

STAFF POSITION 60-001

CLARIFICATION OF THE 300-1000 YEARS PERIOD FOR SUBSTANTIALLY COMPLETE  
CONTAINMENT OF HIGH-LEVEL WASTES WITHIN THE WASTE PACKAGES UNDER 10 CFR  
60.113(a)(1)(ii)(A)

Division of High-Level Waste Management  
Office of Nuclear Material Safety and Safeguards  
U.S. Nuclear Regulatory Commission

July 27, 1990

9008170267 900816  
PDR WASTE  
WM-1 PDC

STAFF POSITION 60-001

SUBJECT: CLARIFICATION OF THE 300-1000 YEARS PERIOD FOR SUBSTANTIALLY COMPLETE CONTAINMENT OF HIGH-LEVEL WASTES WITHIN THE WASTE PACKAGES UNDER 10 CFR 60.113(a)(1)(ii)(A)

THE QUESTION: Under the applicable performance objective in 10 CFR Part 60, may waste packages for high-level waste be designed for a lifetime in excess of 1000 years and, if so, may containment over the entire design lifetime be factored into required engineered barrier system and overall repository system performance assessments?

STAFF POSITION: The requirement in 10 CFR 60.113(a)(1)(ii)(A) for substantially complete containment of high-level wastes within the waste packages for a period not less than 300 years nor more than 1000 years following repository closure is a minimum performance requirement which is not intended, and should not be interpreted, as a cap on the waste package lifetime or a limitation on the credit that can be taken (in engineered barrier system and overall repository system performance assessments) if the waste package is designed to provide containment in excess of 1000 years.

ISSUANCE DATE: July 27, 1990

DISCUSSION: § 60.113 contains the subsystem performance requirements for both the engineered and natural barriers of the geologic repository. Specifically, 10 CFR 60.113(a)(1)(ii)(A) states that, assuming anticipated processes and events:

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 as referenced, 10 CFR 60.113(b) states that:

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.

The phrase "not less than 300 years nor more than 1000 years" from § 60.113(a)(1)(ii)(A) can possibly be taken out of context and interpreted to mean (1) that the waste package must be designed to have a lifetime no greater than the stated period or (2) that, in assessing the performance of the waste package and the engineered barrier system, one must assume that the waste package fails at the end of the stated period. These interpretations would mischaracterize the "containment" requirement. Sound safety policy (as reflected in the rules) should encourage good waste package design, including a long period of expected containment. Either of the interpretations mentioned above - a limitation on the waste package lifetime or limitation on the period

for which containment may be factored into analyses - would be at odds with this desirable safety practice. Neither the language nor the regulatory history of the rule requires or supports any such interpretation. The waste package may be designed for a longer lifetime and such longer lifetime may be considered in evaluations of compliance with the engineered barrier system and overall repository system performance objectives.

### I. Evolution of the "Containment" Rule

An understanding of the Commission's intent in the "containment" requirement of 10 CFR 60.113 is best obtained by a review of the rule from its development in proposed form to its promulgation in final form. The "containment" rule as proposed states in part that "... the waste packages will contain all radionuclides for at least the first 1000 years after permanent closure." (46 FR 35280, July 8, 1981). It is important to note that the containment period in the proposed rule was fixed as a single durational figure (i.e., 1000 years) and was unequivocally expressed as a minimum. However, a number of commentors expressed concern with the formulation of the proposed "containment" rule as well as the other subsystem performance requirements. They pointed out that these requirements were supposed to contribute to ensuring compliance with an overall EPA standard, yet, at the time the requirements were proposed and commented upon, there was no such EPA standard. (All that was available was an EPA "working draft," not even a proposed EPA rule.) The staff accordingly sought Commission guidance on the question whether to proceed with the numerical subsystem performance objectives as part of the final rule or to defer their publication until after the EPA standard had been issued. (SECY-82-427, "Commission Options on Developing Final Technical Criteria for Disposal of High-Level Waste in Geologic Repositories.") The language which the staff suggested for publication -- should the Commission approve -- would have required a specific containment period (1000 years), subject to adjustment to take into consideration a variety of factors, including the standard that EPA might actually promulgate. The specific text

(submitted as part of SECY-82-288, "10 CFR Part 60 - Disposal of High-Level Radioactive Wastes In Geologic Repositories: Technical Criteria") reads as follows:

Containment of HLW within the waste packages will be substantially complete for a period of 1,000 years after permanent closure of the geologic repository, or such other period as may be approved or specified by the Commission.

The Commission decided that the staff should proceed to finalize the technical criteria, including numerical performance objectives for the waste packages. However, the Commission decided that the wording should be modified so that, as the final rule states, the containment period, to be determined by the Commission, "shall be not less than 300 years nor more than 1,000 years after permanent closure."

The change can be traced to a Commissioner's recommendation, dated December 8, 1982 (captioned "HIGH LEVEL WASTE TECHNICAL RULE"):

Replacing the staff formulation of the designed waste package containment period in Section 60.113(a)(1)(ii)(A) (1,000 years after closure or such other period as may be approved or specified by the Commission) with the requirement that the Commission specify the appropriate period within a range of from 200 to 1,000 years, taking into account the four factors in Section 60.113(b). This should accomplish essentially the same purpose as the staff's formulation in a more neutral form.

(In subsequent Commission direction to the staff, the 200-year figure was changed to 300 years.)

This history establishes clearly that the Commission intended no departure from the principle that a specific minimum containment period for the waste package should be specified. This was a cornerstone of the proposed rule and

the staff's suggested revision, and the Commission undertook no change in that purpose. The only alteration was one designed to eliminate the apparent presumption that the minimum containment period was to be 1000 years; by providing a range, the length of this minimum period would be formulated "in a more neutral form." That is, the flexibility provided in the rule (considering factors specific to particular sites and designs) could be applied to set an appropriate minimum containment period; and so long as it was of sufficient duration to cover the period when radiation and thermal conditions in the engineered barrier system are dominated by fission product decay (Section 60.113(a)(1)(i)(A)), the rule expressed no further preference for any particular number of years within the range.

The Commission's views were developed in the statement of considerations accompanying publication of final technical criteria. The concern that was being addressed involved uncertainties arising out of thermal disturbances of the area near the emplaced waste: the specification of a minimum containment period (i.e., a prescribed period to be determined within a broad range) would limit the source term (i.e., radionuclide releases from the waste package) during the thermal pulse and thereby reduce these uncertainties. The discussion (48 FR 28194, June 21, 1983 at 28196) includes the following:

...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)(1)(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.

Given this discussion, it is evident in the public record as well as internal documents that the Commission had in mind the fixing of a particular minimum containment period (generally within the 300 - 1,000 year range) that would suffice to eliminate some of the principal sources of uncertainty. (This is emphasized by the Commission's explanation, also at 48 FR 28196, of its defense in depth approach as one that would prescribe "minimum performance standards for each of the major elements of the repository.") There is nothing to suggest that the 300 - 1,000 year range would play any other part in the application of the requirements of 10 CFR Part 60.

## II. Relation of the Containment Requirement to Other Post Closure Performance Objectives

As discussed below, the containment requirement has an intended relationship to both the overall repository system performance objective and the controlled release performance objective of the engineered barrier system.

### A. Overall System Performance Objective

As noted above, the containment requirement was established as a measure that would limit the uncertainties arising out of thermal disturbances of the area near the emplaced waste. The underlying reason for limiting the uncertainties was the Commission's expectation that application of the EPA standard would be facilitated thereby. Thus, satisfaction of the containment requirement would

"ordinarily contribute to meeting the [EPA] standards"; and the "definite contribution" of the waste package would be important "for the Commission to be able to conclude that the EPA standard will be met." (48 FR at 28196.) Clearly, if the performance of the waste package in accordance with Section 60.113(a) is deemed to contribute to a finding of compliance with the EPA standard, then the containment for an even longer period should make even more of a contribution. To the extent warranted by the data submitted in support of the license application, containment of radionuclides within the waste packages can and should be recognized in applying the EPA standard, without any arbitrary time limitation.

#### B. Controlled-Release Performance Objective

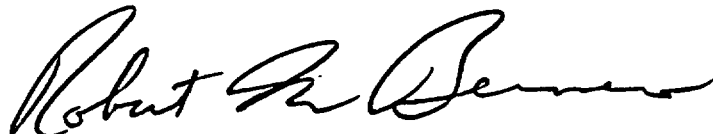
The close relationship between the two performance objectives in 10 CFR 60.113(a)(1)-- the containment requirement and the controlled-release requirement-- needs to be recognized (See 48 FR 28209). These are coupled requirements that serve to control the release of radionuclides to the geologic setting and thereby contribute to meeting the EPA standard. The controlled-release performance objective specifies that following the containment period, the release rate of any radionuclide from the "engineered barrier system" shall not exceed specified values. The issue arises because the Commission indicated its intention that each of the multiple barriers described in the rule must make a definite contribution to satisfying the EPA standard; a valid question, then, is whether credit for containment of radionuclides in the waste package beyond the containment period can be taken in judging whether satisfaction of the controlled-release performance objective would in fact contribute to meeting the EPA standard. The text of the rule is really unambiguous on the point, as the controlled-release requirement pertains to the "engineered barrier system," which by definition includes the waste packages. Accordingly, in determining whether releases from the engineered barrier system are kept low enough, one must consider the role of the components of that system, and that includes the role of the waste packages. Once again, whatever degree of containment can be demonstrated by the applicant will be recognized in determining whether the engineered barrier system is making the contribution envisaged by the Commission.



### III. Conclusion

Inasmuch as the waste package will be assessed by the NRC staff on the merits of its design and its anticipated performance in the repository setting, the staff can give credit, if warranted, for waste packages designed to provide containment in excess of 1000 years. In other words, the staff would not arbitrarily assume in its compliance assessment for the waste package and engineered barrier system that the waste package will fail at 1000 years. The staff recognizes the licensee's option to do more than just meet the Commission's requirements (i.e., the minimum standards) and that, when warranted, the staff's assessments should reflect those design enhancements. In this regard, the purpose of the natural and engineered barriers subsystem requirements is to add confidence that the overall EPA containment requirements will be met. One way of minimizing uncertainties related to compliance with the EPA standard is to propose a waste package design for containment well in excess of 1000 years and the DOE could factor this design into the performance assessment which will be documented in its license application.

For the reasons cited above, the 300 - 1000 year containment period specified in 10 CFR 60.113(a)(1)(ii)(A) is not to be viewed as the waste package lifetime but rather the minimum period for which substantially complete containment of radionuclides within the waste package must be provided.



Robert M. Bernero, Director  
Office of Nuclear Material Safety  
and Safeguards

STAFF POSITION 60-002

"PERFORMANCE OBJECTIVES RELATING TO ISOLATION OF THE WASTE"

Division of High-Level Waste Management  
Office of Nuclear Material Safety and Safeguards  
U.S. Nuclear Regulatory Commission

August 8, 1990

9008100320  
⑥  
900

Staff Position SP 60-002

**SUBJECT: THE MEANING OF THE PHRASE "PERFORMANCE OBJECTIVES RELATING TO ISOLATION OF THE WASTE" [10 CFR 60.122(a)]**

**THE QUESTION:** In 10 CFR 60.122, "Siting Criteria," what performance objectives are encompassed by the phrase "performance objectives relating to isolation of the waste"?

**STAFF POSITION:** In 10 CFR 60.122(a), the phrase "performance objectives relating to isolation of the waste" refers to the performance objectives set out in 10 CFR 60.112, "Overall System Performance Objective for the Geologic Repository After Permanent Closure," and 10 CFR 60.113, "Performance of Particular Barriers After Permanent Closure," but does not refer to the performance objectives set out in 10 CFR 60.111.

**ISSUANCE DATE:** August 8, 1990

**DISCUSSION:**

The text of 10 CFR 60.122(a) is attached. This section contains the phrase "performance objectives relating to isolation of the waste" in several places. The question is: What are the "performance objectives relating to isolation of the waste" that must be considered? The term "isolation of waste" is discussed in 10 CFR 60.102, "Concepts," and is as follows:

"(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....

(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." [emphasis in original]

It is clear that the term isolation is used only in reference to the period following permanent closure. The performance objectives for the period of repository operations contained in 10 CFR 60.111 relate to radiation protection during preclosure repository operations and do not pertain to isolation of the waste following permanent closure. Therefore, the staff has concluded that the preclosure performance objectives of 10 CFR 60.111 are unrelated to waste isolation and are not encompassed by the term "performance objectives relating to isolation of the waste" in 10 CFR 60.122.

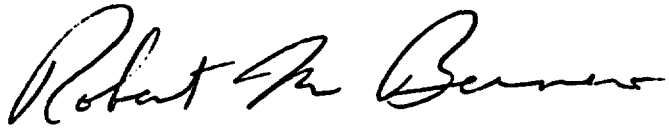
The performance objectives of 10 CFR 60.112, which implement the overall U.S. Environmental Protection Agency (EPA) Standard in 40 CFR 191 by reference, establish limits for amounts and concentrations of material entering the accessible environment following permanent closure. Thus, it is clear that in using the term "performance objectives relating to isolation of the waste," the Commission had in mind at least the overall EPA Standard.

The staff considers that the performance objectives set out in 10 CFR 60.113 also relate to isolation of the waste and that they should be considered when applying 10 CFR 60.122. Justification for this position can be found in the Statement of Considerations accompanying the proposed technical criteria for Subpart E in 10 CFR Part 60, 46 FR 35280, July 8, 1981 (at 35283-84). There, the Commission observed that in order to have confidence in the ability of a geological repository to contain and isolate the wastes for an extended period of time, the repository must consist of multiple barriers - specifically, it concluded, two major engineered barriers (waste packages and underground facility), in addition to the natural barrier provided by the geological setting. The Commission emphasized these elements "...to take advantage of the opportunity to attain greater confidence in the isolation of the waste."

It is clear, therefore, that when the Commission referenced "performance objectives relating to isolation of the waste," it had in mind the multiple performance objectives set out in 10 CFR 60.113 as well as the overall EPA Standard that is implemented by 10 CFR 60.112.

This staff position reflects sound policy considerations. It calls for the applicant to consider the siting criteria, as specified in 10 CFR 60.122, to demonstrate - for each of the relevant performance objectives referenced above - that the favorable conditions together with the engineering barrier system are sufficient to provide reasonable assurance that such objectives will be met and that any potentially adverse condition will not compromise the ability of the geologic repository to meet such objectives. If the applicant is unable to make such a demonstration, it seems unlikely that it could otherwise satisfy the requirements of 10 CFR 60.113 that the Commission so emphasized.

Finally, it should be noted that the current position is a clarification of the applicability of 10 CFR 60.122. It does not modify the performance objectives. In fact, the scope of 10 CFR 60.122 is limited by the specific language of those performance objectives. In particular, the position does not imply the need for additional analysis of favorable or potentially adverse conditions, where such conditions have no relevance to a given performance objective.



Robert M. Bernero, Director  
Office of Nuclear Material Safety  
and Safeguards

Attachment:  
10 CFR 60.122(a) Text

ATTACHMENT

TEXT FROM SECTION 10 CFR 60.122(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 barrier 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;

(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.

STAFF POSITION 60-003

DEFINITION OF THE TERM "PERFORMANCE OBJECTIVES" AS USED IN 10 CFR 60.133(1)

Division of High-Level Waste Management  
Office of Nuclear Material Safety and Safeguards  
U.S. Nuclear Regulatory Commission

August 8, 1990

STAFF POSITION 60-003

SUBJECT: DEFINITION OF THE TERM "PERFORMANCE OBJECTIVES" AS USED IN  
10 CFR 60.133(i)

THE QUESTION: In 10 CFR 60.133(i), "Thermal Loads," what performance objectives are encompassed by the phrase "... designed so that the performance objectives will be met...?"

STAFF POSITION: The term "performance objectives" as used in Section 60.133(i) of 10 CFR Part 60 is considered by the NRC staff to apply to both the preclosure and postclosure performance objectives identified in 60.111, 60.112 and 60.113 of 10 CFR Part 60.

ISSUANCE DATE: August 8, 1990

DISCUSSION: Section 60.133(i) falls within a portion of the rule entitled, "Design Criteria For the Geologic Repository Operations Area." The "Geologic Repository Operations Area" is defined in 60.2 as: "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" (emphasis added). The presence of the word "are" in the last sentence seems to limit the applicability of the regulations under this heading to the preclosure period thus excluding the performance objectives stated in 60.112 and 60.113.

On the other hand, Sections 60.112 and 60.113 identify postclosure performance objectives which must be considered when designing the Engineered Barrier System (EBS). The EBS includes the underground facility. Section 60.133(i) is a design criterion for the underground facility. Thus, since 60.133(i) is a design criterion for the underground facility, it appears to be a design criterion applicable to achieving the postclosure performance objectives of 60.112 and 60.113.



However, both the language and regulatory history of §60.133 afford ample support that the design of the underground facility should consider short-term and long-term thermal loads. Thus, in proposing its technical criteria (46 FR 35280, July 8, 1981, at 35285), the Commission explained that the technical criteria required the design of the repository to accommodate potential interaction of the waste, the underground facility, and the site. The rationale for this policy was stated thus: "The Commission believes such requirements are necessary to assure that the ability of the repository to contain and isolate the wastes will not be compromised by the construction of the repository." The rule as it was then being proposed, §60.132(k), called for the underground facility to be designed so that the predicted thermal and thermomechanical response of the rock will not degrade significantly the performance of the repository or the ability of the natural or engineered barriers to retard radionuclide migration. This was an unequivocal reference to long-term (postclosure) performance. Although the final regulation was modified, there was no change in intent, for the Commission indicated that the specific reference to retardation of radionuclide migration -- which was deleted -- "is already covered by requiring that the performance objectives be met." 46 FR 28194, June 21, 1983 at 28215.

Moreover, the regulations reveal that the drafters consciously restricted the scope of the performance objectives to preclosure concerns where that was the intent - as in §60.133(g)(1), which requires design of the ventilation facility to control certain functions "in accordance with the performance objectives of §60.111(a)" - i.e., preclosure criteria.



Robert M. Bernero, Director  
Office of Nuclear Material Safety  
and Safeguards