



OFFICE OF THE  
SECRETARY

UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

January 10, 2002

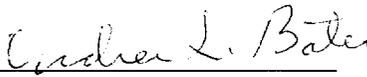
COMMISSION VOTING RECORD

DECISION ITEM: SECY-01-0206

TITLE: PROPOSED RULE: 10 CFR PART 63:  
SPECIFICATION OF A PROBABILITY FOR  
UNLIKELY FEATURES, EVENTS, AND  
PROCESSES

The Commission (with all Commissioners agreeing) approved the subject paper as recorded in the Staff Requirements Memorandum (SRM) of January 10, 2002.

This Record contains a summary of voting on this matter together with the individual vote sheets, views and comments of the Commission.

  
Annette L. Vietti-Cook  
Secretary of the Commission

Attachments:

1. Voting Summary
2. Commissioner Vote Sheets

cc: Chairman Meserve  
Commissioner Dicus  
Commissioner Diaz  
Commissioner McGaffigan  
Commissioner Merrifield  
OGC  
EDO  
PDR

VOTING SUMMARY - SECY-01-0206

RECORDED VOTES

	APRVD	DISAPRVD	ABSTAIN	NOT PARTICIP	COMMENTS	DATE
CHRM. MESERVE	X				X	12/18/01
COMR. DICUS	X				X	12/12/01
COMR. DIAZ	X				X	12/12/01
COMR. McGAFFIGAN	X				X	12/03/01
COMR. MERRIFIELD	X				X	12/05/01

COMMENT RESOLUTION

In their vote sheets, all Commissioners approved the staff's recommendation and provided some additional comments and edits. Subsequently, the comments and edits of the Commission were incorporated into the guidance to staff as reflected in the SRM issued on January 10, 2002.

NOTATION VOTE

RESPONSE SHEET

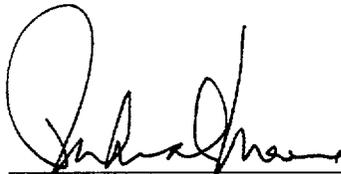
TO: Annette Vietti-Cook, Secretary  
FROM: CHAIRMAN MESERVE  
SUBJECT: **SECY-01-0206 - PROPOSED RULE: 10 CFR PART 63:  
SPECIFICATION OF A PROBABILITY FOR UNLIKELY  
FEATURES, EVENTS, AND PROCESSES**

Approved Xw/edits Disapproved \_\_\_\_\_ Abstain \_\_\_\_\_

Not Participating \_\_\_\_\_

COMMENTS:

See attachment.



\_\_\_\_\_  
SIGNATURE

Dec 18, 2011

\_\_\_\_\_  
DATE

Entered on "STARS" Yes X No \_\_\_\_\_

**NUCLEAR REGULATORY COMMISSION**

**10 CFR Part 63**

**RIN 3150-AG91**

**Specification of a Probability for Unlikely Features, Events and Processes**

**AGENCY:** Nuclear Regulatory Commission.

**ACTION:** Proposed rule.

**SUMMARY:** The Nuclear Regulatory Commission (NRC) is proposing to amend its regulations governing the disposal of high-level radioactive wastes in a <sup>potential</sup> proposed geologic repository at Yucca Mountain, Nevada, to ~~quantitatively~~ <sup>in quantitative terms. That is, it would be defined as</sup> define the term "unlikely" ~~as~~ a range of numerical values for use in determining whether a feature, event, or process (FEP) or sequence of events and processes should be excluded from certain required assessments. The NRC is proposing this amendment to clarify how it plans to implement two of the final environmental standards for Yucca Mountain issued by the U.S. Environmental Protection Agency (EPA). Specifically, EPA's final standards require the exclusion of "unlikely" FEPs, or sequences of events and processes, from the required assessments for the human intrusion and ground-water protection standards. In accordance with the Energy Policy Act of 1992, the NRC has adopted EPA's final standards in its recently published technical requirements for a <sup>potential</sup> proposed geologic repository at Yucca Mountain.

**FOR FURTHER INFORMATION CONTACT:** Timothy McCartin, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, telephone (301) 415-7285, e-mail: [tjm3@nrc.gov](mailto:tjm3@nrc.gov); or Clark Prichard, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, telephone (301) 415-6203, e-mail: [cwp@nrc.gov](mailto:cwp@nrc.gov).

**SUPPLEMENTARY INFORMATION:**

**I. Background**

On November 2, 2001 (66 FR 55732), the U.S. Nuclear Regulatory Commission (NRC) published its final rule, 10 CFR Part 63, governing disposal of high-level radioactive wastes in a proposed geologic repository at Yucca Mountain, Nevada. These are the regulations that the U.S. Department of Energy (DOE) must meet in any ~~potential~~ <sup>a potential</sup> license application for construction and operation of the repository. As mandated by the Energy Policy Act of 1992, Pub. L. 102-486 (EnPA), NRC's final rule adopts the radiation protection standards established by the U.S. Environmental Protection Agency (EPA) in 40 CFR Part 197 (66 FR 32074; June 13, 2001). EPA's standards for disposal include an individual protection standard (40 CFR 197.20); a human intrusion standard (40 CFR 197.25); and ground-water protection standards (40 CFR 197.30). These EPA standards have been incorporated into NRC's regulations at 10 CFR 63.311, 63.321, and 63.331, respectively.

DOE's performance assessments are required to consider the naturally occurring features, events, and processes (FEPs) that could affect the performance of a geologic

proposed rule initiates the rulemaking to quantitatively define the term “unlikely” promised by the Commission.

## II. Discussion

EPA’s standards for disposal include an individual protection standard; a human intrusion standard; and ground-water protection standards. EPA’s standards also prescribe that DOE should exclude “very unlikely” FEPs from the performance assessments used to determine compliance with the three postclosure standards (i.e., individual protection, human intrusion, and ground-water protection). Unlike the broader purposes served by the performance assessment for the all-pathway individual protection standard, the performance assessments used to determine compliance with the human intrusion standard and the ground-water protection standards serve narrow, focused objectives. In the case of the performance assessment for human intrusion, the purpose is to evaluate the robustness of the repository system to the consequences of human intrusion. In the case of the performance assessment for ground-water protection, the purpose is to evaluate the degradation of the ground-water resource. Consistent with the specific purposes of these two standards, EPA prescribed specific conditions to be used in determining compliance with the human intrusion standard and the ground-water protection standards, including the exclusion of not only “very unlikely” FEPs, but also “unlikely” FEPs. Although EPA’s final standards did not specify a numerical value to quantitatively define unlikely FEPs, the preamble to the standards stated that the exclusion of

because unlikely is bounded by these two categories. Very unlikely FEPs have been described in the EPA standards as FEPs with such low probability of occurrence that they need not be considered in any performance assessments for Yucca Mountain. As mentioned previously, the EPA standards quantitatively define very unlikely FEPs as those FEPs with less than a 0.01 ~~percent~~ <sup>Percent</sup> chance of occurring within the 10,000 year compliance period (i.e., annual probability less than  $10^{-8}$ ). In a qualitative sense, likely FEPs are those FEPs that can be reasonably expected to occur during the 10,000 year compliance period. From a probabilistic perspective, any FEP with an annual probability of  $10^{-4}$  or higher would have a high probability of occurring (i.e., approximately a 60 percent or higher chance of occurring within the 10,000 year compliance period).<sup>2</sup> However, likely FEPs should include not only FEPs very likely to occur, but also those reasonably likely to occur. Given uncertainties in estimating the occurrence of FEPs over a 10,000 year time period, the Commission believes a prudent decision is to consider FEPs, with 10 percent or greater chance of occurring within the 10,000 year compliance period, as likely FEPs. Thus, unlikely FEPs are defined as those FEPs with less than a 10 percent chance but greater than or equal to a 0.01 percent chance, of occurring within the 10,000 year compliance period (i.e., annual probability greater than or equal to  $10^{-8}$  and less than  $10^{-5}$ ).

~~Therefore,~~ <sup>2</sup> In light of the foregoing discussion, the Commission seeks comment on the appropriateness of using an annual probability range of greater than or equal to  $10^{-8}$  and less than  $10^{-5}$  to define unlikely FEPs. As a matter of reference, current understanding of FEPs relevant to Yucca Mountain indicates that this designation would allow exclusion of igneous

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<sup>2</sup> Any FEP with an annual probability of  $10^{-4}$  would be expected to occur once over a 10,000 year period. An expectation that an FEP would occur does not guarantee such an occurrence. Thus, the probability of an occurrence would necessarily be less than one. In fact, using the laws of probability, the probability of one or more such occurrences is 0.63.

with the human intrusion standard and ground-water protection standards, which have a regulatory compliance period of 10,000 years. The Commission made clear in its final regulations in Part 63 that the “[C]riteria set out in this final rule apply specifically and exclusively to the proposed repository at Yucca Mountain” (66 FR 55732; November 2, 2001). Similarly, the proposed definition for the term “unlikely” in this rulemaking is intended to apply specifically and exclusively to the <sup>Potential</sup> proposed repository at Yucca Mountain and is not intended to suggest or imply precedent for NRC regulations in other parts of this Chapter that use the term “unlikely” in significantly different contexts (e.g., compliance periods of tens of years, higher dose limits, different facilities, and different activities).

### **III. Section-by-Section Analysis**

#### Section 63.342 Limits on performance assessments

This section specifies how DOE will determine which features, events, and processes will be considered in the performance assessments described in Subpart L of Part 63.

### **IV. Plain Language**

The Presidential memorandum dated June 1, 1998, entitled “Plain Language in Government Writing” directed that the Government’s writing be in plain language. This memorandum was published on June 10, 1998 (63 FR 31883). The NRC requests comments on the proposed rule specifically with respect to the clarity and effectiveness of the language used. Comments should be sent to the address listed under the ADDRESSES caption of the preamble.

the final EPA standards. NRC published proposed Part 63, "Disposal of High-Level Radioactive Wastes in a Proposed Geologic Repository at Yucca Mountain, Nevada", on February 22, 1999. (64 FR 8640) EPA published its proposed standards for Yucca Mountain, 40 CFR Part 197, on August 27, 1999 (64 FR 46976), and its final standards on June 13, 2001 (66 FR 32073). NRC published final Part 63, revised to conform to the final EPA standards, on November 2, 2001 (63 FR 55731). These are the regulations that DOE must meet in any potential license application for construction and operation of the repository. EPA's standards for disposal include an individual protection standard (40 CFR 197.20); a human intrusion standard (40 CFR 197.25); and ground-water protection standards (40 CFR 197.30). These EPA standards have been incorporated into NRC's regulations at 10 CFR 63.311, 63.321, and 63.331, respectively.

FEPs are features, events, and processes used to characterize the repository system. Probabilities for FEPs in the context of the potential geologic repository at Yucca Mountain have primarily been focused on igneous activity, seismic events, fault movements, and rock fall. An issue in postclosure performance assessments of the repository is what FEPs should be considered in performance assessments. For the purposes of analyses for estimating compliance with the standards for human intrusion and ground-water protection, Part 63 does not specify a quantitative probability limit for unlikely FEPs that should not be considered.<sup>2</sup> However, in the "statement of considerations" for the final rule, the Commission noted that it considered the approach of specifying a value in the regulations " ... to be consistent with the intent of EPA's final standards and may revisit the question of specifying a numerical value by rulemaking in the future" (63 FR 55734). EPA supports the approach of establishing a numerical value for unlikely FEPs that should be excluded from the assessments for the human intrusion standard and ground-water protection standards.

#### Applicable Current NRC Regulations

Under 10 CFR 63.321(b)(1), DOE must demonstrate the earliest time after disposal that the waste package would degrade sufficiently that a human intrusion could occur without recognition by the drillers and "... demonstrate that there is a reasonable expectation that the reasonably maximally exposed individual receives no more than an annual dose of 0.15 mSv

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<sup>2</sup> Section 63.342, "Limits on performance assessments," does specify a quantitative limit for very unlikely FEPs -- less than one chance in 10,000 of occurring within 10,000 years of disposal -- that should not be included in DOE's performance assessments.

of human intrusion and ground-water protection would not occur until the license application review stage of the licensing process.

This alternative would require no current resources to conduct a rulemaking, or otherwise revise NRC's regulatory guidance. However, this issue could be subject to contention in the licensing review. Resolving this issue could require a significant amount of future staff time from both NRC and the other parties involved in the licensing review.

(2) Amend 10 CFR 63.342 to include a probability limit for unlikely FEPs that should not be included in DOE's performance assessments. <sup>for human intrusion and ground-water protection.</sup> The probability limit proposed would classify unlikely FEPs as those that are estimated to have less than one chance in 10 of occurring within 10,000 years of disposal, but at least one chance in 10,000 of occurring within 10,000 years of disposal (the upper limit of very unlikely FEPs).

This alternative would clearly delineate those FEPs that DOE must include in its evaluation of the effects of human intrusion and its evaluation of ground-water protection. This would provide clearer requirements for the content of the license application. This would allow DOE's license application to concentrate on these effects rather than to speculate on what constitutes unlikely FEPs, some of which might not be determined to be relevant as a result of the licensing review. It would also allow other parties to the review to know in advance what unlikely FEPs would be excluded, allowing them to more sharply focus their resources. The end result would be a more efficient licensing process.

Adequate public input would be assured because this rulemaking will follow the normal notice and comment process required by the Administrative Procedures Act. A proposed rule will be published, and public comments will be received and considered before publication of a final rule.

This alternative -- development of a rulemaking -- would be more costly in current staff resources than alternatives (1) and (3). It is estimated that the NRC staff resources needed for development of this rulemaking would be 0.8 full-time equivalent staff years.

(3) Provide guidance on what constitutes unlikely FEPs in regulatory guidance -- the Yucca Mountain Review Plan -- rather than in the regulations in Part 63.

NOTATION VOTE

RESPONSE SHEET

TO: Annette Vietti-Cook, Secretary

FROM: COMMISSIONER DICUS

SUBJECT: **SECY-01-0206 - PROPOSED RULE: 10 CFR PART 63:  
SPECIFICATION OF A PROBABILITY FOR UNLIKELY  
FEATURES, EVENTS, AND PROCESSES**

w/comments

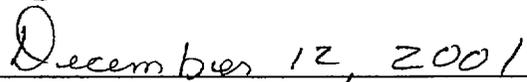
Approved: xxx Disapproved \_\_\_\_\_ Abstain \_\_\_\_\_

Not Participating \_\_\_\_\_

COMMENTS:

See attached comments.

  
\_\_\_\_\_  
SIGNATURE

  
\_\_\_\_\_  
DATE

Entered on "STARS" Yes x No \_\_\_\_\_

*Comments of Commissioner Dicus Regarding SECY 01-0206*

I commend staff for their efforts in providing the Commission with the proposed Part 63 rule amendment in such a timely manner and for detailing a well thought out approach to defining unlikely features, events, and processes (FEPs) in the context of Yucca Mountain's 10,000 year post-closure compliance period. Given the uncertainties in being able to estimate the occurrence of natural FEPs over a 10,000 year time-frame, I support staff's recommendation to specify a probability range of values between  $10^{-5}$  to  $10^{-8}$ , rather than a single probability value. I believe that this approach will allow for appropriate consideration and better characterization of the range of possible scenarios associated with unlikely FEPs at Yucca Mountain and provide the opportunity for more meaningful public and stakeholder input.

Additionally, I recommend that footnote 2 contained on page 8 of the FRN be deleted, as well as the text reference to the footnote "(i.e., approximately 60 percent or higher chance of occurring within the 10,000 year compliance period)<sup>2</sup>." Although not disputing the degree of accuracy described in the footnote or the text, I believe that including such information would add unnecessary confusion and debate potential to the public comment process.

*gjd*

12-12-01

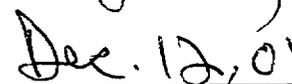
NOTATION VOTE

RESPONSE SHEET

TO: Annette Vietti-Cook, Secretary  
FROM: COMMISSIONER DIAZ  
SUBJECT: **SECY-01-0206 - PROPOSED RULE: 10 CFR PART 63:  
SPECIFICATION OF A PROBABILITY FOR UNLIKELY  
FEATURES, EVENTS, AND PROCESSES**

Approved <sup>w/edits</sup> xx  Disapproved \_\_\_\_\_ Abstain \_\_\_\_\_  
Not Participating \_\_\_\_\_

COMMENTS:

  
\_\_\_\_\_  
SIGNATURE  
  
\_\_\_\_\_  
DATE

Entered on "STARS" Yes  No

unlikely FEPs is intended to focus these assessments on the “expected” or “likely” performance of the repository.<sup>1</sup> *This intent is consistent with the Commission's policy of using risk-insights and realistic scenarios in focusing licensee and regulatory attention on design and operational issues commensurate with their importance to public health and safety.*

Under 10 CFR 63.321(b)(1), DOE must demonstrate the earliest time after disposal that the waste package would degrade sufficiently that a human intrusion could occur without recognition by the drillers and “...demonstrate that there is a reasonable expectation that the reasonably maximally exposed individual receives no more than an annual dose of 0.15 mSv (15 mrem) as a result of a human intrusion, at or before 10,000 years after disposal.” The elements of the stylized human intrusion scenario are specified by 10 CFR 63.322 and specifically direct DOE to assume that no releases are included which are caused by unlikely natural processes and events. With respect to the ground-water standards (10 CFR 63.331), DOE must demonstrate that there is a reasonable expectation that, for 10,000 years of undisturbed performance (i.e., 10,000 years during which the occurrence of unlikely FEPs do not disturb the repository) after disposal, releases of radionuclides from waste in the Yucca Mountain disposal system into the accessible environment will not cause the level of radioactivity in the representative volume of ground water to exceed the limits specified in a table attached to 10 CFR 63.331.

In assessing compliance with both the human intrusion standard and ground-water protection standards, 10 CFR 63.342 provides that unlikely FEPs, or sequences of events and

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<sup>1</sup> For example, the preamble states: (1) “[t]he assessment of resource pollution potential is based upon the engineered design of the repository being sufficiently robust under expected conditions to prevent unacceptable degradation of the ground-water resource over time” (66 FR 32114; June 13, 2001); and (2) the term “undisturbed,” which is used in connection with demonstrating compliance with the ground-water protection standards, means the “disposal system is not disturbed by human intrusion but that other processes or events that are likely to occur could disturb the system” (66 FR 32104; June 13, 2001).

NOTATION VOTE

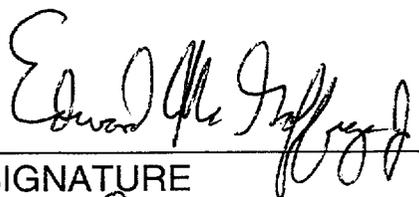
RESPONSE SHEET

TO: Annette Vietti-Cook, Secretary  
FROM: COMMISSIONER MCGAFFIGAN  
SUBJECT: **SECY-01-0206 - PROPOSED RULE: 10 CFR PART 63:  
SPECIFICATION OF A PROBABILITY FOR UNLIKELY  
FEATURES, EVENTS, AND PROCESSES**

Approved   X   <sup>w/edits</sup> Disapproved \_\_\_\_\_ Abstain \_\_\_\_\_  
Not Participating \_\_\_\_\_

COMMENTS:

Approved with minor edits to FRN.



SIGNATURE

December 3, 2001

DATE

Entered on "STARS" Yes \_\_\_\_\_ No \_\_\_\_\_

**FOR FURTHER INFORMATION CONTACT:** Timothy McCartin, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, telephone (301) 415-7285, e-mail: tjm3@nrc.gov; or Clark Prichard, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, telephone (301) 415-6203, e-mail: cwp@nrc.gov.

**SUPPLEMENTARY INFORMATION:**

**I. Background**

On November 2, 2001 (66 FR 55732), the U.S. Nuclear Regulatory Commission (NRC) published its final rule, 10 CFR Part 63, governing disposal of high-level radioactive wastes in a proposed geologic repository at Yucca Mountain, Nevada. These are the regulations that the U.S. Department of Energy (DOE) must meet in any potential license application for construction and operation of the repository. As mandated by the Energy Policy Act of 1992, Pub. L. 102-486 (EnPA), NRC's final rule adopts the radiation protection standards established by the U.S. Environmental Protection Agency (EPA) in 40 CFR Part 197 (66 FR 32074; June 13, 2001). EPA's standards for disposal include an individual protection standard (40 CFR § 197.20); a human intrusion standard (40 CFR 197.25); and ground-water protection standards (40 CFR 197.30). These EPA standards have been incorporated into NRC's regulations at 10 CFR 63.311, 63.321, and 63.331, respectively. X

DOE's performance assessments are required to consider the naturally occurring features, events, and processes (FEPs) that could affect the performance of a geologic

because unlikely is bounded by these two categories. Very unlikely FEPs have been described in the EPA standards as FEPs with such low probability of occurrence that they need not be considered in any performance assessments for Yucca Mountain. As mentioned previously, the EPA standards quantitatively define very unlikely FEPs as those FEPs with less than a 0.01 percent chance of occurring within the 10,000 year compliance period (i.e., annual probability less than  $10^{-8}$ ). In a qualitative sense, likely FEPs are those FEPs that can be reasonably expected to occur during the 10,000 year compliance period. From a probabilistic perspective, any FEP with an annual probability of  $10^{-4}$  or higher would have a high probability of occurring (i.e., approximately a 60 percent or higher chance of occurring within the 10,000 year compliance period)<sup>2</sup>. However, likely FEPs should include not only FEPs very likely to occur but also those reasonably likely to occur. Given uncertainties in estimating the occurrence of FEPs over a 10,000 year time period, the Commission believes a prudent decision is to consider FEPs with 10 percent or greater chance of occurring within the 10,000 year compliance period as likely FEPs. Thus, unlikely FEPs are defined as those FEPs with less than a 10 percent chance but greater than or equal to a 0.01 percent chance, of occurring within the 10,000 year compliance period (i.e., annual probability greater than or equal to  $10^{-8}$  and less than  $10^{-5}$ ).

Therefore, in light of the foregoing discussion, the Commission seeks comment on the appropriateness of using an annual probability range of greater than or equal to  $10^{-8}$  and less than  $10^{-5}$  to define unlikely FEPs. As a matter of reference, current understanding of FEPs relevant to Yucca Mountain indicates that this designation would allow exclusion of igneous

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<sup>2</sup> Any FEP with an annual probability of  $10^{-4}$  would be expected to occur once over a 10,000 year period. An expectation that an FEP would occur does not guarantee such an occurrence. Thus, the probability of an occurrence would necessarily be less than one. In fact, using the laws of probability, the probability of one or more such occurrences is 0.63.

NOTATION VOTE

RESPONSE SHEET

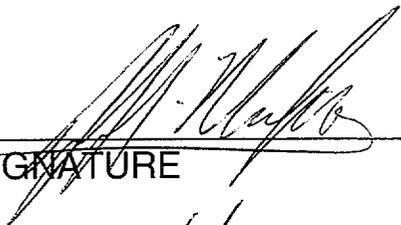
TO: Annette Vietti-Cook, Secretary  
FROM: COMMISSIONER MERRIFIELD  
SUBJECT: **SECY-01-0206 - PROPOSED RULE: 10 CFR PART 63:  
SPECIFICATION OF A PROBABILITY FOR UNLIKELY  
FEATURES, EVENTS, AND PROCESSES**

Approved  Disapproved  Abstain

Not Participating

COMMENTS:

*See attached comments*

  
\_\_\_\_\_  
SIGNATURE

*12/5/01*  
\_\_\_\_\_  
DATE

Entered on "STARS" Yes  No

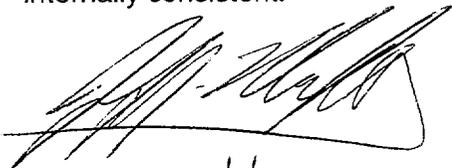
Comments from Commissioner Merrifield on SECY-01-0206:

I approve, with modifications as described below, the staff recommendations in SECY-01-0206 for specification of a range of probability values in 10 CFR Part 63 to define unlikely features, events, or processes (FEPs) in the licensing review of Yucca Mountain relating to the standards for human intrusion and groundwater protection. I commend the staff for assembling a draft rulemaking package in a relatively short time frame.

The lower level of probability for unlikely FEPs is clearly indicated by the definition of very unlikely FEPs in the EPA standards, which are reflected in 10 CFR Part 63. The upper value for unlikely FEPs is the major focus of the paper. The staff has recommended as an upper boundary for unlikely FEPs to be any FEP with a 10% chance of occurring once in a lifetime. The staff argument is somewhat subjective and is based on accounting for some uncertainty in calculating values over 10,000 years. Other subjective arguments could easily be made supporting some other standard. For example, it could easily be argued that more conservatism may be appropriate and therefore the standard should be less than a 1% chance of occurring once in a lifetime. Alternatively, another argument could be that there is enough conservatism in the calculations that an upper probability for unlikely FEPs should be a probability of occurring once in a lifetime. Nevertheless, I believe the staff recommendation is a sufficient starting point to obtain public comments before a final decision is reached.

However, there is one discussion in the Federal Register notice and supporting material that should be changed. Several places in the package discuss the fact that a FEP with a probability of occurring once in 10,000 years has only a 0.63 chance that it will actually occur. The limited discussion of the derivation of the 0.63 value could cause confusion with the general public. For example, the discussion could leave the wrong impression that the 0.63 value applies to any situation which occurs once in a lifetime, when mathematically the 0.63 value applies in this situation because the lifetime is 10,000 years. If the 0.63 value were important to the paper, the derivation of the value should be explained in the paper. However, the 0.63 value has no relevance to the standards proposed in the paper and its direct reference should be deleted from the paper. It is acceptable to have a more general statement that the paper is dealing with probabilities and even if a probability value is calculated that something will occur once in a lifetime there is a chance that it will not occur.

Attached is also an editorial change to make one sentence in the Federal Register notice internally consistent.



12/5/01

because unlikely is bounded by these two categories. Very unlikely FEPs have been described in the EPA standards as FEPs with such low probability of occurrence that they need not be considered in any performance assessments for Yucca Mountain. As mentioned previously, the EPA standards quantitatively define very unlikely FEPs as those FEPs with less than a 0.01 percent chance of occurring within the 10,000 year compliance period (i.e., annual probability less than  $10^{-8}$ ). In a qualitative sense, likely FEPs are those FEPs that can be reasonably expected to occur during the 10,000 year compliance period. From a probabilistic perspective, any FEP with an annual probability of  $10^{-4}$  or higher would have a high probability of occurring (i.e., approximately a 60 percent or higher chance of occurring within the 10,000 year compliance period)<sup>2</sup>. However, likely FEPs should include not only FEPs very likely to occur but also those reasonably likely to occur. Given uncertainties in estimating the occurrence of FEPs over a 10,000 year time period, the Commission believes a prudent decision is to consider FEPs, with 10 percent or greater chance of occurring within the 10,000 year compliance period, as likely FEPs. Thus, unlikely FEPs are defined as those FEPs with less than a 10 percent chance but greater than or equal to a 0.01 percent chance, of occurring within the 10,000 year compliance period (i.e., annual probability <sup>less than  $10^{-5}$  but</sup> greater than or equal to  $10^{-8}$  <sub>which is the upper boundary for very unlikely events,</sub> and ~~less than  $10^{-5}$~~ ).

*Sentence changed to be internally consistent.*

Therefore, in light of the foregoing discussion, the Commission seeks comment on the appropriateness of using an annual probability range of greater than or equal to  $10^{-8}$  and less than  $10^{-5}$  to define unlikely FEPs. As a matter of reference, current understanding of FEPs relevant to Yucca Mountain indicates that this designation would allow exclusion of igneous

<sup>2</sup> Any FEP with an annual probability of  $10^{-4}$  would be expected to occur once over a 10,000 year period. An expectation that an FEP would occur does not guarantee such an occurrence. Thus, the probability of an occurrence would necessarily be less than one. ~~In fact, using the laws of probability, the probability of one or more such occurrences is 0.63.~~

*Staff to modify as appropriate to address comment in main body of vote.*