Westinghouse Non-Proprietary Class 3

ENCLOSURE 4

Specialized Seismic Option Report - Action Item List from June 2016 NRC Audit - Updated

(Non-Proprietary)

The U.S. Nuclear Regulatory Commission (NRC) staff conducted an audit related to the review of HSP-GW-GLR-001, "The Specialized Seismic Option Report" (Option Report). The primary audit took place June 7–9, 2016 at the Westinghouse facility in Rockville Maryland. The staff audited documents that support the Option Report evaluations and conclusions. Action items were collected during the audit and subsequent telephone calls and meetings. Attachment A provides the complete action item list and the status of each item. There are a total of 61 action items. The status of the action items is broken down into four categories, as follows

1. Closed during the audit: Action items that were closed during the audit and require no further action. There are 13 action items in this category.

2. Closed – to be confirmed by NRC: Action items that require clarification and for which some of the clarification is provided in the attachments to this letter. There are 29 action items in this category.

3. Closed – issued as Request for Additional Information (RAI): Action items that resulted in a RAI issued by the NRC to which Westinghouse will provide a response at a later date. There are 13 action items in this category.

4. Open – to be addressed by Westinghouse: Action items that require clarification and for which the clarification will be provided at a later date via a voluntary submittal of a clarification to a previously addressed RAI. There are 6 action items in this category.

Attachment A

Action Item List
(Westinghouse Non-Proprietary Class 3)

AI Number	Action Item	Status
1	Need to clarify the frequency in which the Option spectra governs in both the horizontal and the vertical directions since they have different control points. In Sections 3.1, 3.2 and executive summary.	Closed – to be confirmed by NRC: Clarification is provided in the Specialized Seismic Option Report (OR) text revisions provided in Attachment B to this letter.
2	Page 2-1 [ ]^{a,c} - only mentioned here. Delete [ ]^{a,c} from here or other places in the report.	Closed – to be confirmed by NRC: Clarification is provided in the OR text revisions provided in Attachment B to this letter.
3	Page 3-1 bottom. [ ]^{a,c} Clarify. 3-1 - next sentence - "and for [ ]^{a,c} " - make consistent.	Closed – to be confirmed by NRC: Clarification is provided in the OR text revisions provided in Attachment B to this letter.
4	Figure 3-18 - Address some inconsistencies between description in text and figure.	Closed – to be confirmed by NRC: Clarification is provided in the OR text revisions provided in Attachment B to this letter.
5	Page A-48 [ ]^{a,c} - should this be removed? - make consistent.	Closed – to be confirmed by NRC: Clarification is provided in the revised Specialized Seismic Option Report Appendix A (DCD Mark-up) Revisions provided in Attachment C to this letter.
6	Page 4-4 states [ ]^{a,c}. However 4-2 changed the [ ]^{a,c}. Modify Page 4-4 for consistency.	Closed – to be confirmed by NRC: Clarification is provided in the OR text revisions provided in Attachment B to this letter.
7	Provide further clarification on the [ ]^{a,c} basis.	Closed – to be confirmed by NRC: Clarification is provided in the OR text revisions provided in Attachment B to this letter.
8	"More robust design" - define the meaning of this statement or remove.	Closed – issued as RAI-SSO-012.
9	What is the driver for the [ ]^{a,c} change?	Closed during the audit.
10	[ ]^{a,c} - look into that.	Closed during the audit.
11	Containment Vessel - was more [ ]^{a,c} done?	Open – to be addressed by Westinghouse: Clarification will be provided at a later date via a voluntary submittal of a clarification to previously addressed RAI-SSO-002.

AI Number	Action Item	Status
12	[ ]^{a,c} - how is the missing mass handled?	Closed – to be confirmed by NRC: There are no changes to the Option Report. Based on the comment WEC will prepare supporting internal documentation to explain how the missing mass is handled. The documentation can be made available for audit.
13	Want an Option vs **AP1000®** plant [ ]^{a,c} comparison for the top of the shield building. Follow-up: provide a physical explanation for the [ ]^{a,c}.	Open – to be addressed by Westinghouse: Clarification will be provided at a later date via a voluntary submittal of a clarification to previously addressed RAI-SSO-001.
14	Page A-49 Auxiliary and Shield Building (ASB) equivalent static - clarification needed.	Closed – to be confirmed by NRC: Calculation note HSP-1000-S2C-070, Revision 0 provides additional clarification on the ASB equivalent static work.
15	Make corrections to tables in the 3.8 table markups - A-96, A-100, A-102 (What does E'sads mean?)	Closed – to be confirmed by NRC: Clarification is provided in the revised OR Appendix A (DCD Mark-up) Revisions provided in Attachment C to this letter.
16	Why is the [ ]^{a,c} ?	Closed during the audit.
17	Provide the 5 time histories that are in the [ ]^{a,c}. Digitized data? Or plot?	Closed – to be confirmed by NRC: The data was provided via HSP_NRC_000022, "Westinghouse Specialized Seismic Option Report – Five Time History Data Request," June 7, 2016.
18	Provide clarification on the methodology for [ ]^{a,c}.	Closed during the audit.
19	Provide a plot of Power Spectral Density (PSD) at a greater frequency range [ ]^{a,c}.	Closed – issued as RAI-SSO-009.

AI Number	Action Item	Status
20	Time history / [ ] / table of accelerations - some of the accelerations are less than the [ ]a,c.	Closed during the audit.
21	[ ]a,c - seismic Margin Analysis (SMA) used Safe Shutdown Earthquake (SSE) in the load combinations without defining the SSE that was being used. Need to clarify in the technical report this definition of SSE versus ESS. Follow-up: A description of load combination of Service Level D that should include the ESS load in the load combination to be provided in Section 4.2.1 of the topical report.	Closed – to be confirmed by NRC: Clarification is provided in the OR text revisions provided in Attachment B to this letter.
22	Margin to stress limits is low for certain components - need references for the **AP1000** plant margins. Follow-up: Section 4.2 of the topical report should have a discussion of the high stress ratios (e.g. high ratios of Demand/Allowable are [ ]a,c, respectively in Tables 4-12, 4-13, 4-15 and 4-17) that would be acceptable. Note that these high stress ratios are [ ]a,c, for a given similar amplitude of the response spectra.	Closed – to be confirmed by NRC: Clarification is provided in the OR text revisions provided in Attachment B to this letter.
23	Provide the basis for the composite uncertainty (beta values).	Closed during the audit.
24	Provide the Passive Containment Cooling System (PCS) tank interior wall in markups of Table 3H.5-9. SMA - clarification for the PCS Tank High Confidence Low Probability of Failure (HCLPF). Clarify where related markups for the Topical Report came from. Add table for PCS tank wall.	Closed – to be confirmed by NRC: Clarification is provided in the revised OR Appendix A (DCD Mark-up) Revisions provided in Attachment C to this letter.
25	Add an additional example to "conservatism in the structural qualification approach" (page 5-4). [ ]a,c Add more details to the report.	Closed – issued as RAI-SSO-012.

AI Number	Action Item	Status
26	SMA conclusions of higher value HCLPF. Topical taking credit for [ ]^{a,c}. Conservatism in the **AP1000** plant seismic. Add to page 5-4.	Closed – issued as RAI-SSO-012.
27	Maximum sliding displacement - 4 numbers - one is not a maximum. Make consistent.	Closed – to be confirmed by NRC: Calculation note HSP-1000-S2C-004, Revision 0 provides the four values for sliding displacement in Tables 5.2-1 and 5.2.2. The values in the Option Report are consistent with the maximum values provided for the basemat. Clarification is provided in the OR text revisions provided in Attachment B to this letter.
28	Bearing pressure - [ ]$^{a, c}$.	Closed – to be confirmed by NRC: The third paragraph of Section 4.1.1.2 of the Option report is related to the [ ]^{a,c} pressures. During the audit of the [ ]^{a,c} a question arose about the fact that the maximum bearing pressure in the calculation was [ ]^{a,c}. The Option Report is consistent with the values below from the calculation notes. [ ]^{a,c}

AI Number	Action Item	Status
29	[ ]a,c. Not consistent with the Standard Review Plan (SRP) - need to provide and justify the [ ]a, c.	Closed – issued as RAI-SSO-009.
30	Fatigue [ ]a,c put language in the topical report on the Combined License (COL) to perform in detailed analysis.	Closed during the audit. Note that this is addressed by the markups provided in response to Action Item 54.
31	[ ]a,c - need to check again what was done for the **AP1000** plant in Rev. 19.	Closed – issued as RAI-SSO-008.
32	[ ]a,c of steel allowable for [ ]a,c. All the result show ESS divided by allowable. What is [ ]a,c ? Need to check on this. Is this consistent with the **AP1000** plant?	Closed during the audit.
33	Page A-5 - Chapter 3 should be Chapter 5.	Closed – to be confirmed by NRC: Clarification is provided in the revised OR Appendix A (DCD Mark-up) Revisions provided in Attachment C to this letter.
34	Page A-6 why is the [ ]a,c deleted? Why use the soil angle of [ ]a,c?	Closed – issued as RAI-SSO-016.
35	Page A-176 - [ ]a,c - need to clarify (correct page A-176).	Closed – to be confirmed by NRC: Clarification is provided in the revised OR Appendix A (DCD Mark-up) Revisions provided in Attachment C to this letter.
36	Tables in shield building roof that did [ ]a,c - add a footnote to the existing DCD table. Page A-179 - only show sheet 3 of 3. Add sheets 1, 2a, 2b and 2c with the footnote.	Closed – to be confirmed by NRC: Clarification is provided in the revised OR Appendix A (DCD Mark-up) Revisions provided in Attachment C to this letter.

AI Number	Action Item	Status
37	Page A-183 - explain why the design strength [ ]^{a,c} the **AP1000** plant value?	Closed – issued as RAI-SSO-015.
38	Page A-184 - Explain why the required thickness [ ]^{a,c} the **AP1000** plant? And also provide APP-GW-GLR-602 Section 4 which is referenced in the report.	Closed – issued as RAI-SSO-015.
39	Page A-186 -all the reinforcement ratios greater than 1 - need to correct these - should be less than 1.	Closed – to be confirmed by NRC: Clarification is provided in the revised OR Appendix A (DCD Mark-up) Revisions provided in Attachment C to this letter.
40	Page - A-196 - Explain why the figure was changed.	Closed during the audit.
41	Page A-199 - Provide a better figure and explain why things were deleted.	Closed – issued as RAI-SSO-016.
42	Table 6-1 of Option Report - [ ]^{a,c}	Closed during the audit.
43	In IRWST made the [ ]^{a,c}. Provide justification that the Safety Relief Valve (SRV) loads are still valid. (Basis)	Closed – issued as RAI-SSO-010.
44	Voluntary submit RAI-002 to include discussion of the CV and how not only buckling but stress analysis was done - include in the markups for reports. (Tied to item 11)	Open – to be addressed by Westinghouse: Clarification will be provided at a later date via a voluntary submittal of a clarification to previously addressed RAI-SSO-002.
45	Anywhere where SRP is mentioned provide the version you are using.	Open – to be addressed by Westinghouse: Clarification will be provided at a later date via a voluntary submittal of a clarification to previously addressed RAI-SSO-003.
46	RAI-003 - justification of the SRP changes - [ ]^{a,c} is not the latest - should update the reference to include the latest version.	Open – to be addressed by Westinghouse: Clarification will be provided at a later date via a voluntary submittal of a clarification to previously addressed RAI-SSO-003.

AI Number	Action Item	Status
47	Provide the [ ] that are used.	Open – to be addressed by Westinghouse: Clarification will be provided at a later date via a voluntary submittal of a clarification to previously addressed RAI-SSO-003.
48	Address [ ]^{a,c} - Address qualitatively in the Option Report.	Closed – issued as RAI-SSO-013.
49	Page A-94 - the sentence that was removed - we need to put back. [ ]^{a,c}. Review Chapter 2 markups for consistency.	Closed – to be confirmed by NRC: Clarification is provided in the revised OR Appendix A (DCD Mark-up) Revisions provided in Attachment C to this letter.
50	Minor deviations due to [ ]^{a,c} so propose markups to OR 3.2 and DCD Section 2.5 - there are expected markups to include these minor changes.	Closed – to be confirmed by NRC: This is addressed by the markups provided in response to Action Items 3 and 49.
51	Inconsistency in factors. [ ]^{a,c}. Factor changed vs remaining the same.	Closed during the audit.
52	NRC Staff would like to get from WEC verification on provided reinforcement, [ ]^{a,c}, and that it meets the required reinforcement but also need to confirm that we are [ ]^{a,c}.	Closed – to be confirmed by NRC: The mark-ups in OR Appendix A [ ]^{a,c} Clarification is provided in the OR text revisions provided in Attachment B to this letter.
53	WEC Please clarify why [ ]^{a,c} are screened out.	Closed – to be confirmed by NRC: There are no changes to the Option Report. Based on the comment WEC will revise the supporting internal documentation to better explain why the LARs were screened out such that they are not included in the OR. The documentation can be made available for audit.
54	[ ]^{a,c} calculation only service level D. What about other levels (A, B, C)?	Closed – to be confirmed by NRC: Clarification is provided in the OR text revisions provided in Attachment B to this letter.

AI Number	Action Item	Status
55	Similar question for [ ]^{a,c} as item 54	Closed – to be confirmed by NRC: Clarification is provided in the OR text revisions provided in Attachment B to this letter.
56	[ ]^{a,c} Open items (OIs) in calc note.	Closed during the audit.
57	[ ]^{a,c} applied in service level D. What about other piping calculations?	Closed – to be confirmed by NRC: Clarification is provided in the OR text revisions provided in Attachment B to this letter.
58	[ ]^{a,c} similar to #56 on open items. But OI #5 is on hydro loads. Confusing. Can you clarify hydro loads for this Service level D calculation?	Closed during the audit.
59	Compliance with 10 CFR 50.55a? Will these be COL Application (COLA) requirements?	Closed – to be confirmed by NRC: Clarification is provided in the OR text revisions provided in Attachment B to this letter.
60	Perform a global search of entire Option Report for "electrical raceway" and change to "cable tray".	Closed – to be confirmed by NRC: Clarification is provided in the OR text revisions provided in Attachment B to this letter.
61	Provide the basis for the statements on Fuel in the Option Report.	Closed – issued as RAI-SSO-007.

Attachment B

Specialized Seismic Option Report (OR) Text Revisions[1,2]
(Westinghouse Non-Proprietary Class 3)

[1] Note: Revisions to the OR Table of Contents, List of Tables and List of Figures that result from the text revisions are not provided.

[2] Note: Some of the changes are from prior RAI responses.

OPTION ENHANCED SEISMIC SPECTRUM

The Specialized Seismic Option project selected an ESS to extend the certified **AP1000** plant design spectra to cover [ ]^{a,c}.

The ESS includes a peak ground acceleration (PGA) of [ ]^{a,c}, and exceeds the certified **AP1000** plant CSDRS over the frequency range from [ ]^{a,c}.

AI #1

A comparison of the ESS and the certified **AP1000** plant CSDRS for the horizontal and vertical components is shown in Figure 3. Figure 4 shows the certified **AP1000** plant CSDRS, the ESS, and an example spectrum from a western United States [ ]^{a,c}.

[ ]^{a,c}

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

The piping systems evaluated include the following key systems inside the containment vessel:

- [
-
-
-
-
-]^{a,c}

Heating, ventilation, and air conditioning (HVAC) ducting and ~~electrical raceway~~cable trays were also evaluated to ensure that structural changes needed to accommodate the ESS would be limited inside the CV, and not affect system performance and the safety analyses. AI #60

FUEL AND SPENT FUEL RACKS

The effect of the ESS on the certified **AP1000** plant fuel that would be used with the Option plant was evaluated, and the existing fuel design was shown to be acceptable due to the [
]^{a,c}

SEISMIC MARGIN ANALYSIS

The effect of the ESS on the certified **AP1000** plant DCD Revision 19 Chapter 19 seismic margin analysis (SMA) was evaluated by performing updated high-confidence, low probability of failure (HCLPF) evaluations of the SSCs included in the certified **AP1000** plant DCD Chapter 19. No additional design enhancements are required to meet the acceptance criteria of the SMA.

OPTION DESIGN ENHANCEMENTS

The Option builds on the certified **AP1000** plant design to demonstrate that the design can be extended to sites bounded by the ESS by incorporating minimal design enhancements. These enhancements include [

]^{a,c}.

The Option incorporates these enhancements while maintaining the same [

]^{a,c} as the certified **AP1000** plant design.

CONCLUSIONS

This Option Report can be referenced by a future COLA to provide the bases for departures from the certified **AP1000** plant DCD Revision 19 necessary to accommodate a site with seismic conditions bounded by the ESS; and the associated departures are defined as markups to the certified **AP1000** plant DCD Revision 19. The supporting technical analyses and evaluations provide the bases for the key design enhancements, as well as provide a roadmap for the detailed design phase to ensure any additional structural enhancements are identified and incorporated.

OPTION REPORT CONTENT (ROADMAP)

This Option Report provides a comprehensive summary of the reviews, evaluations, and analyses that were conducted by the Option team, as well as the results of those reviews, evaluations, and analyses. The Option Report includes the following sections:

Chapter Number	Title	Purpose
N/A	Executive Summary	Provides a summary of the Option and this report.
1	Introduction and Overview of the Specialized Seismic Option	Provides the overall objectives for the Option along with the key design requirements. Also defines the licensing approach for the Option. This section also contains the list of definitions and acronyms for the report.
2	Evaluation Approach	Describes the evaluation approaches used for: • Development of the ESS and ISRS • Evaluations of the SSCs • Evaluations of the safety analyses • Evaluations of the licensing items • Detailed design phase
3	Enhanced Seismic Spectra	Describes the generation of the ESS and ISRS. This section also includes a discussion of the certified **AP1000** plant CSDRS and hard rock high frequency (HRHF) spectra generation and changes to these for the Specialized Seismic Option.
4	Structure, System, and Component Evaluations	Contains evaluations of the SSCs, including the basis, the analysis, and the results for the following: • NI Structures • Primary System Components • Distributed Systems — Piping — HVAC and ~~Electrical Raceway~~Cable Trays • Fuel and Fuel Racks • Equipment Seismic Qualification.
5	Seismic Margin Analysis	Provides the approach and the results of the SMA.
6	Identification of Structural Design Enhancements	Lists enhancements required by the ESS loads.
7	Review of Safety Analyses	Assessment of the effect of the enhancements on the certified **AP1000** plant safety analyses.

AI #60

1.3 CONTENTS OF THE OPTION REPORT

This Option Report provides a comprehensive summary of the reviews, evaluations, and analyses that were conducted by the Option team, as well as the results of those reviews, evaluations, and analyses. The Option Report includes the following sections:

Chapter Number	Title	Purpose
N/A	Executive Summary	Provides a summary of the Option and this report.
1	Introduction and Overview of the Specialized Seismic Option	Provides the overall objectives for the Option along with the key design requirements. Also defines the licensing approach for the Option. This section also contains the list of definitions and acronyms for the report.
2	Evaluation Approach	Describes the evaluation approaches used for: • Development of the ESS and ISRS • Evaluations of the SSCs • Evaluations of the safety analyses • Evaluations of the licensing items • Detailed design phase
3	Enhanced Seismic Spectra	Describes the generation of the ESS and ISRS. This section also includes a discussion of the certified **AP1000** plant CSDRS and hard rock high frequency (HRHF) spectra generation and changes to these for the Specialized Seismic Option.
4	Structure, System, and Component Evaluations	Contains evaluations of the SSCs, including the basis, the analysis, and the results for the following: • NI Structures • Primary System Components • Distributed Systems — Piping — HVAC and ~~Electrical Raceway~~Cable Trays • Fuel and Fuel Racks • Equipment Seismic Qualification.
5	Seismic Margin Analysis	Provides the approach and the results of the SMA.
6	Identification of Structural Design Enhancements	Lists enhancements required by the ESS loads.
7	Review of Safety Analyses	Assessment of the effect of the enhancements on the certified **AP1000** plant safety analyses.

AI #60

2 EVALUATION APPROACH

The Westinghouse certified **AP1000** plant design described in DCD Revision 19 was certified on the basis that the design satisfied NRC regulatory requirements and possessed a seismic margin factor of 1.67 times the design basis CSDRS. Through the detailed design process, it has been recognized that there is significant margin in the certified **AP1000** plant design. By referencing an enhanced set of design spectra (or ESS), a future COL applicant is able to take credit for the inherent certified **AP1000** plant margin. The design enhancements required to accommodate the Specialized Seismic Option, and associated ESS, are limited and do not affect **AP1000** plant safety analyses. The Specialized Seismic Option design continues to provide the required seismic margin factor of 1.67 in the design of Seismic Category I SSCs.

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.

RAI-SSO-003, Rev. 1

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 [AI #2
]^{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 Appendix 3G.

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.) remain 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. AI #52

2.2.2 Systems and Components

The key safety-significant certified **AP1000** plant systems and components have been evaluated for ESS seismic demands. Limited changes have been identified for consideration during the detailed design phases. A review of these changes finds that they satisfy the required margin factor of 1.67×ESS and that they do not affect the certified **AP1000** plant safety analyses. A more detailed description of the mechanical design is provided in Section 4.2 of this report.

2.3 EFFECT ON SAFETY ANALYSIS AND PRA

The certified **AP1000** plant DCD Revision 19 changes, as well as the anticipated detailed design enhancements resulting from the Specialized Seismic Option, do not affect the design of the steel containment, or [ ]^{a,c}. Further, there are no changes that affect the certified **AP1000** plant [ ]^{a,c}. The Specialized Seismic Option maintains a seismic margin of 1.67×CSDRS (or ESS), and therefore does not affect the certified **AP1000** plant probabilistic risk assessment described in DCD Chapter 19. Changes to HCLPF values of risk-significant components for certified **AP1000** plant DCD Chapter 19 Table 19.55-1 are indicated in Appendix A of this report. The minimum HCLPF for the Specialized Seismic Option has a peak ground acceleration of [ ]^{a,c} A more detailed description of the DCD Chapter 19 changes is provided in Section 5 of this report.

3 ENHANCED SEISMIC SPECTRA

The certified **AP1000** plant DCD Revision 19 utilizes an SSE, referred to as the CSDRS. The peak ground acceleration (PGA) for both the horizontal and vertical CSDRS is 0.30g. More details are provided in Section 3.7.1 of the certified **AP1000** plant DCD Revision 19 (Reference 1).

3.1 DEVELOPMENT OF THE ENHANCED SEISMIC SPECTRA (ESS)

The Specialized Seismic Option plant ESS extend the certified **AP1000** plant design spectra to cover [ ]^{a,c}.

For the ESS, the seismic response has been increased from a PGA of 0.3g to [ ]^{a,c}, and horizontal spectral accelerations are amplified above the certified **AP1000** plant CSDRS accelerations [ ]^{a,c} AI #1

The ESS are shown in Figure 3-1 and Figure 3-2 for the horizontal and vertical components. The horizontal and vertical enhanced seismic spectrum values are presented in Tables 3-1 and 3-2, respectively. Figure 3-3 and Figure 3-4 show how the certified **AP1000** plant CSDRS applicability is being extended by the ESS.

3.2 DESCRIPTION OF DCD CSDRS AND HRHF SPECTRA

The certified **AP1000** plant certification includes two ground motion spectra that the combined license COL applicant can compare with their site GMRS: the CSDRS, and the HRHF described in Section 3.7 and Appendices 3G and 3I of certified **AP1000** plant DCD Revision 19. The spectra defined as the HRHF spectra are shown in Appendix 3I. A methodology to address these high frequency site spectra was developed and approved by the U.S. NRC in NRC DC/COL ISG-01 (2008). This methodology did not require an evaluation of the total plant; it required evaluation of a selected sample of structures and equipment. A seismic evaluation of these structures and components was performed to demonstrate that the HF seismic event is non-damaging and that the CSDRS controls the design.

The ESS are based upon the Regulatory Guide 1.60 Revision 1 spectra (Reference 5) and an increase in the horizontal response spectra from [AI #1 AI #3

]^{a,c}

RAI-SSO-001, Rev. 1

as described in Figure 3-4. Therefore, the [ ]^{a,c} of the Option is higher than **AP1000** plant DCD Revision 19.

These seismic responses are used to evaluate piping, supports, components, HVAC, and electrical equipment.

3.5 UNDERSTANDING THE ESS IMPACT ON THE AP1000 PLANT DESIGN

[

]^{a,c}

[

AI #4

AI #4

AI #4

]^{a,c}

RAI-SSO-002, Rev. 1

One of the key objectives of this Option Report is to demonstrate that the higher ESS generated demands can be accommodated in the Option plant [

]^{a,c}

[

]a,c

[

]a,c

4.1.1.1 Stability

The models and analysis methods used to evaluate nuclear island stability are described in the certified **AP1000** plant DCD Revision 19 Section 3.8.5.5. [

]a,c

[

]a,c

[

AI #27

]a,c

4.1.1.2 Bearing Reactions

The models and analysis methods used to determine bearing reactions are described in certified **AP1000** plant DCD Revision 19 Section 3.8.5. [

]a,c

The reactions of the certified **AP1000** plant and the Option for the vertical and overturning moment seismic loads used to develop bearing reactions are compared using the NI10 model and modal superposition time history analyses. These linear analysis results given in Table 4-1 show that the [ ]a,c

Similar conclusions are obtained when the bearing reactions from the 2D nonlinear analyses are compared. [

]a,c

[

]^{a,c}

~~Consequently, for the Option, there are [~~ ~~]^{a,e} to the design of nuclear island basemat and the AP1000 basemat calculations can [~~ ~~]^{a,e}~~ AI #6

4.1.1.3 Nonlinear Behavior Effect on In-Structure Response Spectra

The effects of basemat uplift were evaluated using an [

]^{a,c} The comparisons, given in Figure 4-1, showed that the [

]^{a,c}

4.1.2 Auxiliary Building

The design of the certified **AP1000** plant auxiliary building is described in the certified **AP1000** plant DCD Revision 19 Section 3.8.4. The auxiliary building is a concrete shear-wall structure consisting of vertical shear/bearing walls and horizontal floor slabs. It wraps around approximately 50 percent of the circumference of the shield building. Walls are spaced 18 to 25 feet apart. The floor slabs and the structural walls of the auxiliary building are structurally connected to the cylindrical section of the shield building. The walls carry the vertical loads from the structure to the basemat. Lateral loads are transferred to the walls by the roof and floor slabs. The walls then transmit the loads to the basemat. The walls also provide stiffness to the basemat and distribute the foundation loads between them. This configuration of the structures above the basemat, in combination with the basemat, provides an efficient overall structure.

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.

The results for the certified **AP1000** plant critical sections for the auxiliary building are provided in summary in Table 4-3 and in more detail Appendix A.6.3 of this report. For the Option, [

]^{a,c}.

[
]^{a,c} The critical sections are designed in accordance with the ACI 349-01 and AISC-N690.
[ ]^{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 Tables 3.8.4-1 and 3.8.4-2. The certified **AP1000** plant DCD Revision 19 tables and figures also show the reinforcement provided for each critical section.

The results for the certified **AP1000 plant** critical sections for the CIS are provided in summary in Table 4-6. For the Option, [

]^{a,c}

4.1.6 Containment Vessel and Polar Crane

[
]^{a,c} The temperature profile is shown in Figure 4-3 using the 3-D model of the containment vessel. The seismic analysis performed for the ESS was a time history analysis using the NI10 model. The containment vessel seismic accelerations are obtained from this analysis.

Using the same load combinations as used in the certified **AP1000** plant design, buckling analysis using the 3-D shell model was performed. [

AI #7

]^{a,c} It was found that for both the local and global buckling analyses the stresses were within acceptable limits.

The results for the Option polar crane evaluation are provided in Summary in Table 4-7 and are
[
]^{a,c}

4.1.7 Adjacent Structures

Structures adjacent to the nuclear island, such as the turbine building, and annex building, are structurally separated from the NI structures by a 2-inch gap at and below the grade. A 4-inch minimum gap is provided above grade elevation.

The results for the maximum displacements between the roof of NI structures and the turbine/annex structures are provided in summary in Table 4-8 of this report. As a result, [
]^{a,c}

4.2 PRIMARY SYSTEM COMPONENT EVALUATIONS

This section describes the approach and results of component structural evaluations which were performed to identify applicable changes to the certified **AP1000** plant DCD Revision 19 and to demonstrate confidence that the required enhancements are minor, feasible, and do not affect certified **AP1000** plant DCD Revision 19 [ ]^{a,c}, component performance or component support configuration. The evaluations conclude that enhancements were [

]^{a,c}. Changes at this level are below the level of the DCD; as a result, no changes [ ]^{a,c}. Component and component support figures are shown in Sections 3.8 and 5.4 of the certified **AP1000** plant DCD Revision 19 for illustrative purposes to show the support and sub-component configurations. [

]^{a,c}

4.2.1 Component Evaluation Approach

Certified **AP1000** plant DCD Revision 19 Tier 2 Chapter 3.9 describes the structural design and analysis methods and acceptance criteria for mechanical systems and components, including primary system components. These include design conditions, transients, and acceptance criteria, analytical methods, ASME Code requirements, and testing requirements. Certified **AP1000** plant DCD Revision 19 Tier 2 Chapter 3.8 describes the primary component supports and includes support figures for the purpose of showing the support configurations.

For the Specialized Seismic Option, the seismic loads are based on the ESS rather than the CSDRS seismic loads described in the certified **AP1000** plant DCD Revision 19. The effect of this change is determined through evaluation of the following primary components:

[ ]^{a,c}

[

]^{a,c}

[

]^{a,c} AI #22

[

AI #22

]a,c

[

]a,c

[a,c]

The purpose of these evaluations was to identify applicable changes to the certified **AP1000** plant DCD Revision 19 and to demonstrate confidence that the required enhancements are [

]a,c

[

AI #21

AI #21, 54, 55, 59

]a,c

AI #21, 54, 55, 59

[

]a,c

[

]a,c

4.2.2 [ ]a,c

[

]a,c

4.2.3 [ ]a,c

[

]a,c

4.3 PIPING, HVAC, AND ~~ELECTRICAL RACEWAY~~CABLE TRAY EVALUATIONS

AI #60

Piping, HVAC, and ~~electrical raceway~~cable trays structural design criteria are included in the certified **AP1000** plant DCD Revision 19, but their design details are below the level of the certified **AP1000** plant DCD Revision 19 and are confirmed via ITAAC. Therefore, the Option project focuses on performing structural evaluations of piping, HVAC, and ~~electrical raceway~~cable trays that would confirm that the required design enhancements for distributive systems inside containment would not affect:

- [ ]^{a,c}
- Functionality or performance of the distributive system
- Global layout

4.3.1 Piping

This section describes the approach and results of [ ]^{a,c} piping structural evaluations which were performed to identify applicable changes to the certified **AP1000** plant DCD Revision 19 and to demonstrate confidence that the required enhancements are minor, feasible, and do not affect the certified **AP1000** plant DCD Revision 19 [ ]^{a,c} or system performance.

[

]^{a,c}

The [ ]^{a,c} evaluated piping systems are:

- [
-
-
-
-]^{a,c}

[

]^{a,c}

These piping systems are shown in Figures 4-15 to 4-21.

To obtain seismic loads, response spectra analyses and/or time history analyses were initially performed on the original **AP1000** plant configuration and then rerun with the enhancements described in the section to confirm acceptability. The load combinations are the same as those used for the certified **AP1000** plant design. The plant conditions remain unchanged except for the higher seismic ESS loads.

The piping evaluation results presented in this section show that the ESS may be incorporated by
[

]^{a,c}

4.3.1.1 [ ]^{a,c}

[

AI #57

]^{a,c}

[

]^{a,c}

4.3.1.2 [ ]^{a,c}

[

]^{a,c}

[

]a,c

4.3.1.4 [ ]a,c

[

]a,c

[

]a,c

4.3.2 [ ]a,c

[

]a,c

4.3.3 HVAC and ~~Electrical Raceway~~Cable Trays

AI #60

An assessment of HVAC and ~~electrical raceway~~cable trays was performed in order to ensure that the [ ]a,c

[AI #60
AI #21
AI #60

AI #60

AI #60

]a,c

4.4 NUCLEAR FUEL AND SPENT FUEL RACKS

4.4.1 Nuclear Fuel (Operational Configuration)

[

]a,c

4.4.2 Spent Fuel Racks

RAI-SSO-006, Rev. 0

~~Each rack in the spent fuel pool consists of an array of cells interconnected to each other at several elevations and to a thick baseplate at the bottom elevation. These rack modules are free standing, neither anchored to the pool floor nor braced to the pool wall. A representative spent fuel rack layout is shown in Figures 4-22 and 4-23.~~

~~[~~

~~]a,c~~

Table 4-12. [ ]^{a,c}

^{a,c}

AI #22

Table 4-13. [ ]^{a,c}

AI #22

^{a,c}

AI #22

Table 4-14. [ ]^{a,c}

^{a,c}

Table 4-15. [ ]^{a,c}

^{a,c}

AI #22

Table 4-16. [ ]^{a,c}

a,c

Table 4-17. [ ]^{a,c}

a,c

AI #22

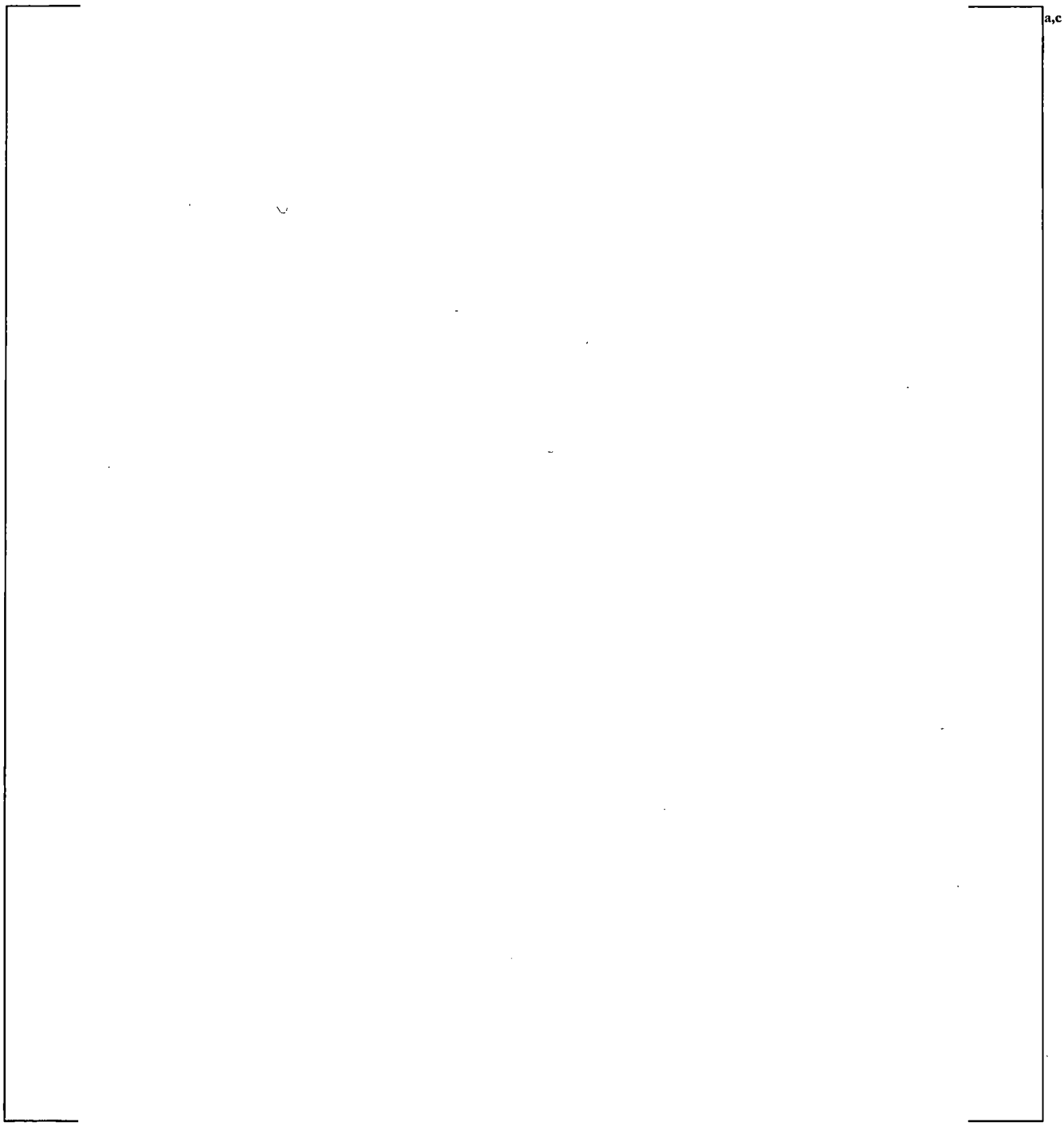

a,c

Figure 4-25. ~~Electrical Raceway~~Cable Trays

AI #60

6 IDENTIFICATION OF STRUCTURAL DESIGN ENHANCEMENTS

As discussed in Section 1, the Option Report provides the confidence that the certified **AP1000** plant design can be enhanced to accommodate the ESS. The evaluations described within this report provide confidence that the required level of enhancements necessary to withstand the demands associated with the ESS are limited to structural enhancements that are [ ]^{a,c} and do not affect layout as reflected in general arrangement drawings or system functionality and performance. As such, the certified **AP1000** plant's [ ]^{a,c} are not affected, as described in Section 7 of this report, and the effects to the certified AP1000 plant design are limited to structural portions of the certified **AP1000** plant DCD Revision 19. A detailed design phase would be implemented by a COL that would address the COL information items provided in this report and the certified **AP1000** plant DCD Revision 19.

The limited design enhancements made to provide this confidence are provided in Table 6-1 through 6-3. The design enhancements fall into one of the following categories: building structures, primary system components, and distributed systems (piping, HVAC, and ~~electrical raceway~~cable trays). A summary of the enhancements for each of these categories is included in the remainder of this section. The evaluation bases supporting the chosen enhancements are discussed in Section 4, and Section 9 describes the effects on the certified **AP1000** plant DCD Revision 19. AI #60

6.1 NUCLEAR ISLAND BUILDING AND ADJACENT STRUCTURES

[

]^{a,c}

6.2 PRIMARY SYSTEM COMPONENTS

The primary system components design enhancements are shown in Table 6-2. [

]^{a,c}

6.3 DISTRIBUTED SYSTEMS (PIPING, HVAC, AND ~~ELECTRICAL RACEWAY~~CABLE TRAYS)

AI #60

The enhancements anticipated during detailed design of the distributed systems are shown in Table 6-3.
[

]^{a,c}

6.4 SAFETY-RELATED MECHANICAL AND ELECTRICAL EQUIPMENT SEISMIC QUALIFICATIONS

The same certified **AP1000** plant safety-related mechanical and electrical equipment would be seismically qualified with the applicable seismic demands associated with the ESS. [

]^{a,c}

[

]^{a,c}

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

AI #7

Table 6-2. Design Enhancements for Primary System Components

a,c

		Option Report Evaluation Section
		4.2.7
		4.2.8
		4.2.9

Table 6-3. Design Enhancements for Piping, HVAC, and ~~Electrical Raceway~~Cable Trays AI #60

a,c

		Option Report Evaluation Section
		4.3.1.1
		4.3.1.3
		4.3.1.4
		4.3.3

Table 8-2. COL Information Item Changes (cont.)

COL Information Item No.	Subject	DCD Revision 19 Subsection	Changes	Location of Markups
3.9-2	Design Specification and Reports	3.9.8.2	[ ]a,c	Appendix A.4 Appendix 6.4
5.3-5	Reactor Vessel Insulation	5.3.6.5	[ ]a,c	Appendix A.4 Appendix A.7

AI #54

The conclusions are demonstrated by evaluations or assessments of the following:

- Seismic Category I structures on the NI
- Non-Seismic Category I structures that are adjacent to the NI
- Primary system components
- Key piping systems inside the containment vessel
- HVAC ducting and ~~electrical raceway~~cable trays AI #60
- Fuel
- Spent fuel racks
- SMA

The Option reviewed the certified **AP1000** plant DCD Revision 19 and identified all areas affected, as well as those areas not affected. Additionally, assessments were performed of the following items that would be involved or considered in a future COLA:

- All existing License Amendment Requests (LARs)
- Operating experience from new plant designs
- All material referenced documents (certified **AP1000** plant DCD Revision 19 Table 1.6-1)

The same evaluation, analysis and design enhancement processes as used for the creation of this Specialized Seismic Option Report would be employed for the detailed design phase by the COL applicant. The detailed design phase would be identical to that of the certified **AP1000** plant. The detailed design phase would evaluate the remaining SSCs required to show the certified **AP1000** plant incorporating the Specialized Seismic Option meets all the applicable acceptance criteria.

This report includes sufficient information for a technical reviewer to conclude that:

- [

-]^{a,c}

- Design enhancements (structural enhancements) as described in this Option Report do not affect the certified **AP1000** plant's safety analyses, system functionality, and general arrangement drawings.

- The SMA (required by certified **AP1000** plant DCD Revision 19 Chapter 19) confirmed that there was sufficient margin for the systems and components.

- The affected sections of the certified **AP1000** plant DCD Revision 19 are identified in the Option Report.

- A COL applicant can have confidence in referencing this Option Report and proceeding into the detailed design phase.

Details of the required design enhancements to meet the design acceptance criteria in the certified **AP1000** plant DCD Chapter 3 are provided in the report, and they include the following:

- [

AI #60

]^{a,c}

No additional design enhancements are required to meet the acceptance criteria of the SMA (for certified **AP1000** plant DCD Chapter 19).

It is therefore concluded that changes to the certified **AP1000** plant design to meet the Specialized Seismic Option enhanced seismic demand are limited, can be met without affecting safety analyses or plant layout, and the Specialized Seismic Option can be used to extend the range of applicability of the certified **AP1000** plant DCD Revision 19 design. The COL can follow the standard design protocols using the Specialized Seismic Option and the overall design.

This Option Report does not affect the finality of the existing certified **AP1000** plant design, nor does it affect any existing applicants or licensees currently referencing the certified **AP1000** plant DCD Revision 19.

The Specialized Seismic Option for the certified **AP1000** plant design continues to protect the health and safety of the public.

Attachment C

Specialized Seismic Option Report Appendix A (DCD Mark-up) Revisions[1]
(Westinghouse Non-Proprietary Class 3)

[1] Note: Action item modifications are highlighted in gray.

A.3 TIER 1 CHAPTER 35 DCD REVISION 19 MARKUPS FOR OPTION

AI #33

CN T1-5.0-1

Revise Tier 1 Section 5 text as follows:

5 SITE PARAMETERS

Table 5.0-1 identifies the key site parameters that are specified for the design of safety-related aspects of structures, systems, and components for the AP1000. An actual site is acceptable if its site characteristics fall within the AP1000 plant site design parameters in Table 5.0-1.

[

]^{a,c}

CN T1-5.0-2

Revise Tier 1 Table 5.0-1 as follows:

Table 5.0-1
Site Parameters

Maximum Ground Water Level	Plant elevation 98 ft
Maximum Flood Level	Plant elevation 100 ft (design grade elevation)
Precipitation Rain Snow/Ice	 20.7 in/hr [ ]^{a,c} Ground snow load of 75 lb/ft^2 with exposure factor of 1.0 and importance factor of 1.2
Air Temperature	Limits based on historical data excluding peaks of less than 2 hours duration Maximum temperature of 115° dry bulb/86.1°F coincident wet bulb Maximum wet bulb 86.1°F (noncoincident) Minimum temperature of [ ]^{a,c}
Tornado Wind Speed Maximum Pressure Differential	 Maximum wind speed of 300 mph Maximum pressure differential of 2.0 lb/in^2
Tornado Missile Spectra	4000-lb automobile at 105 mph horizontal, 74 mph vertical 275-lb, 8-in. shell at 105 mph horizontal, 74 mph vertical 1-in.-diameter steel ball at 105 mph in the most damaging direction
Soil Average Allowable Static [ ]^{a,c} Bearing Capacity [ ]^{a,c} Dynamic Bearing Capacity for Normal Plus Safe Shutdown Earthquake (SSE) Shear Wave Velocity Liquefaction Potential	 The allowable bearing capacity, including a factor of safety appropriate for the design load combination, shall be greater than or equal to the average bearing demand of 8,900 lb/ft^2 over the footprint of the nuclear island at its excavation depth. [ ]^{a,c} The allowable bearing capacity, including a factor of safety appropriate for the design load combination, shall be greater than or equal to the maximum bearing demand of 35,000 lb/ft^2 at the edge of the nuclear island at its excavation depth, or site-specific analyses demonstrate factor of safety appropriate for normal plus safe shutdown earthquake loads. Greater than or equal to 8000 ft/sec based on low-strain, best estimate soil properties over the footprint of the nuclear island at its excavation depth. None

AI #49

AI #49

A.5 TIER 2 CHAPTER 2 DCD REVISION 19 MARKUPS FOR OPTION

CN T2-2.5-1

Revise Tier 2 Section 2.5, subsections 2.5 through 2.5.4.1 text as follows:

2.5 GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL ENGINEERING

Combined License applicants referencing the AP1000 plant certified design and the Specialized Seismic Option (Reference 4) will address site specific information related to basic geological, seismological, and geotechnical engineering of the site and the region, as discussed in the following subsections.

2.5.1 Basic Geological and Seismic Combined License Information

Combined License applicants referencing the AP1000 plant certified design and the Specialized Seismic Option will address the following regional and site-specific geological, seismological, and geophysical information as well as conditions caused by human activities:

- Structural geology of the site
- Seismicity of the site
- Geological history
- Evidence of paleoseismicity
- Site stratigraphy and lithology
- Engineering significance of geological features
- Site groundwater conditions
- Dynamic behavior during prior earthquakes
- Zones of alteration, irregular weathering, or structural weakness
- Unrelieved residual stresses in bedrock
- Materials that could be unstable because of mineralogy or unstable physical properties
- Effect of human activities in the area

2.5.2 Vibratory Ground Motion

The AP1000 plant with the Specialized Seismic Option is designed for an earthquake defined by a peak ground acceleration (PGA) of [ ]^{a,c} and the design response spectra specified in subsection 3.7.1.1, and Figures 3.7.1-1 and 3.7.1-2. The AP1000 plant design earthquake with the Specialized Seismic Option is referred to as the AP1000 plant ~~Certified Seismic Design Response Spectra (CSDRS)~~ Enhanced Seismic Spectrum (ESS). [

AI #3

]^{a,c}

[

]a,c

2.5.2.1 Combined License Seismic and Tectonic Characteristics Information

Combined License applicants referencing the AP1000 certified design with the Specialized Seismic Option will address the following site-specific information related to the vibratory ground motion aspects of the site and region:

- Seismicity
- Geologic and tectonic characteristics of site and region
- Correlation of earthquake activity with seismic sources
- Probabilistic seismic hazard analysis and controlling earthquakes
- Seismic wave transmission characteristics of the site
- SSE ground motion

The site-specific ground motion response spectra (GMRS) for comparison against the ~~CSDRS~~ ESS are determined in the free-field on the ground surface. [AI #49

]a,c

The Combined License applicant must demonstrate that the proposed site meets the following requirements:

1. [

]a,c

2. The site-specific ground motion response spectra (GMRS) at the finished grade level in the free-field are less than or equal to the AP1000 plant certified seismic design spectra ~~(CSDRS)~~ ESS given in Figures 3.7.1-1 and 3.7.1-2.

3. In lieu of (1) and (2) above, for a site where the nuclear island is founded on hard rock with shear wave velocity greater than 8,000 feet per second, the site-specific ground motion response spectra (GMRS) may be defined at the foundation level and shown to be less than or equal to the ~~CSDRS~~ ESS given in Figures 3.7.1-1 and 3.7.1-2.

4. [

]a,c

- [

AI #49

]a,c

- The 2D analyses are performed for parameter studies.

  Results will be compared to the corresponding 2D or 3D generic analyses.

2.5.2.3.1 2D Analyses

[

]a,c

2.5.2.3.2 3D Analyses

If required, a 3D evaluation will consist of a site-specific dynamic analysis and generation of in-structure response spectra at six key locations to be compared with the floor response spectra of the certified design at 5-percent damping. [

]a,c. The site is acceptable if the floor response spectra from the site-specific evaluation do not exceed the ~~AP1000 spectra~~ESS for each of the locations identified below or the exceedances are justified:

Containment internal structures at elevation of reactor vessel support	Figure 3G.4-5X to 3G.4-5Z
Containment operating floor	Figure 3G.4-6X to 3G.4-6Z
Auxiliary building NE corner at elevation 116'-6"	Figure 3G.4-7X to 3G.4-7Z
Shield building at fuel building roof	Figure 3G.4-8X to 3G.4-8Z
Shield building roof	Figure 3G.4-9X to 3G.4-9Z
Steel containment vessel at polar crane support	Figure 3G.4-10X to 3G.4-10Z

[

AI #49

]^{a,c}

2.5.3 Surface Faulting Combined License Information

Combined License applicants referencing the AP1000 certified design will address the following surface and subsurface geological, seismological, and geophysical information related to the potential for surface or near-surface faulting affecting the site:

- Geological, seismological, and geophysical investigations
- Geological evidence, or absence of evidence, for surface deformation
- Correlation of earthquakes with capable tectonic sources
- Ages of most recent deformation
- Relationship of tectonic structures in the site area to regional tectonic structures
- Characterization of capable tectonic sources
- Designation of zones of quaternary deformation in the site region
- Potential for surface tectonic deformation at the site

The AP1000 design has not been evaluated for a site where there is a fault displacement potential. A COL applicant will satisfy the requirement for no surface or near surface tectonic structure capable of displacements beneath the nuclear island and adjacent seismic Category II structures by completing geological, seismological, and geophysical investigations that are consistent with the guidance of Regulatory Guide 1.206.

2.5.4 Stability and Uniformity of Subsurface Materials and Foundations

Combined License applicants referencing the AP1000 certified design will address the following site-specific information related to the stability and uniformity of subsurface materials and foundations.

- Excavation
- Bearing capacity
- Settlement
- Liquefaction

[

]a,c

2.5.4.1 Excavation

Excavation for the nuclear island structures below grade may use either a sloping excavation or a vertical face as described in subsequent paragraphs. If sloping excavations are to be used on a soil site, the Combined License applicants must evaluate the 3D effects on the site response and [

]a,c. If backfill is to be placed adjacent to the exterior walls of the nuclear island, the Combined License applicant will provide information on the properties of backfill and its compaction requirements as described in subsection 2.5.4.6.3 and will evaluate its properties against those used in the seismic analyses described in subsection 3.7.2.

AI #49

For the vertical face alternative, excavation in soil for the nuclear island structures below grade will establish a vertical face with lateral support of the adjoining undisturbed soil or rock. This vertical face will be covered by a waterproof membrane as described in subsection 3.4.1.1.1.1 and is used as the outside form for the exterior walls below grade of the nuclear island. Alternative methods include a soil nailing and mechanically stabilized earth (MSE) walls.

CN T2-2.5-2

Revise Tier 2 Section 2.5, subsections 2.5.4.2 through 2.5.4.5.3.1 text as follows:

2.5.4.2 Bearing Capacity

[

]a,c

[

]a,c

CN T2-2.5-3

Revise Tier 2 Section 2.5, subsection 2.5.4.6.2 text as follows:

2.5.4.6.2 The Combined License applicant will establish the properties of the foundation[ ]a,c to be within the range considered for design of the nuclear island basemat.

Properties of Underlying Materials – A determination of the static and dynamic engineering properties of foundation [ ]a,c in the site area will be addressed. This information will include a discussion of the type, quantity, extent, and purpose of field explorations, as well as logs of borings and test pits. Results of field plate load tests, field permeability tests, and other special field tests (e.g., bore-hole extensometer or pressuremeter tests) will also be provided. Results of geophysical surveys will be presented in tables and profiles. Data will be provided pertaining to site-specific[ ]a,c layers (including their thicknesses, densities, moduli, and Poisson's ratios) between the basemat and the underlying rock stratum. Plot plans and profiles of site explorations will be provided.[

AI #49

]a,c

Laboratory Investigations of Underlying Materials – Information about the number and type of laboratory tests and the location of samples used to investigate underlying materials will be provided. Discussion of the results of laboratory tests on disturbed and undisturbed [ ]a,c samples obtained from field investigations will be provided.

CN T2-2.5-4

Revise Tier 2 Section 2.5, subsection 2.5.4.6.4 through 2.5.4.6.6 text as follows:

2.5.4.6.4 Ground Water Conditions – Groundwater conditions will be described relative to the foundation stability of the safety-related structures at the site. The [ ]a,c properties of the various layers under possible groundwater conditions during the life of the plant will be compared to the range of values assumed in the standard design in Table 2-1.

[

AI #5

]^{a,c}

CN-T2-3.8-21

Revise Tier 2 Section 3.8, subsection 3.8.5.6 paragraph 2 text as follows:

There are no special construction techniques used in the construction of the nuclear island structures foundation. [
]^{a,c}

AI #49

CN T2-3.8-22

Revise Tier 2 Section 3.8, subsection 3.8.6.1 paragraphs 1 and 2 text as follows:

3.8.6.1 Containment Vessel Design Adjacent to Large Penetrations

~~The Combined License information requested in this subsection has been completely addressed in APP-GW-GLR-005 (Reference 53), and the applicable changes are incorporated into the DCD. No additional work is required by the Combined License applicant to address the Combined License information requested in this subsection.~~

~~The following words represent the original Combined License Information Item commitment, which has been addressed as discussed above:~~

CN T2-3.8-23

Revise Tier 2 Section 3.8, subsection 3.8.7 Reference 57 text as follows:

57. [APP-GW-GLR-602, Revision ~~1~~ 5 (Proprietary) and APP-GW-GLR-603, Revision ~~1~~ 5 (Non-Proprietary), "AP1000 Shield Building Design Details for Select Wall and RC/SC Connections," Westinghouse Electric Company LLC.]*

CN T2-3.8-25

Revise Tier 2 Section 3.8, Table 3.8.3-3 with the following:

Table 3.8.3-3

Definition of CRITICAL Locations and Thicknesses for Containment Internal Structures(1)

Wall Description (see detail in subsection 3.8.3.5.8.1)	Applicable Column Lines	Applicable Elevation Range	[*Concrete Thickness(2)*]*	Required Thickness of Surface Plates (inches)(3) (Maximum)	[*Thickness of Surface Plates Provided (inches)*]*
Containment Structures					
Module Wall 1	West wall of refueling cavity	Wall separating IRWST and refueling cavity from elevation 103′ to 135′-3″	[*4′-0″concrete-filled structural wall module with 0.5-in.-thick steel plate on inside and outside of wall*]*	[ ]a,c	[*0.5 -.0.01 +0.1*]*
Module Wall 2	South wall of west steam generator cavity	Wall separating IRWST and west steam generator cavity from elevation 103′ to 135′-3″	[*2′-6″concrete-filled structural wall module with 0.5-in.-thick steel plate on inside and outside of wall*]*	[ ]a,c	[*0.5 -.0.01 +0.1*]*
CA02 Module Wall	North east boundary wall of IRWST	Wall separating IRWST and maintenance floor from elevation 103′ to 135′-3″	[*2′-6″concrete-filled structural wall module with 0.5-in.-thick steel plate on inside and outside of wall*]*	[ ]a,c	[*0.5 -.0.01 +0.1*]*

AI #15

Notes:

1. The applicable column lines and elevation levels are identified and included in Figures 1.2-9, 3.7.2-12 (sheets 1 through 12), 3.7.2-19 (sheets 1 through 3) and on Table 1.2-1.

[2. *The concrete thickness includes the steel face plates. Thickness greater than 3′-0″ have a construction tolerance of +1″, -3/4″. Thickness less than or equal to 3′-0″ have a construction tolerance of +1/2″, -3/8″.*]*

3. These plate thicknesses represent the thickness required for operating and design basis loads except for designed openings or penetrations. These values apply for each face of the applicable wall unless specifically indicated on the table. For load combinations with thermal loads, the evaluation is performed as described in DCD subsection 3.8.3.5.3.4.

4. The required steel area of Module Wall 2 is less than the provided steel area for the load combinations not including thermal. For the load combinations that include thermal, the ASME Code philosophy is adopted. The Module Wall 2 ratio of max stress intensity range / twice the yield strength is 0.51.

AI #15

a,c

AI #15

AI #15

Table 3.8.3-7 (Sheet 1 of 2)
DESIGN SUMMARY OF STEEL WALL OF IRWST

Mechanical Loads Only
AISC Interaction Ratio

a,c

Table 3.8.3-7 (Sheet 2 of 2)

DESIGN SUMMARY OF STEEL WALL OF IRWST

AI #15

a,c

Note:

1. Results of the evaluation of mechanical and thermal loads are shown against the AISC allowables when the stresses are less than yield. Portions of the steel wall at the end of the wall exceed yield due to the restraint provided by the adjacent concrete. These areas are evaluated against the ASME allowables as described in subsection 3.8.3.5.3.4.
2. "Esads↑" represents positive seismic load combined with Automatic Depressurization System hydrodynamic load by absolute sum
3. "E'sads↑" represents positive seismic load (all member forces except axial forces are reversed to negative) combined with Automatic Depressurization System hydrodynamic load by absolute sum AI #15
4. "Esads↓" represents negative seismic load combined with Automatic Depressurization System hydrodynamic load by absolute sum
5. "E'sads↓" represents negative seismic load (the axial forces are reversed to positive) combined with Automatic Depressurization System hydrodynamic load by absolute sum
6. "Espl↑" represents negative seismic load combined with accident pressure load by Square Root of the Sum of the Squares (SRSS)

a,c

AI #35

AI #35

AI #35

AI #35

Table 3H.5-9 (Sheet 1 of ~~34~~)

AI #24

SHIELD BUILDING ROOF REINFORCEMENT SUMMARY (TENSION RING)

Tension Ring – Axial Force and Bending Verification

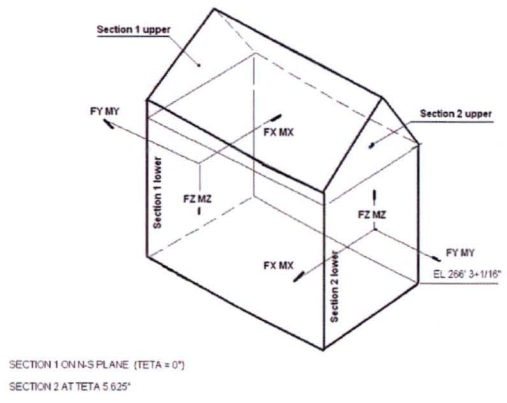
Location		Seismic Maximum Stresses		Maximum Stresses ksi	F_y ksi	Maximum Steel Area Required[2][3] (in^2/ft)	[*Steel Area Provided*]*	[*Design Limit[1] for Ratio Max Required/ Provided*]*
Section	**Angles**	**Seismic L/C**	**f_a ksi**					
2 lower	5.625°	9	14.31	14.31	50	7.74	[*Liner 1 1/2"= 18 (in^2/ft) (Min)*]*	[*0.43 + 2%*]*
	84.375°	17	12.52					
1 lower	0°	9	12.97					
	90°	17	11.39					

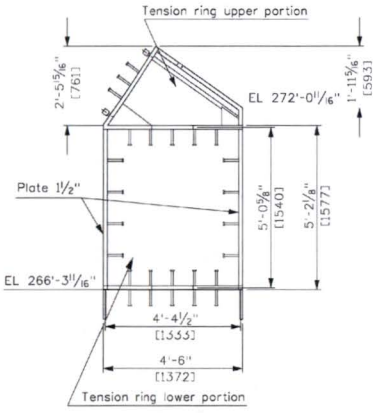
AI #36

Tension Ring – Shear Force and Torsion Verification

Location		Seismic Maximum Stresses		Maximum Stresses ksi	F_y ksi	Maximum Steel Area Required[2][3] (in^2/ft)	[*Steel Area Provided*]*	[*Design Limit for Ratio Max Required/ Provided*]*
Section	**Angles**	**Seismic L/C**	**f_v ksi**					
2 lower	5.625°	17	4.83	5.52	50	5.04	[*Liner 1 1/2"= 18 (in^2/ft) (Min.)*]*	[*0.28 + 2%*]*
	84.375°	9	5.52					
1 lower	0°	18	3.20					
	90°	11	4.00					

AI #36





Notes:

1. [*Two percent of the value may be added to the design limit as an allowance for minor variances in analysis results.*]*
2. 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.
3. The maximum reinforcement required shown here is greater than that calculated considering the ESS.

AI #36

*NRC Staff approval is required prior to implementing a change in this information; see DCD Introduction Section 3.5.

AI #24

Table 3H.5-9 (Sheet 2a of ~~34~~)

SHIELD BUILDING ROOF REINFORCEMENT SUMMARY (AIR INLET)

AIS Reinforcement Summary – Horizontal Sections						
Locations (Figure 3H.5-11)		**Steel Area (Vertical Direction – Z Local Dir.)**				
		Required - Seismic Load Combinations (in^2/ft)		**Maximum Required[2][3] (in^2/ft)**	***[Provided]****	***[Design Limit[1] for Ratio Max Required/ Provided]****
Sections	**Angles**	**Seismic L/C**	**Values**			
5+6	0°-5.625°	16	1.65	2.10	*[Liner 1"= 12 (in^2/ft) (Min.)]**	*[0.175 + 2%]**
	84.375°-90°	8	1.41			
8	0°-5.625°	16	2.10			
	84.375°-90°	8	1.69			
9	0°-5.625°	16	2.10			
	84.375°-90°	8	1.68			
11	0°-5.625°	16	1.61	1.61	*[Liner 3/4"= 9 (in^2/ft) (Min.)]**	*[0.18 + 2%]**
	84.375°-90°	24	1.21			

AI #36

Notes:

1. *[Two percent of the value may be added to the design limit as an allowance for minor variances in analysis results.]**
2. 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.
3. The maximum reinforcement required shown here is greater than that calculated considering the ESS.

AI #36

*NRC Staff approval is required prior to implementing a change in this information; see DCD Introduction Section 3.5.

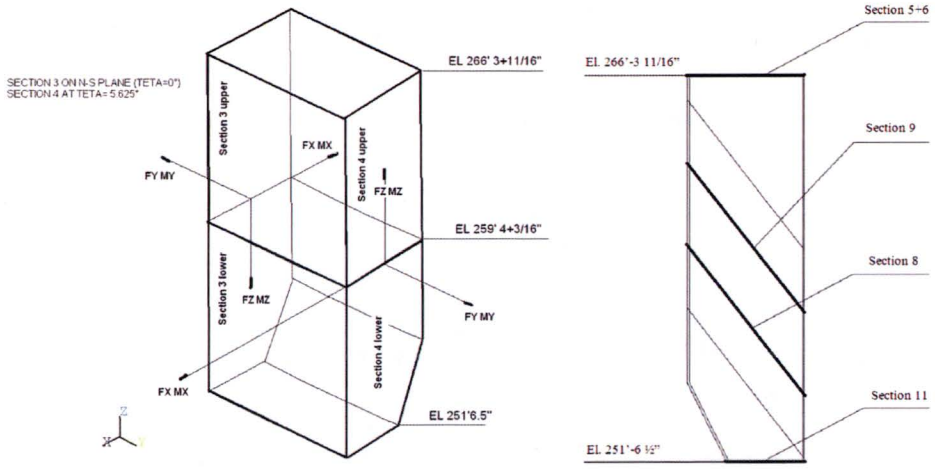
AI #24

Table 3H.5-9 (Sheet 2b of ~~34~~)

SHIELD BUILDING ROOF REINFORCEMENT SUMMARY (AIR INLET)

AIS Reinforcement Summary – Vertical Sections						
Locations (Figure 3H.5-11)		**Steel Area (Hoop Direction – Y Local Dir.)**				
Sections	**Angles**	**Required - Seismic Load Combinations (in^2/ft)**		**Maximum Required[2][3] (in^2/ft)**	***[Provided]****	***[Design Limit[1] for Ratio Max Required/ Provided]****
		Seismic L/C	**Values**			
3 Upper	0°	9	9.56	10.04	*[Liner 1"= 12 (in^2/ft) (Min.)]**	*[0.84 + 2%]**
	90°	17	8.32			
3 Lower	0°	9	8.14			
	90°	18	7.03			
4 Upper	5.625°	9	10.04			
	84.375°	17	8.69			
4 Lower	5.625°	9	7.98			
	84.375°	19	6.82			

AI #36



Notes:

1. *[Two percent of the value may be added to the design limit as an allowance for minor variances in analysis results.]**
2. 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.
3. The maximum reinforcement required shown here is greater than that calculated considering the ESS.

AI #36

*NRC Staff approval is required prior to implementing a change in this information; see DCD Introduction Section 3.5.

AI #24

Table 3H.5-9 (Sheet 2c of ~~34~~)

SHIELD BUILDING ROOF REINFORCEMENT SUMMARY (AIR INLET)

AI #36

Out of Plane Shear Reinforcement Summary – AIS							
Locations (Figure 3H.5-11)		**Required – Seismic Load Combinations (in^2/ft)**			**Maximum Required[2][3] (in^2/ft)**	***[Steel Area Provided]****	***[Design Limit[1] for Ratio Max Required/ Provided]****
Angles	**Sections**	**Seismic L/C**	**Values**	**Sum**			
0° - 5.625°	Max of Vertical Sections 3 upper - 4 upper	1	0.10	0.10	0.34	*[3 #6 TIE BAR @2.8125° (41.36)' (8 1/2'in vertical direction) = 0.54 (in^2/ft) (Min.)]**	*[0.63 + 2%]**
	Horizontal Section 5+6		0.00				
84.375° - 90°	Max of Vertical sections 3 upper - 4 upper	1	0.10	0.10			
	Horizontal Section 5+6		0.00				
0° - 5.625°	Max of Vertical Sections 3 upper – 4 upper	9	0.10	0.34			
	Horizontal Section 8		0.24				
84.375° - 90°	Max of Vertical Sections 3 upper – 4 upper	1	0.10	0.30			
	Horizontal Section 8		0.20				
0° - 5.625°	Max of Vertical Sections 3 lower - 4 lower	0	0.093	0.22			
	Horizontal Section 9		0.127				
84.375° - 90°	Max of Vertical Sections 3 lower - 4 lower	0	0.183	0.18			
	Horizontal Section 9		0.000				
0° - 5.625°	Max of Vertical Sections 3 lower - 4 lower	1	0.167	0.17			
	Horizontal Section 11		0.000				
84.375° - 90°	Max of Vertical Sections 3 lower - 4 lower	0	0.02	0.02			
	Horizontal Section 11		0.00				

Notes:

1. [*Two percent of the value may be added to the design limit as an allowance for minor variances in analysis results.*]*
2. 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.
3. The maximum reinforcement required shown here is greater than that calculated considering the ESS.

AI #36

*NRC Staff approval is required prior to implementing a change in this information; see DCD Introduction Section 3.5

a,c

AI #24

a,c

AI #24

a,c

AI #39

Note:

1. Steel beams are not considered as reinforcement for the reinforced concrete roof. Ratio for conical roof steel beams is based on demand and allowable stresses in psi.