Department of Energy
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Project No. WM-00011

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U.S. Nuclear Regulatory Commission
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PRECLOSURE SEISMIC DESIGN TOPICAL REPORTS

References: (1) Yucca Mountain Site Characterization Project 1997. *Preclosure Seismic Design Methodology for a Geologic Repository at Yucca Mountain.* Topical Report YMP/TR-003-NP, Revision 2.

(2) Yucca Mountain Site Characterization Project 1997. *Methodology to Assess Fault Displacement and Vibratory Ground Motion Hazards at Yucca Mountain.* Topical Report YMP/TR-002-NP, Revision 1.

(3) Civilian Radioactive Waste Management System Management & Operating Contractor 2000. *Characterize Framework for Seismicity and Structural Deformation at Yucca Mountain, Nevada.* ANL-CRW-GS-000003, Revision 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000510.0175.

This letter is to inform the U.S. Nuclear Regulatory Commission (NRC) of the U.S. Department of Energy's (DOE) intent to revise and reissue the topical report related to preclosure seismic design methodology *Preclosure Seismic Design Methodology for a Geologic Repository at Yucca Mountain,* YMP/TR-003-NP, Revision 2 (STR#2) (Reference 1). The purpose of this topical report revision is to focus the seismic design approach specifically to address compliance with 10 CFR Part 63. The revised topical report will be risk-informed and will consider the evolution of regulations related to seismic design for other nuclear facilities.

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These regulations, including 10 CFR Part 63, are risk-informed, in that the determination of appropriate seismic design-basis ground motion hazard levels is based on consideration of the risk significance of the facility and its components, as determined from the preclosure safety analysis. Design-basis ground motion hazard levels adopted in the revised topical report are comparable to those given in the final rule at CFR Part 72 for independent fuel storage installations and monitored retrievable storage facilities, and are consistent with recent NRC licensing actions at the Private Fuel Storage Facility, Mixed Oxide Fabrication Facility, and Idaho Spent Fuel Facility.

STR#2 is the second of two topical reports that together provide supporting technical documentation for satisfying regulatory requirements for both the ground motion and the fault displacement inputs for preclosure design. The first seismic topical report (STR#1), *Methodology to Assess Fault Displacement and Vibratory Ground Motion Hazards at Yucca Mountain*, (Reference 2) described the approach that was used to evaluate the seismic hazard at Yucca Mountain, Nevada. STR#2 describes the preclosure seismic design methodology and is the subject of this letter.

The DOE plans to submit Revision 3 of STR#2 to the NRC in May 2004. An annotated outline for the revision of STR#2 is provided with this letter (enclosure 1). The approach contained in the annotated outline for the revised STR#2 is consistent with precedents adopted for nuclear facilities with comparable or higher risks to workers and the public and is responsive to the regulatory concepts described in 10 CFR 63.102 and the preclosure performance objectives established in 10 CFR 63.111. The DOE requests that the NRC staff provide comments on the overall approach and on the annotated outline for the revision to STR#2. Comments would be most helpful if provided by mid-April 2004.

This letter is also to inform the NRC that DOE no longer intends to issue the third seismic topical report (STR#3), *Preclosure Vibratory Ground Motions and Fault Displacement Design Inputs for a Geologic Repository at Yucca Mountain*. STR#3 was planned to demonstrate the implementation of the methodology for developing seismic design inputs, as well as to briefly summarize how seismic design inputs would be used in the postclosure performance assessment. Due to a shift in our approach to providing information, which includes preparing technical basis documents in specific technical areas grouped to pertain both to License Application sections and to Key Technical Issue (KTI) agreements, we note that the information originally intended for inclusion in STR#3 will be included in other documents.

Specifically, the DOE intends to provide the information originally intended for inclusion in STR#3 primarily in *Technical Basis Document No. 14: Low-Probability Seismic Events* (in preparation), supported by technical data in two additional reports: *Characterize Framework for Seismicity and Structural Deformation at Yucca Mountain, Nevada* (Reference 3) and *Development of Earthquake Ground Motion Input for Preclosure Seismic Design and*

Postclosure Performance Assessment of a Geologic Repository at Yucca Mountain, NV currently being revised. Together, these documents will contain the information originally intended to be included in STR #3. We believe that STR#3 would be redundant to these documents. In addition, current scheduling for STR#3 indicates that it could not be completed until mid-2004, a time frame that makes meaningful review of the document and comment by NRC staff difficult.

For your ease in correlating the contents of STR#3 with these new documents, we refer you to Table 1, Enclosure 2, and note the following: information previously planned to have been contained in Section 2 of STR#3 is now contained in Reference 3; information planned to have been contained in Section 3 of STR#3 is now planned to be contained in *Development of Earthquake Ground Motion Input for Preclosure Seismic Design and Postclosure Performance Assessment of a Geologic Repository at Yucca Mountain, NV* and Technical Basis Document No. 14; and information planned to have been contained in Section 4 of STR #3 will be contained in Technical Basis Document No. 14. We believe your receipt of these three documents will satisfy KTI agreements Repository Design Thermal Mechanical Environment (RDTME) 2.01, RDTME 3.03, and Structural Deformation and Seismicity 2.02 which called for submittal of STR#3, and will allow you to close these agreements.

Please note that the *Technical Basis Document No. 14: Low-Probability Seismic Events* is currently scheduled to be provided to the NRC in March 2004. However, this schedule is being revised, and we will alert you to the changes when finalized. Please also note that Reference 3 (previously submitted as an enclosure to a letter from Stephan Brocoum (DOE) to John T. Greeves (NRC), dated August 23, 2000) is available on the NRC reference system (i.e., ADAMS Accession Number: ML003718339).

If you have any questions concerning this letter and its enclosures, please contact Carol L. Hanlon at (702) 794-1324, or Jon P. Ake at (702) 794-5526.

Joseph D. Ziegler, Director
Office of License Application and Strategy

OLA&S:CLH-0648

Enclosures:
1. Annotated Outline for Revision of Topical Report *Preclosure Seismic Design Methodology for a Geologic Repository at Yucca Mountain* (STR#2) (Revision 00, January 2004)
2. Table 1. Crosswalk of Information Originally to be Provided in Seismic Topical Report # 3 and Alternate Sources for the Information

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QA: N/A

Annotated Outline for Revision of Topical Report
Preclosure Seismic Design Methodology
for a Geologic Repository at Yucca Mountain (STR#2)

REV 00

January 2004

Prepared for:

U.S. Department of Energy
Office of Repository Development
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Prepared by:

Bechtel SAIC Company, LLC
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Under Contract Number
DE-AC28-01RW12101

Enclosure 1

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Annotated Outline for Revision of Topical Report
Preclosure Seismic Design Methodology
for a Geologic Repository at Yucca Mountain (STR#2)

REV 00

January 2004

Approved by: William Boyle

2/12/04
Date

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ABSTRACT

This topical report will address the preclosure seismic design methodology for a planned geologic repository at Yucca Mountain, Nevada. The report is being revised to reflect changes in the regulations (i.e., 10 CFR Part 63), the issuance of the Yucca Mountain Review Plan, and the issuance of other regulations and guides that have relevance to seismic design (Regulatory Guide 1.165, 10 CFR Part 72). This report will describe the design basis ground motion levels that will be used for evaluating structures, systems, and components (SSCs) determined to be important to safety. Two design basis ground motion levels are to be employed, (DBGM-1 and DBGM-2) as having mean annual exceedance probabilities of 1×10^{-3} and 5×10^{-4}, respectively.

To ensure that the combination of design basis ground motions and design procedures are adequately conservative, analyses will be conducted that demonstrate adequate seismic margins and compliance with the preclosure performance objectives of 10 CFR 63.111. The report will describe the methods for analyses that will be conducted for SSCs important to safety at "beyond-design basis ground motion" levels to demonstrate the capacity of SSCs important to safety to perform their intended safety functions at ground motion levels that are greater than the design basis ground motions. The report will also describe the approach to seismic margin analyses. High confidence of low probability of failure (HCLPF) seismic margins analyses will demonstrate that SSCs important to safety designed to DBGM-1 or –2 have adequate seismic margins to ensure that seismically-initiated event sequences will meet the preclosure performance objectives.

The report will also describe the methods, procedures, and criteria that the U.S. Department of Energy intends to use to provide reasonable assurance that SSCs important to safety will meet the pertinent 10 CFR Part 63 preclosure performance objectives with respect to fault displacement. Fault avoidance and fault displacement design criteria (for those cases where fault avoidance is not feasible for SSCs important to safety) are defined. Where avoidance is not feasible, SSCs will be designed to withstand the design basis fault displacement (DBFD) without loss of their intended safety functions. Two DBFD levels are to be utilized, DBFD-1 at an annual probability of exceedance of 1×10^{-4} and DBFD-2 at an annual probability of exceedance of 5×10^{-5}.

This report will be the second of two topical reports on seismic hazards and preclosure seismic design of the planned geologic repository at Yucca Mountain, Nevada, and is referred to as Seismic Topical Report #2 (STR#2).

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CONTENTS

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ACRONYMS AND ABBREVIATIONS

DBFD	design basis fault displacement
DBGM	design basis ground motions
DOE	U.S. Department of Energy
HCLPF	high confidence of low probability of failure
NRC	U.S. Nuclear Regulatory Commission
PCSA	preclosure safety analysis
SSCs	structures, systems, and components
STR#1	Seismic Topical Report #1, *Methodology to Assess Fault Displacement and Vibratory Ground Motion Hazards at Yucca Mountain,* YMP/TR-002-NP, Rev 1. (YMP 1997a)
STR#2	Seismic Topical Report #2, *Preclosure Seismic Design Methodology for a Geologic Repository at Yucca Mountain,* YMP/TR-003-NP, Rev 2. (YMP 1997b); also used to refer to proposed revision of this document

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1. INTRODUCTION

This section will discuss the purpose of this topical report and its overall scope. It will be noted that this document has evolved with the changes in the regulations (10 CFR Part 60, 10 CFR Part 63), the development of the Yucca Mountain Review Plan, and the issuance of other regulations and guides that have relevance to seismic design (e.g., Regulatory Guide 1.165, 10 CFR Part 72). It will also be noted that this document will describe the processes whereby systems, structures, and components (SSCs) identified by the preclosure safety analysis (PCSA) to be important to safety will be designed for seismic effects. Given that 10 CFR Part 63 provides risk-based performance objectives and not seismic design bases, a key purpose of this topical report will be to specify the seismic design bases and to outline the approach that will be used to demonstrate compliance with the preclosure performance objectives of 10 CFR Part 63. It will also be noted that this topical report provides the overall justification for seismic design bases and it outlines the methodology for integrating PCSA seismic analyses with design to ensure compliance with 10 CFR Part 63.

1.1 BACKGROUND

This section will explain that this report is the second of two topical reports on seismic hazards and preclosure seismic design of the planned geologic repository at Yucca Mountain, Nevada. The section will summarize the scope of previous seismic topical reports and review the history of submittals, reviews, and revisions. It will state that the first seismic topical report, *Methodology to Assess Fault Displacement and Vibratory Ground Motion Hazards at Yucca Mountain* (STR#1) (YMP 1997a), described the approach that was used to evaluate seismic hazard at Yucca Mountain. It will note that the second seismic topical report, *Preclosure Seismic Design Methodology for a Geologic Repository at Yucca Mountain* (STR#2) (YMP 1997b) is to describe the seismic design methodology. STR#2 will also define the mean annual exceedance probabilities for seismic design inputs corresponding to Design Basis Ground Motions (DBGM-1 and DBGM-2) for SSCs important to safety. It will be noted that the implementation of the PSHA methodology, development of seismic design inputs for preclosure analysis, and development of ground motion inputs for postclosure analysis will be given in the document entitled, *Technical Basis Document No. 14: Low-Probability Seismic Events* (in preparation), and supported by technical data in two additional reports, *Development of Earthquake Ground Motion Input for Preclosure Seismic Design and Postclosure Performance Assessment of a Geologic Repository at Yucca Mountain, NV* (BSC 2003) and *Characterize Framework for Seismicity and Structural Deformation at Yucca Mountain, Nevada* (CRWMS M&O 2000). These documents will cover all the information originally planned to be included in a third topical report.

In addition, this section will note that the methods described for seismic design are specifically applicable to *preclosure* SSCs and to demonstrating compliance with preclosure performance objectives of 10 CFR 63.111. There is no explicit seismic design for *postclosure*, but the effects of seismic hazards (vibratory ground motion and fault displacement) on postclosure performance assessment are being evaluated in the Total System Performance Assessment for License Application.

1.2 SCOPE

This section will outline the scope of the topical report. It will be noted that the establishment of preclosure seismic design criteria involves both PCSA as well as repository design. It will also be noted that the specification of the PCSA activities and the seismic design activities is not part of the scope of this document. Pointers to the documentation for those activities will be given in Sections 1.3.1 and 1.3.2.

This section will summarize the bases for the development of a seismic design methodology in accordance with 10 CFR Part 63. This will include the (a) definitions of Category 1 and 2 event sequences per 10 CFR 63.2, (b) the specifications of "reasonable" initiating events per 10 CFR 63.102, (c) definitions of the preclosure performance objectives per 10 CFR 63.111, and (d) the description of the required elements of the PCSA per 10 CFR 63.112. It will be noted that the *Yucca Mountain Review Plan* (NRC 2003) does not impose prescriptive seismic design criteria, but leaves that development to the U.S. Department of Energy (DOE), as well as the responsibility to demonstrate their appropriateness. This topical report will present the seismic design bases that DOE will invoke and establishes the process that will be used to demonstrate that they meet the intent of the regulations.

This section will indicate that a risk-informed process is being followed in establishing seismic design bases, which has been endorsed by the NRC. Examples of such risk-informed policy in NRC regulations for power plants, interim storage facilities, and fuel cycle facilities will be discussed as precedents.

1.2.1 Relation to Preclosure Safety Analysis

This section will summarize the PCSA process for identifying SSCs important to safety, which is the starting point for seismic design. The PCSA is to provide the risk information needed for a risk-informed seismic design. The seismic design basis ground motions will be risk-informed, such that the severity of the design motions increases with the safety importance of the SSCs.

1.2.2 Relation to Preclosure Repository Design and Postclosure Performance Assessment

This section will indicate that the result of exercising the methodology in this topical report will be DBGMs for SSCs important to safety. The DBGMs will be expressed as the ground motions associated with particular annual probabilities of exceedance. The actual amplitude of the ground motions associated with a DBGM level will be a function of the location and is developed as part of seismic design inputs (BSC 2003). After assignment to a particular DBGM level and appropriate modification of the motions to make them location-specific, the ground motions will be used for design. Likewise, current applicable elements of NUREG-0800 (NRC 1981) will become part of the design requirements for SSCs important to safety. This section will also discuss the manner in which ground motions will be used for postclosure analyses of potential earthquake effects.

1.3 ORGANIZATION OF THIS REPORT

This section will provide an overview of the organization of this report.

2. REGULATORY FRAMEWORK

This section will describe NRC regulations and regulatory actions regarding seismic design levels at NRC-regulated nuclear facilities. DOE criteria and approaches to establishing seismic design levels will also be described.

2.1 10 CFR PART 63 "DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES IN A PROPOSED GEOLOGIC REPOSITORY AT YUCCA MOUNTAIN, NEVADA"

This section will identify the sections of 10 CFR Part 63 that relate to identifying and evaluating seismically-initiated event sequences, the development of preclosure seismic design criteria, and demonstrating compliance with the preclosure performance objectives. Category 1 and 2 event sequences will be defined and the need to include seismically-initiated event sequences in the PCSA will be discussed. The concepts of design bases and design criteria will also be defined according to their usage in 10 CFR Part 63.

2.2 YUCCA MOUNTAIN REVIEW PLAN

The Yucca Mountain Review Plan (NRC 2003) will be discussed in terms of the NRC staff's expectations and emphasis during review of the LA. As such, it provides a context for the development of a preclosure seismic design methodology and criteria that will meet the staff's expectations. This will include the utilization of a risk-informed basis for the development of design bases. In addition to vibratory ground motions, the consideration of fault displacement will also be discussed.

2.3 SEISMIC DESIGN OF NUCLEAR POWER PLANTS AND OTHER NUCLEAR FACILITIES

An important regulatory context for the preclosure seismic design methodology for a repository at Yucca Mountain are regulations and regulatory guidance that are relied upon by the NRC and other agencies for determining the seismic safety at other nuclear facilities. This section will discuss current regulations and regulatory guidance relating to the development of seismic design bases for nuclear power plants and other nuclear facilities. It will be indicated that these design methodologies have adopted a risk-informed approach to design basis development.

2.4 NUREG-0800, STANDARD REVIEW PLAN

This section will note that the Yucca Mountain Review Plan does not provide specific seismic design acceptance criteria, as does NUREG-0800. For this reason, the DOE has evaluated the sections of NUREG-0800 that directly relate to seismic design methodology for potential applicability to mined geologic repository systems. NUREG-0800 sections and their applicability will be given in this report.

3. DESIGN BASIS GROUND MOTIONS AND DESIGN PROCEDURES

This section describes the design basis ground motion levels that will be used for SSCs determined by the PCSA to be important to safety. The assignment of DBGM levels is risk-informed such that SSCs determined in the PCSA to be more risk-significant will be subjected to more severe seismic design bases. It will be noted that the seismic event sequence analysis, the levels of DBGM, and the design procedures have all been informed by precedents in the seismic design of other nuclear facilities. Likewise, the annual probabilities of exceedance used for the DBGM levels are comparable to those employed for other facilities having similar risk significance.

This section will note that acceptable seismic safety is achieved through a combination of two important design aspects: 1) the DBGM level and 2) the conservatism in the design procedures, acceptance criteria, codes, and standards. DOE will identify the seismic design bases and design procedures it determines will provide reasonable assurance that the preclosure performance objectives of 10 CFR Part 63 have been met. The selected DBGM levels and design procedures outlined in this section will ensure compliance with these performance objectives.

3.1 DESIGN BASIS GROUND MOTIONS FOR SSCS IMPORTANT TO SAFETY

This section defines the DBGM levels that will be used in the design of SSCs important to safety. The design levels are expressed in terms of mean annual probabilities of exceedance in order to be consistent with NRC regulations for other facilities and to be consistent with a risk-informed regulatory policy. It will be emphasized that the DBGM levels represent amplitudes of ground motion and the characterization of the ground motions (e.g., in terms of accelerations, velocities, response spectra, time histories) will be a function of the requirements for design implementation.

3.1.1 Design Basis Ground Motion Levels

This section will present the two DBGM levels (DBGM-1 and DBGM-2), having mean annual exceedance probabilities of 1×10^{-3} and 5×10^{-4}, respectively. These exceedance probabilities correspond with return periods of 1,000 and 2,000 years. The discussion will include a summary of the manner in which the risk significance of SSCs important to safety will be evaluated in the PCSA and, in turn, the assignment of DBGMs. The PCSA methodology will be described for the anticipated classification of SSCs according to their risk significance and assignment into the two design basis ground motion levels. It will be stated that the analyses, as described below in this document, will provide information to the PCSA for the event sequence analyses. The PCSA will ensure adequate seismic margins and compliance with 10 CFR Part 63 preclosure performance objectives. If these analyses indicate that it is necessary to demonstrate compliance, more severe design criteria (i.e., design levels at lower annual probabilities of exceedance than 5×10^{-4}) will be invoked.

3.1.2 Regulatory Precedents

To provide a framework for the DBGM levels given in this document, this section will summarize and compare the DBGM levels in terms of annual probability of exceedance for other NRC-regulated nuclear facilities, including new nuclear power plants, fuel cycle facilities, and interim storage facilities. Seismic design criteria developed for DOE nuclear facilities (e.g., DOE-STD-1020-2002) will also be summarized. This comparison will show that, consistent with a risk-informed approach, the proposed DBGM levels are reasonable and appropriate relative to other facilities having comparable or greater levels of risk.

3.2 DESIGN PROCEDURES AND ACCEPTANCE CRITERIA

The section will describe the intention to implement NUREG-0800 (NRC 1981). The applicable sections of NUREG-0800 will be defined, as well as the exceptions that will be taken. The acceptance criteria from other standard review plans will also be indicated.

3.3 SEISMIC MARGIN EVALUATION AND COMPLIANCE DEMONSTRATION

To ensure the combination of design basis ground motions and design procedures are adequately conservative, this section will discuss that two type of structural analyses will be conducted that will demonstrate adequate seismic margins and will comply with the preclosure performance objectives of 10 CFR 63.111. The approaches and analyses that will be undertaken have precedents in the design evaluations that have been conducted to evaluate the seismic margin of nuclear facilities, for example the NRC's Individual Plant Examination of External Events (IPEEE) program. The two types of analyses are discussed in Sections 3.3.1 and 3.3.2 and in Appendices A and B.

3.3.1 Beyond-Design Basis Ground Motions Analysis

This section will describe the first of two structural analyses that will demonstrate the adequacy of seismic margins and compliance with preclosure safety objectives. Seismic capacity analyses will be conducted for SSCs important to safety at "beyond-design basis ground motion" levels to demonstrate the capacity of SSCs important to safety to perform their intended safety functions at ground motion levels that are greater than the design basis ground motions. For example, SSCs designed to the DBGM-2 level (5 x 10^{-4} annual probability of exceedance) will be evaluated for ground motions at the 1 x 10^{-4} annual probability of exceedance. Linear elastic demand analyses or, if necessary, non-linear evaluation of the SSCs will be performed to compare the seismic demands to high confidence strength capacities. If seismic demands exceed the strength capacities, the applicable SSC will be redesigned and reevaluated to ensure adequate seismic margin. Appendix A will provide a detailed discussion of the approach to be followed.

3.3.2 HCLPF Seismic Margin Analysis

This section will describe the second type of structural analyses that will be used to demonstrate adequacy of seismic margins and compliance with preclosure safety objectives. Event sequence analyses will be conducted in accordance with the definitions of Category 1 and Category 2 event sequences in 10 CFR 63.2. The purpose of the analyses is to provide assurance that the SSCs important to safety will perform their intended safety functions to mitigate any exceedance of the preclosure performance objectives in 10 CFR 63.111. The PCSA process will be summarized for developing event sequences with seismic initiators, evaluating the dose consequences, and classifying SSCs as important to safety. The approach to HCLPF seismic margin analyses will be further discussed in Appendix B.

The HCLPF seismic margin analyses will demonstrate that SSCs important to safety designed to DBGM-1 or -2 have adequate seismic margins to ensure that seismically-initiated event sequences will meet the preclosure performance objectives. The approach to evaluate SSCs important to safety in seismically-initiated event sequences will follow the approach identified in NUGEG/CR-4334 (Budnitz et al. 1985). This type of analysis has precedent in the seismic margin method endorsed by the NRC as an acceptable method for seismic margin analysis as part of NUREG-1407 (Chen et al 1991). The HCLPF capacity, which is defined as the ground motion level at which there is a mean conditional probability of failure of 0.01 (1%) or less, will be calculated for each SSC in the event sequence. For SSCs important to safety designed to DBGM-2, the HCLPF capacity will be compared with the ground motions associated with annual probabilities of exceedance of 1×10^{-4} to demonstrate acceptable performance at these beyond-design basis ground motion levels. If the HCLPF capacity exceeds the 1×10^{-4} ground motions, this will assure that there is essentially a zero chance of failure at these ground motion levels and that there is significant margin beyond the design basis ground motion level. If the HCLPF capacity does not exceed the 1×10^{-4} ground motion level, the SSC will be redesigned to a higher level of ground motion such that there will be acceptable performance at the 1×10^{-4} ground motion level. In the same way, SSCs important to safety designed to DBGM-1 will have their HCLPF capacities compared to a 5×10^{-4} ground motion level (and in some special cases, to a 1×10^{-4} ground motion level) to ensure adequate seismic margin.

Because the beyond-design basis ground motion level of 1×10^{-4} is comparable to the accepted design bases for nuclear power plants, and because the DOE will demonstrate safe performance at this level and considerable margin beyond this level following approaches that have well-established nuclear precedents, it is reasonable in the context of the concepts described in 10 CFR 63.102 to consider initiating events with annual probabilities of exceedance of 1×10^{-4} or higher in the PCSA for determining event sequences. It is anticipated that SSCs important to safety for which acceptable performance has been demonstrated at the 1×10^{-4} level will have HCLPF capacities that substantially exceed the 1×10^{-4} ground motion levels. Demonstrating this will ensure that there is less than a 1- percent chance of unacceptable performance at the 1×10^{-4} annual probability level.

This section will indicate that the DOE considers that the approach outlined above is consistent with precedents adopted for nuclear facilities with comparable or higher risks to workers and the public and that it meets the regulatory intent of the concepts described in §63.102 and the preclosure performance objectives established in 10 CFR 63.111.

3.4 COMPARISON WITH OTHER SEISMIC DESIGN BASES

This section will show that the preclosure seismic design bases in this document are consistent with design practice for nuclear facilities. Comparisons will be made with DBGM annual probabilities of exceedance, risk-reduction ratios, and annual probabilities of failure. The comparison will show that the proposed risk-informed approach to seismic design, together with the design procedures and acceptance criteria, will lead to failure probabilities that are comparable to those for similar facilities.

4. MITIGATION OF FAULT DISPLACEMENT HAZARDS

This section will describe the methods, procedures, and criteria that the DOE intends to use to provide reasonable assurance that SSCs important to safety will meet the pertinent 10 CFR Part 63 preclosure performance objectives with respect to fault displacement. The section will summarize the DOE's approach to implementing the staff's guidance in NUREG-1451 (McConnell et al. 1992) and NUREG-1494 (McConnell and Lee 1994) and identifying "Type 1 Faults." It will be stated that the primary design approach for fault displacement is to locate (whenever feasible) SSCs important to safety away from Type I faults so that no explicit fault displacement design is required. However, for those SSCs (if any) that must consider fault displacement, the design basis for fault displacements shall be a factor of ten lower mean annual probability of exceedance than those for ground motions. A description will be given of the approach to determining design basis fault displacements and the fault-displacement design acceptance criteria.

4.1 CRITERIA FOR FAULT AVOIDANCE

This section describes the DOE position that the exposure of SSCs to a fault displacement hazard can be limited by avoiding the locations of faults that have a significant potential for fault displacement. These will be identified as Type 1 faults. The concept of setback distances will be described for those cases where significant faults (if any) might otherwise transect an important to safety SSC.

4.2 CRITERIA FOR FAULT DISPLACEMENT DESIGN

This section will describe the fault displacement design criteria for those cases where fault avoidance is not feasible for SSCs important to safety. These SSCs will be designed to withstand the design basis fault displacement (DBFD) without loss of their intended safety functions. The section will define two DBFD levels of DBFD-1 at an annual probability of exceedance of 1×10^{-4} and DBFD-2 at an annual probability of exceedance of 5×10^{-5}. The acceptance criteria for fault displacement design will also be described.

5. SUMMARY

This section will summarize the seismic design bases for vibratory ground motions and for fault displacement. It will describe the process for identifying those SSCs important to safety that will be evaluated for their potential design ground motion and the manner in which DBGM levels will be assigned. DBGM-1 and DBGM-2 annual probability of exceedance levels will be compared with design criteria for nuclear facilities having comparable or higher levels of risk significance to demonstrate the DBGM levels are risk-informed. The beyond-design basis ground motions analysis and the HCLPF seismic margins analyses will also be summarized, which provide assurance that the preclosure performance objectives of 10 CFR Part 63 are met.

6. REFERENCES

6.1 DOCUMENTS CITED

Budnitz, R.J.; Amico, P.J.; Cornell, C.A.; Hall, W.J.; Kennedy, R.P.; Reed, J.W.; and Shinozuka, M. 1985. *An Approach to the Quantification of Seismic Margins in Nuclear Power Plants.* NUREG/CR-4334. (UCID-20444). Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 254460.

BSC (Bechtel SAIC Company) 2003. *Development of Earthquake Ground Motion Input for Preclosure Seismic Design and Postclosure Performance Assessment of a Geologic Repository at Yucca Mountain, NV.* MDL-MGR-GS-000003 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20031201.0001.

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6.2 CODES, STANDARDS, AND REGULATIONS

10 CFR 60. Energy: Disposal of High-Level Radioactive Wastes in Geologic Repositories. Readily available.

10 CFR 63. Energy: Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada. Readily available.

10 CFR 72. Energy: Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste. Readily available.

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APPENDIX A

Beyond-Design Basis Earthquake Ground Motions Analysis

This appendix will describe the methodology that will be used to demonstrate that SSCs important to safety will maintain their intended safety functions when subjected to ground motions that exceed their design basis ground motions. These beyond-design basis ground motion analyses will be described as a series of steps that proceed from a linear elastic seismic demand analysis to, if necessary, a non-linear evaluation of the SSC. Acceptance criteria for each step will be given in terms of high confidence limit states that have been established in precedents for nuclear facilities. Because most of the structures important to safety are expected to be low-rise concrete shear wall structures, detailed acceptance criteria will be presented for such structures as an example.

APPENDIX B

HCLPF Seismic Margin Analysis

This appendix will describe the manner in which the seismic response and capacity of SSCs important to safety will be evaluated. The methods will focus in particular on establishing the HCLPF capacities for SSCs within seismically initiated event sequences. The HCLPF estimates will be based on a specification of what constitutes unacceptable damage for each specific SSC in the event sequence. The appendix will discuss regulatory precedents for the use of the HCLPF approach for evaluating the seismic margins of nuclear power plants. For SSCs designed to DBGM-2 levels, the HCLPF capacities will be compared to the ground motions associated with a mean annual probability of exceedance of 1×10^{-4} to demonstrate adequate seismic margin. DBGM-1 SSCs will be evaluated by comparing the HCLPF capacities to the 5×10^{-4} ground motion level.

Table 1. Crosswalk of Information Originally to be Provided In Seismic Topical Report #3 and Alternate Sources for the Information

Seismic Topical Report #3	Alternate Source for Information
Section 1 – Introduction	N/A
Section 2 – Seismic Hazard Analysis	ANL-CRW-GS-000003, Rev 0, *Characterize Framework for Seismicity and Structural Deformation at Yucca Mountain, Nevada*
Section 3 – Preclosure Seismic Design Inputs: Vibratory Ground Motion	MDL-MGR-GS-000003, Rev 0, *Development of Earthquake Ground Motions for Preclosure Seismic Design and Postclosure Performance Assessment at Yucca Mountain, NV*
Section 3 – Preclosure Seismic Design Inputs: Fault Displacement	*Technical Basis Document No. 14 - Low Probability Seismic Events*
Section 3 – Preclosure Seismic Design Inputs: Underground Nuclear Explosions	N/A
Section 4 – Seismic Hazard Results for Postclosure Performance Assessment	*Technical Basis Document No. 14 - Low Probability Seismic Events*

Enclosure 2