOE shall make available to the Commission for inspection, upon reasonable notice, records kept by DOE pertaining to activities under this part.

(c)(1) DOE shall upon requests by the Director, Office of Inspection and Enforcement, provide rent-free office space for the exclusive use of the Commission inspection personnel. Heat, air-conditioning, light, electrical outlets and janitorial services shall be furnished by DOE. The office shall be convenient to and have full access to the facility and shall provide the inspector both visual and acoustic privacy.

(2) The space provided shall be adequate to accommodate a full-time inspector, a part-time secretary and transient NRC personnel and will be

generally commensurate with other office facilities at the geologic repository operations area. A space of 250 square feet either within the geologic repository operations area's office complex or in an office trailer or other onsite space at the geologic repository operations area is suggested as a guide. For locations at which activities are carried out under licenses issued under other parts of this chapter, additional space may be requested to accommodate additional full-time inspectors. The Office space that is provided shall be subject to the approval of the Director, Office of Inspection and Enforcement. All furniture, supplies and communication equipment will be furnished by the Commission.

(3) DOE shall afford any NRC resident inspector assigned to that location, or other NRC inspectors identified by the Regional Administrator as likely to inspect the facility, immediate unfettered access, equivalent to access provided regular employees, following proper identification and compliance with applicable access control measures for security, radiological protection and personal safety.

15. Subparts E, F, G, H, and I are added to read as follows:

**Subpart E—Technical Criteria****§ 60.101 Purpose and nature of findings.**

(a)(1) Subpart B of this part prescribes the standards for issuance of a license to receive and possess source, special nuclear, or byproduct material at a geologic repository operations area. In particular, § 60.41(c) requires a finding that the issuance of a license will not constitute an unreasonable risk to the health and safety of the public. The purpose of this subpart is to set out performance objectives and site and design criteria which, if satisfied, will support such a finding of no unreasonable risk.

(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. A reasonable assurance, on the basis of the record before the Commission, that the objectives and criteria will be met is the general standard that is required. For § 60.112, and other portions of this subpart that impose objectives and criteria for repository performance over long times into the future, there will inevitably be greater uncertainties. Proof of the future performance of engineered barrier systems and the geologic setting over time periods of many hundreds or many thousands of

years is not to be had in the ordinary sense of the word. For such long-term objectives and criteria, what is required is reasonable assurance, making allowance for the time period, hazards, and uncertainties involved, that the outcome will be in conformance with those objectives and criteria.

Demonstration of compliance with such objectives and criteria will involve the use of data from accelerated tests and predictive models that are supported by such measures as field and laboratory tests, monitoring data and natural analog studies.

(b) Subpart B of this part also lists findings that must be made in support of an authorization to construct a geologic repository operations area. In particular, § 60.31(a) requires a finding that there is reasonable assurance that the types and amounts of radioactive materials described in the application can be received, possessed, and disposed of in a geologic repository operations area of the design proposed without unreasonable risk to the health and safety of the public. As stated in that paragraph, in arriving at this determination, the Commission will consider whether the site and design comply with the criteria contained in this subpart. Once again, while the criteria may be written in unqualified terms, the demonstration of compliance may take uncertainties and gaps in knowledge into account, provided that the Commission can make the specified finding of reasonable assurance as specified in paragraph (a) of this section.

#### § 60.102 Concepts.

This section provides a functional overview of Subpart E. In the event of any inconsistency with definitions found in § 60.2, those definitions shall prevail.

(a) *The HLW facility.* NRC exercises licensing and related regulatory authority over those facilities described in section 202 (3) and (4) of the Energy Reorganization Act of 1974. Any of these facilities is designated a *HLW facility*.

(b) *The geologic repository operations area.* (1) This part deals with the exercise of authority with respect to a particular class of HLW facility—namely a *geologic repository operations area*.

(2) A *geologic repository operations area* consists of those surface and subsurface areas that are part of a geologic repository where radioactive waste handling activities are conducted. The underground structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals, is designated the *underground facility*.

(3) The exercise of Commission authority requires that the geologic repository operations area be used for *storage* (which includes *disposal*) of *high-level radioactive wastes (HLW)*.

(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, the storage of this radioactive waste is subject to the requirements of this part.

(c) *Areas related to isolation.*

Although the activities subject to regulation under this part are those to be carried out at the geologic repository operations area, the licensing process also considers characteristics of adjacent areas that are defined in other ways. There is to be an area surrounding the underground facility referred to above, which is designated the *controlled area*, within which DOE is to exercise specified controls to prevent adverse human actions following permanent closure. The location of the controlled area is the *site*. The *accessible environment* is the atmosphere, land surface, surface water, oceans, and the portion of the lithosphere that is outside the controlled area. There is an area, designated the *geologic setting*, which includes the geologic, hydrologic, and geochemical systems of the region in which a geologic repository operations area is or may be located. The geologic repository operations area plus the portion of the geologic setting that provides isolation of the radioactive waste make up the *geologic repository*.

(d) *Stages in the licensing process.*

There are several stages in the licensing process. The *site characterization* stage, though begun before submission of a license application, may result in consequences requiring evaluation in the license review. The *construction stage* would follow, after issuance of a construction authorization. A *period of operations* follows the issuance of a license by the Commission. The period of operations includes the time during which *emplacement* of wastes occurs; any subsequent period before permanent closure during which the emplaced wastes are *retrievable*; and *permanent closure*, which includes sealing of shafts. Permanent closure represents the end of active human intervention with respect to the engineered barrier system.

(e) *Isolation of waste.* (1) During the first several hundred years following permanent closure of a geologic repository, when radiation and thermal levels are high and the uncertainties in assessing repository performance are

large, special emphasis is placed upon the ability to contain the wastes by waste packages within an *engineered barrier system*. This is known as the *containment period*. The *engineered barrier system* includes the waste packages and the underground facility. A *waste package* is composed of the waste form and any containers, shielding, packing, and absorbent materials immediately surrounding an individual waste container. The *underground facility* means the underground structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals.

(2) Following the containment period special emphasis is placed upon the ability to achieve isolation of the wastes by virtue of the characteristics of the geologic repository. The engineered barrier system works to control the release of radioactive material to the geologic setting and the geologic setting works to control the release of radioactive material to the accessible environment. *Isolation* means inhibiting the transport of radioactive material so that amounts and concentrations of the materials entering the accessible environment will be kept within prescribed limits.

#### Performance Objectives

§ 60.111 Performance of the geologic repository operations area through permanent closure.

(a) *Protection against radiation exposures and releases of radioactive material.* The geologic repository operations area shall be designed so that until permanent closure has been completed, radiation exposures and radiation levels, and releases of radioactive materials to unrestricted areas, will at all times be maintained within the limits specified in Part 20 of this chapter and such generally applicable environmental standards for radioactivity as may have been established by the Environmental Protection Agency.

(b) *Retrievability of waste.* (1) The geologic repository operations area shall be designed to preserve the option of waste retrieval throughout the period during which 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. To satisfy this objective, the geologic repository operations area shall be designed so that any or all 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, unless a different time period is approved or specified by the Commission. This different time period may be established on a case-by-case basis consistent with the emplacement schedule and the planned performance confirmation program.

(2) This requirement shall not preclude decisions by the Commission to allow backfilling part or all of, or permanent closure of, the geologic repository operations area prior to the end of the period of design for retrievability.

(3) For purposes of this paragraph, a reasonable schedule for retrieval is one that would permit retrieval in about the same time as that devoted to construction of the geologic repository operations area and the emplacement of wastes.

**§ 60.112 Overall system performance objective for the geologic repository after permanent closure.**

The geologic setting shall be selected and the engineered barrier system and the shafts, boreholes and their seals shall be designed to assure that releases of radioactive materials to the accessible environment following permanent closure conform to such generally applicable environmental standards for radioactivity as may have been established by the Environmental Protection Agency with respect to both anticipated processes and events and unanticipated processes and events.

**§ 60.113 Performance of particular barriers after permanent closure.**

(a) *General provisions.* (1) *Engineered barrier system.* (i) The engineered barrier system shall be designed so that assuming anticipated processes and events: (A) Containment of HLW will be substantially complete during the period when radiation and thermal conditions in the engineered barrier system are dominated by fission product decay; and (B) any release of radionuclides from the engineered barrier system shall be a gradual process which results in small fractional releases to the geologic setting over long times. 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.

(ii) In satisfying the preceding requirement, the engineered barrier system shall be designed, assuming anticipated processes and events, so that:

(A) Containment of HLW within the waste packages will be substantially complete for a period to be determined by the Commission taking into account the factors specified in § 60.113(b) provided, that such period shall be not less than 300 years nor more than 1,000 years after permanent closure of the geologic repository; and

(B) The release rate of any radionuclide from the engineered barrier system following the containment period shall not exceed one part in 100,000 per year of the inventory of that radionuclide calculated to be present at 1,000 years following permanent closure, or such other fraction of the inventory as may be approved or specified by the Commission; provided, that this requirement does not apply to any radionuclide which is released at a rate less than 0.1% of the calculated total release rate limit. The calculated total release rate limit shall be taken to be one part in 100,000 per year of the inventory of radioactive waste, originally emplaced in the underground facility, that remains after 1,000 years of radioactive decay.

(2) *Geologic setting.* The geologic repository shall be located so that pre-waste-emplacment groundwater travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment shall be at least 1,000 years or such other travel time as may be approved or specified by the Commission.

(b) On a case-by-case basis, the Commission may approve or specify some other radionuclide release rate, designed containment period or pre-waste-emplacment groundwater travel time, provided that the overall system performance objective, as it relates to anticipated processes and events, is satisfied. Among the factors that the Commission may take into account are—

(1) Any generally applicable environmental standard for radioactivity established by the Environmental Protection Agency;

(2) The age and nature of the waste, and the design of the underground facility, particularly as these factors bear upon the time during which the thermal pulse is dominated by the decay heat from the fission products;

(3) The geochemical characteristics of the host rock, surrounding strata and groundwater; and

(4) Particular sources of uncertainty in predicting the performance of the geologic repository.

(c) Additional requirements may be found to be necessary to satisfy the overall system performance objective as

it relates to unanticipated processes and events.

**Land Ownership and Control**

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

(a) *Ownership of land.* (1) Both the geologic repository operations area and the controlled 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.

(2) These lands shall be held free and clear of all encumbrances, if significant, such as: (i) Rights arising under the general mining laws; (ii) easements for right-of-way; and (iii) all other rights arising under lease, rights of entry, deed, patent, mortgage, appropriation, prescription, or otherwise.

(b) *Additional controls.* Appropriate controls shall be established outside of the controlled area. DOE shall exercise any jurisdiction and control over surface and subsurface estates necessary to prevent adverse human actions that could significantly reduce the geologic repository's ability to achieve isolation. The rights of DOE may take the form of appropriate possessory interests, servitudes, or withdrawals from location or patent under the general mining laws.

(c) *Water rights.* (1) DOE shall also have obtained such water rights as may be needed to accomplish the purpose of the geologic repository operations area.

(2) Water rights are included in the additional controls to be established under paragraph (b) of this section.

**Siting Criteria**

**§ 60.122 Siting criteria.**

(a)(1) A geologic setting shall exhibit an appropriate combination of the conditions specified in paragraph (b) of this section so that, together with the engineered barriers system, the favorable conditions present are sufficient to provide reasonable assurance that the performance objectives relating to isolation of the waste will be met.

(2) If any of the potentially adverse conditions specified in paragraph (c) of this section is present, it may compromise the ability of the geologic repository to meet the performance objectives relating to isolation of the waste. In order to show that a potentially adverse condition does not so compromise the performance of the geologic repository the following must be demonstrated:

(i) The potentially adverse human activity or natural condition has been adequately investigated, including the

extent to which the condition may be present and still be undetected taking into account the degree of resolution achieved by the investigations; and

(ii) The effect of the potentially adverse human activity or natural condition on the site has been adequately evaluated using analyses which are sensitive to the potentially adverse human activity or natural condition and assumptions which are not likely to underestimate its effect; and

(iii)(A) The potentially adverse human activity or natural condition is shown by analysis pursuant to paragraph (a)(2)(ii) of this section not to affect significantly the ability of the geologic repository to meet the performance objectives relating to isolation of the waste, or

(B) The effect of the potentially adverse human activity or natural condition is compensated by the presence of a combination of the favorable characteristics so that the performance objectives relating to isolation of the waste are met, or

(C) The potentially adverse human activity or natural condition can be remedied.

(b) *Favorable conditions.* (1) The nature and rates of tectonic, hydrogeologic, geochemical, and geomorphic processes (or any of such processes) operating within the geologic setting during the Quaternary Period, when projected, would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

(2) For disposal in the saturated zone, hydrogeologic conditions that provide—

(i) A host rock with low horizontal and vertical permeability;

(ii) Downward or dominantly horizontal hydraulic gradient in the host rock and immediately surrounding hydrogeologic units; and

(iii) Low vertical permeability and low hydraulic potential between the host rock and surrounding hydrogeologic units; or

(iv) Pre-waste-emplacment groundwater travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment that substantially exceeds 1,000 years.

(3) Geochemical conditions that—(i) Promote precipitation or sorption of radionuclides; (ii) Inhibit the formation of particulates, colloids, and inorganic and organic complexes that increase the mobility of radionuclides; or (iii) Inhibit the transport of radionuclides by particulates, colloids, and complexes.

(4) Mineral assemblages that, when subjected to anticipated thermal loading, will remain unaltered or alter to mineral assemblages having equal or

increased capacity to inhibit radionuclide migration.

(5) Conditions that permit the emplacement of waste at a minimum depth of 300 meters from the ground surface. (The ground surface shall be deemed to be the elevation of the lowest point on the surface above the disturbed zone.)

(6) A low population density within the geologic setting and a controlled area that is remote from population centers.

(c) *Potentially adverse conditions.*

The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(1) Potential for flooding of the underground facility, whether resulting from the occupancy and modification of floodplains or from the failure of existing or planned man-made surface water impoundments.

(2) Potential for foreseeable human activity to adversely affect the groundwater flow system, such as groundwater withdrawal, extensive irrigation, subsurface injection of fluids, underground pumped storage, military activity or construction of large scale surface water impoundments.

(3) Potential for natural phenomena such as landslides, subsidence, or volcanic activity of such a magnitude that large-scale surface water impoundments could be created that could change the regional groundwater flow system and thereby adversely affect the performance of the geologic repository.

(4) Structural deformation, such as uplift, subsidence, folding, or faulting that may adversely affect the regional groundwater flow system.

(5) Potential for changes in hydrologic conditions that would affect the migration of radionuclides to the accessible environment, such as changes in hydraulic gradient, average interstitial velocity, storage coefficient, hydraulic conductivity, natural recharge, potentiometric levels, and discharge points.

(6) Potential for changes in hydrologic conditions resulting from reasonably foreseeable climatic changes.

(7) Groundwater conditions in the host rock, including chemical composition, high ionic strength or ranges of Eh-pH, that could increase the solubility or chemical reactivity of the engineered barrier system.

(8) Geochemical processes that would reduce sorption of radionuclides, result in degradation of the rock strength, or adversely affect the performance of the engineered barrier system.

(9) For disposal in the saturated zone, groundwater conditions in the host rock that are not reducing.

(10) Evidence of dissolution such as breccia pipes, dissolution cavities, or brine pockets.

(11) Structural deformation such as uplift, subsidence, folding, and faulting during the Quaternary Period.

(12) Earthquakes which have occurred historically that if they were to be repeated could affect the site significantly.

(13) Indications, based on correlations of earthquakes with tectonic processes and features, that either the frequency of occurrence or magnitude of earthquakes may increase.

(14) More frequent occurrence of earthquakes or earthquakes of higher magnitude than is typical of the area in which the geologic setting is located.

(15) Evidence of igneous activity since the start of the Quaternary Period.

(16) Evidence of extreme erosion during the Quaternary Period.

(17) The presence of naturally occurring materials, whether identified or undiscovered, within the site, in such form that:

(i) Economic extraction is currently feasible or potentially feasible during the foreseeable future; or

(ii) Such materials have greater gross value or net value than the average for other areas of similar size that are representative of and located within the geologic setting.

(18) Evidence of subsurface mining for resources within the site.

(19) Evidence of drilling for any purpose within the site.

(20) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

(21) Geomechanical properties that do not permit design of underground opening that will remain stable through permanent closure.

#### Design Criteria for the Geologic Repository Operations Area

##### § 60.130 Scope of design criteria for the geologic repository operations area.

Sections 60.131 through 60.134 specify minimum criteria for the design of the geologic repository operations area. These design criteria are not intended to be exhaustive, however. Omissions in §§ 60.131 through 60.134 do not relieve DOE from any obligation to provide such safety features in a specific facility needed to achieve the performance objectives. All design bases must be consistent with the results of site characterization activities.

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

(a) *Radiological protection.* The geologic repository operations area shall be designed to maintain radiation doses, levels, and concentrations of radioactive material in air in restricted areas within the limits specified in Part 20 of this chapter. Design shall include—

(1) Means to limit concentrations of radioactive material in air;

(2) Means to limit the time required to perform work in the vicinity of radioactive materials, including, as appropriate, designing equipment for ease of repair and replacement and providing adequate space for ease of operation;

(3) Suitable shielding;

(4) Means to monitor and control the dispersal of radioactive contamination;

(5) Means to control access to high radiation areas or airborne radioactivity areas; and

(6) A radiation alarm system to warn of significant increases in radiation levels, concentrations of radioactive material in air, and of increased radioactivity released in effluents. The alarm system shall be designed with provisions for calibration and for testing its operability.

(b) *Structures, systems, and components important to safety.* (1) *Protection against natural phenomena and environmental conditions.*

The structures, systems, and components important to safety shall be designed so that natural phenomena and environmental conditions anticipated at the geologic repository operations area will not interfere with necessary safety functions.

(2) *Protection against dynamic effects of equipment failure and similar events.* The structures, systems, and components important to safety shall be designed to withstand dynamic effects such as missile impacts, that could result from equipment failure, and similar events and conditions that could lead to loss of their safety functions.

(3) *Protection against fires and explosions.* (i) The structures, systems, and components important to safety shall be designed to perform their safety functions during and after credible fires or explosions in the geologic repository operations area.

(ii) To the extent practicable, the geologic repository operations area shall be designed to incorporate the use of noncombustible and heat resistant materials.

(iii) The geologic repository operations area shall be designed to include explosion and fire detection alarm systems and appropriate suppression systems with sufficient

capacity and capability to reduce the adverse effects of fires and explosions on structures, systems, and components important to safety.

(iv) The geologic repository operations area shall be designed to include means to protect systems, structures, and components important to safety against the adverse effects of either the operation or failure of the fire suppression systems.

(4) *Emergency capability.* (i) The structures, systems, and components important to safety shall be designed to maintain control of radioactive waste and radioactive effluents, and permit prompt termination of operations and evacuation of personnel during an emergency.

(ii) The geologic repository operations area shall be designed to include onsite facilities and services that ensure a safe and timely response to emergency conditions and that facilitate the use of available offsite services (such as fire, police, medical and ambulance service) that may aid in recovery from emergencies.

(5) *Utility services.* (i) Each utility service system that is important to safety shall be designed so that essential safety functions can be performed under both normal and accident conditions.

(ii) The utility services important to safety shall include redundant systems to the extent necessary to maintain, with adequate capacity, the ability to perform their safety functions.

(iii) Provisions shall be made so that, if there is a loss of the primary electric power source or circuit, reliable and timely emergency power can be provided to instruments, utility service systems, and operating systems, including alarm systems, important to safety.

(6) *Inspection, testing, and maintenance.* The structures, systems, and components important to safety shall be designed to permit periodic inspection, testing, and maintenance, as necessary, to ensure their continued functioning and readiness.

(7) *Criticality control.* All systems for processing, transporting, handling, storage, retrieval, emplacement, and isolation of radioactive waste shall be designed to ensure that a nuclear criticality accident is not possible unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. Each system shall be designed for criticality safety under normal and accident conditions. The calculated effective multiplication factor ( $k_{eff}$ ) must be sufficiently below unity to show at least a 5% margin, after

allowance for the bias in the method of calculation and the uncertainty in the experiments used to validate the method of calculation.

(8) *Instrumentation and control systems.* The design shall include provisions for instrumentation and control systems to monitor and control the behavior of systems important to safety over anticipated ranges for normal operation and for accident conditions.

(9) *Compliance with mining regulations.* To the extent that DOE is not subject to the Federal Mine Safety and Health Act of 1977, as to the construction and operation of the geologic repository operations area, the design of the geologic repository operations area shall nevertheless 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. Any deviation from relevant design requirements in 30 CFR, Chapter I, Subchapters D, E, and N will give rise to a rebuttable presumption that this requirement has not been met.

(10) *Shaft conveyances used in radioactive waste handling.* (i) Hoists important to safety shall be designed to preclude cage free fall.

(ii) Hoists important to safety shall be designed with a reliable cage location system.

(iii) Loading and unloading systems for hoists important to safety shall be designed with a reliable system of interlocks that will fail safely upon malfunction.

(iv) Hoists important to safety shall be designed to include two independent indicators to indicate when waste packages are in place and ready for transfer.

**§ 60.132 Additional design criteria for surface facilities in the geologic repository operations area.**

(a) *Facilities for receipt and retrieval of waste.* Surface facilities in the geologic repository operations area shall be designed to allow safe handling and storage of wastes at the geologic repository operations area, whether these wastes are on the surface before emplacement or as a result of retrieval from the underground facility.

(b) *Surface facility ventilation.* Surface facility ventilation systems supporting waste transfer, inspection, decontamination, processing, or packaging shall be designed to provide protection against radiation exposures and offsite releases as provided in § 60.111(a).

(c) *Radiation control and monitoring.*  
 (1) *Effluent control.* The surface facilities shall be designed to control the release of radioactive materials in effluents during normal operations so as to meet the performance objections of § 60.111(a).

(2) *Effluent monitoring.* The effluent monitoring systems shall be designed to measure the amount and concentration of radionuclides in any effluent with sufficient precision to determine whether releases conform to the design requirement for effluent control. The monitoring systems shall be designed to include alarms that can be periodically tested.

(d) *Waste treatment.* Radioactive waste treatment facilities shall be designed to process any radioactive wastes generated at the geologic repository operations area into a form suitable to permit safe disposal at the geologic repository operations area or to permit safe transportation and conversion to a form suitable for disposal at an alternative site in accordance with any regulations that are applicable.

(e) *Consideration of decommissioning.* The surface facility shall be designed to facilitate decontamination or dismantlement to the same extent as would be required, under other parts of this chapter, with respect to equivalent activities licensed thereunder.

#### § 60.133 Additional design criteria for the underground facility.

(a) *General criteria for the underground facility.* (1) The orientation, geometry, layout, and depth of the underground facility, and the design of any engineered barriers that are part of the underground facility shall contribute to the containment and isolation of radionuclides.

(2) The underground facility shall be designed so that the effects of credible disruptive events during the period of operations, such as flooding, fires and explosions, will not spread through the facility.

(b) *Flexibility of design.* The underground facility shall be designed with sufficient flexibility to allow adjustments where necessary to accommodate specific site conditions identified through in situ monitoring, testing, or excavation.

(c) *Retrieval of waste.* The underground facility shall be designed to permit retrieval of waste in accordance with the performance objectives of § 60.111.

(d) *Control of water and gas.* The design of the underground facility shall provide for control of water or gas intrusion.

(e) *Underground openings.* (1) Openings in the underground facility shall be designed so that operations can be carried out safely and the retrievability option maintained.

(2) Openings in the underground facility shall be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock.

(f) *Rock excavation.* The design of the underground facility shall incorporate excavation methods that will limit the potential for creating a preferential pathway for groundwater or radioactive waste migration to the accessible environment.

(g) *Underground facility ventilation.* The ventilation system shall be designed to—(1) Control the transport of radioactive particulates and gases within and releases from the underground facility in accordance with the performance objectives of § 60.111(a).

(2) Assure continued function during normal operations and under accident conditions; and

(3) Separate the ventilation of excavation and waste emplacement areas.

(h) *Engineered barriers.* Engineered barriers shall be designed to assist the geologic setting in meeting the performance objectives for the period following permanent closure.

(i) *Thermal loads.* The underground facility shall be designed so that the performance objectives will be met taking into account the predicted thermal and thermomechanical response of the host rock, and surrounding strata, groundwater system.

#### § 60.134 Design of seals for shafts and boreholes.

(a) *General design criterion.* Seals for shafts and boreholes shall be designed so that following permanent closure they do not become pathways that compromise the geologic repository's ability to meet the performance objectives or the period following permanent closure.

(b) *Selection of materials and placement methods.* Materials and placement methods for seals shall be selected to reduce, to the extent practicable: (1) The potential for creating a preferential pathway for groundwater; or (2) radioactive waste migration through existing pathways.

#### Design Criteria for the Waste Package

#### § 60.135 Criteria for the waste package and its components.

(a) *High-level-waste package design in general.* (1) Packages for HLW shall be designed so that the in situ chemical,

physical, and nuclear properties of the waste package and its interactions with the emplacement environment do not compromise the function of the waste packages or the performance of the underground facility or the geologic setting.

(2) The design shall include but not be limited to consideration of the following factors: solubility, oxidation/reduction reactions, corrosion, hydriding, gas generation, thermal effects, mechanical strength, mechanical stress, radiolysis, radiation damage, radionuclide retardation, leaching, fire and explosion hazards, thermal loads, and synergistic interactions.

(b) *Specific criteria for HLW package design.* (1) *Explosive, pyrophoric, and chemically reactive materials.* The waste package shall not contain explosive or pyrophoric materials or chemically reactive materials in an amount that could compromise the ability of the underground facility to contribute to waste isolation or the ability of the geologic repository to satisfy the performance objectives.

(2) *Free liquids.* The waste package shall not contain free liquids in an amount that could compromise the ability of the waste packages to achieve the performance objectives relating to containment of HLW (because of chemical interactions or formation of pressurized vapor) or result in spillage and spread of contamination in the event of waste package perforation during the period through permanent closure.

(3) *Handling.* Waste packages shall be designed to maintain waste containment during transportation, emplacement, and retrieval.

(4) *Unique identification.* A label or other means of identification shall be provided for each waste package. The identification shall not impair the integrity of the waste package and shall be applied in such a way that the information shall be legible at least to the end of the period of retrievability. Each waste package identification shall be consistent with the waste package's permanent written records.

(c) *Waste form criteria for HLW.* High-level radioactive waste that is emplaced in the underground facility shall be designed to meet the following criteria:

(1) *Solidification.* All such radioactive wastes shall be in solid form and placed in sealed containers.

(2) *Consolidation.* Particulate waste forms shall be consolidated (for example, by incorporation into an encapsulating matrix) to limit the

availability and generation of particulates.

(3) *Combustibles.* All combustible radioactive wastes shall be reduced to a noncombustible form unless it can be demonstrated that a fire involving the waste packages containing combustibles will not compromise 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.

(d) *Design criteria for other radioactive wastes:* Design criteria for waste types other than HLW will be addressed on an individual basis if and when they are proposed for disposal in a geologic repository.

#### Performance Confirmation Requirements

##### § 60.137 General requirements for performance confirmation.

The geologic repository operations area shall be designed so as to permit implementation of a performance confirmation program that meets the requirements of Subpart F of this part.

#### Subpart F—Performance Confirmation Program

##### § 60.140 General requirements.

(a) The performance confirmation program shall provide data which indicates, where practicable, whether—

(1) Actual subsurface conditions encountered and changes in those conditions during construction and waste emplacement operations are within the limits assumed in the licensing review; and

(2) Natural and engineered systems and components required for repository operation, or which are designed or assumed to operate as barriers after permanent closure, are functioning as intended and anticipated.

(b) The program shall have been started during site characterization and it will continue until permanent closure.

(c) The program shall include in situ monitoring, laboratory and field testing, and in situ experiments, as may be appropriate to accomplish the objective as stated above.

(d) The program shall be implemented so that:

(1) It does not adversely affect the ability of the natural and engineered elements of the geologic repository to meet the performance objectives.

(2) It provides baseline information and analysis of that information on those parameters and natural processes pertaining to the geologic setting that may be changed by site

characterization, construction, and operational activities.

(3) It monitors and analyzes changes from the baseline condition of parameters that could affect the performance of a geologic repository.

(4) It provides an established plan for feedback and analysis of data, and implementation of appropriate action.

##### § 60.141 Confirmation of geotechnical and design parameters.

(a) During repository construction and operation, a continuing program of surveillance, measurement, testing, and geologic mapping shall be conducted to ensure that geotechnical and design parameters are confirmed and to ensure that appropriate action is taken to inform the Commission of changes needed in design to accommodate actual field conditions encountered.

(b) Subsurface conditions shall be monitored and evaluated against design assumptions.

(c) As a minimum, measurements shall be made of rock deformations and displacement, changes in rock stress and strain, rate and location of water inflow into subsurface areas, changes in groundwater conditions, rock pore water pressures including those along fractures and joints, and the thermal and thermomechanical response of the rock mass as a result of development and operations of the geologic repository.

(d) These measurements and observations shall be compared with the original design bases and assumptions. If significant differences exist between the measurements and observations and the original design bases and assumptions, the need for modifications to the design or in construction methods shall be determined and these differences and the recommended changes reported to the Commission.

(e) In situ monitoring of the thermomechanical response of the underground facility shall be conducted until permanent closure to ensure that the performance of the natural and engineering features are within design limits.

##### § 60.142 Design testing.

(a) During the early or developmental stages of construction, a program for in situ testing of such features as borehole and shaft seals, backfill, and the thermal interaction effects of the waste packages, backfill, rock, and groundwater shall be conducted.

(b) The testing shall be initiated as early as is practicable.

(c) A backfill test section shall be constructed to test the effectiveness of backfill placement and compaction procedures against design requirements

before permanent backfill placement is begun.

(d) Test sections shall be established to test the effectiveness of borehole and shaft seals before full-scale operation proceeds to seal boreholes and shafts.

##### § 60.143 Monitoring and testing waste packages.

(a) A program shall be established at the geologic repository operations area for monitoring the condition of the waste packages. Waste packages chosen for the program shall be representative of those to be emplaced in the underground facility.

(b) Consistent with safe operation at the geologic repository operations area, the environment of the waste packages selected for the waste package monitoring program shall be representative of the environment in which the wastes are to be emplaced.

(c) The waste package monitoring program shall include laboratory experiments which focus on the internal condition of the waste packages. To the extent practical, the environment experienced by the emplaced waste packages within the underground facility during the waste package monitoring program shall be duplicated in the laboratory experiments.

(d) The waste package monitoring program shall continue as long as practical up to the time of permanent closure.

#### Subpart G—Quality Assurance

##### § 60.150 Scope.

As used in this part, "quality assurance" comprises all those planned and systematic actions necessary to provide adequate confidence that the geologic repository and its subsystems or components will perform satisfactorily in service. Quality assurance includes quality control, which comprises those quality assurance actions related to the physical characteristics of a material, structure, component, or system which provide a means to control the quality of the material, structure, component, or system to predetermined requirements.

##### § 60.151 Applicability.

The quality assurance program applies to all systems, structures and components important to safety, to design and characterization of barriers important to waste isolation and to activities related thereto. These activities include: site characterization, facility and equipment construction, facility operation, performance confirmation, permanent closure, and

decontamination and dismantling of surface facilities.

**§ 60.152 Implementation.**

DOE shall implement a quality assurance program based on the criteria of Appendix B of 10 CFR Part 50 as applicable, and appropriately supplemented by additional criteria as required by § 60.151.

**Subpart H—Training and Certification of Personnel**

**§ 60.160 General requirements.**

Operations of systems and components that have been identified as important to safety in the Safety Analysis Report and in the license shall be performed only by trained and certified personnel or by personnel under the direct visual supervision of an individual with training and certification in such operation. Supervisory personnel who direct operations that are important to safety must also be certified in such operations.

**§ 60.161 Training and certification program.**

DOE shall establish a program for training, proficiency testing, certification and requalification of operating and supervisory personnel.

**§ 60.162 Physical requirements.**

The physical condition and the general health of personnel certified for operations that are important to safety shall not be such as might cause operational errors that could endanger the public health and safety. Any condition which might cause impaired judgment or motor coordination must be considered in the selection of personnel for activities that are important to safety. These conditions need not categorically disqualify a person, so long as appropriate provisions are made to accommodate such conditions.

**Subpart I—Emergency Planning Criteria [Reserved]**

Dated at Washington, D.C., this 13th day of June 1983.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,  
Secretary of the Commission.

[FR Doc. 83-16319 Filed 6-20-83; 9:45 am]  
BILLING CODE 7590-01-M

**FEDERAL RESERVE SYSTEM**

**12 CFR Parts 207, 220, 221 and 224**

**Regulations G, T, U and X; Securities Credit Transactions**

**AGENCY:** Board of Governors of the Federal Reserve System.

**ACTION:** Final rule; correction.

**SUMMARY:** This document corrects a previous Federal Register document, FR Doc. 83-15384 (List of OTC Margin Stocks), which was published at page 26587 of the issue for Thursday, June 9, 1983, to be effective June 20, 1983.

**FOR FURTHER INFORMATION CONTACT:** Jamie Lenoci, Financial Analyst, Division of Banking Supervision and Regulation, Board of Governors of the Federal Reserve System, Washington, D.C. 20551, (202) 452-2781.

**SUPPLEMENTARY INFORMATION:** Based upon corrected information received from the Company, the stock of Chemical Leaman Corporation, \$2.50 par common, should remain on the List of OTC Margin Stocks. The stock of The Central Bancorporation, Inc., \$5.00 par common was inadvertently omitted from the printed copy of the complete List of OTC Margin Stocks although it was not listed as a deletion from the list.

Accordingly, in accordance with § 207.2(f)(2) of Regulation G, § 220.2(e)(2) of Regulation T, and § 221.3(d)(2) of Regulation U the stock of Chemical Leaman Corporation, \$2.50 par common, is removed from the list of deletions from the Board's List and is added to the complete List of OTC Margin Stocks on file at the Office of the Federal Register; and the stock of the Central Bancorporation, Inc., \$5.00 par common, is added to the complete List on file at the Office of the Federal Register.

By order of the Board of Governors of the Federal Reserve System, June 16, 1983.

James McAfee,  
Associate Secretary of the Board.

[FR Doc. 83-16608 Filed 6-16-83; 4:06 pm]  
BILLING CODE 6210-01-M

**CONSUMER PRODUCT SAFETY COMMISSION**

**16 CFR Part 1406**

**Provision of Performance and Technical Data for Coal and Wood Burning Appliances**

**AGENCY:** Consumer Product Safety Commission.

**ACTION:** Final rule.

**SUMMARY:** The Commission amends its rule which requires that coal and wood burning stoves, freestanding fireplaces, and similar appliances bear a label stating that furnishings and other combustibles should be kept a "considerable distance away" from the appliance. The amendment would allow the use of alternate language stating that such objects should be kept "far away" from the appliance. This change is made to allow manufacturers to use a shorter statement to convey the safety message.

**EFFECTIVE DATES:** This amendment shall become effective October 17, 1983, which is also the effective date of the rule.

**ADDRESSES:** All materials that the Commission has that are relevant to this proceeding may be seen in, or copies obtained from, the Office of the Secretary, 8th Floor, 1111 18th Street NW., Washington, D.C. 20207.

**FOR FURTHER INFORMATION CONTACT:** Wade Anderson, Directorate for Compliance and Administrative Litigation, Consumer Product Safety Commission, Washington, D.C. 20207, phone (301) 492-8100.

**SUPPLEMENTARY INFORMATION:** On May 18, 1983, the Commission published a final rule in the Federal Register that requires that certain performance and technical data be supplied with coal and wood burning stoves, freestanding fireplaces, and similar appliances in order that consumers will be aware of important safety information concerning the installation, operation, and maintenance of these appliances. 16 CFR Part 1406; 48 FR 21898. Part of the data required by this rule is to be in the form of labeling on the device, and the rule also requires that complete installation, operation, and maintenance directions be provided with the appliance. Sales catalogs and other point of sale literature are required to state certain minimum clearance distances to combustibles and to refer to the possibility of other installation restrictions.

Section 1406.4(a)(1)(ix) of the rule requires that the label contain a "statement that furnishings and other combustible materials should be kept a considerable distance from the appliance." This requirement is intended to help prevent fires that can occur if furnishings or other combustible materials are placed too close to the appliance.

After the Commission had voted on the present language of § 1406.4(a)(1)(ix), a stove manufacturer wrote to the Commission, suggesting that the requirement be changed so that