# REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**APR1400 Design Certification**

**Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD**

**Docket No. 52-046**

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| **RAI No.:** | **433-8363** |
| **SRP Section:** | **SRP 19** |
| **Application Section:** | **19.1** |
| **Date of RAI Issue:** | **03/08/2016** |

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## Question No. 19-73

10 CFR 52.47(a)(27) states that a DC application must contain an FSAR that includes a description of the design-specific PRA and its results. SECY 93-087 approves an alternative approach to seismic PRA for the design certification (DC) application and interim staff guidance (ISG) 20 provide guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a DC.

Based on the staff review of APR1400 DCD Tier 2, Section 19.1.5, the staff needs additional information to confirm the validity of the applicant’s high confidence in low probability of failure (HCLPF) capacities. The staff expectation at the DC stage is that the design of structures within the scope of DC is essentially complete. Consequently, it is also expected that all the critical structural sections are identified, and the structural HCLPF values are specific to APR1400. In order to evaluate the application, the staff requests the applicant address the following:

a. 1)Provide the bases and justifications for the assumed HCLPF values (including screened out components). 2)Provide a detailed description of the methodologies used for obtaining the structures, systems, and components (SSCs) HCLPF capacities. 3)Provide a detailed description of HCLPF capacities for structures, systems and components (SSCs) obtained through calculations. 4)Provide strategies for ensuring adequate as-built HCLPF capacities for those SSCs whose capacities were determined by means other than calculations. 5)For all the above, as applicable, provide the basis and justification for determining HCLPF capacities via alternate methods relative to ISG-20.

b. Demonstrate the seismic margin of 1.67 times the certified seismic design response spectra (CSDRS) for the seismic Category I structures against the seismic induced sliding and overturning.

c. Based on the information provided in Section 19.1.5.1.1.2, List Item f, provide the basis for the assumption that failure of buildings that are not seismic Category I do not impact

SSCs designed to be seismic Category I for the review-level earthquake (RLE). *Explain how this will be confirmed by the combined license (COL) applicant.*

## Response – (Rev. 1)

a. The fragility analysis results were updated and documented in the seismic fragility analysis calculation (9-035-N392-304 Rev.2). It was uploaded in ERR.

1) Specific HCLPF values for the NI building, EDG/DFOT building and RCS components were developed by CDFM method. ESWIS, CCW Hx. Building and BOP components of the SEL are assigned to COL items (COL 19.1(7)) and assumed to have HCLPF capacities equal to or exceed 1.67 times CSDRS.

Table 19.1-43 of DCD Section 19.1 is revised as shown in Attachment 1 of Response to RAI 433-8363 Question 19-75.

DCD Section 19.1.9 is revised as shown in Attachment 1 and 2.

Table 19.1-4 of DCD Section 19.1 is revised as shown in Attachment 3.

DCD Section 19.1.10 is revised as shown in Attachment 4.

2) According to DC/COL-ISG-020, two methods are acceptable for determining seismic fragility of the structures, systems, and components (SSCs) to demonstrate a seismic margin over the design-specific CSDRS. They are the Conservative Deterministic Failure Margin (CDFM) method and the Separation of Variables (SOV) method. The CDFM method requires code allowable as capacity and design analysis demand while the SOV method requires determination of medians and variabilities associated with capacities, equipment response, and structural response. The CDFM method is selected for this evaluation for the APR1400 Design Certification application.

3) The NI building, EDG/DFOT building and the RCS components of the APR1400 standard design are evaluated by the CDFM method. The resulting HCLPF capacities and the associated failure modes of the SSCs are summarized as below and all the SSCs meet the target HCLPF capacity of 0.5g.

| Component | Location | Failure mode | HCLPF |
|---|---|---|---|
| Buildings | | | |
| Reactor Contain Building | | Tangential shear failure near the base | 0.94g |
| Reactor Containment Internal | | Tangential shear failure of secondary shield wall near the base | 1.09g |
| Auxiliary Building | | Shear failure of shear wall at the basemat | 0.51g |
| Emergeny Diesel Generator Building | | Shear failure of shear wall at the basemat | 0.87g |

| | | | |
|---|---|---|---|
| Diesel Fuel Oil Tank Building | | Shear failure of shear wall at the basemat | 0.73g |
| Stability of NI Structure | | Sliding toward the turbine building | 0.52g |
| RCS Components | | | |
| Reactor Pressure Vessel | Containment El. 69'~156' | Column Support | 0.92g |
| Reactor Vessel Internal | Containment El. 69'~156' | Core Support Barrel lower flange | 0.51g |
| CEDM | Containment El. 69'~156' | Binding of control extension shaft | 0.64 |
| Reactor Coolant Pumps | Containment El. 114'~136'06" | Upper horizontal column support | 1.31g |
| Steam Generator | Containment El. 114'~136'06" | Anchorage failure of snubber lever support assembly | 0.60g |
| Pressurizer | Containment El. 114'~156' | Skit support | 0.63g |
| Steam Generator's Nozzle | Containment El. 114'~136'06" | Steam generator economizer nozzle | 0.54g |
| Pressurizer's nozzle | Containment El. 114'~156' | Pressurizer spray nozzle | 0.51g |
| RCS Piping | Containment | Large loss of coolant at aurge line nozzle | 0.55g |

4) ESWIS, CCW Hx. building and BOP components of the SEL are determined by means other than calculations. These SSCs are assumed to have HCLPF capacities equal to or exceed 1.67 times CSDRS and assigned to COL items (COL 19.1(7)).

DCD Section 19.1.9 is revised as shown in Attachment 1 and 2.

Table 19.1-4 of DCD Section 19.1 is revised as shown in Attachment 3.

DCD Section 19.1.10 is revised as shown in Attachment 4.

5) Following the guidance given in ISG-020, the APR1400 design-specific documents and drawings were reviewed to identify potential failure modes of the individual SSCs and APR1400 design-specific seismic demands were used. As for capacity, code capacities were used and inelastic energy absorption capability, if any, was considered. The Conservative Deterministic Failure Margin (CDFM) approach was selected to calculate specific HCLPF values of the NI building, EDG/DFOT building and RCS components. The ESW Intake Structure, CCW Hx. building and BOP components of the SEL are assigned to COL items (COL 19.1(7)) and assumed to have HCLPF capacities equal to or exceed 1.67 times CSDRS.

DCD Section 19.1.9 is revised as shown in Attachment 1 and 2.

Table 19.1-4 of DCD Section 19.1 is revised as shown in Attachment 3.

DCD Section 19.1.10 is revised as shown in Attachment 4.

b. Global stability of the NI structure, against sliding and overturning, is evaluated and documented in the seismic fragility analysis calculation, 9-035-N392-304 Rev.2. It demonstrates the NI structure has a HCLPF capacity greater than 1.67 times the certified seismic design response spectra (CSDRS). A HCLPF calculation for the EDG/DFOT building against the seismic induced sliding and overturning will be submitted to the NRC by June 30 2016.

c. The turbine and compound building near the NI building will be designed to be seismic Category II. Spatial interaction potential between the NI and the seismic Category II buildings will be addressed in specific fragility calculations. These calculations are assigned to COL items (COL 19.1 (17)).

DCD Section 19.1.9 is revised as shown in Attachment 1 and 2.

Table 19.1-4 of DCD Section 19.1 is revised as shown in Attachment 3.

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**Impact on DCD**

Table 19.1-43 of DCD Section 19.1 is revised as shown in Attachment 1 of Response to RAI 433-8363 Question 19-75.

DCD Section 19.1.9 is revised as shown in Attachment 1 and 2.

Table 19.1-4 of DCD Section 19.1 is revised as shown in Attachment 3.

DCD Section 19.1.10 is revised as shown in Attachment 4.

**Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

There is no impact on the Technical Specifications.

**Impact on Technical/Topical/Environmental Reports**

There is no impact on any Technical, Topical, or Environmental Report.

RAI 433-8363 - Question 19-73_Rev.1

COL 19.1(3) The COL applicant is to describe the uses of PRA in support of licensee programs, and identify and describe risk-informed applications being implemented during the operational phase. See Subsection 19.1.1.4.

COL 19.1(4) The COL applicant is to review as-designed and as-built information and conduct walkdowns as necessary to confirm that the assumptions used in the PRA (including PRA inputs to RAP and SAMDA) remain valid with respect to internal events, internal flood and fire events (routings and locations of pipe, cable, and conduit), and HRA analyses (development of operating procedures, emergency operating procedures, and severe accident management guidelines and training), external events including PRA-based seismic margins and HCLPF fragilities, and LPSD procedures. See Subsection 19.1.2.2.

COL 19.1(5) The COL applicant is to conduct a peer review of the PRA relative to the industry PRA Standard prior to use of the PRA to support risk-informed applications, as applicable. See Subsection 19.1.2.3.

COL 19.1(6) The COL applicant is to describe the PRA maintenance and upgrade program. See Subsection 19.1.2.4.

COL 19.1(7) The COL applicant is to confirm that the PRA-based seismic margin assessment is bounding for the selected site, and to update the assessment to include site-specific SSC and soil effects (including sliding, overturning liquefaction, and slope failure). The COL applicant is to confirm that the as-built plant has adequate seismic margin. See Subsection 19.1.5.1.2.

← New text is added as shown B

COL 19.1(8) The COL applicant is address following issues with a site-specific risk assessment, as applicable:

- Dam failure
- External flooding
- Extreme winds and tornadoes
- Industrial or military facility

RAI 433-8363 - Question 19-73_Rev.1

B

The COL applicant is to demonstrate that HCLPF capacity is equal to or exceed 1.67 times the GMRS for site-specific structures (ESWIS and CCW Hx Building).

The COL applicant is to demonstrate that HCLPF capacity is equal to or exceed 1.67 times the CSDRS for BOP components. and is to complete the SEL.

The COL applicant is to demonstrate that the seismic capacity for equipment qualified by testing should remain functionally operational within 1.67 times the required response spectra (CSDRS-based RRS) in the procurement specification.

bolts (versus the 40 bolts used to secure the hatch during at-power operation); four bolts are sufficient to secure the hatch so that no visible gap can be seen between the seals and the sealing surface. See Subsection 19.1.6.2.

COL 19.1(15) The COL applicant is to develop a configuration control program requiring that, during Modes 4, 5, and 6, the watertight flood doors and fire doors be maintained closed in at least one quadrant. Furthermore, the COL applicant is to incorporate, as part of the aforementioned configuration control program, a provision that if the flood or fire doors to this designated quadrant must be opened for reasons other than normal ingress/egress, a flood or fire watch must be established for the affected doors.

COL 19.1(15) The COL applicant is to develop outage management procedures that limit planned maintenance that can potentially impair one or both SC trains during the shutdown modes.

COL 19.1(16) The COL applicant is to develop procedures and a configuration management strategy to address the period of time when one SC train is unexpectedly unavailable (including the termination of any testing or maintenance that can affect the remaining train and restoration of all equipment to its nominal availability).

New text is added as shown A

### 19.1.10 References

1. ASME/ANS RA-S-2008, "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications" (Revision 1 RA-S-2002), American Society of Mechanical Engineers, April 2008.

2. ASME/ANS RA-Sa-2009, "Addenda to ASME/ANS RA-S-2008," American Society of Mechanical Engineers, February 2009.

3. Regulatory Guide 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Rev. 2, U.S. Nuclear Regulatory Commission, March 2009.

RAI 433-8363 - Question 19-73

RAI 433-8363 - Question 19-73_Rev.1

A

~~COL 19.1(17) The COL applicant is to demonstrate that the ESWIS, CCW Hx building and BOP components of the SEL have HCLPF capacities equal to or exceed 1.67 times CSDRS and is to complete the SEL.~~

COL 19.1(~~18~~ 17) The COL applicant is to demonstrate that failure of buildings that are not seismic Category I (e.g., turbine building and compound building) does not impact SSCs designed to be seismic Category I.

Table 19.1-4 (25 of 25)

| No. | Insight | Disposition |
|---|---|---|
| Risk Insights from PRA Models | | |
| 58 | The fire PRA assumes that the fire barrier management procedures used during LPSD will include directions to provide reasonable assurance that breached risk-significant fire barriers can be closed in sufficient time to prevent the spread of fire across the barrier. The procedural direction is to include the use of a fire watch whose duties are commensurate with the risk associated with the barrier. For example, for fire barriers that separate two fire compartments that both contain no equipment or cables necessary to prevent core damage or large early release during LPSD conditions, or have been demonstrated to have low risk significance, there will at least be a roving fire watch to check the barrier during rounds. For fire barriers separating fire compartments that contain equipment or cables necessary to prevent core damage or large early release during LPSD conditions, and have been demonstrated to be risk significant with respect to fire, a permanent fire watch will be established until the barrier is reclosed. In the latter case, the fire barrier management procedure is to direct that hoses or cables that pass through a fire barrier use isolation devices on both sides of a quick-disconnect mechanism that allow for reclosure of the barrier in a timely fashion to re-establish the barrier prior to fire spread across the barrier. | Subsection 19.1.6.3.1.2<br>COL 19.1(11) |
| ## | ~~The COL applicant is to demonstrate that the ESWIS, CCW HX building and BOP components of the SEL have HCLPF capacities equal to or exceed 1.67 times CSDRS and is to complete the SEL.~~<br>The COL applicant is to demonstrate that HCLPF capacity is equal to or exceed 1.67 times the GMRS for site-specific structures (ESWIS and CCW Hx Building) and HCLPF capacity is equal to or exceeds 1.67 times the CSDRS for BOP components, and is to complete the SEL.<br><br>At the design certification phase, specific design data for the BOP components such as material properties, analysis results, qualification test information, etc. are not available. Appendix E of EPRI-NP-1002988 (Reference 55) presents example calculations showing that the equipment designed for 0.25g SSE can have 0.5g or higher HCLPF considering the conservatism in the design process. The EPRI-NP-6041 (Reference 39) indicates that Seismic Category I concrete structure and BOP equipment can have 0.5g HCLPF as long as the structure and the equipment are designed in accordance with the current code and standard and the anchorage is rugged. The generic fragility data provided by the Electric Power Research Institute (EPRI) Utility Requirements Document (Reference 37) show the BOP components have HCLPF capacities higher than 0.5g.<br><br>The COL applicant is to demonstrate that failure of buildings that are not seismic Category I (e.g., turbine building and compound building) does not impact SSCs designed to be seismic Category I. | COL 19.1(~~17~~ 7)<br><br>COL 19.1(~~18~~ 17) |

42. NUREG-1921, “EPRI/NRC-RES Fire Human Reliability Analysis Guidelines,” U.S. Nuclear Regulatory Commission, November 2009.

43. EPRI 1016735, “Fire PRA Methods Enhancements: Additions, Clarifications, and Refinements to EPRI 1019189,” Electric Power Research Institute, December 2008.

44. NUREG/CR-4527, “An Experimental Investigation of Internally Ignited Fires in Nuclear Power Plant Control Cabinets, Part II: Room Effects Tests,” U.S. Nuclear Regulatory Commission, April 1987.

45. Regulatory Guide 1.102, “Flood Protection for Nuclear Power Plants,” U.S. Nuclear Regulatory Commission, September 1976.

46. EPRI 1021086, “Pipe Rupture Frequencies for Internal Flooding Probabilistic Risk Assessments (PRAs),” Electric Power Research Institute, October 2010.

47. NUREG/CR-6144 (BNL-NUREG-52399), “Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Surry, Unit 1,” U.S. Nuclear Regulatory Commission, June 1994.

48. Inspection Manual Chapter 0609, Appendix G, “Shutdown Operations Significance Determination Process,” U.S. Nuclear Regulatory Commission, February 2005.

49. NUMARC 93-01, “Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants,” Nuclear Energy Institute, July 2000.

50. NEI 00-04, “10 CFR 50.69 SSC Categorization Guideline,” Rev. 0, Nuclear Energy Institute, July 2005.

51. CAFTA 6.0b, Software Manual, EPRI, Palo Alto, CA, 2014.

52. NUREG/CR-7114, “A Framework for Low Power/Shutdown Fire PRA,” U.S. Nuclear Regulatory Commission, September 2013.

53. NUREG/CR-7150, “Joint Assessment of Cable Damage and Quantification of Effects from Fire (JACQUE-FIRE),” May 2014.

54. DC/COL-ISG-020, "Interim Staff Guidance on Implementation of a Probabilistic Risk AssessmentBased Seismic Margin Analysis for New Reactors", U.S. Nuclear Regulatory Commission.

55. EPRI 1002988, "Seismic Fragility Application Guide"Electric Power Research Institute, December 2002.

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| **Application Section:** | **19.1** |
| **Date of RAI Issue:** | **03/08/2016** |

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## Question No. 19-74

10 CFR 52.47(a)(27) states that a design certification (DC) application must contain an FSAR that includes a description of the design-specific PRA and its results. SECY 93-087 approves an alternative approach to seismic PRA for the DC application and interim staff guidance (ISG) 20 provide guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a DC.

(a) Design control document (DCD) Section 19.1.5.1.1(e) states "At the design certification phase, specific design data such as material properties, analysis results, qualification test information, etc. are not available. Where available, information from the reference plant is used for the component fragility. The generic data are based on the fragilities provided by the Electric Power Research Institute (EPRI) Utility Requirements Document (Reference 37)." Clarify whether at the DC stage the design of structures within the scope of DC is essentially complete, and the above statement applies to systems and components only.

(b) DCD Table 3.2-1 lists the classification of structures, systems, and components. The emergency diesel generator building (EDGB) is listed as Seismic Category I. Further, Table 19.1-43 of the DCD lists the High Confidence of Low Probability of Failure (HCLPF) capacity for the EDGB as 0.67g, and indicates that it is an assumed value. HCLPF capacities for the other Category I structures included in the design certification are stated to be qualified by analysis. Given that EDGB is designated as seismic Category I, is within the scope of DC, is addressed in the seismic analysis in DCD Section 3.6, and design details are shown in DCD Chapter 3, Section 3.8A, Figures 38A-53 through 3.8A-56, the staff requests the applicant to provide a fragility and HCLPF capacity derivation specifically for the EDGB.

## Response – (Rev. 1)

a. Design control document (DCD) Section 19.1.5.1.1(e) is deleted and revised as shown in Attachment 1. At the DC stage, NI and EDG/DFOT buildings are the design of structures within the scope of DC and fragilities of the buildings are complete.

b. The EDG Block consists of the EDG Building and the Diesel Fuel Oil Tank (DFOT). Both buildings are critical to shear failure. The EDG Building is controlled by Wall WAC26 on the west, and the resulting HCLPF capacity is 0.87g. The DFOT is controlled by Wall WAA26-02 on the west, and the resulting HCLPF capacity is 0.73g. All the HCLPF capacities are referenced to the CSDRS anchored to 0.3g at the finished grade level.

   Table 19.1-43 of DCD Section 19.1 is revised as shown in the response to RAI No.433-8363 19-75 Attachment 1.

   DCD Section 19.1.5.1.1.1 page 19.1-123 item (b) is revised as shown in Attachment 2.

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**Impact on DCD**

DCD Section 19.1.5.1.1 (e) is revised as shown in Attachment 1.

Table 19.1-43 of DCD Section 19.1 is revised as shown in the response to RAI No. 433-8363 19-75 Attachment 1.

DCD Section 19.1.5.1.1.1 page 19.1-123 item (b) is revised as shown in Attachment 2.

**Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

There is no impact on the Technical Specifications.

**Impact on Technical/Topical/Environmental Reports**

There is no impact on any Technical, Topical, or Environmental Report.

The starting point to perform SMA is to select a review level earthquake (RLE). SMA demonstrates that sufficient margin in seismic design exists by showing the high confidence of low probability of failures (HCLPFs) of the plant and components are greater than the RLE. The RLE of the APR1400 is 0.5g.

b. Development of seismic equipment list

The seismic equipment list is provided from the internal events PRA model. Also, earthquake-specific SSCs such as passive components and structures related to a safety function, which are not addressed in the internal events PRA model, are included in the fragility analysis and system analysis.

c. Identification of seismic initiating event category

Initiating events due to a seismic event are identified from the internal events PRA. However, there are some major differences between seismic and internal events for the purpose of identifying the initiating event category, which are as follows: 1) seismic events may damage passive plant components and structures (e.g., steam generators, auxiliary building, etc.) that are not explicitly modeled in the internal events PRA; and 2) seismic events may simultaneously damage multiple SSCs in the plant.

d. Development of system models

The SMA system models are developed from the internal events PRA model to include the important accident sequences. This model also contains random failures and human errors from the internal events PRA. System models are modified to accommodate a seismic event. The model is used to estimate seismic margins and to identify vulnerabilities in the design.

e. Fragility analysis

~~At the design certification phase, specific design data such as material properties, analysis results, qualification test information, etc. are not available. Where available, information from the reference plant is used for the component fragility. The generic data are based on the fragilities provided by the Electric Power Research Institute (EPRI) Utility Requirements Document (Reference 37).~~

← New text is added as shown A

42. NUREG-1921, "EPRI/NRC-RES Fire Human Reliability Analysis Guidelines," U.S. Nuclear Regulatory Commission, November 2009.

43. EPRI 1016735, "Fire PRA Methods Enhancements: Additions, Clarifications, and Refinements to EPRI 1019189," Electric Power Research Institute, December 2008.

44. NUREG/CR-4527, "An Experimental Investigation of Internally Ignited Fires in Nuclear Power Plant Control Cabinets, Part II: Room Effects Tests," U.S. Nuclear Regulatory Commission, April 1987.

45. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, September 1976.

46. EPRI 1021086, "Pipe Rupture Frequencies for Internal Flooding Probabilistic Risk Assessments (PRAs)," Electric Power Research Institute, October 2010.

47. NUREG/CR-6144 (BNL-NUREG-52399), "Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Surry, Unit 1," U.S. Nuclear Regulatory Commission, June 1994.

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49. NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," Nuclear Energy Institute, July 2000.

50. NEI 00-04, "10 CFR 50.69 SSC Categorization Guideline," Rev. 0, Nuclear Energy Institute, July 2005.

51. CAFTA 6.0b, Software Manual, EPRI, Palo Alto, CA, 2014.

52. NUREG/CR-7114, "A Framework for Low Power/Shutdown Fire PRA," U.S. Nuclear Regulatory Commission, September 2013.

53. NUREG/CR-7150, "Joint Assessment of Cable Damage and Quantification of Effects from Fire (JACQUE-FIRE)," May 2014.

54. DC/COL-ISG-020, "Interim Staff Guidance on Implementation of a Probabilistic Risk AssessmentBased Seismic Margin Analysis for New Reactors", U.S. Nuclear Regulatory Commission.

55. EPRI 1002988, "Seismic Fragility Application Guide"Electric Power Research Institute, December 2002.

RAI 433-8363 - Question 19-74

RAI 433-8363 - Question 19-74_Rev.1

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Per ISG-020 (Reference 54), two methods can be used to calculate the structure, system and component HCLPF capacity to demonstrate a seismic margin over the design-specific CSDRS. They are the Conservative Deterministic Failure Margin (CDFM) approach and the Separation of Variables approach. For the APR1400 Design Certification application, the CDFM approach is used. As delineated in ISG-020, APR1400 design-specific documents and drawings are reviewed to identify potential failure modes of the individual SSCs and APR1400 design-specific seismic demands are used. As for capacity, code capacities are used and inelastic energy absorption capability, if any, is considered. The resulting HCLPF capacities are described in DCD Section 19.1.5.1.2.2.

At the design certification phase, specific design data for the BOP components, such as material properties, analysis results, qualification test information, etc. are not available. Appendix E of EPRI-NP-1002988 (Reference 55) presents example calculations showing that the equipment designed for 0.25g SSE can have 0.5g or higher HCLPF considering the conservatism in the design process. The EPRI-NP-6041 (Reference 39) indicates that Seismic Category I concrete structure and BOP equipment can have 0.5g HCLPF as long as the structure and the equipment are designed in accordance with the current code and standard and the anchorage is rugged. The generic fragility data provided by the Electric Power Research Institute (EPRI) Utility Requirements Document (Reference 37) show the BOP components have HCLPF capacities higher than 0.5g.

The seismic capacity for equipment qualified by testing will ensure that the equipment should remain functionally operational within 1.67 times the required response spectra (RRS) in the procurement specification. The seismic demands to equipment defined in terms of RRS should use CSDRS-based seismic input and account for the structural amplifications caused by the supporting structures, including soil-structure interaction effects and supporting systems, and incorporate an additional seismic margin factor (1.67 times RRS).

10) Check valves

11) Instrumentation such as resistance temperature detectors, pressure transmitters, etc.

12) Electrical components/relays/circuit breakers (not specifically analyzed in Table 19.1-42)

b. Since a formal evaluation of the EDG building has not been completed, it is assumed that the building fragility is greater than that of the diesel generators and associated equipment contained in the building.

19.1.5.1.1.2 Seismic Fragility Analysis

Seismic fragilities are calculated for component groups developed from the SEL. For the SMA, component fragility values from the reference plants are assumed to apply. The exception to the use of fragility information from the reference plants is when a component has a HCLPF of less than 0.5g. In such cases, it is assumed that the APR1400 design will be modified to increase the capacity of components to at least a 0.5g HCLPF.

A fragility evaluation is performed to obtain the seismic margin of components and structures that could have an effect on safe shutdown of the plant following a seismic event. In this evaluation, the seismic margin values of components and structures modeled in the accident sequences are obtained. The seismic margin is expressed in terms of HCLPF values.

$$HCLPF = A_m \times \exp(-1.65 \times (\beta_R + \beta_U))$$

or

$$HCLPF = A_m \times \exp(-2.33 \times \beta_C)$$

The equation for mean failure probability is:

$$= \text{Normal distribution of } \left[\frac{(\ln 1.0g) - (\ln A_m)}{\sqrt{(\beta_R{}^2 + \beta_U{}^2)}}\right]$$