

Westinghouse Non-Proprietary Class 3

ENCLOSURE 4

Westinghouse Specialized Seismic Option Report - Response to NRC Request for Information

(Non-Proprietary)

Westinghouse Non-Proprietary Class 3

Please find attached the following request for information (RAI) responses:

RAI-SSO-003 Revision 2

RAI-SSO-007 Revision 1

RAI-SSO-008 Revision 0

RAI-SSO-009 Revision 0

RAI-SSO-010 Revision 0

RAI-SSO-013 Revision 0

RAI-SSO-015 Revision 0

RAI-SSO-016 Revision 0



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Specialized Seismic Option Report Review

Response to Request for Additional Information (RAI)

Response No. RAI-SSO-003

Revision 2

Question:

WEC will need to clarify its consistency with the most current versions of the Nuclear Regulatory Commission (NRC) guidance or justify the use of alternate methods of analysis as applicable. For example, in the option report (OR), it is not clear if the guidance found in interim staff guidance (ISG)-20 regarding operating modes and peer review for seismic margin analysis (SMA) is used. Also, WEC will need to clarify the version of the NRC guidance used in the development of time histories (see Sections 2.1 and 3.3.1) and demonstrate consistency with current NRC guidance or provide justification for use of alternate methods of analysis as applicable.

Supplemental Question:

In its response, Westinghouse concludes that its [

]^{a,c} To assist the staff in its evaluation of Westinghouse's assessment described above, Westinghouse is requested to provide technical bases and details of its assessment including the parameters it evaluated to support the aforementioned conclusions.

On Page 3 of 4 of its response, Westinghouse states that [

]^{a,c} Westinghouse is requested to include the SRP revision number used for this analysis in the topical report. Also, Westinghouse is requested to provide the [

Further Westinghouse is requested to provide the reason for the [

]^{a,c} relative to the corresponding
AP1000 Rev. 19 displacements.

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Additionally, Westinghouse is requested to clarify in the topical report, the [

] ^{a,c}

As discussed above, the staff request Westinghouse to propose mark-ups to the topical report consistent with their response.

Westinghouse Response:

Clarification of Regulatory Guidance

The Specialized Seismic Option of the certified **AP1000**[®] Standard Plant involves enhancements to key seismic design parameters; namely design response spectra and corresponding design time histories. Another key change is the application of the Specialized Seismic Option [^{a,c} These design and site parameter changes affect several Design Control Document (DCD) subsections as described in Chapter 9 of the Specialized Seismic Option report. In addition, changes to DCD Tier 1, Tier 2, and Tier 2* information are shown as 'mark-ups' in Appendix A of the Option report. [

] ^{a,c}

[

] ^{a,c}

PRA-Based Seismic Margin

The Option does not introduce [^{a,c} **AP1000** plant DCD, Revision 19, Subsection 19.55, describes the approach for performing the **AP1000** plant SMA. Changes to this DCD section are shown in Appendix A.9 of the Option Report. Revised High Confidence of Low Probability of Failure (HCLPF) values for the more risk-significant SSC's are also shown in Appendix A.9 Table 19.55-2. These values, [

] ^{a,c} Accordingly, the Option continues to ensure design capacity to resist beyond design basis seismic events.

As part of the **AP1000** plant DCD, Revision 19, safety review, NRC performed an evaluation of SMA methods, HCLPF results, and Combined License (COL) commitments [

from the guidance in ISG-20.]^{a,c} The Option requires no departures

A COL referencing the Option will perform site-specific PRA. As required under NRC regulations (10 CFR 50.71(h)), COL holders will develop a level 1 and level 2 PRA. The PRA will cover those initiating events and modes for which NRC-endorsed consensus standards on PRA exist one year prior to the scheduled date for initial loading of fuel. Regulatory Guide 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," reference 4, provides regulatory guidance for meeting the requirements of 10 CFR 50.71(h) and references the NRC-endorsed PRA standard (ASME/ANS RA-S-2008, reference 5, and addenda ASME/ANS RA-Sa-2009, reference 6). This PRA standard requires the COL to incorporate independent peer review of methods used to develop structural and component fragilities to ensure they reflect the site-specific and as-built conditions of the plant. A site-specific PRA, performed in accordance with the NRC-endorsed standard, will ensure that overall risk is within acceptable limits, and will also provide the COL holder with valuable risk insights for making decisions regarding the safety of the plant.

Time Histories for Nuclear Island Stability Evaluation

[

[

]^{a,c}

]^{a,c}

Supplemental Westinghouse Response:

Westinghouse has developed responses to the staff's supplemental question(s) as described below:

Excerpt of NRC Question Being Answered

- a) *To assist the staff in its evaluation of Westinghouse's assessment described above, Westinghouse is requested to provide technical bases and details of its assessment including the parameters it evaluated to support the aforementioned conclusions.*

Westinghouse Response to Excerpt

Appendix A to the Option Report, Subsections A.5 and A.6, provide the Tier 2 changes to Chapters 2 and 3 of the certified **AP1000** plant DCD, Revision 19. All changes described in Subsections A.5 and A.6 of the Option Report are performed in accordance with the [

] ^{a,c}

The Option Report, Section 4.0, describes evaluations of **AP1000** plant Seismic Category I structures and components that confirm the Option plant design, with its [

] ^{a,c} described in Option Report, Section 6.0, meets acceptance criteria. In addition, Section 4.0 identifies the respective **AP1000** plant DCD Revision 19 subsections that describe methods of design and analysis methods, including relevant SRP criteria.

As described in the Option Report, Section 1.2.2, Westinghouse performed a detailed technical evaluation of [

] ^{a,c}

Westinghouse believes that the most significant Option design changes (from the **AP1000** plant DCD Revision 19) are the use of increased seismic spectra (i.e., using the Enhanced Seismic

Spectrum, instead of the CSDRS) and corresponding design time histories as described in Option Report, Sections 3.1 and 3.3. Acknowledging the significance of these changes, Westinghouse confirmed that the ESS time histories satisfied the [

] ^{a,c} both of which are important design considerations and are strongly influenced by the ESS.

[

] ^{a,c}

[

] ^{a,c} The remaining fraction of changes were judged to be either not applicable to the Option design or they were not related to design or analysis methods (e.g., COL information items).

[

] ^{a,c}

Stability Analysis Sensitivity Study

[

] ^{a,c}

Based on the above, Westinghouse concludes that the seismic analysis and design methods referenced in the Option Report are sufficient for ensuring the safety function of Seismic Category I Systems, Structures and Components (SSCs) under design basis seismic demands and in demonstrating compliance with applicable NRC regulatory requirements.

Excerpt of NRC Question Being Answered

- b) On Page 3 of 4 of its response, Westinghouse states that []^{a,c} Westinghouse is requested to include the SRP revision number used for this analysis in the topical report.

Westinghouse Response to Excerpt

[

] ^{a,c}

Excerpt of NRC Question Being Answered

- c) Also, Westinghouse is requested to provide the [] ^{a,c}

Westinghouse Response to Excerpt

[

] ^{a,c} and are available for staff audit review.

Excerpt of NRC Question Being Answered

- d) Further Westinghouse is requested to provide the reason for the [] ^{a,c} relative to the corresponding AP1000 Rev. 19 displacements.

Westinghouse Response to Excerpt

The seismic displacement values for of the Option design are limited to the [

] ^{a,c}

Excerpt of NRC Question being Answered

e) *Additionally, Westinghouse is requested to clarify in the topical report, the [*

]^{a,c}

Westinghouse Response to Excerpt

Westinghouse used the [

^{a,c} developed
and satisfies applicable regulatory criteria. The Option Report, Section 2.1 will be revised to
provide clarification.

Table RAI-SSO-003-1: Review of Key SRP Changes

a,c

Table RAI-SSO-003-1: Review of Key SRP Changes (continued)

a,c

Table RAI-SSO-003-4

a,c

Table RAI-SSO-003-4 (Continued)

a,c

Table RAI-SSO-003-4 (Continued)

a,c

Reference(s):

1. HSP-GW-GLR-001, Revision 0, "The Specialized Seismic Option Report," September 2015 (Proprietary) and HSP-GW-GLR-002, Revision 0, "The Specialized Seismic Option Report," September 2015 (Non-Proprietary)
2. NUREG-1793, Supplement 2, Final Safety Evaluation Report - **AP1000** Design Certification, (ML112061231), August 15, 2011.
3. Interim Staff Guidance (ISG)-20, DC/COL-ISG-020, "Interim Staff Guidance on Implementation of a Seismic Margin Analysis for New Reactors Based on Probabilistic Risk Assessment," ML100491233, March 15, 2010
4. RG 1.200 "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Revision 2, March 2009
5. ASME/ANS RA-S-2008 "Standard for Level 1 / Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications,"
6. Addenda ASME/ANS RA-Sa-2009 "Addenda to ASME/ANS RA-S-2008 Standard for Level I/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications"
7. SRP 3.7.1, Revision 3, Seismic Design Parameters, March 2007
8. NRC Memo, "Technical Report in Support of Staff's Activity to Enhance Guidance for Review of Seismic and Civil Structural Issues", Dated February 19, 2013 [ML13042A173]
9. NRC Memo, "Technical Rationale for Enhancements to Seismic and Structural Review Guidance", Dated December 23, 2014 [ML14280A341]

Specialized Seismic Option Report Text Revision:

2.1 APPLICATION OF THE SPECIALIZED SEISMIC OPTION ESS

The seismic design basis for the Specialized Seismic Option is the ESS as described in Section 1.1 of this report. Figure 2-1 shows the Option site conditions which along with the ESS form the seismic design basis evaluated in this report. As such, the certified **AP1000** plant DCD Revision 19 CSDRS is revised to represent the Specialized Seismic Option ESS []^{a,c}.

This design change affects DCD Revision 19 Tier 1 Chapters 1.2 and 5.0 and Tier 2 Chapters 2.5, 3.7, 3.10, 19, and Appendix 3I.

As the certified **AP1000** plant CSDRS is changed to the Specialized Seismic Option ESS, the development of new design time histories is required. ~~These new time histories were developed in accordance with~~ These new time histories were confirmed to satisfy the []

[]^{a,c}. This change affects certified **AP1000** plant DCD Revision 19 Section 3.7.1 and is further described in Section 3 of this report.

Specialized Seismic Option Report Appendix A (DCD Mark-up) Revision:

None

Technical Report (TR) Revision:

None



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Specialized Seismic Option Report Review

Response to Request for Additional Information (RAI)

Response No. RAI-SSO-007

Revision 1

Question:

Section 4.4.1 of the OR compares the [

future audit regarding this material.]^{a,c} Staff will require WEC to clarify this topic at a

Supplemental Question:

(DSRA/SRSB)

Title 10 of the Code of Federal Regulations (10 CFR), Part 50, Appendix A, General Design Criterion (GDC) 2, requires that structures, systems, and components (SSCs) important to safety are designed to withstand the effects of earthquakes without the loss of capability to perform their safety functions. The design bases for these SSCs shall reflect: (1) the severity of the historical reports, with sufficient margin to cover the limited accuracy, quantity, and time period for the accumulated data, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed. NUREG-0800 Section 4.2 Appendix A (II)(2) provides review guidance regarding the review of methods used to analyze the design loads and component capacity.

In September 28, 2015, Westinghouse Electric Company (WEC) submitted Option Report HSP-GW-GLR-001, Rev 0, "The Specialized Seismic Option Report" (known from this point forward as Option Report) for review and approval. Section 4.4.1 of the Option Report discusses the []^{a,c} in relation to the Option response spectrum. The submittal concludes that the Option response spectrum [

] ^{a,c}

The staff notes that while the Option response spectra [

] ^{a,c}. Additionally, the Option response spectra becomes [

] ^{a,c} (see Figure 3-19 of HSP-GW-GLR-001). This has caused the staff to question whether or not the AP1000[®] fuel assembly [

] ^{a,c}.

Perform an evaluation of the AP1000 fuel assembly structural response for the Option response spectrum and provide justification for [

] ^{a,c}.

Westinghouse Response:

Westinghouse will have seismic calculations available for review which include the combined effects of all [] ^{a,c}. The calculation notes will show that [] ^{a,c} for the Specialized Seismic Option. The calculations to clarify this topic will be made available at a future audit regarding this material. ~~WEC does not propose revised text to the Specialized Seismic Option (Reference 1) in response to this RAI.~~

Supplemental Westinghouse Response:

In response to this RAI, Westinghouse performed a [] ^{a,c} seismic evaluation of the AP1000 plant fuel assembly structural response for the Specialized Seismic Option (hereafter, "Option") Enhanced Seismic Spectrum (ESS). The [] ^{a,c} evaluation considers [] ^{a,c}, including the [] ^{a,c}.

] ^{a,c}. This RAI response provides justification that the existing AP1000 plant fuel configuration does not require modification for Option ESS incorporation by showing ESS level fuel structural demands meet applicable structural acceptance criteria.

ESS building response motions were generated using methods outlined in the Option Report consistent with applicable regulatory guidance. The Option Report (Reference 1) and supporting calculation notes were reviewed by the NRC as part of the Option project audit in June 2016 (Reference 2). [] ^{a,c} were generated using the [] ^{a,c}.

] ^{a,c} seismic evaluations which were reviewed as part of the Option project audit except that the conservatively established [] ^{a,c} was changed to a more realistic [] ^{a,c}.

] ^{a,c}. Detailed design evaluation parameters, such as [] ^{a,c}, are not described in regulatory guidance, the standard review plan, or the

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AP1000 plant DCD (Reference 3). Application of []^{a,c} was previously reviewed and accepted by the NRC in Reference 4 for []^{a,c}. A []^{a,c} is substantiated by test to be a reasonable and conservative value for use in []^{a,c} safe-shutdown earthquake evaluation for the ESS transient. Per markups contained herein, Table 4-21 of the Option Report shows that ESS level fuel demands meet applicable structural criteria.

Reference(s):

1. HSP-GW-GLR-001, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Proprietary) and HSP-GW-GLR-002, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Non-Proprietary).
2. HSP NRC 000023, Revision 0, "Westinghouse Specialized Seismic Option Report – Action Items from June 2016 NRC Audit", August 16, 2016.
3. APP-GW-GL-700, Revision 19, "AP1000 Design Control Document", June 2011.
4. WCAP-17524-P-A, "AP1000 Core Reference Report," May 2015.
5. HSP NRC 000017, Revision 0, "Westinghouse Specialized Seismic Option Report – Response to NRC Request for Augmentation and/or Clarification," February 15, 2016.

Specialized Seismic Option Report (OR) Revision:

~~None.~~ Revisions to Section 4.4.1 text are provided. It is noted that Table 4-21 was marked as Not Used in the response to RAI-SSO-006 provided by Reference 5 and is being repurposed for this RAI response.

4.4.1 Nuclear Fuel (Operational Configuration)

[

] ^{a,c}

Table 4-21. [

] ^{a,c}

a,c

Specialized Seismic Option Report Appendix A (DCD Mark-up) Revision:

None.

Table 3.7.1-1	
SAFE SHUTDOWN EARTHQUAKE DAMPING VALUES	
	Percent
Welded and friction-bolted steel structures and equipment	4
Bearing bolted structures and equipment	7
Prestressed concrete structures	5
Reinforced concrete structures	7
Concrete filled steel plate structures	5
[Piping (for uniform envelope response spectra analysis)]	5
Piping (alternative for time history analysis and independent support motion response spectra analysis)	
Less than or equal to 12-inch diameter	2
Greater than 12-inch diameter	3
Primary coolant loop	4]*
Fuel assemblies	[] ^{a,c}
Control rod drive mechanisms	5
Full cable trays and related supports	10
Empty cable trays and related supports	7
Conduits and related supports	7
HVAC ductwork	7
HVAC welded ductwork	4
Cabinets and panels for electrical equipment	5
Equipment such as welded instrument racks and tanks	3

Technical Report (TR) Revision:

None.



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Specialized Seismic Option Report Review

Response to Request for Additional Information (RAI)

Response No. RAI-SSO-008

Revision 0

Question:

(DEIA/MEB)

Westinghouse Option Report, HSP-GW-GLR-001 "The Specialized Seismic Option Report," Revision 0 (Agencywide Documents Access and Management System Accession No. ML15274A048), Section 4.3.3 related to HVAC and Cable Trays.

BACKGROUND

During an audit of the specialized seismic option (SSO or the option), the NRC staff reviewed the adequacy of methods for seismic analysis of heating, ventilating and air-conditioning (HVAC) and Cable Trays in WEC Calculations [

] ^{a,c}. The results for the enhanced seismic spectra (ESS) option for HVAC were obtained by [

] ^{a,c}. There may be additional areas where the [^{a,c}. The NRC staff does not agree with the definition of the [^{a,c}. Section 5.2 of the

Option Report defines the [

] ^{a,c}. The NRC staff notes that the linear static solution can be obtained with the same models [^{a,c}. The WEC calculations indicate that the [

] ^{a,c} as part of the Option. However, the input floor response spectra (FRS) was based on the results of the [

] ^{a,c}. Implementing [^{a,c}. Therefore, the NRC staff does not believe it to be appropriate to use a [

] ^{a,c}. Therefore, the additional information identified below is requested.

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REQUEST

The applicant is requested to provide (1) a technical basis for using the []^{a,c}, (2) a technical basis for []

[]^{a,c} for the option, and (3) the scope of structures and components that are analyzed using a []^{a,c}.

Westinghouse Response:

(1) The []^{a,c} is applied to structures that require no modification when qualified using the []^{a,c}. The []^{a,c}.

(2) The HVAC and Cable tray supports in the Option report are qualified using one of three methods: []^{a,c}.
[]

[]^{a,c}

The []^{a,c} was only used for structures that require no modification; therefore, request (2) does not apply to structures which were qualified using the scaling factor method.

[]^{a,c} were used for members that required modifications from the **AP1000** plant configuration.

The Nuclear Island (NI10) building analysis incorporated design changes outlined in the Option Report (Reference 1) prior to ESS production. The HVAC and cable trays are []^{a,c} in the NI10 global building analysis. []^{a,c} associated with the HVAC and cable tray enhancements are []^{a,c} on in-structure response spectra generation.

(3) The structures that were qualified using the []^{a,c} include:

- HVAC designs, with no enhancements, with supports attached to []^{a,c} See Table RAI-SSO-008-1 for additional details.

Table RAI-SSO-008-1: HVAC and Cable Tray Scaling Method Details ^{a,c}

--

- Also, in the SMA evaluation – [

]^{a,c} There are no enhancements to these components affecting the dynamic models; therefore, []^{a,c}

Westinghouse does not propose revised text to the Specialized Seismic Option (Reference 1) in response to this RAI.

Reference(s):

1. HSP-GW-GLR-001, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Proprietary) and HSP-GW-GLR-002, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Non-Proprietary).
2. [

] ^{a,c}
3. [

] ^{a,c}

Specialized Seismic Option Report (OR) Revision:

None

Specialized Seismic Option Report Appendix A (DCD Mark-up) Revision:

None

Technical Report (TR) Revision:

None



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Specialized Seismic Option Report Review

Response to Request for Additional Information (RAI)

Response No. RAI-SSO-009

Revision 0

Question:

(DEIA/SEB)

10 CFR 50 Appendix S requires that the safety functions of SSCs must be assured during and after the vibratory ground motion associated with the SSE ground motion through design, testing, or qualification methods. Ensuring no power deficiency in the acceleration time histories over the frequency range of interest to the SSCs is one of the acceptance criteria used for determining the validity of these time histories used in the seismic analysis and design of SSCs in accordance with 10 CFR 50 Appendix S. The staff reviewed the **AP1000**[®] SSO report and the supporting calculations and determined that the information requested below is needed in order to determine the acceptability of the acceleration time histories.

Figure 3-10 of the **AP1000** SSO report shows the power spectral density (PSD) of the design time histories up to around []^{a,c} upper bound frequency as used for the NUREG-0800 Section 3.7.1, Rev. 4 Appendix A target PSD. This upper bound frequency reflects the NRC Regulatory Guide (RG) 1.60 horizontal spectral shape that has a zero period acceleration (ZPA) frequency of 33 Hz. The NUREG-0800 Section 3.7.1 Rev. 4, Appendix A target PSD is compatible with the RG 1.60 horizontal spectral shape. However, compared to the ZPA frequency of []^{a,c} for the **AP1000** SSO ESS, an upper bound frequency of []^{a,c} appears to be low. NUREG-0800 Section 3.7.1 Rev. 4, Appendix B indicates that for response spectral shapes other than the RG 1.60 horizontal spectral shape, the PSD should be evaluated up to a frequency that is consistent with the design response spectra. Therefore, the staff requests the applicant to provide a PSD assessment of all time histories to cover a []^{a,c} that is consistent with the **AP1000** SSO ESS.

During the staff audit in the week of June 6, 2016, the staff raised the above concern to the applicant and subsequently, the applicant showed plots of PSD curves up to []^{a,c} to

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address this concern. Those plots showed that the []^{a,c},
 contradicting the common expectation of averaging. The frequency window of []^{a,c} did not appear to explain this observation. Thus, the staff requests the applicant to explain why the []^{a,c}.

During the audit, the staff reviewed WEC Technical Report []^{a,c} which, in addition to the design acceleration time histories, utilizes another 4 sets of acceleration time histories for the nonlinear stability analysis. The PSDs of these 4 sets of acceleration time histories were estimated utilizing their entire duration in the Fourier transform and effective time durations in the denominator of the PSD equation []^{a,c}. The effective time duration of an acceleration time history is defined as the time for its normalized cumulative Arias intensity to rise from 5 percent to 75 percent, adjusted by a factor of 1/0.7. Based on the staff experience, the applicant's method can overestimate the PSD for those frequencies at which the wave components have very low magnitude but span a time longer than the effective time duration. Further, the applicant's method is not consistent with the NUREG-0800 guidance which states that the Fourier transform should be performed over the strong motion portion of the time history, during which the acceleration time history achieves near maximum and nearly stationary power. The applicant indicated during the audit that in contrast to the method described above, the method actually used to estimate the PSD of the design acceleration time histories is consistent with the SRP guidance. Therefore, the staff requests the applicant to provide a technical justification for the adequacy of the method used for estimating the PSDs of the 4 additional sets of time histories or use a method that is consistent with the guidance described in []^{a,c}.

Accordingly, the SSO report should be updated to reflect any necessary changes due to the requested information above for the PSD assessment (for example, update Figure 3-10 of the SSO report).

NOTE: Westinghouse has submitted the 5 sets of time histories to the staff for confirmatory analysis.

Westinghouse Response:

1. The Power Spectral Density (PSD) of all time histories associated with the Enhanced Seismic Spectra (ESS) are calculated using the method consistent with the guidance described in []

] ^{a,c}

The averaged PSD is computed over a frequency band width of []

] ^{a,c}

The raw PSDs of all time histories associated with the ESS have been evaluated up to above [] ^{a,c}. Thus, the corresponding [] ^{a,c} PSD can be calculated up to [] ^{a,c}, which is equal to the cutoff frequency of the ESS. As a result, the guideline given in [] ^{a,c} of the one-sided PSD has been met.

Figures RAI-SSO-009-01 through RAI-SSO-009-03 provide the PSDs of single set of the design time histories, which were used to evaluate the seismic responses of the Option Plant structures and components to the ESS, as presented in the Option Report (Reference 1). In Figures RAI-SSO-009-01 through RAI-SSO-009-03, the red lines represent the raw PSDs, and the green lines represent the [] ^{a,c} PSDs. It has been shown that the PSDs of the single set of the design time histories do not have significant gaps in energy at any frequency over the frequency range that is consistent with the ESS.

Figure RAI-SSO-009-04 shows how to calculate the S_a PSD at S_a for the vertical time history. S_a

S_a

Furthermore, the raw PSDs have also been S_a . Figures RAI-SSO-009-05 through RAI-SSO-009-07 illustrate the comparisons S_a

S_a

Revised Option Report Figure 3-10 is provided in the Specialized Seismic Option Report (OR) Revision section of this response.



**Figure RAI-SSO-009-01: PSDs of Single Set of Design Time Histories
(Horizontal X-Direction)**



**Figure RAI-SSO-009-02: PSDs of Single Set of Design Time Histories
(Horizontal Y-Direction)**



**Figure RAI-SSO-009-03: PSDs of Single Set of Design Time Histories
(Vertical Z-Direction)**



Figure RAI-SSO-009-04: Example of Calculation Method of $\pm 20\%$ Frequency Band Averaged PSD



Figure RAI-SSO-009-05: Raw and Averaged PSDs of Single Set of Design Time Histories (Horizontal X-Direction)



Figure RAI-SSO-009-06: Raw and Averaged PSDs of Single Set of Design Time Histories (Horizontal Y-Direction)



Figure RAI-SSO-009-07: Raw and Averaged PSDs of Single Set of Design Time Histories (Vertical Z-Direction)

2. Multiple sets of artificial time histories were generated for the ESS in []^{a,c}. The one-sided raw PSDs have been calculated up to []^{a,c} for these time histories []^{a,c}. Note that the []^{a,c} for each time history.

The []^{a,c}. Hence, the guidance described in []^{a,c} has been met.

Figures RAI-SSO-009-08 through RAI-SSO-009-010 present the []^{a,c}

[]^{a,c} in the directions of horizontal-x, horizontal-y and vertical-z, respectively. It has been shown that the PSDs of the multiple sets of the time histories []^{a,c}



**Figure RAI-SSO-009-08: Averaged PSDs of Multiple Sets of Time Histories
(Horizontal X-Direction)**



**Figure RAI-SSO-009-09: Averaged PSDs of Multiple Sets of Time Histories
(Horizontal Y-Direction)**



**Figure RAI-SSO-009-010: Averaged PSDs of Multiple Sets of Time Histories
(Vertical Z-Direction)**

Reference(s):

1. HSP-GW-GLR-001, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Proprietary) and HSP-GW-GLR-002, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Non-Proprietary).
2. HSP-1000-S2C-004, Rev. 1, "Nuclear Island Non-Linear Stability Analysis for ESS," October 2016 (Proprietary).

Specialized Seismic Option Report (OR) Revision:

Replace Figure 3-10 with the following.

a,c

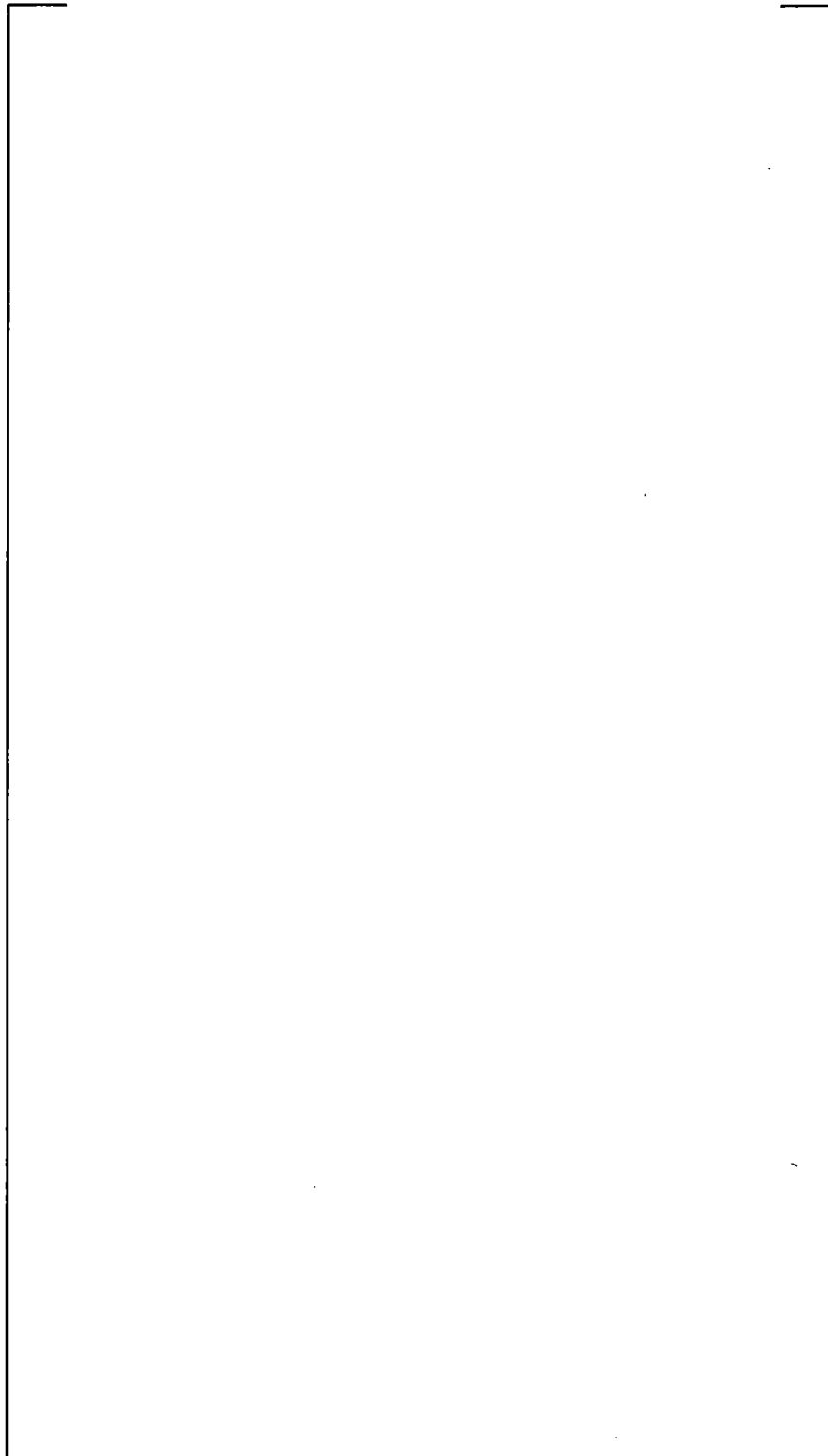


Figure 3-10. Power Spectral Density of Design Time Histories

Specialized Seismic Option Report Appendix A (DCD Mark-up) Revision:

None

Technical Report (TR) Revision:

None



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Specialized Seismic Option Report Review

Response to Request for Additional Information (RAI)

Response No. RAI-SSO-010

Revision 0

Question:

(DEIA/SEB)

Section 4.1.5 in Option Report HSP-GW-GLR-001, Revision 0 describes the design enhancements for the []^{a,c} that are necessary to accommodate the demand of the ESS. These enhancements modified the structural stiffness and mass of the []^{a,c}, changing its dynamic properties. While the Option Report addresses the dynamic response of the []^{a,c} for the ESS, the staff review did not find information about the dynamic response of the []^{a,c} such as those resulting from []^{a,c}. To demonstrate compliance with GDC 2 and consistent with the guidance in NUREG-0800 Section 3.8.3, the staff requests the applicant to provide the technical basis that demonstrate that the dynamic response of the []^{a,c} due to the aforementioned []^{a,c} does not adversely affect the structural performance of the []^{a,c} considering the design enhancements.

Westinghouse Response:

The []^{a,c} is associated with blowdown of the primary system through the spargers. Condensation during sparger discharge results in high frequency pressure oscillations that have a frequency range of 40 to 60 hertz. After increasing the plate thickness and circumferential beams the significant modes of the []^{a,c} wall are still less than 20 Hz. Thus, the []^{a,c} are not affected by the []^{a,c} wall enhancements. The []^{a,c} pressurization is still bounded by using a 5.0 psi equivalent static pressure on the []^{a,c} wall.

Westinghouse does not propose revised text to the Specialized Seismic Option (Reference 1) in response to this RAI.

Reference(s):

1. HSP-GW-GLR-001, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Proprietary) and HSP-GW-GLR-002, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Non-Proprietary).

Specialized Seismic Option Report (OR) Revision:

None

Specialized Seismic Option Report Appendix A (DCD Mark-up) Revision:

None

Technical Report (TR) Revision:

None



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Specialized Seismic Option Report Review

Response to Request for Additional Information (RAI)

Response No. RAI-SSO-013

Revision 0

Question:

(DEIA/SEB)

10 CFR 52.47(a)(27) requires a description of the design-specific PRA and its results. During the audit of June 7-9, 2016, the evaluation supporting the conclusion in Section 5.2, of the SSO Report, which states, "The seismic margin assessment (SMA) evaluation considers the effect of uplift and sliding of the nuclear island (NI) basement foundation. The NI seismic response has been evaluated at 1.1 times the review level ESS (1.67xESS), and it is concluded that the NI basemat retains its stability against sliding and overturning," was not available for staff review. The staff requests the applicant to provide a description of the evaluation to support the conclusion that the NI basemat retains its stability against sliding and overturning.

The staff in addition requests the applicant to revise the proposed markups for DCD Chapter 19 to clarify that the review level ESS is 1.67 x ESS.

Westinghouse Response:

A description of the evaluation to support the conclusion that the NI basemat retains its stability against sliding and overturning will be added to the last paragraph of Section 5.2 of the Option Report (Reference 1). The proposed markups to the DCD presented on page A-212 of the Option Report indicates that the review level ESS is 1.67xESS. No additional revisions are proposed to the DCD.

Reference(s):

1. HSP-GW-GLR-001, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Proprietary) and HSP-GW-GLR-002, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Non-Proprietary).

Specialized Seismic Option Report (OR) Revision:

The last paragraph of Section 5.2 will be modified as follows:

The SMA evaluation considers the effect of uplift and sliding of the NI basemat foundation. The NI seismic response has been evaluated at 1.1 times the review level ESS ($1.67 \times \text{ESS}$). The analysis is conservative since no [^{a,c} is credited. The resulting maximum displacement at the base of the nuclear island basemat (elevation 60.5) is [

] . This is negligible sliding and uplift during the seismic event and it is concluded that the NI basemat retains its stability against sliding and overturning.

Specialized Seismic Option Report Appendix A (DCD Mark-up) Revision:

None

Technical Report (TR) Revision:

None



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Specialized Seismic Option Report Review

Response to Request for Additional Information (RAI)

Response No. RAI-SSO-015

Revision 0

Question:

(DEIA/SEB)

The staff reviewed Option Report HSP-GW-GLR-001, Revision 0 and identified areas in need of clarification. The applicant is requested to address the following:

- a) Section 2.2.1 in the Option Report states that in general, the SSO ESS imparts higher seismic demands on the certified **AP1000**[®] NI critical sections. Further, this section indicates that while modeling refinements have been made, the dynamic response and overall behavior of the refined models (e.g. ISRS, base shears, story forces, etc.) remain consistent with that described in the certified **AP1000** plant DCD Rev. 19. Given that in general the ESS imparts higher seismic demands, the staff requests the applicant to clarify what is meant by the indication that the ISRS, base shears, story forces, etc. remain consistent with the descriptions in **AP1000** DCD Rev. 19.
- b) Appendix A to the Option Report includes markups for Table 3H.5-13, "Design Summary of Floor at Elevation 135'-3" Area 1 (Main Control Room Ceiling)." In the design evaluation results the markups show that [

]^{a,c} the values in
AP1000 DCD Rev. 19. The applicant is requested to clarify the reason for the
[

]^{a,c} relative to the **AP1000** DCD Rev. 19.
- c) Appendix A to the Option Report includes markups for Table 3H.5-14, "Design Summary of Enhanced Shield Building Comparison to Acceptance Criteria (sheet 1, 2 and 3)." In

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general, the markups show that the []^{a,c} than
AP1000 DCD Rev. 19 required values. The applicant is requested to explain what is
 causing the []^{a,c}.

Westinghouse Response:

(a) Westinghouse will clarify the fourth sentence of Section 2.2.1 to read:

"The dynamic response and overall behavior of these refined models (e.g., ISRS, base shears, story forces, etc.) are obtained using methodology consistent with that described in the certified **AP1000** plant DCD Revision 19.

(b) The design shear strength of the Option was determined in a different manner than the **AP1000** plant. In **AP1000** plant DCD Revision 19, the design shear strength is calculated based on []^{a,c}.
 On the other hand, in Specialized Seismic Option Report Revision 0, the design shear strength is calculated based on []

[]^{a,c}. To be consistent with the **AP1000** plant the Option design shear strength will be calculated based on []^{a,c}. The maximum bending moment and maximum shear force will also be recalculated (See Markups to Table 3H.5-13).

(c) The shear for the Option was determined in a different manner than the **AP1000** plant DCD Revision 19. The shear reinforcement calculation method was changed from beam action to 2 way action. To be consistent with the **AP1000** plant the Option shear reinforcement will be calculated using beam action (See Markups to Table 3H.5-14). The required plate thickness is slightly less for the Option because the forces are lower for the Option (See Tables RAI-SSO-015-1 to RAI-SSO-015-3).

Table RAI-SSO-015-1: Seismic Forces at Fuel Building Roof Location



a,c

Table RAI-SSO-015-2: Seismic Forces at Intersection with Wall 7.3



a,c

Table RAI-SSO-015-3: Seismic Forces at Grade on the West Side

a,c

Reference(s):

1. HSP-GW-GLR-001, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Proprietary) and HSP-GW-GLR-002, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Non-Proprietary).
2. HSP-NRC-000023, Rev. 0, "Westinghouse Specialized Seismic Option Report – Action Items from June 2016 NRC Audit," August 2016.

Specialized Seismic Option Report (OR) Revision:

Revise Section 2.2.1 as follows. It is noted that additions to Section 2.2.1 provided by Reference 2 to address audit action item 52 are included in the revisions below.

2.2 EFFECT ON DESIGN

2.2.1 Structures

In general, the Specialized Seismic Option ESS imparts higher seismic demands on the certified **AP1000** plant nuclear island critical sections, while maintaining the required margin to referenced codes and standards. The seismic demands on critical sections are derived [

]^{a,c}. Although there have been local modeling refinements made (more accurate representation of mass distribution and wall openings), there are [

]^{a,c}. The dynamic response and overall behavior of these refined models (e.g., ISRS, base shears, story forces, etc.) are obtained using methodology consistent with that described in the certified **AP1000** plant DCD Revision 19. The required changes to the nuclear island critical sections (i.e., required design reinforcement) affect DCD Sections 3.8 and Appendix 3H. The increase in reinforcement in these critical sections was minor. The maximum compression check showed that the critical sections did not surpass the maximum reinforcement ratio criteria. In addition, higher demands require limited design changes to the IRWST steel tank structure, which are described in certified **AP1000** plant DCD Tier 1, Table 3.3-1 and certified **AP1000** plant DCD Section 3.8.3. A more detailed description of the structural design enhancements is provided in Section 4.1 of this report.

Specialized Seismic Option Report Appendix A (DCD Mark-up) Revision:



a,c

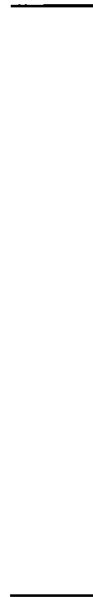
Note:

1. Thermal loads have been considered in the design of critical sections. The required reinforcement values shown do not include the load case where seismic and normal thermal loads are numerically combined as the normal thermal loads were assessed to be insignificant. When the seismic and normal thermal loads are numerically combined, the value of required reinforcement may increase; however, in all cases the required reinforcement is less than the provided reinforcement and thus the design of the critical section reinforcement is acceptable.

a,c

Notes:

1. *[The Tier 2* designation for "Plate thickness required" requires NRC approval if this value is exceeded as a result of design changes or detail design adjustments identified during preparation of fabrication or construction drawings or instructions.]**
2. The 0.75-inch plate thickness is the nominal plate size for the shield building away from connections, attachments, and other local loads. The plate may be thicker (up to 1.0-inch nominal thickness) in the area around these local loads.



a,c

Technical Report (TR) Revision:

None



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Specialized Seismic Option Report Review

Response to Request for Additional Information (RAI)

Response No. RAI-SSO-016

Revision 0

Question:

(DEIA/SEB)

The staff reviewed Option Report HSP-GW-GLR-001, Revision 0 and identified areas in need of editorial corrections and/or revisions to avoid inconsistencies in the Option Report descriptions. The applicant is requested to address the following:

- a) In the executive summary of the **AP1000**[®] SSO Report the figures of the comparison of the ESS and the certified **AP1000** plant CSDRS, as well as the Example Spectrum (Figure 3 and 4 page vi) should include the damping value.
- b) First paragraph in Section 2.1. "Application of the specialized seismic option ESS," states, "This design change affects DCD Revision 19 Tier 1 Chapters 1.2 and 5.0 and Tier 2 Chapters 2.5, 3.7, 3.10, 19, and Appendix 3I." The staff reviewed Table 9-2 "DCD Change road map for Appendix A changes" and Appendix A "Markups of the certified **AP1000** DCD Revision 19 to support the Specialized Seismic Option" and found that some sections are missing in the statement, therefore the applicant is requested to revise that statement and include the sections missing to be consistent with the information in Table 9-2 in the SSO Report. This also applies to the last paragraph in Section 2.1.
- c) In the Option Report, the first paragraph in Section 4.1 seems to limit the scope of the design calculation performed for the Option to the []^{a,c}. However, the last paragraph in Section 4.1 along with the subsequent 4.1 subsections describe design calculations performed for critical sections for steel containment and containment internal structures. To avoid inconsistencies in the description regarding the scope of the design calculations

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performed, the staff requests the applicant augment the description in the first paragraph in Section 4.1, similar to the 2nd sentence in the last paragraph in Section 4.1, to include the other structures for which design calculations are performed for the SSO Report.

- d) In the Option Report, Section 4.1.2 "Auxiliary Building," the applicant states "The auxiliary building critical sections, shown in this report in []^{a,c}. However, []^{a,c} could not be located in SSO Report. The staff requests the applicant to add []^{a,c} to the report
- e) In the Option Report, Section 5.1 describes the use of the strength factor and ductility factor with the conservative deterministic failure margin (CDFM) method for the Option Report. Further, in its response to RAI SSO-004, the applicant confirmed these factors to be the only factors used in the CDFM calculations for the Option Report. To avoid inconsistencies regarding the factors used for the CDFM calculations for the Option Report, the applicant is requested to provide markups for DCD Section 19.55.2.2.3 (under CDFM method) to remove the description of damping factor.
- f) In the Option Report, Table 6-1 summarizes the design enhancements for building structures. Regarding the design enhancements for the []^{a,c} Option Report, Table 6-1 (and respective information in Table 7-2) described the []^{a,c} but did not describe the []^{a,c}, described in Section 4.1.5 and Table 4-9. Additionally, the description in Table 6-1, references the []^{a,c}; however, the []^{a,c} are the same as given in **AP1000** DCD Rev. 19. The staff requests the applicant to revise the description in Table 6-1 (and respective information in Table 7-2) to be consistent with the description in Section 4.1.5 and Table 4-9.
- g) Appendix A to the Option Report includes markups to DCD Tier 1 Table 5.0-1 removing the information related to the []^{a,c}. However, based on the markups to Option Report, Section 3.8, such information continues to be applicable for the SSO Option Report (i.e. the information remains in DCD Section 3.8.5.5.3). The staff agrees with the applicability of such information to the Option Report, and therefore, requests the applicant to keep the information related to the minimum required angle of internal friction in DCD Tier 1 Table 5.0-1.
- h) Figure 3H.5-11 in Appendix A to the Option Report is missing certain details and lines, therefore, the applicant is requested to provide a better figure with necessary details, such as missing structural details and dimension lines and also explain why some information has been deleted.

Westinghouse Response:

- (a) Revised titles for Option Report Figures 3 and 4 specifying the damping value are

provided in the Specialized Seismic Option Report (OR) Revision section of this response.

- (b) The listing of affected portions of the DCD Revision 19 in Section 2.1 are only those associated with an identified design change.

The first paragraph in Section 2.1 is only discussing those associated with the change in []^{a,c}. These are indicated in Table 9-2 by noting []^{a,c} in the Reason for Change column.

The last paragraph in Section 2.1 is only discussing those associated with the change in []^{a,c}. These are indicated in Table 9-2 by noting []^{a,c} in the Reason for Change column.

Revisions to Option Report Section 2.1 modifying the list of affected portions of DCD Revision 19 are provided in the Specialized Seismic Option Report (OR) Revision section of this response.

- (c) Revisions to Option Report Section 4.1 are provided in the Specialized Seismic Option Report (OR) Revision section of this response.

- (d) A revision to []^{a,c} is not being provided for the Option. As noted in the Option Report, Section 4.1.2, the auxiliary building critical sections []^{a,c}.

Revisions to Option Report Section 4.1.2 to remove the pointer to a modified []^{a,c} are provided in the Specialized Seismic Option Report (OR) Revision section of this response.

- (e) Markups for DCD Section 19.55.2.2.3 are provided in the Specialized Seismic Option Report Appendix A (DCD Mark-up) Revision section of this response.
- (f) Revisions to Option Report Tables 6-1 and 7-2 are provided in the Specialized Seismic Option Report (OR) Revision section of this response.
- (g) This was addressed in Action Item #49 in HSP_NRC_000023 (Reference 2) which included revisions to Tier 1 Table 5.0-1.
- (h) A redrawn Figure 3H.5-11 Sheet 5 is provided in the Specialized Seismic Option Report Appendix A (DCD Mark-up) Revision section of this response. This figures shows the necessary structural details.

Reference(s):

1. HSP-GW-GLR-001, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Proprietary) and HSP-GW-GLR-002, Rev. 0, "The Specialized Seismic Option Report," September 2015 (Non-Proprietary).
2. HSP_NRC_000023, Revision 0, "Westinghouse Specialized Seismic Option Report – Action Items from June 2016 NRC Audit", August 2016.
3. HSP_NRC_000021, Revision 0, "Westinghouse Specialized Seismic Option Report – Response to NRC Request for Augmentation and/or Clarification Supplemental Questions," May 2016.

Specialized Seismic Option Report (OR) Revision:**Option Report Changes for Part a of this RAI:**

Revise Figures 3 and 4 titles as follows:

Figure 3. Comparison of the ESS and the Certified AP1000 Plant CSDRS []^{a,c}

Figure 4. Comparison of ESS, Certified AP1000 Plant CSDRS, and Example Spectrum []^{a,c}

Option Report Changes for Part b of this RAI:

Revise Section 2.1. It is noted that changes to Section 2.1 previously provided in the response to RAI-SSO-003 (Reference 3) and to address audit action item 2 (Reference 2) are included in the revisions below.

2.1 APPLICATION OF THE SPECIALIZED SEISMIC OPTION ESS

The seismic design basis for the Specialized Seismic Option is the ESS as described in Section 1.1 of this report. Figure 2-1 shows the Option site conditions which along with the ESS form the seismic design basis evaluated in this report. As such, the certified **AP1000** plant DCD Revision 19 CSDRS is revised to represent the Specialized Seismic Option ESS []^{a,c}.

This design change affects DCD Revision 19 Tier 1 Chapters 1.2 and 5.0 and Tier 2 Chapters 2.5, 3.7, 3.8, 3.9, 3.10, 19, and Appendixes 3G, 3H and 3I.

As the certified **AP1000** plant CSDRS is changed to the Specialized Seismic Option ESS, the development of new design time histories is required. ~~These new time histories were developed in accordance with~~ These new time histories were confirmed to satisfy the []

[]^{a,c}. This change affects certified **AP1000** plant DCD Revision 19 Section 3.7.1 and is further described in Section 3 of this report.

A future **AP1000** plant COLA, referencing the Specialized Seismic Option, would develop site specific GMRS in accordance with NRC RG 1.208. These GMRS, developed at the foundation elevation in the free-field, would be compared to the Specialized Seismic Option ESS to demonstrate suitability of siting of an **AP1000** Standard Plant at the proposed site. The Specialized Seismic Option ESS would become the safe shutdown earthquake (SSE) for the COLA. The seismic design for plant-specific SSCs, including detailed design and changes needed during construction, would be based on this SSE. In addition, the design of site-specific structures, such as cooling towers or intake structures would also be based on this SSE.

The future **AP1000** plant COLA, referencing the Specialized Seismic Option, []^{a,c}. The Specialized Seismic Option would be sited on []^{a,c} with either supporting structures adjacent to the nuclear island. This design change affects certified **AP1000** plant DCD Revision 19 Tier 1 Chapter 5.0 and Tier 2 Chapters 2.5, 3.7, 3.8, 19 and Appendixes 3C and 3G.

Option Report Changes for Part c of this RAI:

Revise the first paragraph of Section 4.1 as follows:

4.1 NUCLEAR ISLAND BUILDING AND ADJACENT STRUCTURES EVALUATIONS

The higher ESS generated demands can be accommodated in the Option plant without any plant layout changes. Demonstrating that the design thickness of the nuclear island walls and slabs remains acceptable is accomplished by performing design calculations of a number of structural elements of nuclear island building structures. []

[]^{a,c}.

Option Report Changes for Part d of this RAI:

Revise the second paragraph of Section 4.1.2 as follows:

The auxiliary building critical sections, ~~shown in this report in~~ []

[]^{a,c}.

The critical sections are designed in accordance with the ACI 349-01, "Code Requirements for Nuclear Safety Related Concrete Structures" (Reference 13). []

[]^{a,c} The reinforcement required is calculated for the member forces for each of the load combinations described in certified **AP1000** plant DCD Revision 19 Appendix 3H. The certified **AP1000** plant DCD Revision 19 tables and figures also show the reinforcement provided for each critical section.

Option Report Changes for Part e of this RAI:

None

Option Report Changes for Part f of this RAI:

Revise Table 6-1 and Table 7-2 as follows. It is noted that changes to Table 6-1 previously provided to address audit action item 7 (Reference 2) are included in the revisions below.

Table 6-1. Design Enhancements for Building Structures

		a,c
		Option Report Evaluation Section
		4.1.1, 4.1.2, 4.1.4, 4.1.5
		4.1.5
		4.1.4, 8.2.4
		4.1.6
		4.1.6

Table 7-2. Safety Analysis Input Parameters for Each Design Enhancement

a,c

Option Report Changes for Part g of this RAI:

Refer to Action Item #49 in HSP_NRC_000023 (Reference 2) which included revisions to Tier 1 Table 5.0-1.

Option Report Changes for Part h of this RAI:

None

Specialized Seismic Option Report Appendix A (DCD Mark-up) Revision:

DCD Mark-up Changes for Part e of this RAI:

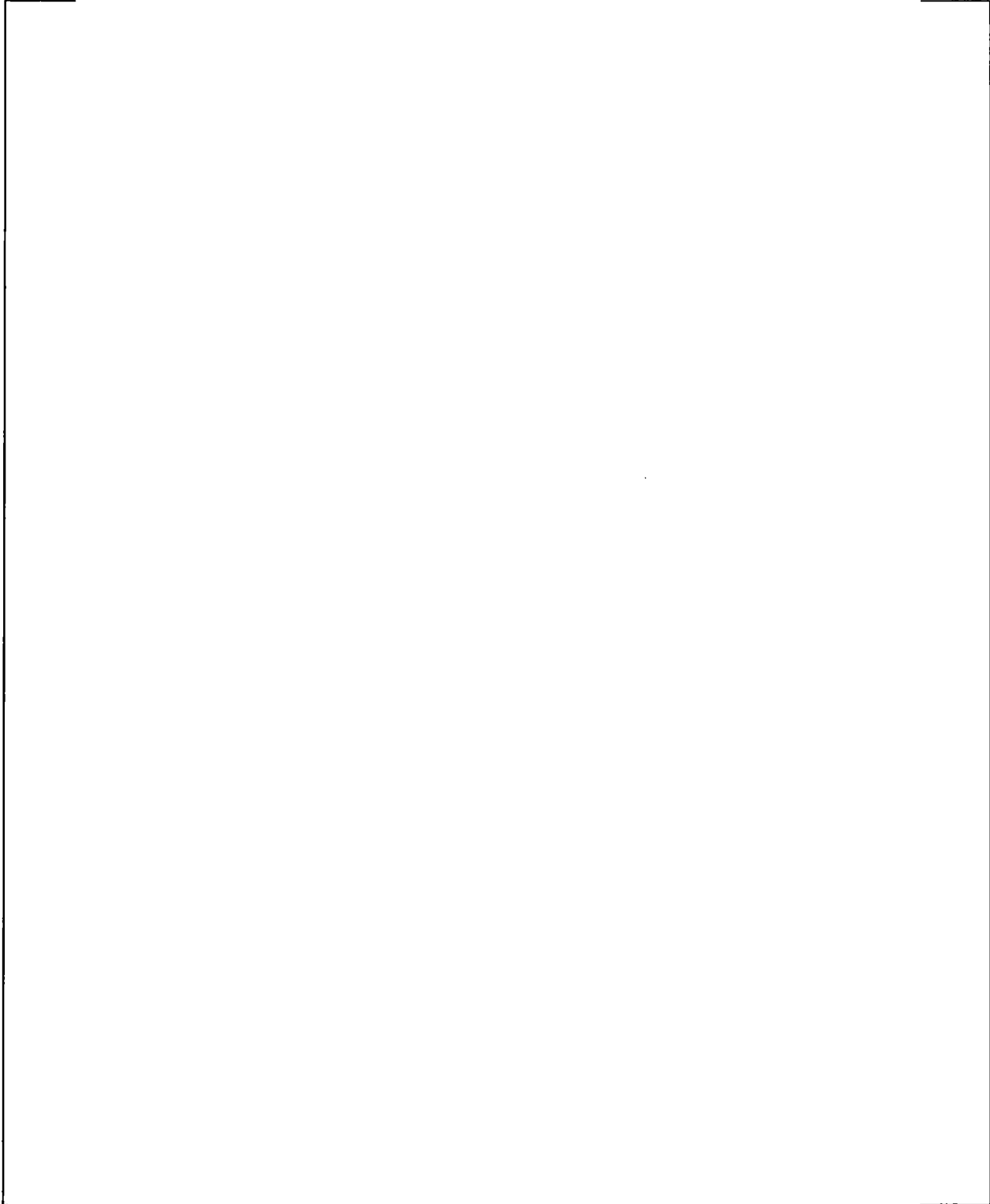
Markup DCD Section 19.55.2.2.3 discussion of CDFM as follows:

Conservative Deterministic Failure Margin Method

The HCLPF values for the shield building and the exterior walls of the Auxiliary Building were calculated using the conservative deterministic failure margin approach. A finite element analysis was performed of the structures that considered cracking of the concrete and redistribution of the loads. Deterministic margin factors were defined for ~~three~~two items: strength; and inelastic energy absorption; ~~and damping~~.

DCD Mark-up Changes for Part h of this RAI:

Replace Figure 3H.5-11 Sheet 5 with the following.



a,c

Technical Report (TR) Revision:

None