RAI Volume 2, Chapter 2.1.1.4, Seventh Set, Number 1:

Provide information on the acceptable structural behavior, or Limit States of the facility structures, considered in calculating potential event sequences initiated by failure of mechanical and other systems. Also identify for each important to safety building the Limit States used for performance evaluation and associated technical basis.

According to BSC (2007ba, Section B1), failure Limit State A is used in general for performance evaluations and failure Limit State C is applicable where confinement is necessary to maintain a negative pressure. However, it is not clear which Limit states were used for each ITS building.

1. RESPONSE

1.1 LIMIT STATE FOR FRAGILITY CALCULATION FOR ITS FACILITIES

For important to safety (ITS) facilities (Initial Handling Facility, Receipt Facility, Canister Receipt and Closure Facility (CRCF), and Wet Handling Facility), the *Seismic Event Sequence Quantification and Categorization Analysis* (BSC 2009) uses Limit State A (imminent collapse) to calculate the seismic fragilities and event sequence frequencies for the facilities. As discussed in the categorization analysis (BSC 2009, Section 4.3.3), the confinement heating, ventilation, and air-conditioning system is conservatively assumed to be unavailable for mitigation for the seismic event sequence analysis. Therefore, confinement is not modeled, and Limit State C (confinement maintained) is not used in the seismic event sequence analysis for ITS facilities.

1.2 LIMIT STATE OF STRUCTURES ASSOCIATED WITH FRAGILITY CALCULATION FOR EQUIPMENT

For equipment, although the limit state nomenclature is not used, the potentially degraded state of the structure is incorporated into the calculation of equipment fragilities when this is a factor for the failure modes of interest. *Development of Equipment Seismic Fragilities at Yucca Mountain Surface Facilities* (BSC 2008) provides the overall methodology and the specific structural response factors considered for the equipment, including fragility calculations. The impacts of structural concrete cracking are included in the equipment fragility calculation through the damping factor of safety, which is part of the overall structure response factor in the fragility calculation.

Some equipment, such as the cask transfer trolley and waste package transfer trolley, are located on the ground level of the facilities, with failure modes that are associated with tipover, rocking, or sliding impacts. These failure modes are not significantly impacted by the potentially degraded state of the facility structure. In addition, some of the equipment is designed to International Building Code standards (ICC 2006). This equipment design has relatively low seismic capacity (0.37 g median fragility (BSC 2009, Table 6.2-2)) when compared to the ITS facility seismic capacities (>4 g median fragility (BSC 2009, Table 6.2-1)). Thus, the building does not have any significant degradation at the acceleration levels that cause failure of the International Building Code-designed equipment.

Seismic fragility evaluations (BSC 2008) are performed for the major ITS equipment that are supported by the building structures (e.g., the canister transfer machine and the cask handling crane). The canister transfer machine and the cask handling crane are supported high in the CRCF structure. The median seismic capacities of the collapse failure mode of the canister transfer machine and the cask handling crane are 2.39 g and 2.79 g, respectively (BSC 2009, Table 6.2-2). The CRCF structure has a median seismic capacity of 4.61 g. Thus, at failure of the canister transfer machine and the cask handling crane, the demand to capacity ratios of the CRCF structure will be greater than 0.5. At this demand to capacity level, the allowable structural damping value for generation of design in-structure response spectra is 7%, per Table 3-2 of ASCE/SEI 43-05, *Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities*. However, for conservative design purposes, a structural damping value of 4% is used for the CRCF design in-structure response spectra generation.

In contrast to the design calculation of in-structure response spectra, which is conservative, the equipment fragility calculation is adjusted for a more realistic structural damping value. The damping factor of safety (for the structural damping value) is used to account for conservatism in the hysteresis damping in the building structure used in the seismic response analysis. For the fragility calculation for the canister transfer machine and cask handling crane, due to the soil structure interaction, the structure damping factor of safety is determined to be insignificant due to the high radiation damping of the foundation media (BSC 2008, Sections A6.5.4.2 and B6.5.2).

Thus, although the facility limit state nomenclature is not used for equipment fragility calculations, the potential structural degradation of the ITS facilities is considered in the evaluation of equipment seismic fragilities. Specifically, the impacts of structural concrete cracking are included in the equipment fragility calculation through the damping factor of safety, which is part of the overall structure response factor in the fragility calculation.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

ASCE/SEI 43-05. 2005. *Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities*. Reston, Virginia: American Society of Civil Engineers. TIC: 257275.

BSC (Bechtel SAIC Company) 2008. *Development of Equipment Seismic Fragilities at Yucca Mountain Surface Facilities*, 000-PSA-MGR0-02200-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080310.0001.

BSC 2009. *Seismic Event Sequence Quantification and Categorization Analysis*. 000-PSA-MGR0-01100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20090112.0013.

ICC (International Code Council) 2006. *2006 International Building Code*. Falls Church, Virginia: International Code Council. TIC: 258069.

RAI Volume 2, Chapter 2.1.1.4, Seventh Set, Number 2:

> Provide information on how the DOE plans to ensure that design assumptions, for example seismic restraint capacity must not govern the seismic event sequences for the canister transfer machine (BSC 2008bg, Section 6.2.2.12), will be satisfied in the final design.
>
> In Section 6.2.2.12 of BSC 2008bg, DOE has stated that "In the detailed design of the CHC [Cask Handling Crane] the seismic restraints must not control the crane fragility as noted in Table 6.2-2 above. This could be accomplished by increasing the load factor by two for the seismic design loads for the restraints." DOE has, however, not provided information on how this and similar requirements will be implemented in the design basis for CTM and CHC or other structures, systems, and components in Table 1.9-3.

1. RESPONSE

1.1 CONFIGURATION MANAGEMENT

The purpose of the preclosure seismic safety analysis is to establish a set of nuclear safety design bases that are documented in SAR Sections 1.2, 1.3, 1.4 and 1.9. The preclosure seismic safety analysis includes modeling techniques and approximations that are relevant for the design as documented in the SAR that allow an analysis to be performed to determine the design requirements that are compiled in *Preclosure Nuclear Safety Design Bases* (BSC 2008a). At this stage of the design, design assumptions are not needed to develop nuclear safety design bases. The modeling techniques and approximations, such as performing a fragility analysis as if there is no margin to the code allowables for seismic restraints, were used to assure that the nuclear safety design bases are conservatively established. These nuclear safety design bases are equipment failure frequencies of the form described in Section 1.2 of this response and are documented as described in the remainder of this section. Meeting these conservatively established nuclear safety design bases requirements during detailed design assures that there will be margin in the design of the structures, systems, and components (SSCs) and that they will perform in compliance with the regulation.

Design requirements and their flow-down to appropriate calculations, specifications, and drawings are controlled in accordance with the configuration management system, described in SAR Section 5, pages 5-5 and 5-6, and implemented through repository procedures. One of the purposes of the configuration management system is to manage potential changes to the design or safety analysis to ensure that the performance of the eventual as-built design and SSCs satisfy the nuclear safety design bases.

The nuclear safety design bases that govern the design of repository important to safety (ITS) SSCs are maintained in the preclosure nuclear safety design bases document (BSC 2008a), the purpose of which is to compile the designation of ITS SSCs, the specific safety function(s) to be performed by each ITS SSC, and the controlling parameters and values that the SSC must meet to achieve the safety function. The preclosure nuclear safety design bases document (BSC 2008a) extracts the nuclear safety design bases from the results of the preclosure safety analysis.

Repository requirements flow from the preclosure nuclear safety design bases document (BSC 2008a) to the *Basis of Design for the TAD Canister-Based Repository Design Concept* (BSC 2008b). Design criteria necessary to support the development of designs for repository SSCs are provided in the *Project Design Criteria Document* (BSC 2009b), and are summarized in the surface and subsurface facility design descriptions of the SAR. The project design criteria (BSC 2009b) incorporate design input based on Yucca Mountain site-specific conditions, as well as guidance and design input from commercial nuclear industry design, codes and standards, and proven technology in use at other facilities. Repository design documents (e.g., drawings, specifications, calculations) must satisfy the requirements set forth in the basis of design (BSC 2008b) and meet or exceed the acceptance criteria presented in the project design criteria (BSC 2009b). The design process, design change control, and the development and maintenance of design criteria are governed by established repository procedures. The SAR reflects, at a summary level, the incorporation of requirements that flow sequentially from the preclosure nuclear safety design bases document (BSC 2008a), basis of design (BSC 2008b), and project design criteria (BSC 2009b) to the design. At each point in the design process, the design must meet these requirements.

Proposed changes to design documents upon which the SAR is based are screened for impact as part of the process of review for changes in accordance with repository procedures. The scope and impact of the proposed change to the content/methodology presented in the SAR is then defined and evaluated, and the SAR is updated as appropriate.

1.2 NUCLEAR SAFETY DESIGN BASES

The preclosure nuclear safety design bases related to seismic events presented in Tables 1.9-2 through 1.9-7 in SAR Section 1.9 are based on seismic event sequences that use seismic fragility distributions of the equipment and the seismic hazard distribution. The preclosure nuclear safety design bases provide the failure frequencies to be used as nuclear safety design basis controlling parameters for ITS equipment. These preclosure nuclear safety design bases are included directly in the specification for the equipment. As part of the specification requirements, the final design of the equipment must meet the failure frequency requirements, which means that the fragility of the final design is consistent with the fragility of the current design. This does not mean that the median fragility (A_m) and composite uncertainty (β_C) of the final design are exactly the same as for the current design, since different median fragilities and composite uncertainties can meet the preclosure nuclear safety design bases failure frequencies, given that the seismic hazard distribution does not change. However, the final design failure frequency quantified by the convolution of the final design fragility distribution with the seismic hazard distribution will meet the preclosure nuclear safety design bases requirements.

Guidance for the required fragility and convolution calculations, and associated documentation requirements will be provided in a specification as described in the response to RAI 2.2.1.1.4-7-005.

1.3 EXAMPLE

In the cases of the canister transfer machine and cask handling crane, *Development of Equipment Seismic Fragilities at Yucca Mountain Surface Facilities* (BSC 2008c) indicates that the seismic restraints could potentially have less seismic capacity than the overall design of the bridge girders and trolley frames. Table 1 provides the median capacities for the collapse failure mode:

Table 1. Median Capacities for the Collapse Failure Mode

Equipment	Overall Median Capacity (g)	Seismic Restraint Median Capacity (g)
Canister Transfer Machine	2.39	1.59
Cask Handling Crane	2.79	2.11

Source: Development of Equipment Seismic Fragilities at Yucca Mountain Surface Facilities (BSC 2008c, Table 6).

In part, the lower seismic capacity of the seismic restraints was due to a highly conservative aspect of the fragility calculation (i.e., the seismic restraint design would meet minimum design requirements with no margin). Seismic capacity of a design may be assured in a variety of ways. In this case, rather than increasing the load factor by two for the seismic design loads for the restraints, the seismic capacity of the seismic restraints was increased by requiring them to have the seismic capacity of the bridge girders and trolley frames. Thus, the seismic event sequence quantification (BSC 2009a) used these higher overall median capacities. When convolved with the hazard distribution, this resulted in a lower frequency of failure, resulting in a more stringent nuclear safety design basis requirement.

The preclosure nuclear safety design bases seismic requirements for the canister transfer machine and cask handling crane are stated in terms of “mean frequency of collapse due to the spectrum of seismic events must be less than or equal to … per year.” Therefore, the final designs, including the seismic restraints, must meet the more stringent failure frequency requirements of the preclosure nuclear safety design bases. This will be achieved by the application of the requirements flow-down and configuration management described in Sections 1.1 and 1.2.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2008a. *Preclosure Nuclear Safety Design Bases.* 000-30R-MGR0-03500-000-000. Las Vegas, Nevada; Bechtel SAIC Company.
ACC: ENG.20080312.0036.

BSC 2008b. *Basis of Design for the TAD Canister-Based Repository Design Concept.* 000-3DR-MGR0-00300-000-003. Las Vegas, Nevada; Bechtel SAIC Company. ACC: ENG.20081006.0001.

BSC 2008c. *Development of Equipment Seismic Fragilities at Yucca Mountain Surface Facilities*, 000-PSA-MGR0-02200-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080310.0001.

BSC 2009a. *Seismic Event Sequence Quantification and Categorization Analysis*, 000-PSA-MGR0-01100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20090112.0013.

BSC 2009b. *Project Design Criteria Document.* 000-3DR-MGR0-00100-000-008. Las Vegas, Nevada; Bechtel SAIC Company. ACC: DOC.20090331.0010.

RAI Volume 2, Chapter 2.1.1.4, Seventh Set, Number 3:

Provide the following information:

a) Technical basis for seismic failure probabilities of structures, systems, and components used for a basic event in the SAPHIRE analysis.

The failure probabilities used in the SAPHIRE analysis are not consistent with those shown in Tables 6.2.1 and 6.2.2 of BSC 2008bg. For example, in Table 6.2-1 of BSC 2008a, the probability value for CRCF building collapse is $7.8x10^{-7}$. However, the cut-set report in SAPHIRE for event sequence 03 for event tree S-060-CRCF-S-IE-TWP shows a value of $3.311x10^{-9}$ for basic event S-060-STR-COLLAPSE.

b) Technical basis of the statement in Page 41/42 (BSC 2008bg), "seismic failure probabilities listed by the basic event circles represent the conditional probability of failure at the design basis ground motion (DBGM2)-2 ground motions, and do not represent the seismic failure probability for event sequences".

SAR Section 1.7.1.4 states that the quantification of event sequences starts with the calculation of the mean annual frequency of failure of the SSC obtained by convolution of the site-specific seismic hazard curve with the fragility curve of the SSC. Mean annual frequency is then multiplied with total exposure time over the preclosure period to calculate expected number of seismic failure of the SSCs. The statement quoted from BSC 2008bg is in contradiction with the SAR Section 1.7.1.4.

c) Significance and technical basis for the input parameter "Screening G-Level" in the basic event data base in the SAPHIRE software. In addition, provide validation and verification of seismic hazard and SSC fragility convolution calculations in the SAPHIRE software.

DOE has provided discussion (p 42, BSC 2008bg) on how the seismic hazard curve data and fragility parameters for SSCs are entered into SAPHIRE 7.27 software. However, clarification is needed on the significance and basis for the data entered in "Screening G-Level" (see for example, basic event S-060-STR-COLLAPSE).

1. RESPONSE

1.1 SEISMIC FAILURE FREQUENCIES

Limitations of the SAPHIRE software prevent display of the range of seismic failure frequency values in printed outputs even though the entire fragility distribution (curve) was used in the calculations. SAPHIRE Version 7.27 was used to develop and quantify the seismic event sequences provided in *Seismic Event Sequence Quantification and Categorization Analysis* (BSC 2009, Tables 6.2-1 and 6.2-2). In calculating the seismic failure frequency, the seismic basic event is represented by a fragility distribution, and is convolved with the seismic hazard distribution. During the SAPHIRE convolution calculation, the actual failure probability of the seismic basic event varies with the earthquake acceleration. However, SAPHIRE can only print one failure probability for each basic event in a cut-set report. Therefore, SAPHIRE gives the user the choice to select the seismic acceleration to use for the printed report (which is termed the "screening G-level" in SAPHIRE). While the lowest or highest seismic acceleration can be selected, the failure probability at the design basis ground motion-2 (DBGM-2) (selected for the printed report) provides consistency in the cut-set reports and fault tree graphics, and provides information that is relevant with respect to the design basis earthquake. This single value used in the printed reports does not represent the full convolution calculation. The entire fragility distribution is used to represent the seismic failure probabilities.

For the example listed in the RAI, the failure probability of 7.8×10^{-7} for the Canister Receipt and Closure Facility (CRCF) structure from the seismic event sequence analysis (BSC 2009, Table 6.2-1) is the convolved seismic failure frequency. The cut-set report value of 3.311×10^{-9} for basic event S-060-STR-COLLAPSE cited in the RAI is the probability of CRCF structural failure at the DBGM-2 acceleration, which is 0.45 g.

Therefore, there is no inconsistency between the seismic event sequence quantification report failure frequencies and the seismic failure probabilities from the SAPHIRE cut-set reports. The difference is that SAPHIRE can only print one value in the cut-set report, but the convolution calculation uses the distributions.

The values presented in the seismic event sequence analysis (BSC 2009, Tables 6.2-1 and 6.2-2) are not failure probabilities for a specific earthquake acceleration level. Rather, they are failure frequencies calculated on an annual basis. They result from the SAPHIRE convolution of the fragility distribution over the range of seismic accelerations, using the seismic hazard frequency at each acceleration level. The printed value in the SAPHIRE cut-set report and the associated "screening G-level" does not represent the full convolution calculation.

1.2 APPARENT DISCREPANCY WITH GRAPHIC FAULT TREE FAILURE PROBABILITIES

The statement that is quoted by the NRC in section b) of this RAI in the categorization analysis (BSC 2009, Section 4.3.3.2) is not inconsistent with SAR Section 1.7.1.4. The statement in the categorization analysis (BSC 2009) was made to alert the reader that the "failure probabilities" printed on the fault tree graphics are not convolved at this point in the analysis description, and are only the failure probabilities at the DBGM-2 level. As discussed above, the failure probability at the DBGM-2 level provides consistency between the cut-set reports and fault tree graphics, and provides information that is relevant with respect to the design basis earthquake. However, this single value used in the printed reports does not represent the full SAPHIRE convolution calculation.

1.3 VALIDATION AND VERIFICATION DOCUMENTS

The “screening G-level” parameter was used for selecting the acceleration for the printed reports and fault trees. It is not a calculation output and does not represent the results of event sequence analyses presented in the SAR.

For the validation and verification, the following documents are provided:

- *Software Independent Verification and Validation Report, SAPHIRE Version 7.27* (DOE 2007a).
- *Software Validation Report for: SAPHIRE v7.27 using Windows XP* (DOE 2007b).

These formal validation and verification documents include several test cases that were successfully run to test the seismic features of the SAPHIRE Version 7.27 software.

1.4 COMPARING SAPHIRE RESULTS

Based on the clarification call with the NRC on June 23, 2009, instructions are provided below to enable comparison of the SAPHIRE seismic convolution calculation with those of a hand calculation, such as a spreadsheet. Both the overall results and intermediate results at each acceleration interval can be compared.

With the CRCF facility as an example, open the CRCF file in SAPHIRE (Version 7.27), and click on the “Sequence” button. In the pop-up “sequences” box, select a sequence, such as the CRCF-S-IE-TWP sequence 3 identified in the RAI, then right click and select the uncertainty calculation using the “ALL SEPARATE” option. It is suggested to enter 1234 for the “Seed,” and change the “Number of samples” to 10 to reduce the file size. To compare the intermediate results at each acceleration interval, check the “CSV format” button in the “Intermediate Values” box, and enter a File Name with a .txt extension. Click OK to perform the convolution calculation. The overall sequence uncertainty results will appear in a pop-up box; some minor variation can be expected, as different computers may display results slightly differently.

The intermediate results output file, which is by default stored in the folder that contains the CRCF SAPHIRE database, can then be read with a text program such as Wordpad. Since there were 19 seismic hazard intervals, there are 19 sets of data in the output file, each with two sections. The first section contains the inputs and results for the hazard interval, while the second section contains the detailed Monte Carlo results, which are not necessary for this verification. An example of the first section for the 19th interval is:

Uncertainty Method: MC
Created by SAPHIRE 7.0 Program
CRCF-S-IE-TWP->03,1.920029E-006
060-TWP-STRUCTUR-ETF,5.670000E-003
<PGA-BIN-01>,5.530000E-003
<PGA-BIN-02>,4.410000E-003

<PGA-BIN-03>,3.310000E-003
<PGA-BIN-04>,2.570000E-003
<PGA-BIN-05>,1.960000E-003
<PGA-BIN-06>,1.370000E-003
<PGA-BIN-07>,9.310000E-004
<PGA-BIN-08>,6.150000E-004
<PGA-BIN-09>,4.090000E-004
<PGA-BIN-10>,2.490000E-004
<PGA-BIN-11>,1.440000E-004
<PGA-BIN-12>,8.530000E-005
<PGA-BIN-13>,4.790000E-005
<PGA-BIN-14>,2.540000E-005
<PGA-BIN-15>,1.310000E-005
<PGA-BIN-16>,6.170000E-006
<PGA-BIN-17>,1.950000E-006
<PGA-BIN-18>,4.000000E-007
<PGA-BIN-19>,7.450000E-008
S-060-STR-COLLAPSE,5.581926E-001
SEIS-EVENT,1.000000E+000
CRCF-TAO-CAN,8.143000E+003

The frequency of the sequence contributed by the 19th interval is given in the 3rd line, denoted CRCF-S-IE-TWP->03, and is 1.92×10^{-6}/year. The next line provides the exposure time factor input, while the next 19 lines provide the frequencies of the 19 seismic hazard intervals. The next line, S-060-STR-COLLAPSE, provides the calculated fragility of the CRCF structure for the 19th seismic hazard interval, which is 5.58×10^{-1}. The next line, SEIS-EVENT, is a placeholder used by SAPHIRE for the seismic event sequence name. The last line, CRCF-TAO-CAN, is the input for the number of transportation, aging, and disposal canisters over the preclosure period (throughput) relevant to this event sequence. The sequence frequency for this 19th interval (1.92×10^{-6}/y) can be calculated by multiplying the exposure time factor (5.67×10^{-3}), PGA-BIN-19 interval frequency (7.45×10^{-8}8/y), seismic fragility (5.58×10^{-1}), and throughput (8.143×10^{3}). Thus, the results for each seismic hazard interval, the calculation of fragilities, or the convolution can be verified. The overall seismic sequence frequency is the sum of the frequencies for each of the 19 seismic hazard intervals.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2009. *Seismic Event Sequence Quantification and Categorization Analysis*. 000-PSA-MGR0-01100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20090112.0013.

DOE (U.S. Department of Energy) 2007a. *Software Independent Verification and Validation Report, SAPHIRE Version 7.27*. 10325-IVVR-7.27-00. Las Vegas, Nevada: U.S. Department of Energy, Office of Repository Development. ACC: MOL.20070813.0172.

DOE 2007b. *Software Validation Report for: SAPHIRE v7.27 using Windows XP*. 10325-SVR-7.27-00-WINXP. Las Vegas, Nevada: U.S. Department of Energy, Office of Repository Development. ACC: MOL.20070813.0185.

RAI Volume 2, Chapter 2.1.1.4, Seventh Set, Number 6:

> Provide technical basis for the horizontal aging module seismic fragility parameters, shown in Table 6.2-1 (BSC 2008bg).
>
> DOE indicates in Table 6.2-1 (BSC, 2008bg) that the fragility parameter estimate for horizontal aging module is "based on other ITS structures." It is not clear how DOE developed the estimate of the fragility parameter, and whether or not it is consistent with the horizontal aging module design information in SAR Section 1.2.7.

1. RESPONSE

In *Seismic Event Sequence Quantification and Categorization Analysis* (BSC 2009), a detailed fragility calculation was not performed for the horizontal aging module (because the horizontal aging module standard design will meet or exceed the seismic fragility parameters used in the seismic analysis (BSC 2009, Table 6.2-1)). Instead, the fragility of the waste handling facility with the lowest seismic capacity, the Wet Handling Facility, was used to provide a conservative estimate of the horizontal aging module fragility.

The horizontal aging module and the heavily reinforced concrete important to safety (ITS) waste handling facilities are designed to ACI 349-01/349R-01 (ACI 2001). These ITS structures are designed to the design basis ground motion-2 (DBGM-2), with a horizontal acceleration of 0.45 g, and evaluated for adequate seismic margin using the beyond DBGM of 0.91 g.

Seismic design information for a standard horizontal aging module demonstrates that it is designed to higher seismic accelerations than those required for the ITS structures (Chopra 2003). The robust horizontal aging module standard design used 1.5 g horizontal acceleration in both horizontal directions, and 1.0 g in the vertical direction, acting simultaneously. The modules are connected to each other on the aging pad, with the connections analyzed for 2.25 g. Since these accelerations are higher than the design basis DBGM-2 and the beyond DBGM used for design of the ITS facilities, it is conservative to use the seismic fragility parameters calculated for the waste handling facility with the lowest seismic capacity, the Wet Handling Facility structure, to represent the horizontal aging module.

In SAR Table 1.2.7-1, the design criteria for the horizontal aging module structural collapse safety function indicate that the horizontal aging modules are designed for the beyond DBGM. Instead, as with the ITS structures, the design criteria should be given in terms of the fragility distribution, and the convolution of the fragility distribution with the seismic hazard distribution. Section 3 provides the clarified wording for the horizontal aging module design criteria. The associated "Nuclear Safety Design Bases Controlling Parameters and Values" (AP.SB.HAC.02) in SAR Table 1.2.7-1 are correct, and the fragility parameters given in Table 6.2-1 of *Seismic Event Sequence Quantification and Categorization Analysis* (BSC 2009) are also correct.

2. COMMITMENTS TO NRC

The DOE commits to revising SAR Table 1.2.7-1 in a future update of the license application to add clarification as described in Section 3.

3. DESCRIPTION OF PROPOSED LA CHANGE

In SAR Table 1.2.7-1, replace the design criteria for the horizontal aging module for the structural collapse safety function with the following:

> Fragility assessment of structure collapse is performed to develop the fragility curve for the structure. Convolution of the fragility curve and seismic hazard curve (as described in Section 1.7) is performed to demonstrate compliance.

4. REFERENCES

ACI 349-01/349R-01. 2001. *Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-01) and Commentary (ACI 349R-01)*. Farmington Hills, Michigan: American Concrete Institute. TIC: 252732.

BSC (Bechtel SAIC Company) 2009. *Seismic Event Sequence Quantification and Categorization Analysis*. 000-PSA-MGR0-01100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20090112.0013.

Chopra, U.B. 2003. "Final Safety Analysis Report (FSAR) for the Standard Advanced NUHOMS Horizontal Modular Storage for Irradiated Nuclear Fuel, Revision 0." Letter from U.B. Chopra (Transnuclear) to M.J. Ross-Lee (NRC), March 19, 2003, with enclosures. TIC: 255975.