REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

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

Docket No. 52-046

RAI No.:	**557-9199**
SRP Section:	**03.08.05- Foundations**
Application Section:	**Tier 2, Section 3.8.5 and Tier 1**
Date of RAI Issue:	**12/01/2017**

Question No. 03.08.05-20

10 CFR Part 52, Section 52.54, "Issuance of standard design certification," paragraph (a) states that the Commission may issue a standard design certification in the form of a rule for the design if the Commission determines that, among other things, "There is reasonable assurance that the standard design conforms with the provisions of the Act, and the Commission's regulations." When certified, the Appendix to Part 52 that constitutes the standard design certification will include or reference information that is approved and certified by the staff. This information, designated as Tier 1, generally includes, but is not limited to, design descriptions for significant aspects of the design. Tier 1 information is derived from the broader set of information contained in Tier 2 the Design Control Document (DCD), but is generally limited to the subset of the most safety significant information needed to support the staff's approval basis. Therefore, the staff's reasonable assurance finding for design certification relies, on the applicant's DCD Tier 1 and DCD Tier 2 information.

10 CFR 52.47(a)(2) requires, in part, that a design certification application include a description and analysis of the structures of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished. When evaluating the acceptability of this information for seismic Category I structures, the staff's review focuses on a subset of structural information that includes seismic analysis methods, key dimensions of seismic Category I structures, and design of "critical sections." The use of critical sections in the design of safety-related structures is a risk- informed graded approach to achieve the reasonable assurance of safety. In lieu of the safety review of a large number of structural component designs, the staff performs a detailed review of a limited number of critical sections described in Section 3.8 of the DCD that contributed to the overall risk significance of the structures. This approach provides the staff with reasonable assurance of the overall safety performance of the structures based on the successful performance of these limited but critical risk significant locations. However, even minor changes to these critical sections could, when applied to the entire safety-related structure, result in significant changes to the overall performance of the structure, and therefore, invalidate the basis for the staff's approval.

Therefore, the applicant is requested to incorporate as DCD Tier 1 Design Descriptions, certain characteristic of the seismic analysis and design of “critical sections” for seismic Category I structures. This information needs to be designated as Tier 1 information to support the staff’s reasonable assurance finding. The additional information to be included in APR1400 DCD Tier 1, based on DCD Tier 2, Rev. 1, is given below. This list provides examples and does not constitute a complete set of items to be included in DCD Tier 1. The information to be included in DCD Tier 1 may be in the form of text, tables, and/or figures, which are based on the design presented in DCD Tier 2.

- Identification of the ASME Code(s), Concrete Code, and Structural Steel Code with editions used in the design of safety related structures (e.g., ASME Section III, Division 1, Subsection NE and Division 2, Subsection CC; ACI-349, and ANSI/AISC- 690; with the applicable editions/dates identified).

- Key dimensions of seismic Category I structures (e.g., for the containment - DCD Figures 3.8-1, 2, 4, and 5).

- Design details for critical sections corresponding to reinforced concrete members and structural steel members for safety-related structures (e.g., reactor building, auxiliary building, and emergency diesel generator building). For critical sections, the information to be included is essentially the list of critical sections, locations of the critical sections, and the design details showing what design parameters are provided. An example of design parameters for concrete members is the reinforcement (either the location, direction, size, and spacing; or area of steel per unit length), concrete compressive strength, and wall/floor thickness. For structural steel members, this would typically consist of either the type and size (e.g., W21 X 147) or the equivalent steel member properties. For connections, this would typically consist of key details of the welds or bolts, and if applicable, plate/stiffening elements). The information on demand forces (e.g., FX, MX, etc.) calculated for the design of the sections, calculated stresses, and the available margins are not required. What is required is the design that is provided as described above. Examples of design parameters for critical sections of reinforced concrete and steel members in DCD Tier 2, Rev. 1, to be included in DCD Tier 1 may be obtained from the following:

    - o For reinforced concrete members - Tables 3.8A-3, 5, 11, 12, 13, 21, 23, 24, 27, 29, 33, 36, 37, and 44, or alternatively, comparable design parameters presented in Figures 3.8A-6 through 10, 15 through 17, 25 through 28, 36 through 39, and 40 through 57.

    - o For structural steel members - steel beams and connections supporting the concrete slabs inside containment as shown in the markups for DCD Figure 3.8A-60.

    - o Along with the above information, the material types/designations should be provided (e.g., for concrete - the compressive strength and for steel - the type and grade).

- A summary description of the seismic analysis method(s) (e.g., equivalent static, response spectra, time history) that was used for each of the seismic Category I structures. In addition, DCD Tier 1 should identify the in-structure response spectra for the key locations that would be needed by a COL applicant if a site-specific dynamic analysis evaluation is required.

Response – (Rev.2)

NRC Item 1

KHNP Original Response

The APR1400 is designed to meet the current NRC approved applicable codes and standards, including ASME, concrete, and structural steel codes. Any deviation from the current approved code or standards will be documented in the Design Report (Table 2.2.1-2 Item No. 5 [RCB and AB], Table 2.2.2-2 Item No. 4 [EDGB]) as described in Attachment 1 and noticed to the NRC through the approved design change process. This change process, as stated in 10 CFR Part 50.59, is summarized below:

(2) A licensee shall obtain a license amendment pursuant to Sec. 50.90 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would:

(viii) The source terms in Table 11.1-2 are used in calculation of the normal TIDs for equipment qualification. These source terms are the design basis source terms based upon 1.0% failed fuel with continuous gas stripping operation. This description will be updated for clarification in DCD Subsection 3.11.5.2, as indicated in the markups attached to this response, Attachment 4.

This regulation would govern any applicable changes to the design basis and their applicable codes and /or standards. This regulation is applicable to the technical analyses summarized in Tier 2, rather than the Tier 1 summary information, which is based on this same Tier 2 information.

NRC Feedback 3/05/2018

1. As discussed in the February 23, 2018 public meeting, using the "50.59 Like Process," is not appropriate for screening information that is already in Tier 1 (e.g., the ASME code).

   KHNP Revised Response to NRC Feedback

   Reference to the 50.59 process has been deleted.

   NRC Feedback 4/05/2018

   The staff considers the applicant response to be acceptable.

2. As agreed to by both the NRC staff and the applicant during the February 23, 2018 public meeting, the phrase, "The APR1400 is designed to meet the current NRC approved applicable codes and standards," is broad and needs to be more specific. To help bridge the gap, the NRC RAI identified the addition of the following specific codes and standards that should be include in DCD Tier 1 which would be acceptable to the staff:

- ASME Section III, Division 1, Subsection NE, “Class MC Components,” The American Society of Mechanical Engineers, the 2007 Edition with the 2008 Addenda
- ASME Section III, Division 2, “Code of Concrete Containments,” Subsection CC, American Society of Mechanical Engineers, the 2001 Edition with the 2003 Addenda
- ACI 349, “Code Requirements for Nuclear Safety-Related Concrete Structures,” American Concrete Institute, 1997.
- ANSI/AISC N690 including Supplement 2 (2004), “Specification for the Design, Fabrication and Erection of Steel Safety-Related Structures for Nuclear Facilities,” American Institute of Steel Construction, 1994.

<u>KHNP Revised Response to NRC Feedback</u>

The principal design codes with applicable editions/dates used in the design of safety related structures will be added as Table 2.2.1-5 in Tier 1, as shown in Attachment 1.

<u>NRC Feedback 4/05/2018</u>

The staff considers the applicant response to be acceptable.

3. KHNP is requested to provide markups in DCD Tier 1 (e.g., Sections 2.2.1 and 2.2.2) with this information

<u>KHNP Revised Response to NRC Feedback</u>

Related markups in DCD Tier 1 are provided as Attachment 1.

<u>NRC Feedback 4/05/2018</u>

The staff considers the applicant response to be acceptable. However, similar wording is needed in the design description sections for the Essential Service Water Building (Sec 2.2.8.1) and the Component Cooling Water Heat Exchanger Building (Sec 2.2.9.1) as they are classified as seismic Cat I structures.

<u>KHNP Response to NRC Feedback 4/05/2018</u>

The principle design codes with applicable editions/dates used in the design of ESW building and CCW HX building will be added in design description and ITAAC, as shown in Attachment 1.

<u>NRC Feedback 5/03/2018</u>

Overall, the staff considers the response to be acceptable. However, further clarification is needed pertaining to the appropriate wording for describing the codes used in the design of the Category I structures as discussed in the Tier 1 feedback on ITAAC issues. The NRC feedback, “Comments on RAI Response in Addition to Those on the Revised ITAAC,” provided previously to applicant via email from Tomeka Terry to KHNP dated April 5, 2018 does not appear to be incorporated or addressed. For each of the structures, the ITAAC on codes and standards need to be revised and the ITAAC on critical sections design attributes is missing.

KHNP Response to NRC Feedback 5/03/2018

The NRC feedback, “Comments on RAI Response in Addition to Those on the Revised ITAAC,” will be incorporated as follows:

- The languages regarding the codes for tolerances in Section 2.2.1 and 2.2.2 will be incorporated as shown in Attachment 2.
- NRC staff’s comments on the ITAAC will be incorporated as shown in Attachment 1 and 3.

NRC Item 2

KHNP Original Response

Dimensions of seismic Category I structures (e.g., Reactor Containment Building, Auxiliary Building, Emergency Diesel Generator Building), represented as plan and section views at several levels, are included in Tier 1 Figures 2.2.1-2 through 2.2.1-13 (RCB and AB) and Figures 2.2.2-1 through 2.2.2-2 (EDGB). Tier 1 Table 2.2.1-2 Item No. 4 (RCB and AB) and Tier 1 Table 2.2.2-2 Item No. 3 (EDGB) references key building information and dimensions. Further detail is provided in Tier 2 DCD Section 3.8. Note that these figures as shown in the Attachment 2 have been revised to reflect the appropriate level of information and precision for Tier 1.

In Tier 1, key dimensional information or reference dimensions are provided representing an accumulation of other dimensions. These dimensions state either the mean or nominal dimension and are not relied on for construction, manufacturing or inspection purposes to ensure as-built configurations. Individual tolerances which are adopted in the generic APR1400 DCD comply with the plant’s licensing design basis.

The tolerances shall be in accordance with ACI 117 for the dimensions of concrete structures, and ASME Section III, Division 2, CC-4522 & Appendix F (see DCD Tier 2 for containment shell & dome). As-built dimensions will be evaluated to verify compliance with the design bases and applicable codes and standards. Where a tolerance is exceeded, the structure may be accepted if it meets one of the following criteria: a) exceeding the tolerances does not affect the structural integrity, legal boundaries, or architectural requirements of the element; or b) the element or total erected assembly can be modified to meet all structural and architectural requirements.

Tolerance deviations may be acceptable, subject to regulatory approval, in part because of the general purpose tolerances serve: Tolerances are a means to establish permissible variation in dimension and location, and they are the means by which the designer conveys to the contractor the performance expectations upon which the design is based or that the project requires. Such specified tolerances should reflect design assumptions and project needs, being neither overly restrictive nor lenient. Thus, tolerances are not absolute requirements (See LBP-16-05, April 29, 2016).

For clarity purposes, the following general statements will be added to Subsection 1.2.1.

Dimensions used to describe a reference elevation, length, thickness, etc., are in nominal values, and a dimension should always be considered to mean dimension with appropriate tolerance as specified in the NRC approved code and standards in the Design Certification.

Deviation from identified dimensions and tolerance requirements is permissible when an adequate justification or analysis is provided demonstrating structural integrity and radiation protection margin exists within the plant's licensing design bases.

<u>NRC Feedback 4/05/2018</u>

In regards to the paragraph inserted in Subsection 1.2.1, consider deleting the entire proposed text to be inserted.

<u>KHNP Response to NRC Feedback 4/05/2018</u>

As shown in Attachment 2, the general statements above of Subsection 1.2.1 will be deleted.

<u>NRC Feedback 3/05/2018</u>

1. As discussed in the public meeting in relation to the NRC RAI, additional information to be included in DCD Tier 1 includes generic dimensions of seismic Category I structures as shown in the following figures:

   - Figure 3.8-1, “Typical Section of Containment Structures” (Looking North)
   - Figure 3.8-2, “Typical Section of Containment Structures” (Looking East)
   - Figure 3.8-4, “Arrangement of Containment Post-Tensioning System”
   - Figure 3.8-5, “Liner Plate and Anchorage System”

   Also, dimensional information, such as between column lines on some of the figures that were removed, should be reinserted into DCD Tier 1. Apparently, these were removed because of concerns about construction tolerances; however, those concerns can now be addressed by Item 2 below.

   <u>KHNP Revised Response to NRC Feedback</u>

   The above suggested figures have not been added to Tier 1. They are part of Tier 2. Any changes to the key dimensions in these figures will be addressed through the 50.59 change process.

   <u>NRC Feedback 4/05/2018</u>

   The staff considers the applicant response to be acceptable.

2. In view of the agreement during the public meeting on February 23, 2018 to include a paragraph on tolerances, the staff concludes that the proposed paragraph provided in the RAI response, as modified below, would be acceptable for inclusion in an applicable section of the Tier 1 document.

> *"The tolerances shall be in accordance with ACI 117 [Edition/Date XXXX] for concrete structures, Code of Standard Practice for Steel Buildings and Bridges [Edition/Date XXXX], and ASME Section III, Division 2, Subsection CC & applicable appendices related to tolerances [Edition/Date XXXX] for containment. As-built dimensions will also be evaluated to verify compliance with the design bases and applicable codes and standards."*

<u>KHNP Revised Response to NRC Feedback</u>

The following general statements will be added to Subsection 1.2.1 as shown in the Attachment 2:

> Dimensions used to describe a reference elevation, length, thickness, etc., are in nominal values, and a dimension should always be considered to mean dimension with appropriate tolerance as specified in the NRC approved code and standards in the Design Certification.
>
> Deviation from identified dimensions and tolerance requirements is permissible when an adequate justification or analysis is provided demonstrating structural integrity and radiation protection margin exists within the plant's licensing design bases.

The following paragraph will be added to Tier 1 sections 2.2.1.1 and 2.2.2.1 as shown in the Attachment 2:

> The tolerances shall be in accordance with ACI 117(2010 edition) for concrete structures, Code of Standard Practice for Steel Buildings and Bridges(2010 edition), and ASME Section III, Division 2, Subsection CC & applicable appendices related to tolerances(2001 edition with 2003 Addenda) for containment. As-built dimensions will also be evaluated to verify compliance with the design bases and applicable codes and standards. Where a tolerance is exceeded, the structure may be accepted if it meets one of the following criteria: a) exceeding the tolerances does not affect the structural integrity, legal boundaries, or architectural requirements of the element; or b) the element or total erected assembly can be modified to meet all structural and architectural requirements.

<u>NRC Feedback 4/05/2018</u>

In regards to the proposed inserted paragraphs above, please consider deleting the first two paragraphs and revising the second paragraph (applicable to Section 2.2.1 and 2.2.2) as follows:

Section 2.2.1

> *The tolerances <u>for the dimensions in [specify Tables and/or Figures]</u> shall be in accordance with ACI 117(2010 edition) for concrete structures, <u>ANSI/AISC 303</u> Code of Standard Practice for Steel Buildings and Bridges (2010 edition<u>) for structural steel members/structures</u>, and ASME Section III, Division 2, Subsection CC & applicable appendices related to tolerances (2001 edition with 2003 Addenda) for containment. <u>Any provisions in these codes which provide acceptance criteria for conditions when tolerances are exceeded shall not apply.</u> As-built dimensions will also be evaluated to*

verify compliance with these codes for tolerances and the design bases and applicable codes and standards identified in Table 2.2.1-5. ~~Where a tolerance is exceeded, the structure may be accepted if it meets one of the following criteria: a) exceeding the tolerances does not affect the structural integrity, legal boundaries, or architectural requirements of the element; or b) the element or total erected assembly can be modified to meet all structural and architectural requirements.~~

Section 2.2.2

The tolerances for the dimensions in [specify Tables and/or Figures] shall be in accordance with ACI 117(2010 edition) for concrete structures, ANSI/AISC 303 Code of Standard Practice for Steel Buildings and Bridges (2010 edition) for structural steel members/structures. Any provisions in these codes which provide acceptance criteria for conditions when tolerances are exceeded shall not apply. As-built dimensions will also be evaluated to verify compliance with these codes for tolerances and the design bases and applicable codes and standards identified in Table 2.2.1-5. ~~Where a tolerance is exceeded, the structure may be accepted if it meets one of the following criteria: a) exceeding the tolerances does not affect the structural integrity, legal boundaries, or architectural requirements of the element; or b) the element or total erected assembly can be modified to meet all structural and architectural requirements.~~

KHNP Response to NRC Feedback 4/05/2018

The paragraphs highlighted above will be revised as shown in Attachment 2.

3. KHNP is requested to provide markups in DCD Tier 1 with this information.

KHNP Revised Response to NRC Feedback

Related markups in DCD Tier 1 are provided as Attachment 2.

NRC Feedback 4/05/2018

Please refer to above Tier 1 feedback for ITAAC issues.

KHNP Response to NRC Feedback 4/05/2018

As shown in Attachment 2, the markups for Subsections 1.2.1, 2.2.1 and 2.2.2 will be revised.

NRC Feedback 5/03/2018

The Attachment 2 markups do not fully address the NRC feedback “Comments on RAI Response in Addition to Those on the Revised ITAAC,” provided previously to applicant via email from Tomeka Terry to KHNP dated April 5, 2018.

Explain how this table expanded from 10 pages in Rev. 1 to 32 pages in Rev. 2. Identify what RAI the expansion of pages occurred and provide the associated markups

KHNP Response to NRC Feedback 5/03/2018

The NRC feedback, "Comments on RAI Response in Addition to Those on the Revised ITAAC," will be incorporated as shown in Attachment 2.

The pages of Table 2.2.1-1 were expanded due to RAI 116-8054 Question 14.03.08-1 response.

Finally, additional figures were added to Tier 2 to depict the arrangement of the EDGB Building and structures (Subsection 3.8A.3.1, Figures 3.8A-67 and 3.8A-68). These are shown in Attachment 2.

<u>NRC Feedback 5/29/2018</u>

The staff notes that KHNP did not incorporate or address all of the staff prior feedback. Therefore, KHNP is requested to incorporate or address all of the staff feedback items.

1. KHNP proposes new language in Section 2.2.1 (Shown as Insert "A" in the response, in Attachment page 2 (2/26)). The staff's comments on that language is shown below:

   The tolerances for the dimensions in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13 shall be in accordance with ACI 117 (2010 Edition) for concrete structures, ANSI/AISC 303, Code of Standard Practice for Steel Buildings and Bridges (2010 Edition) for structural steel members/structures, and ASME Section III, Division 2, Subsection CC, and applicable appendices related to tolerances (2001 Edition with 2003 Addenda) for containment. Any provisions in these codes that provide acceptance criteria for conditions when tolerances are exceeded shall not apply, ~~unless approved otherwise by the NRC.~~ ***but a licensee referencing the APR1400 DCD may deviate from the tolerances in these codes using alternative acceptance criteria if these acceptance criteria are approved by the NRC.*** As-built dimensions will also be evaluated to verify compliance with ~~these codes for tolerances within NRC approved construction tolerance acceptance criteria and~~ the design bases and applicable codes and standards identified in Table 2.2.1-5.

2. KHNP proposes new language in Section 2.2.2 (Shown as Insert "B" in the response in Attachment page 21/26) The staff's comments on that language is shown below:

   The tolerances for the dimensions in Table 2.2.2-1 and Figures 2.2.2-1 through 2.2.2-2 shall be in accordance with ACI 117 (2010 edition) for concrete structures, and ANSI/AISC 303, Code of Standard Practice for Steel Buildings and Bridges (2010 Edition) for structural steel members/structures. Any provisions in these codes that provide acceptance criteria for conditions when tolerances are exceeded shall not apply, ~~unless approved otherwise by the NRC~~ ***but a licensee referencing the APR1400 DCD may deviate from the tolerances in these codes using alternative acceptance criteria, if these acceptance criteria are approved by the NRC.*** As-built dimensions will also be evaluated to verify compliance with ~~these codes for tolerances within NRC approved construction tolerance acceptance criteria and~~ the design bases and applicable codes and standards identified in Table 2.2.1-5.

   Staff's Proposal of New COL Item 3.8 (XX) and Revision to DCD Tier 2 Text

   COL 3.8-XX The COL applicant may provide construction tolerance acceptance criteria and the basis for the criteria (e.g., through the use of analysis, industry research, or testing) for cases where the tolerances in ACI 117 and ANSI/AISC 303, for structural concrete and structural steel, respectively, may be exceeded.

DCD Tier 2 - the following revisions would be acceptable to the staff:

Section 3.8.1.6 Materials, Quality Control, and Special Construction Techniques

Concrete and reinforcement forming and placement tolerances not specifically addressed in these references are in accordance with ACI 349 and ACI 117. Any provisions in these codes that provide acceptance criteria for conditions when tolerances are exceeded shall not apply, ~~unless approved otherwise by the NRC~~ ***but a licensee referencing the APR1400 DCD may deviate from the tolerances in these codes using alternative acceptance criteria, if these acceptance criteria are approved by the NRC.*** ~~As-built dimensions will also be evaluated to verify compliance with these codes for tolerances within NRC approved construction tolerance acceptance criteria.~~ ***As-built dimensions will also be evaluated to verify compliance with the design bases and applicable codes and standards identified in Table 3.8-1.*** The COL applicant may provide construction tolerance acceptance criteria and the basis for the acceptance criteria (e.g., through the use of analysis, industry research, or testing) for cases where the tolerances in the codes may be exceeded (COL 3.8-XX).

Sections 3.8.3, 3.8.4, and 3.8.5: inserted in the appropriate locations.

The tolerances for structural concrete shall be in accordance with ACI 117 (2010 edition) for concrete structures, and with ANSI/AISC 303, Code of Standard Practice for Steel Buildings and Bridges (2010 edition) for structural steel members/structures. Any provision in these codes that provide acceptance criteria for conditions when tolerances are exceeded shall not apply, ~~unless approved otherwise by the NRC~~ ***but a licensee referencing the APR1400 DCD may deviate from the tolerances in these codes using alternative acceptance criteria, if these acceptance criteria are approved by the NRC.*** ~~As-built dimensions will also be evaluated to verify compliance with these codes for tolerances within NRC approved construction tolerance acceptance criteria.~~ ***As-built dimensions will also be evaluated to verify compliance with the design bases and applicable codes and standards identified in Table 3.8-1.*** The COL applicant may provide construction tolerance acceptance criteria and the basis for the criteria (e.g., through the use of analysis, industry research, or testing) for cases where the tolerances in ACI 117 and ANSI/AISC 303, for structural concrete and structural steel, respectively, may be exceeded. (COL 3.8-XX).

Staff note: KHNP also needs to include in DCD Tier 2, Section 3.8, Reference list and in DCD Table 3.8-1, ACI 117 (2010) and ANSI/AISC 303 (2010)

KHNP Response to NRC Feedback 5/30/2018

The NRC feedback for the tolerances in DCD Tier 1 will be incorporated in Sections 2.2.1 and 2.2.2 as shown in Attachment 2.

The NRC feedback for the tolerances in DCD Tier 2 will be incorporated in Subsections 3.8.1.6, 3.8.3.6.1, 3.8.4.6, 3.8.5.6, 3.8.6, 3.8.7, and Tables 3.8-1 and 1.8-2 as shown in Attachment 2.

NRC Item 3

KHNP Original Response

The principal critical structural sections and material identification for seismic Category I structures will be added in Tier 1 Table 2.2.1-4, as described in the Attachment 3. Also, an ITAAC governing critical sections will be added to Table 2.2.1-2 Item No.6 and Table 2.2.2-2 Item No.5, as shown in the Attachment 3.

DCD section for detailed design information. Any change to the design basis would be governed under 10 CFR 50.59 process, as discussed in Item No. 1 above. Tables and figures in DCD Tier 2 Section 3.8A summarize the detailed design information for the critical section.

NRC Feedback 3/05/2018

1. In the February 23, 2018 public meeting with the applicant, the staff discussed in great detail the pertinent information regarding the critical sections that would be acceptable to the staff. The applicant was presented with two options which list the critical sections and the design attributes: Option A, in the case of concrete members, includes the minimum area of reinforcement per unit length provided in the design and Option B includes the ratio of demand to capacity. The demand to capacity ratio for concrete members can be defined as the ratio of required reinforcement obtained from the demand loads to the provided reinforcement. This ratio is a measure of the design margin to be maintained for the critical sections. Thus, any design changes made in the future would need to demonstrate that the ratio is equal to or less than (≤) the DCD Tier 1 design ratios. Both options were provided to the applicant by the NRC Project Manager. The applicant is requested to choose the option that's best suitable for its design of the APR1400 plant.

   KHNP Revised Response to NRC Feedback

   The principal critical sections and design attributes for seismic Category I structures will be added in Tier 1 Table 2.2.1-4, as described in Attachment 3. The design attribute is defined as the ratio of demand/capacity. The design attributes may be modified, based on site-specific details, by the COL Applicant. However, this ratio must always be equal to or less than the values stated in Table 2.2.1-4 in order to maintain the structural integrity of seismic Category I structures.

   NRC Feedback 4/05/2018

   The staff considers the applicant response to be acceptable.

2. Feedback for acceptable tabulation of material types/designations was explained to the applicant during the February 23, 2018 public meeting and also provided subsequent to this meeting by the NRC Project Manager as discussed in Item 1 above.

   KHNP Revised Response to NRC Feedback

   See KHNP Revised Response above.

   NRC Feedback 4/05/2018

The staff considers the applicant's response to be acceptable. However, some editorial revisions are needed in Table 2.2.1-4 as a result of the staff's internal meeting, in order to ensure clarity in the information provided in the table. Note that the prior sample Table provided by the staff (for D/C ratios under Option B) was transmitted to KHNP as an example. The intent was to have KHNP adjust that table in order to clearly capture the applicable design attributes for the critical sections. Therefore, KHNP is requested to address the items listed below.

1. Replace the two equations in the Design Attributes heading with the following: Ratio (R) $\leq$ Demand/Capacity (D/C).

2. Where applicable, when D/C ratios exist for multiple load combinations, the D/C ratios should be provided for each load combination. Examples for such cases is given below.

NI Basemat - Design ratios were determined by KHNP in DCD Tier 2, Table 3.8A-10 for the Service Load Combination and Factored Load Combination. Therefore, in the table entries for ratio R in Table 2.2.1-4 of the RAI response, two numerical values should be shown corresponding to each load combination. Then, a footnote number could be inserted next to each directional component for each critical section (e.g., "Flexural Rebar and Shear Reinforcement").

Then, the footnote could state: "For containment reinforcement: ***calculated demand stress vs allowable stress*** for service load combination followed by factored load combination."

For the cases where areas of steel are used to determine the ratio R (instead of stresses), then another footnote could state: "For containment reinforcement: required reinforcement area vs provided reinforcement area for service load combination followed by factored load combination."

Containment Wall and Dome - Design ratios were determined in DCD Tier 2, Table 3.8A-4 for both Mechanical and Mechanical + Thermal load combinations. Therefore, in the table entries for ratio R in Table 2.2.1-4 of the RAI response, two numerical values should be shown corresponding to each load combination. Then, a footnote number could be inserted next to the directional component for each critical section (e.g., "Meridional Direction, Hoop Direction, and Shear Reinforcement").

Then, another set of footnotes could be provided similar to the three footnotes described above as follows:

"For containment reinforcement: ***calculated demand stress vs allowable stress*** for mechanical load combination followed by mechanical plus thermal load combination."

"For containment reinforcement: required reinforcement area vs provided reinforcement area for mechanical load combination followed by mechanical plus thermal load combination."

Other structures – KHNP is requested to use the same or similar footnotes given in the above examples for all the other structures in the table.

3. Note that in the current set of footnotes 1 through 5 (which will be revised based on Item 2 above), the ratios should be reversed in accordance with the equation R ≤ D/C.

4. For the steel liner, several ratios R are available from DCD Tier 2, ***Table 3.8-10***. As noted in Item 2 above, when multiple load combinations exist, the intent is to identify the ratios R for each load combination or at least the governing load combination (i.e., minimum R value). In the case of the liner, the minimum R appears to be 0.435 not 1.00 based on the Factored (membrane & bending strain) load combination in DCD ***Table 3.8-10***. Note that in this case, footnote 5 does not capture the case of allowable strain vs maximum strain. Thus, KHNP is requested to utilize one the footnotes identified in Item 2 above and adjust it to suit the type of response (stress, strain) and the corresponding load combination (see DCD Tier 2, ***Table 3.8-10*** for this information).

<u>NRC Feedback 5/03/2018</u>

The staff corrected the edits as shown above as discussed with the applicant during the April 5, 2018 public meeting.

<u>KHNP Response to NRC Feedback 4/05/2018</u>

As shown in Attachment 3, Table 2.2.1-4 will be revised to add the ratios and footnotes, and to reflect the staff feedback No. 1 through 4 above.

<u>NRC Feedback 5/03/2018</u>

The staff reviewed Table 2.2.1-4 and identified the following:

1. It appears to the staff that the highest D/C ratio is being used rather than the lowest D/C ratio in some cases (e.g., in the Hoop Direction for the Thickened Sections Around Large Penetrations). The staff believes that the lowest D/C ratios must be used as the governing ratio.

2. The shear reinforcements for the critical sections pertaining to the containment (wall and dome & internal structures) that were previously provided are now omitted in this version of the response. These should be included unless otherwise justified.

3. For the Liner Plate, per Footnote 3 of Table 2.2.1-4, it appears to the staff that D/C ratio for the service load case and the factored load case would be provided; however, only one D/C ratio is presented in the Table. The single D/C ratio presented in the table appears to be the highest D/C ratio rather than the governing (i.e., lowest) D/C ratio. Table 3.8-10, in the response to RAI 248-8295, Question 03.08.05-1, provides the liner plate ratios for the Service and Factored load cases corresponding to membrane strain and membrane plus bending strain. The staff believes that the lowest D/C ratios must be used as the governing ratio or the applicant can choose to list all the 4 categories along with their respective ratios in Table 2.2.1-4.

4. For the Containment Internal Structures, explain why only one reinforcement D/C ratio exists rather than two corresponding to the outside layers and inside layers, as was done for the Containment Wall and Dome. If the reinforcement is the same for both layers, this should be identified in the table (e.g., in the footnote or the values can be

repeated in the table with the identification of outside layers and inside layers or the governing (i.e., lowest D/C ratio should be identified and explained in the footnote).

5. It appears to the staff that the highest D/C ratio is being used rather than the lowest D/C ratio for the entire critical sections in the Aux Building. The staff believes that the lowest D/C ratios must be used as the governing ratio or the applicant can choose to list all the zones associated with each critical section along with their respective ratios in Table 2.2.1-4.

6. The applicant is requested to check that the issues discussed above are adequately addressed in other parts of the table.

KHNP Response to NRC Feedback 5/03/2018

As shown in Attachment 3, Table 2.2.1-4 will be revised to list all ratios for categories or zones, and to add the footnote for the containment internal structures to reflect the staff's comment.

5. For the Cylindrical Wall-Basemat Junction Area, the ratio R equal to 0.80 for the inside layer in the Meridional Direction matches the inverse of the design margin ratio 1.25 from DCD Tier 2, Table 3.8A-4. However, the ratio R equal to 0.99 does not appear to match the inverse of the design margin ratio 1.18 from Table 3.8A-4. Please explain the apparent inconsistency. If this was an error, then please check the rest of the table as well.

KHNP Response to NRC Feedback 4/05/2018

DCD Tier 2, Table 3.8A-4(1 of 5) will be revised to match the inverse of the design margin ratio 1.01. The design margin ratio 0.99 (= actual stress/allowable stress = 53.2 ksi/54 ksi) from Table 2.2.1-4 shown in Attachment 3 is correct.

NRC Feedback 5/03/2018

The applicant is requested to provide the updated markup for Table 3.8A-4.

KHNP Response to NRC Feedback 5/03/2018

Please see the updated markup for Table 3.8A-4(1 of 5) in Attachment 3.

6. In an effort to show how the above information could be incorporated into Table 2.2.1-4, see NRC feedback provided in Attachment 3 (page 5/11 through 8/11).

NRC Feedback 5/03/2018

Feedback to the information in Table 2.2.1-4 is provided above.

KHNP Response to NRC Feedback 4/05/2018

Table 2.2.1-4 in Attachment 3 will be revised to reflect the staff feedback.

3. In ITAAC 5, Attachment 1 (2/4); ITAAC 4, Attachment 1 (4/4); ITAAC 5, Attachment 3 (4/9) and ITAAC 4, Attachment 3 (9/9), the applicant used the phrase, “designed in accordance with the NRC approved code and standards in the design certification.” Given that the staff only certifies the Tier 1 information, the phrase seems to be contradictory to the information presented. The staff considers the phrase to be adequate only if the codes identified in the staff feedback to Item 1 above are Tier 1 information and reference is made only to these codes and standards within DCD Tier 1.

KHNP Revised Response to NRC Feedback

See KHNP Revised Response for Item 1.

NRC Feedback 4/05/2018

Please refer to above Tier 1 feedback for ITAAC issues.

KHNP Response to NRC Feedback 4/05/2018

As shown in Attachment 1, ITAAC for applicable codes and standards will be revised.

NRC Feedback 5/03/2018

Overall, the staff considers the response to be acceptable. However, further clarification is needed pertaining to the appropriate wording for describing the codes used in the design of the Category I structures as discussed in the Tier 1 feedback on ITAAC issues. The NRC feedback, “Comments on RAI Response in Addition to Those on the Revised ITAAC,” provided previously to applicant via email from Tomeka Terry to KHNP dated April 5, 2018 does not appear to be incorporated or addressed. For each of the structures, the ITAAC on codes and standards need to be revised and the ITAAC on critical sections design attributes is missing.

KHNP Response to NRC Feedback 5/03/2018

Please see KHNP Response to NRC Feedback 5/03/2018 for Item 1.

NRC Item 4

KHNP Original Response

A description regarding the seismic analysis methods used for seismic Category I structures will be added to DCD Tier 1 Section 2.2.10 as shown in the Attachment 4.

NRC Feedback 3/05/2018

The staff reviewed the applicant response and considered the information provided to be adequate.

NRC Feedback 4/05/2018

The staff considers the applicant response to be acceptable.

Impact on DCD

DCD Tier 1, Subsections 2.2.1.1, 2.2.2.1, 2.2.10, Tables 2.2.1-1, 2.2.1-2, 2.2.1-4, 2.2.1-5, 2.2.2-2, 2.2.10-1, Figures 2.2.1-4 through 2.2.1-11, and Figures 2.2.2-1 through 2.2.2-2 and DCD Tier 2, Subsections 3.8.1.6, 3.8.3.6.1, 3.8.4.6, 3.8.5.6, 3.8.6, 3.8.7, 3.8A.3.1, Tables 3.8.-1, 1.8-2, and Figures 3.8A-67 and 3.8A-68 will be revised or added, as described in the attachments associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on the Technical/Topical/Environmental Report.

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personnel air locks and an equipment hatch. Penetrations are provided for electrical and mechanical components and for the transport of nuclear fuel.

The containment internal structures consist of reinforced concrete and structural steels that support reactor vessel and reactor coolant system. The primary shield wall supports and laterally surrounds the reactor vessel. The secondary shield wall laterally surrounds the primary shield wall and is structurally connected to the primary shield wall by reinforced concrete slabs, beams, and walls. The secondary shield wall supports steam generators and pressurizer. The containment internal structures enclose a reactor cavity area below the reactor vessel which can be flooded during a postulated accident. An indirect gas vent path is provided between the reactor cavity and the free volume of the containment.

The reactor cavity has a corium debris chamber. And the reactor cavity floor is constructed with a fill concrete on steel liner plate. The reactor cavity floor area is free from obstructions to corium debris spreading.

The AB is a reinforced concrete structure which consists of the electrical and control area, the fuel handling area, the chemical and volume control system area, the main steam valve house, and the emergency diesel generator area. The AB laterally surrounds the RCB and is divided by divisional walls.

The NI structures are seismic Category I, and are designed and constructed to withstand the design basis loads associated with:

1. Normal plant operation (including dead loads, live loads, lateral earth pressure loads, hydrodynamic loads, and equipment loads, including the effects of temperature and equipment vibration)

2. External events (including rain, snow, wind, flood, tornado or hurricane, tornado or hurricane generated missiles, and earthquake)

3. Internal events (including flooding, pipe rupture, equipment failure, and equipment failure generated missile)

Seismic classification of the building is shown in Table 2.2.1-3.

1. The basic configuration of the NI structure is as shown in Figure 2.2.1-1 through Figure 2.2.1-13.

The NI structures are designed in accordance with the requirements of ASME Section III Div.2 CC, ASME Section III Div.1 NE, ACI 349 and ANSI/AISC N690 as described in the Table 2.2.1-5.

2.a The containment is designed and constructed to meet the requirements of ASME Section III, Div. 2.

2.b The containment penetrations are designed and constructed to meet ASME Section III.

2.c The containment and its penetrations retain their pressure boundary integrity associated with the design pressure.

2.d The containment and its penetrations maintain the containment leakage rate less than or equal to the maximum allowable leakage rate associated with the peak containment pressure for the design basis accident.

3. The NI structures are seismic Category I, and are designed and constructed to withstand the design basis loads.

4. ~~The key dimensions of the NI structures are described in Table 2.2.1-1~~.

The dimensions and elevations of the NI structures are as described in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13.

5. Nuclear Island(NI) structures are designed and constructed in accordance with the codes and standards listed in Table 2.2.1-5.

2.2.1.2 Inspections, Tests, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for nuclear island structures are specified in Table 2.2.1-2.

The dimensions and elevations of the NI structures are as described in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13.

as-built

Table 2.2.1-2 (2 of 2)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
3. The NI structures are seismic Category I, and are designed and constructed to withstand the structural design basis loads.	3. A structural analysis will be performed to reconcile the as-built NI structures with the structural design basis loads.	3. A report exists and concludes that the NI structures can withstand the design basis loads.
4. ~~The key dimensions of the NI structures are described in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13.~~	4. ~~Inspection will be performed to verify that the as-built wall and slab thickness conform with the structural configuration.~~	4. ~~A report exists and concludes that the NI structure as-built wall and slab thickness conform with the structural configuration as described in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13.~~

Add Item 5 in next page

Inspection will be performed of the dimensions and elevations of the as-built NI structures.

A report exists and concludes that the as-built dimensions and elevations of the NI structures are as described in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13.

~~5. Nuclear Island (NI) Structures are designed in accordance with the NRC approved code and standards in the design certification.~~	~~5. An inspection for any deviation from the approved codes and standards will be performed.~~	~~5. A reports existsand concludes that the as-built NI structures conform to the NRC approved codes and standards.~~

Replaced with "A"

A

5. Nuclear Island (NI) structures are designed and constructed in accordance with the codes and standards listed in Table 2.2.1-5.	5. An analysis will be performed for any deviations from the codes and standards listed in Table 2.2.1-5.	5. A report exists and concludes that the NI structures are designed and constructed in accordance with the codes and standards listed in Table 2.2.1-5.

Table 2.2.1-5

Principal ~~Design~~ Codes and Standards

Document Designation	Edition	Document Title
ASME CC	2001 with 2003 Addenda	Code for Concrete Containment
ACI 349	1997	Code requirements for nuclear safety related concrete structure
~~AISC~~ ANSI/AISC N690	1994 including Supp. 2(2004)	Specification for the Design, Fabrication and Erection of Steel Safety-Related Structures for Nuclear Facilities
ASME NE	2007 with 2008 Addenda	Class MC Components
ACI 117	2010	Specification for Tolerances for Concrete Construction and Materials and Commentary
ANSI/AISC 303	2010	Code of Standard Practice for Steel Buildings and Bridges

Abbreviation
ACI American Concrete Institute
AISC American Institute of Steel Construction
ASME American Society of Mechanical Engineers
ANSI American National Standard Institute

Add new Table

2.2.2 Emergency Diesel Generator Building

2.2.2.1 Design Description

The emergency diesel generator (EDG) building block is located adjacent to east side of the Nuclear Island with seismic isolation gap, and comprises two buildings, one that houses additional two generators and the other for the diesel fuel oil tank (DFOT). Both EDG and DFOT buildings are single-story structures which are composed of reinforced concrete basemat, shearwalls and slabs. The two basemats are horizontally separated by seismic isolation gap. The EDB building block is designed in accordance with the requirements of ACI 349 and ANSI/AISC N690 as described in the Table 2.2.1-5.

The EDG building block is designed and constructed to withstand the structural design basis loads associated with:

1. Normal plant operation (including dead loads, live loads, lateral earth pressure loads, and equipment loads, including the effects of temperature and equipment vibration)

2. External events (including rain, snow, wind, flood, tornado or hurricane, tornado or hurricane generated missiles, and earthquake)

3. Internal events (including flooding, pipe rupture, equipment failure, and equipment failure generated missile)

   a) The basic configuration of the EDG building block is as shown in Figures 2.2.2-1 and 2.2.2-2.

   b) The EDG building block is designed and constructed to withstand the structural design basis loads.

   c) ~~The key dimensions of the EDG building block are described in Table 2.2.2-1.~~ The dimensions and elevations of the EDG building block are as described in Table 2.2.2-1, Figure 2.2.2-1 and Figure 2.2.2-2.

   d) ~~4.~~ The EDG building block is designed ~~in accordance with the NRC approved code and standards in the design certification.~~ and constructed in accordance with the applicable codes and standards listed in Table 2.2.1-5.

2.2.2.2 Inspection, Test, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the EDG building block are specified in Table 2.2.2-2.

The dimensions and elevations of the EDG building block are as described in Table 2.2.2-1, Figure 2.2.2-1 and Figure 2.2.2-2.

Table 2.2.2-2

Emergency Diesel Generator Building Block (1) ITAAC

as-built

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The basic configuration of the EDG building block is as shown in Figures 2.2.2-1 and 2.2.2-2.	1. Inspection of the basic configuration of the as-built EDG building block will be conducted.	1. The EDG building block conforms with the basic configuration as shown in Figures 2.2.2-1 and 2.2.2-2.
2. The EDG building block is designed and constructed to withstand the structural design basis loads.	2. A structural analysis will be performed to reconcile the as-built EDG building block structure with the structural design basis loads.	2. A report exists and concludes that the EDG building block can withstand the structural design basis loads.
3. ~~The key dimensions of the EDG building block are as described in Table 2.2.2-1, Figure 2.2.2-1, and Figure 2.2.2-2.~~	3. ~~Inspection will be performed to verify that the as-built wall and slab thickness conform to the structural configuration.~~	3. ~~A report exists and concludes that the EDG building block as-built wall and slab thickness conform with the structural configuration as described in Table 2.2.2-1, Figure 2.2.2-1, and Figure 2.2.2-2.~~

as-built

(1) EDG building block includes EDG building and DFOT building.

Add Item 4 in next page

Inspection will be performed of the dimenisons and elevations of the as-built EDG building block.

A report exists and concludes that the as-built dimensions and elevations of the EDG building block are as described in Table 2.2.2-1, Figure 2.2.2-1 and Figure 2.2.2-2.

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~~4. The EDG building block is designed in accordance with the NRC approved code and standards in the design certification.~~	~~4. An inspection for any deviation from the approved codes and standards will be performed.~~	~~4. A reports exists and concludes that the as-built NI structures conform to the NRC approved codes and standards.~~

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B

4. The EDG building block is designed and constructed in accordance with applicable codes and standards listed in Table 2.2.1-5.	4. An analysis will be performed for any deviations from the applicable codes and standards listed in Table 2.2.1-5.	4. A report exists and concludes that the EDG building block is designed and constructed in accordance with the applicable codes ~~stanadnadrds~~ and standards listed in Table 2.2.1-5.

2.2.8 Essential Service Water Building

2.2.8.1 Design Description

The Essential Service Water (ESW) buildings are classified as seismic Category I buildings with a concrete structure. The ESW building houses essential service water pumps, cooling tower, and cooling tower basin. The structure is composed of basemat, floors, roofs, and shear walls. The ESW structure provides pump rooms that are separated by reinforced concrete walls and operating floor in which the equipment are installed.

The ESW building is designed in accordance with the requirements of ACI 349 and ANSI/AISC N690 as described in the Table 2.2.1-5.

The ESW building is designed and constructed to withstand the structural design basis loads associated with:

1. Normal plant operation (including dead loads, live loads, lateral earth pressure loads, and hydrostatic loads, hydrodynamic loads, and temperature loads)

2. External events (including rain, snow, wind, flood, tornado or hurricane, tornado or hurricane generated missiles, and earthquake)

3. Internal events (including internal flooding, pipe rupture, equipment failure, and equipment failure generated missile)

   a) The ESW building is designed and constructed to withstand the structural design basis loads.

   b) The ESW building is designed and constructed in accordance with the applicable codes and standards listed in Table 2.2.1-5.

2.2.8.2 Inspection, Test, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the ESW building are specified in Table 2.2.8-1.

Table 2.2.8-1

Essential Service Water Building ITAAC

Design Commitment	Inspections, Tests, Analysis	Acceptance Criteria
1. The Essential Service Water Building is designed and constructed to withstand the structural design basis loads.	1. A structural analysis will be performed to reconcile the as-built ESW structure with the structural design basis loads.	1. A report exists and concludes that the ESW building can withstand the structural design basis loads.
2. The ESW building is designed and constructed in accordance with the applicable codes and standards listed in Table 2.2.1-5.	2. An analysis will be performed for any deviations from the applicable codes and standards listed in Table 2.2.1-5.	2. A report exists and concludes that the ESW building is designed and constructed in accordance with the applicable codes and standards listed in Table 2.2.1-5.

2.2.9 Component Cooling Water Heat Exchanger Building

2.2.9.1 Design Description

The component cooling water (CCW) heat exchanger buildings next to each ESW building are classified as seismic Category I buildings with a concrete structure. The CCW heat exchanger building houses CCW heat exchangers, debris filters. The structure is composed of basemat, floors, roofs, and shear walls. The load resistance of the structure consists of slabs and shear walls combined with concrete columns and beams as the structural elements.

The CCW heat exchanger building is designed and constructed to withstand the structural design basis l

The CCW heat exchanger building is designed in accordance with the requirements of ACI 349 and ANSI/AISC N690 as described in the Table 2.2.1-5.

1. Normal plant operation (including dead loads, live loads, lateral earth pressure loads, and equipment loads, including the effects of temperature and equipment vibration)

2. External events (including rain, snow, wind, flood, tornado or hurricane, tornado or hurricane generated missiles, and earthquake)

3. Internal events (including flooding, pipe rupture, equipment failure, and equipment failure generated missile)

   a) The CCW heat exchanger ~~buildings are~~ building is designed and constructed to withstand the structural design basis loads.

   b) The CCW heat exchanger building is designed and constructed in accordance with the applicable codes and standards listed in Table 2.2.1-5.

2.2.9.2 Inspection, Test, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the CCW heat exchanger building are specified in Table 2.2.9-1.

Table 2.2.9-1

Component Cooling Water Heat Exchanger Building ITAAC

Design Commitment	Inspections, Tests, Analysis	Acceptance Criteria
1. The Component Cooling Water □eat Exchanger ~~Buildings~~ building is designed and constructed to withstand the structural design basis loads.	1. A structural analysis will be performed to reconcile the as-built CCW heat exchanger structure with the structural design basis loads.	1. A report exists and concludes that the CCW heat exchanger building can withstand the structural design basis loads.
2. The CCW heat exchanger building is designed and constructed in accordance with the applicable codes and standards listed in Table 2.2.1-5.	2. An analysis will be performed for any deviations from the applicable codes and standards listed in Table 2.2.1-5.	2. A report exists and concludes that the CCW heat exchanger building is designed and constructed in accordance with the applicable codes and standards listed in Table 2.2.1-5.

1.2 General Provisions

The following general provisions are applicable to the Design Descriptions and the associated ITAAC:

1.2.1 Treatment of Individual Items

The absence of any discussion or depiction of an item in the Design Description or accompanying Figures shall not be construed as prohibiting a licensee from utilizing such an item, unless it would prevent an item from performing its safety function as discussed or depicted in the Design Description or accompanying Figures.

When the term “operate”, “operates”, or “operation” is used with respect to an item discussed in the Acceptance Criteria, it refers to the actuation and running of the item. When the term “exist”, “exists”, or “existence” is used with respect to an item discussed in the Acceptance Criteria, it means that the item is present and meets the Design Description.

Many of the Acceptance Criteria include the words “A report exists and concludes that…” When these words are used, it indicates that the ITAAC for that Design Commitment will be met when it is confirmed that appropriate documentation exists and the documentation shows that the Design Commitment is met. Appropriate documentation can be a single document or a collection of documents that show that the stated acceptance criteria are met. Examples of appropriate documentation include data reports, test reports, inspection reports, analysis reports, evaluation reports, design and manufacturing procedures, certified data sheets, commercial dedication procedures and records, quality assurance records, calculation notes, and equipment qualification data packages.

~~Add "A" in next page~~

1.2.2 Implementation of ITAAC

The ITAAC are provided in tables with the following three column format:

Design Commitment	Inspection, Tests, Analyses	Acceptance Criteria

Each Design Commitment in the left-hand column of the ITAAC tables has an associated Inspections, Tests, or Analyses (ITA) requirement specified in the middle column of the tables.

~~"A"~~

~~Dimensions used to describe a reference elevation, length, thickness, etc., are in nominal values, and a dimension should always be considered to mean dimension with appropriate tolerance as specified in the NRC approved code and standards in the Design Certification.~~

~~Deviation from identified dimensions and tolerance requirements is permissible when an adequate justification or analysis is provided demonstrating structural integrity and radiation protection margin exists within the plant's licensing design bases.~~

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personnel air locks and an equipment hatch. Penetrations are provided for electrical and mechanical components and for the transport of nuclear fuel.

The containment internal structures consist of reinforced concrete and structural steels that support reactor vessel and reactor coolant system. The primary shield wall supports and laterally surrounds the reactor vessel. The secondary shield wall laterally surrounds the primary shield wall and is structurally connected to the primary shield wall by reinforced concrete slabs, beams, and walls. The secondary shield wall supports steam generators and pressurizer. The containment internal structures enclose a reactor cavity area below the reactor vessel which can be flooded during a postulated accident. An indirect gas vent path is provided between the reactor cavity and the free volume of the containment.

The reactor cavity has a corium debris chamber. And the reactor cavity floor is constructed with a fill concrete on steel liner plate. The reactor cavity floor area is free from obstructions to corium debris spreading.

The AB is a reinforced concrete structure which consists of the electrical and control area, the fuel handling area, the chemical and volume control system area, the main steam valve house, and the emergency diesel generator area. The AB laterally surrounds the RCB and is divided by divisional walls.

Add "B" in next page

The NI structures are seismic Category I, and are designed and constructed to withstand the design basis loads associated with:

1. Normal plant operation (including dead loads, live loads, lateral earth pressure loads, hydrodynamic loads, and equipment loads, including the effects of temperature and equipment vibration)

2. External events (including rain, snow, wind, flood, tornado or hurricane, tornado or hurricane generated missiles, and earthquake)

3. Internal events (including flooding, pipe rupture, equipment failure, and equipment failure generated missile)

Seismic classification of the building is shown in Table 2.2.1-3.

1. The basic configuration of the NI structure is as shown in Figure 2.2.1-1 through Figure 2.2.1-13.

"B"

~~The tolerances shall be in accordance with ACI 117(2010 edition) for concrete structures, Code of Standard Practice for Steel Buildings and Bridges(2010 edition), and ASME Section III, Division 2, Subsection CC & applicable appendices related to tolerances(2001 edition with 2003 Addenda) for containment. As-built dimensions will also be evaluated to verify compliance with the design bases and applicable codes and standards. Where a tolerance is exceeded, the structure may be accepted if it meets one of the following criteria: a) exceeding the tolerances does not affect the structural integrity, legal boundaries, or architectural requirements of the element; or b) the element or total erected assembly can be modified to meet all structural and architectural requirements.~~

The tolerances for the dimensions in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13 shall be in accordance with ACI 117(2010 edition) for concrete structures, ANSI/AISC 303(2010 edition) for structural steel members/structures, and ASME Section III, Division 2, Subsection CC & applicable appendices related to tolerances(2001 edition with 2003 Addenda) for containment. Any provisions in these codes which provide acceptance criteria for conditions when tolerances are exceeded shall not apply, but a licensee referencing the APR1400 DCD may deviate from the tolerances in these codes using alternative acceptance criteria, if these acceptance criteria are approved by the NRC. As-built dimensions will also be evaluated to verify compliance with the design bases and applicable codes and standards identified in Table 2.2.1-5.

Table 2.2.1-1 (32 of 32)

Wall or Section Description	Column Lines	Floor Elevation or Elevation Range	Concrete Thickness ~~(1)~~	Applicable Radiation Shielding Wall (Yes/No)
Floors	From AB to AD From 15 to 16	213'-0"	1'-6"	No
Floors	From AI to AK From 20 to 22	215'-0"	2'-0"	Yes
Floors	From AF to AK From 23 to 26	215'-0"	1'-6"	Yes
Floors	From AI to AJ From 22 to 23	226'-6"	1'-6"	Yes

~~(1) Tolerance for the thickness of the walls and slabs is -1/4 inch and + 1 inch.~~ deleted

~~(2)~~ (1) Reduction of the basemat thickness is less than - 5 % of specified thickness.

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Security-Related Information – Withhold Under 10 CFR 2.390

Figure 2.2.1-4 Nuclear Island Structure Plan at Level 1

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RAI 557-9199 - Question 03.08.05-20

Security-Related Information – Withhold Under 10 CFR 2.390

Figure 2.2.1-5 Nuclear Island Structure Plan at Level 2

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Security-Related Information – Withhold Under 10 CFR 2.390

Figure 2.2.1-6 Nuclear Island Structure Plan at Level 3

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Security-Related Information – Withhold Under 10 CFR 2.390

Figure 2.2.1-7 Nuclear Island Structure Plan at Level 4

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Figure 2.2.1-8 Nuclear Island Structure Plan at Level 5

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Security-Related Information – Withhold Under 10 CFR 2.390

Figure 2.2.1-9 Nuclear Island Structure Plan at Level 6

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Security-Related Information – Withhold Under 10 CFR 2.390

Figure 2.2.1-10 Nuclear Island Structure Plan at Level 7

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Security-Related Information – Withhold Under 10 CFR 2.390

Figure 2.2.1-11 Nuclear Island Structure Plan at Roof

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Security-Related Information – Withhold Under 10 CFR 2.390

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2.2.2 Emergency Diesel Generator Building

2.2.2.1 Design Description

The emergency diesel generator (EDG) building block is located adjacent to east side of the Nuclear Island with seismic isolation gap, and comprises two buildings, one that houses additional two generators and the other for the diesel fuel oil tank (DFOT). Both EDG and DFOT buildings are single-story structures which are composed of reinforced concrete basemat, shearwalls and slabs. The two basemats are horizontally separated by seismic isolation gap.

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The EDG building block is designed and constructed to withstand the structural design basis loads associated with:

1. Normal plant operation (including dead loads, live loads, lateral earth pressure loads, and equipment loads, including the effects of temperature and equipment vibration)

2. External events (including rain, snow, wind, flood, hurricane generated missiles, and earthquake)

3. Internal events (including flooding, pipe rupture, equipment failure, and equipment failure generated missile)

   a) The basic configuration of the EDG building block is as shown in Figures 2.2.2-1 and 2.2.2-2.

   b) The EDG building block is designed and constructed to withstand the structural design basis loads.

   c) The key dimensions of the EDG building block are described in Table 2.2.2-1.

2.2.2.2 Inspection, Test, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the EDG building block are specified in Table 2.2.2-2.

"C"

~~The tolerances shall be in accordance with ACI 117(2010 edition) for concrete structures. As-built dimensions will also be evaluated to verify compliance with the design bases and applicable codes and standards. Where a tolerance is exceeded, the structure may be accepted if it meets one of the following criteria: a) exceeding the tolerances does not affect the structural integrity, legal boundaries, or architectural requirements of the element; or b) the element or total erected assembly can be modified to meet all structural and architectural requirements.~~

The tolerances for the dimensions in Table 2.2.2-1 and Figures 2.2.2-1 through 2.2.2-2 shall be in accordance with ACI 117(2010 edition) for concrete structures and ANSI/AISC 303(2010 edition) for structural steel members /structures. Any provisions in these codes which provide acceptance criteria for conditions when tolerances are exceeded shall not apply, but a licensee referencing the APR1400 DCD may deviate from the tolerances in these codes using alternative acceptance criteria, if these acceptance criteria are approved by the NRC. As-built dimensions will also be evaluated to verify compliance with the design bases and applicable codes and standards identified in Table 2.2.1-5.

Table 2.2.2-1

Definition of Wall and Floor Thicknesses for Emergency Diesel Generator Building

Wall or Section Description	Column Lines	Floor Elevation or Elevation Range	Concrete Thickness ~~(1)~~	Applicable Radiation Shielding Wall (Yes/No)
EDG Building				
Basemat	Not Applicable	100'-0"	4'-0"	No
Column Line 26.1 Wall	From AC.8 to AH.2	From 100'-0" to 135'-0"	3'-0"	No
Column Line 28 Wall	From AC.8 to AH.2	From 100'-0" to 135'-0"	3'-0"	No
Column Line AC.8 Wall	From 26.1 to 28	From 100'-0" to 135'-0"	3'-0"	No
Column Line AF Wall	From 26.1 to 28	From 100'-0" to 135'-0"	2'-6"	No
Column Line AH.2 Wall	From 26.1 to 28	From 100'-0" to 135'-0"	3'-0"	No
Floors	Not Applicable	121'-6"	2'-0"	No
Floors	Not Applicable	135'-0"	Variable From 1'-6" to 3'-0"	No
DFOT Building				
Basemat	Not Applicable	63'-0"	4'-0"	No
Column Line 26.1 Wall	From AA.1 to AC.6	From 63'-0" to 100'-0"	2'-6"	No
Column Line 27 Wall	From AA.1 to AC	From 63'-0" to 97'-6"	2'-6"	No
Column Line 28 Wall	From AA.1 to AC.6	From 63'-0" to 100'-0"	4'-0"	No
Column Line AA.1 Wall	From 26.1 to 28	From 63'-0" to 97'-6"	4'-0"	No
Column Line AC.6 Wall	From 26.1 to 28	From 63'-0" to 100'-0"	4'-0"	No
Floors	Not Applicable	97'-6"	2'-0"	No
Floors	Not Applicable	100'-0"	3'-0"	No

~~(1) Tolerance for the thickness of the walls and slabs is -1/4 inch and + 1 inch.~~ deleted

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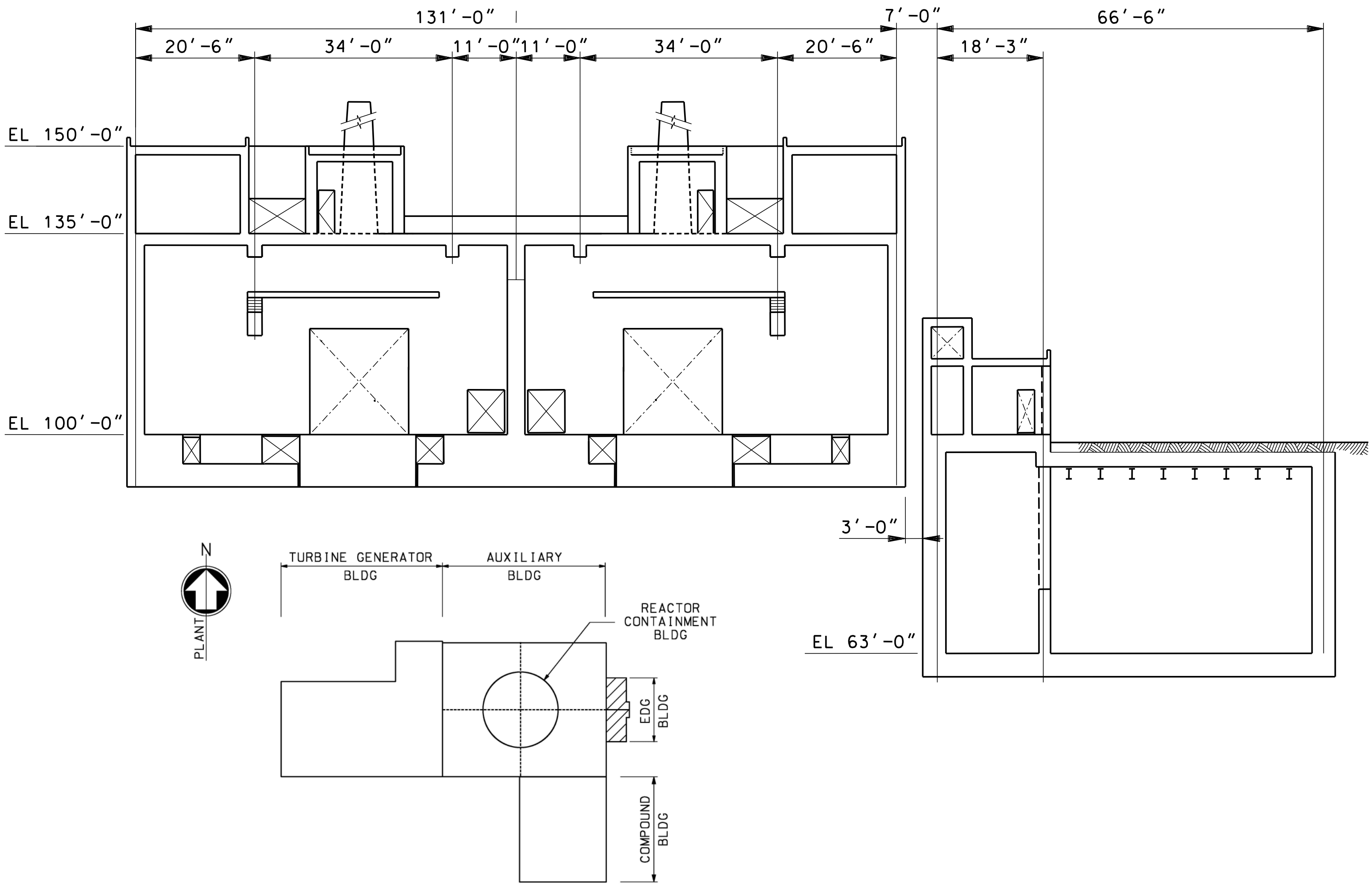

Figure 2.2.2-1 Emergency Diesel Generator Building Block Section

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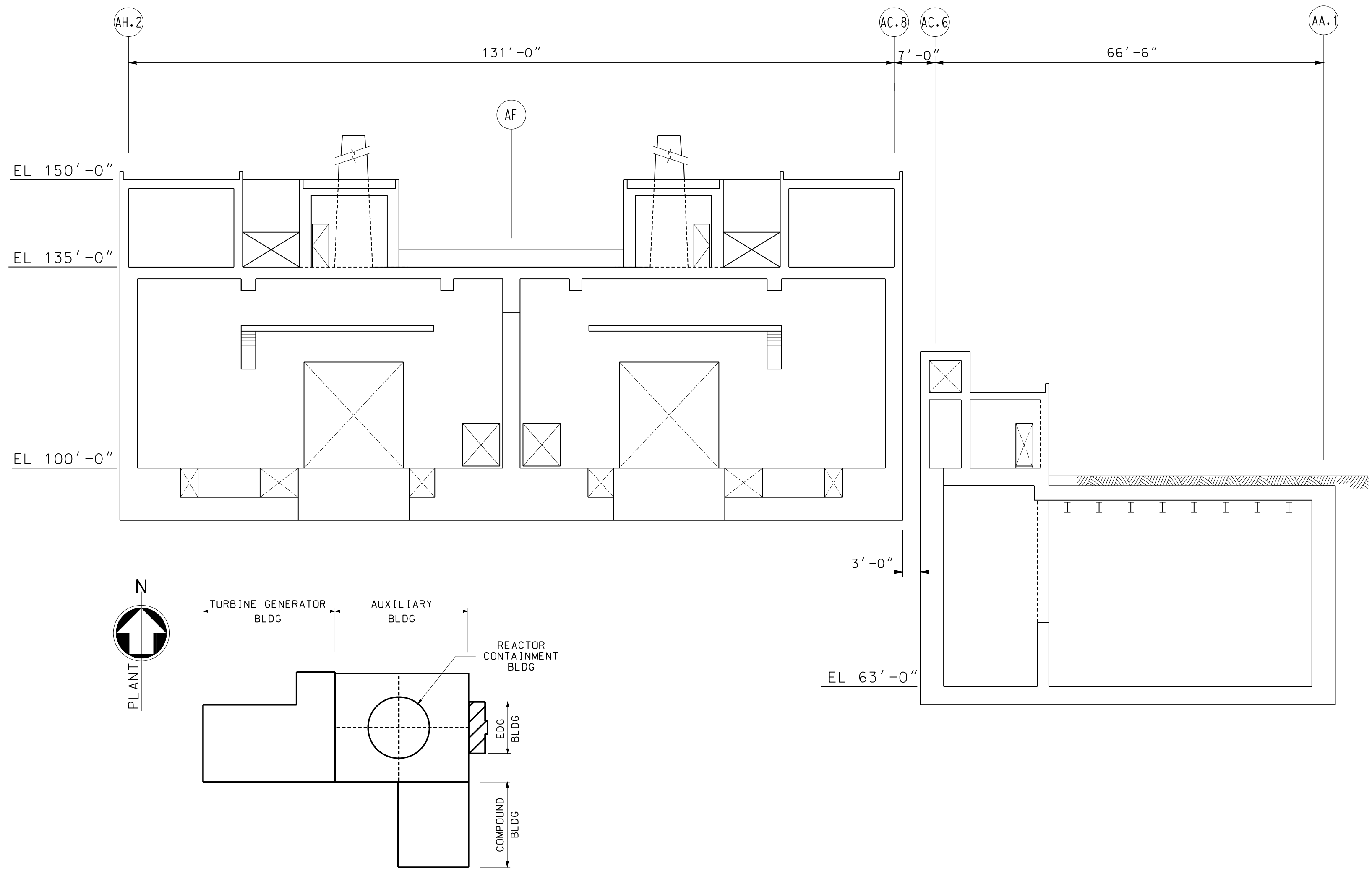

Figure 2.2.2-1 Emergency Diesel Generator Building Block Section

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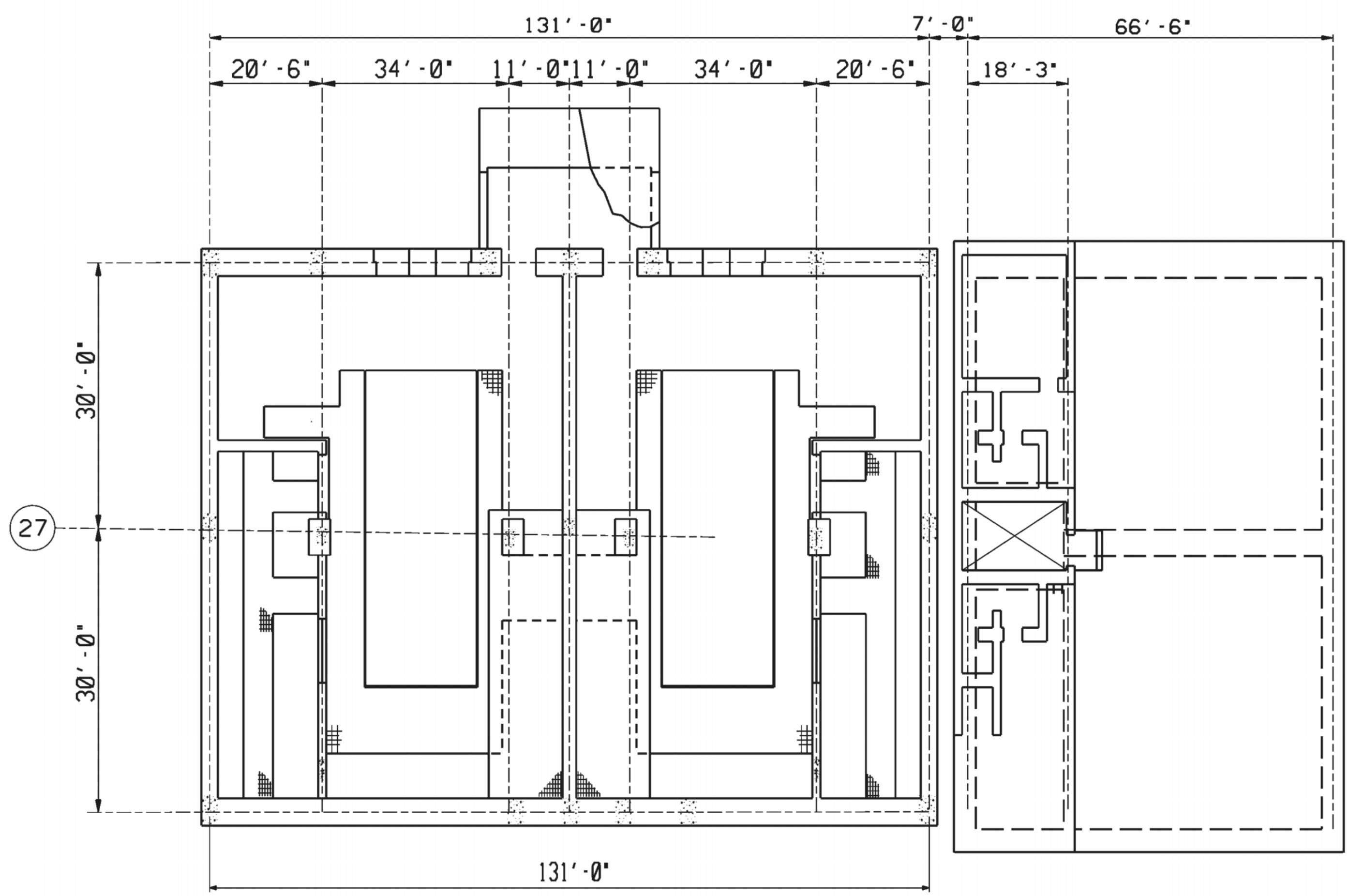

Figure 2.2.2-2 Emergency Diesel Generator Building Block Plan

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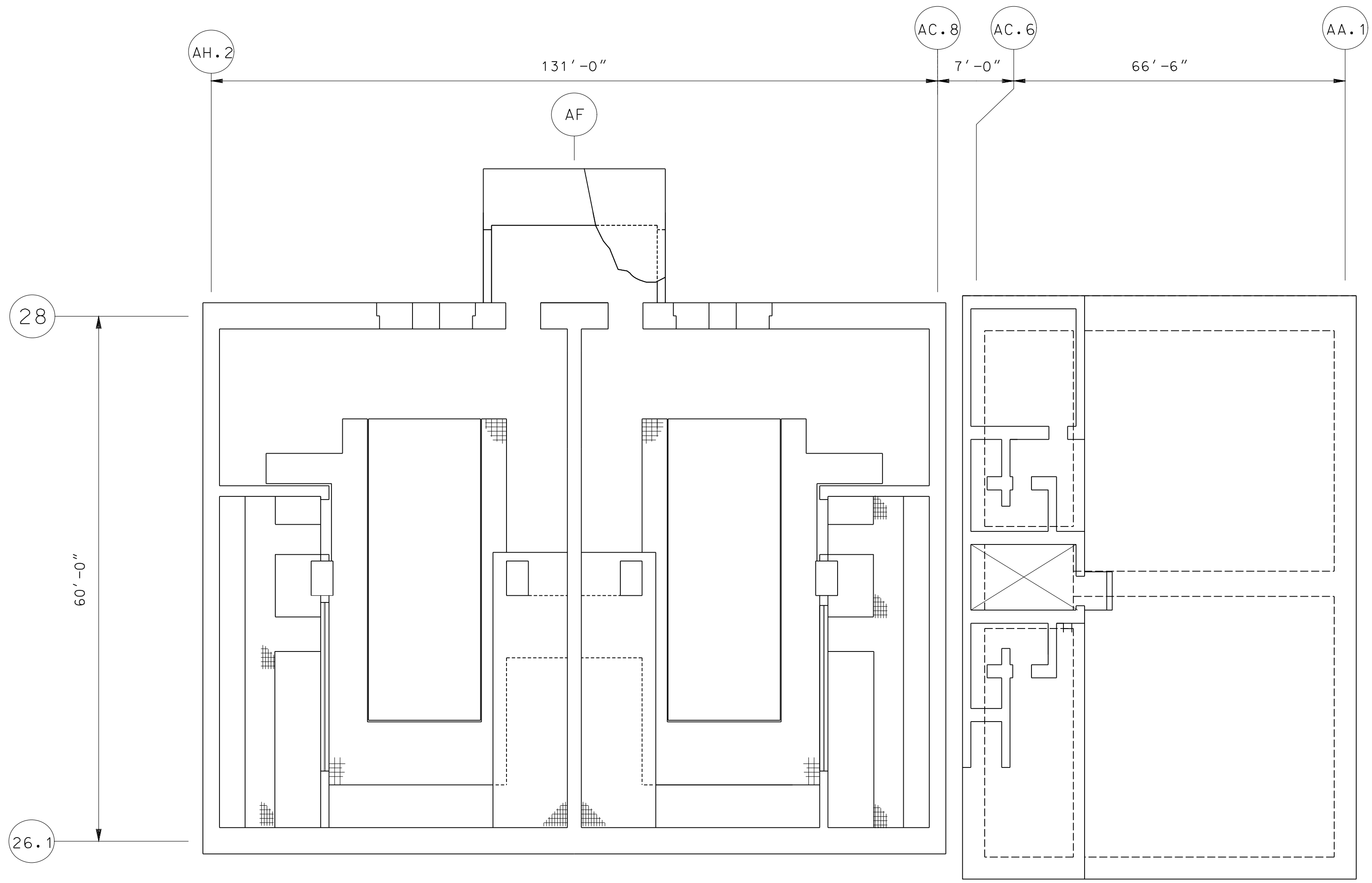

Figure 2.2.2-2 Emergency Diesel Generator Building Block Plan

3.8A.3 Emergency Diesel Generator Building

3.8A.3.1 Structural Description and Geometry

The EDG building block consists of two independent buildings, the EDG building at El. 100 ft 0 in and the diesel fuel oil tank (DFOT) building at El. 63 ft 0 in. The two basemats are separated by the isolation gap of 900 mm (3 ft). The EDG building houses two additional generators, and the DFOT building houses the DFOT.

The lateral load-resisting system of this building is composed of a diaphragm slab at roof level and shear walls monolithically interconnected with the roof. The vertical load-resisting system consists of four columns and the shear walls. The DFOT building is a typical box-type structure, which consists of the slabs, shear walls, and basemat. The building description is provided in Subsection 3.8.4.1.2. The arrangements of the structure are shown in Figures 3.8A-67 and 3.8A-68.

3.8A.3.2 Structural Materials

The major materials of the EDG building block are concrete and reinforcing bars. The properties of the materials are identical to those of the AB, which is described in Subsection 3.8A.2.2.

3.8A.3.3 Loads and Load Combinations

3.8A.3.3.1 Design Loads

The following are the major design loads considered in the design of the EDG building.

Dead Load (D)

Dead load includes the weight of structures and the weight of permanently attached major equipment such as tanks, machinery, and cranes.

The minimum attachment loads include equipment loads lower than 10 kips such as piping, cable trays, and HVAC loads:

a. Concrete floors: 9.6 kN/m^2 (200 psf)

b. Roof floors: 7.2 kN/ m^2 (150 psf)

c. Interior wall: 1.0 kN/ m^2 (20 psf)

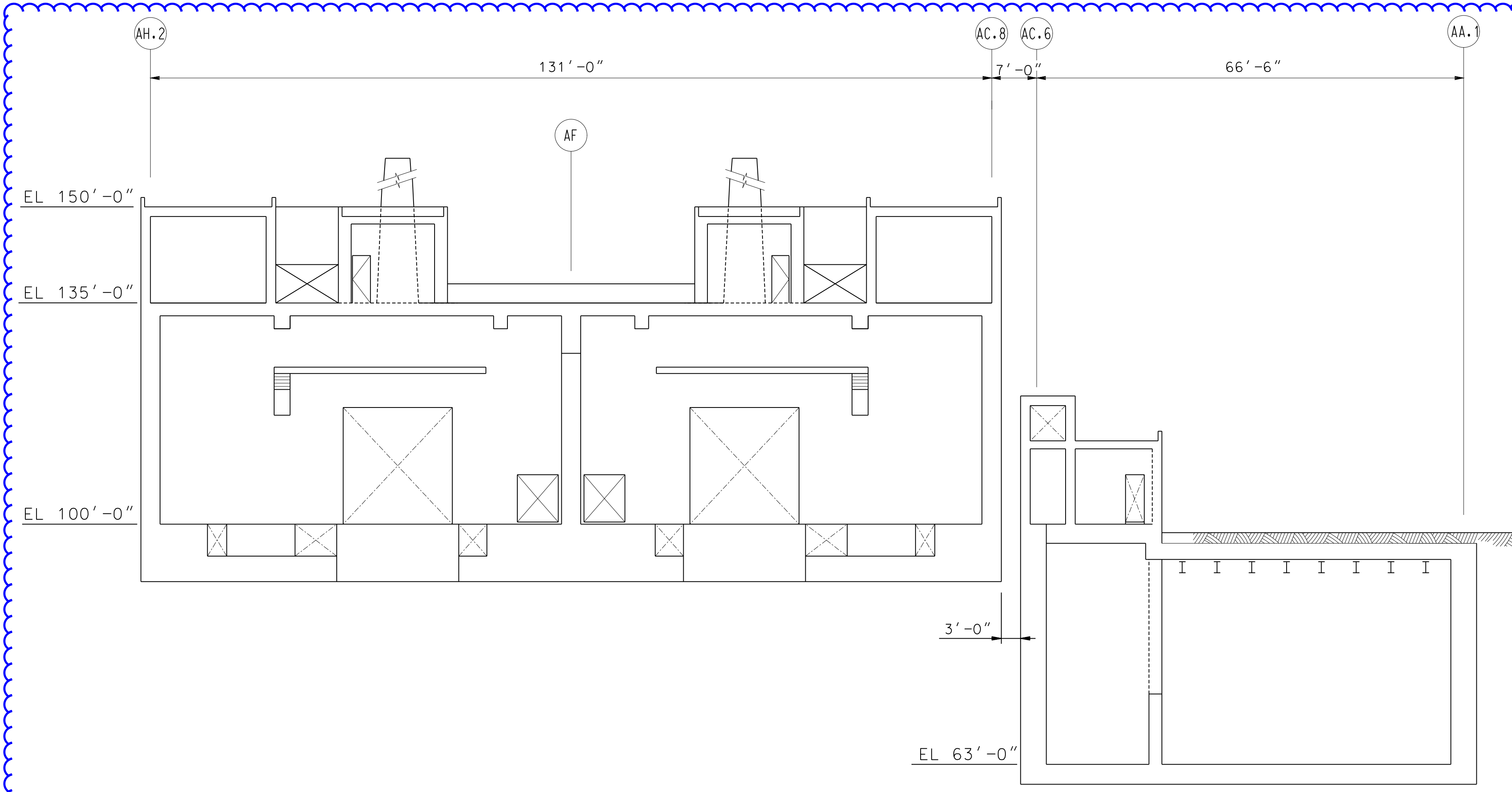

Figure 3.8A-67 Emergency Diesel Generator Building Block Section

Add new figure

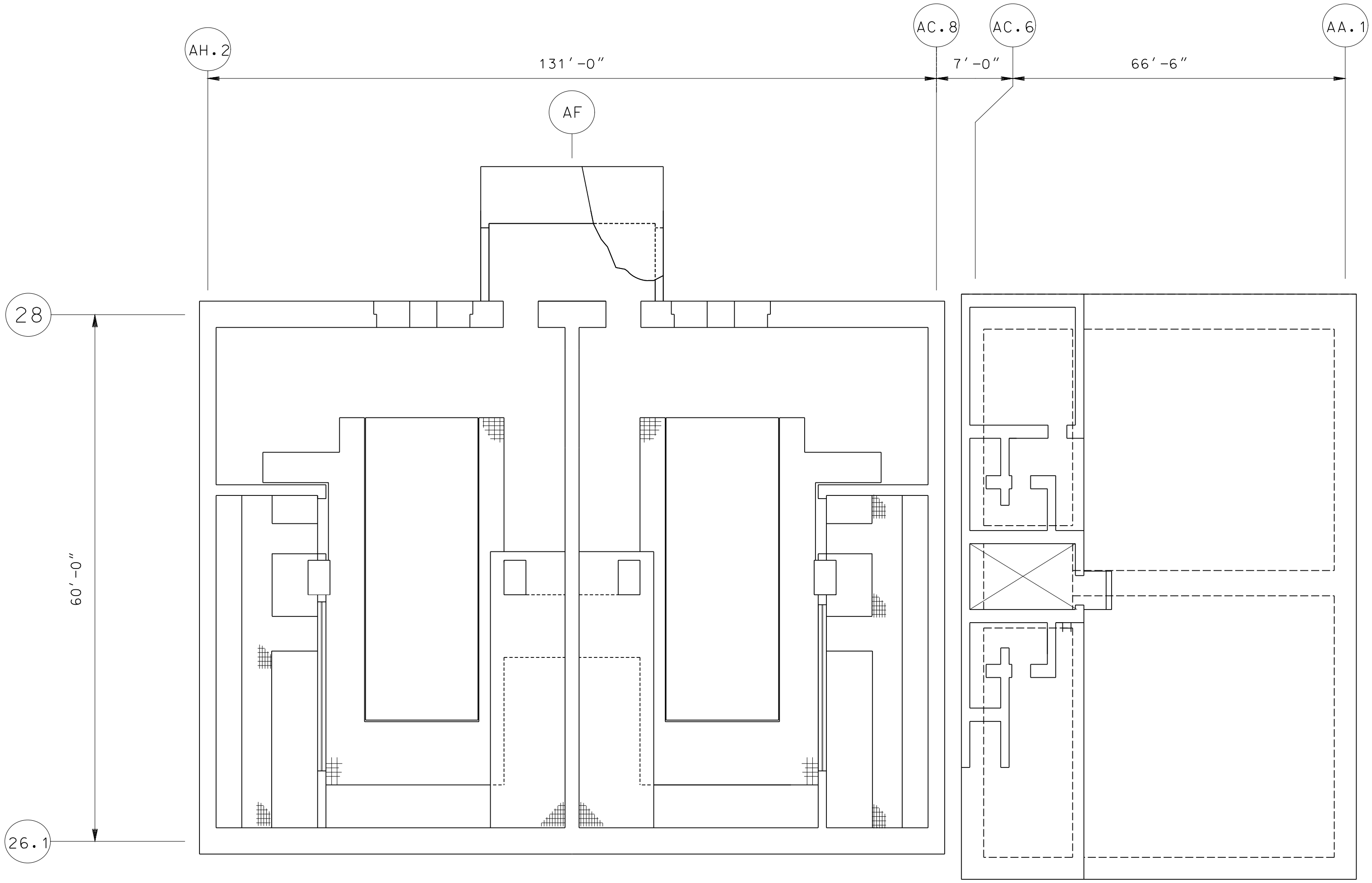

Figure 3.8A-68 Emergency Diesel Generator Building Block Plan

Add new figure

Brackets and Attachments

The allowables given in the ASME Section III, Subarticles CC-3650 and CC-3750, are used as the acceptance criteria for brackets and attachments to the liner.

The APR1400 design avoids the use of brackets and similar items that transmit loads to the liner in the through-thickness direction. As much as practical in the design of attachments that have structural components carrying major loads, for example the upper plates of crane brackets, such a structural component of the attachment is made continuous through the liner. When through-thickness liner loads cannot be avoided and the liner is 25 mm (1 in.) or more thick, then the special welding and material requirements of Subarticle CC-4543.6 are applied. In addition to the requirements given in Subarticle CC-4543.6 (a) through (d), ultrasonic examinations are required prior to fabrication to preclude the existence of laminations in the installed material.

3.8.1.6 Materials, Quality Control, and Special Construction Techniques

This section contains information relating to the materials, quality control program, and special construction techniques and tolerances used in the fabrication and construction of the containment. Materials and quality control satisfy the following requirements:

a. ASME 2001 Edition with 2003 Addenda, Section III, Division 2, Code for Concrete Containments, Articles CC-2000, CC-4000, CC-5000, and CC-6000

b. NRC RG 1.136, Design Limits, Loading Combinations, Materials, Construction, and Testing of Concrete Containments, Revision 3, March 2007.

Concrete and reinforcement forming and placement tolerance not specifically addressed in these references are in accordance with ACI 349 and ACI 117. Add "D" in next page

3.8.1.6.1 Concrete and Concrete Ingredients

The materials to be used for concrete and concrete ingredients are given below.

Cement

Cement used for the concrete containment conforms with the requirements of ASTM C150 (Reference 10).

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"D"

Any provisions in codes which provide acceptance criteria for conditions when tolerances are exceeded shall not apply, but a licensee referencing the APR1400 DCD may deviate from the tolerances in these codes using alternative acceptance criteria, if these acceptance criteria are approved by the NRC. As-built dimensions will also be evaluated to verify compliance with the design bases and applicable codes and standards identified in Table 3.8-1. The COL applicant may provide construction tolerance acceptance criteria and the basis for the criteria (e.g., through the use of analysis, industry research, or testing) for cases where the tolerances in the ACI 117 and ANSI/AISC 303, for structural concrete and structural steel, respectively, may be exceeded (COL 3.8 (22)).

3.8.3.6 Materials, Quality Control, and Special Construction Techniques

3.8.3.6.1 Concrete Internal Structures

Materials, quality control, ~~and~~ special construction techniques , and tolerances for the concrete internal structures are outlined in Subsection 3.8.4.6. The compressive strength of concrete is 6,000 psi at 91 days.

3.8.3.6.2 Structural Steel

The following materials are used:

a. Structural steel – ASTM A36, A572, A588, and A53

b. Bolts – ASTM A325, A490, and A307

c. Anchor bolts – ASTM 193 Grade B-7 and A36

Furnishing and fabrication of structural steel conform with all applicable requirements of AISC N690. Certified mill test reports for structural steel are submitted for review.

3.8.3.6.3 Stainless Steel Pool Liners

Stainless steel pool liners including IRWST liners and HVT liners are fabricated from ASTM A240 Type 304 material, hot rolled, annealed and pickled and further processed by cold rolling. This material quality is ensured in accordance with 10 CFR 50 Appendix B and ASME NQA-1.

Welding procedures are in accordance with ASME Section III, Division 2, Subarticle CC-4540 and ASME Section IX. All seam welds are full-penetration butt welds. The liner plate seam welds are examined and tested as follows:

a. Liquid penetrant examination is performed on austenitic materials. The weld surfaces and at least 12.7 mm (1/2 in.) of the adjacent base material on each side of the weld are examined. The examination coverage is 100 percent of all shop and field seam welds.

b. Vacuum leak test is performed for leak-tightness on all liner plate seam welds.

The structural acceptance criterion on the new fuel storage rack and spent fuel storage rack is to meet the maximum allowable stress limits with given load combinations described in Table 3.8-7C in accordance with the NRC SRP 3.8.4, Appendix D. When the effects of seismic loads are considered, factors of safety against gross sliding and overturning of racks and rack modules under all probable service conditions is in accordance with the NRC SRP 3.8.5, subsection II.5.

3.8.4.6 Material, Quality Control, and Special Construction Techniques

This section contains information relating to the materials, quality control programs, and special construction techniques and tolerances used in the fabrication and construction of the seismic Category I concrete and steel structures other than the reactor containment building.

Add "E" in next page

3.8.4.6.1 Material

The seismic Category I structures are poured-in-place reinforced concrete structures. The major materials that are used in the construction are concrete, reinforcing bars, and structural steel.

3.8.4.6.1.1 Concrete

The minimum concrete compressive strength used in other seismic Category I structures is 34.5 MPa (5,000 psi) at 91 days. The basic ingredients of concrete are cement, fine aggregates, coarse aggregates, and mixing water. Admixtures may be used if needed. The concrete conforms with ACI 349 and ASTM C94.

The COL applicant is to determine the environmental condition associated with the durability of concrete structures and provide the concrete mix design to prevent concrete degradation caused by factors such as the reactions of sulfate and other chemicals, the corrosion of reinforcing bars, and the effect of reactive aggregates (COL 3.8(8)).

Cement is Type I and conforms with ASTM C150. In special circumstances, other approved cements may be used.

Aggregates conform with ASTM C33.

The water and ice used in mixing concrete are clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or steel. The water and ice do not contain more than 500 ppm of chlorides as Cl^-, "E"

The tolerances for structural concrete shall be in accordance with ACI 117, and for structural steel shall be in accordance with ANSI/AISC 303. Any provisions in these codes which provide acceptance criteria for conditions when tolerances are exceeded shall not apply, but a licensee referencing the APR1400 DCD may deviate from the tolerances in these codes using alternative acceptance criteria, if these acceptance criteria are approved by the NRC. As-built dimensions will also be evaluated to verify compliance with the design bases and applicable codes and standards identified in Table 3.8-1. The COL applicant may provide construction tolerance acceptance criteria and the basis for the criteria (e.g., through the use of analysis, industry research, or testing) for cases where the tolerances in the ACI 117 and ANSI/AISC 303, for structural concrete and structural steel, respectively, may be exceeded (COL 3.8 (22)).

minimum angle of internal friction of supporting medium is 35 degrees, which leads to a coefficient of friction of 0.7, and this is to be confirmed by the COL applicant (COL 2.5(10)). The coefficient of friction between the lean concrete and foundation concrete may be used as 1.0 or higher because construction joints of APR1400 shall be intentionally roughened.

The resisting force by base friction is calculated by multiplication of effective dead weight and coefficient of friction. For the calculation of the effective dead weight, probable adverse effects of the buoyant force from design ground water level and seismic uplift force are considered.

For the resisting force by shear keys, partial concave and convex areas of the basemat that are expected to play a role as shear keys are considered. Shear keys may be used to provide additional resistance against basemat sliding. In this sliding evaluation, the difference of passive soil pressure and active soil pressure are considered as the additional resistance provided the direct shear strength on the sliding soil face is larger than the force by passive soil.

3.8.5.5.3 Flotation Acceptance Criteria

The factor of safety against flotation is identified as the ratio of the total dead load of the structure including basemat (D_r) to the buoyant force (F_b). Therefore, $FS_f = D_r / F_b$, not less than the factor of safety determined from Table 3.8-8.

Where:

FS_f = structure factor of safety against flotation caused by the maximum design basis flood or groundwater table

D_r = total dead load of the structure including basemat

F_b = buoyant force caused by the design basis flood or high groundwater table, whichever is greater

3.8.5.6 Material, Quality Control, and Special Construction Techniques

The materials, quality control, ~~and~~ special construction techniques , and tolerances for foundations conform with those set forth for the superstructures as discussed in Subsections 3.8.1.6 and 3.8.4.6 and Appendix 3.8A.

Table 3.8-12 thru Table 3.8-14, and section 3.8.5.4.2.2.d by COL applicant.

6) The effect on the design of seismic Category I structures due to construction sequence analysis shall be accounted for by the COL applicant.

COL 3.8(20) The COL applicant shall perform site-specific evaluations if the shear wave velocity is less than the shear wave velocity profile used in the various basemat evaluations for design certification. The site-specific evaluations ([settlement (maximum vertical displacement, tilt, differential settlement between structures, angular distortion), soil bearing pressure (static and dynamic loading cases), overturning, and sliding]) and 3D FEM global analysis for basemat design of seismic Category I structures shall be performed using the site-specific parameters (measured $E_{static,}$ $E_{dynamic}$ consistent with soil strain assumed in SSI anlaysis) and the methodology described in DCD Tier 2, Subsection 3.8.5 and Technical report APR1400-E-S-NR-14006-P, Subsection 4.

COL 3.8(21) The COL applicant is to confirm that the parking position of the crane and trolley when the crane is not being used is: location of polar crane: Az.280 , trolley location: 12ft 7in away from end of east part. The COL applicant is to confirm that this requirement is included in the technical specification of the COL application for the use of the polar crane.

COL 3.8 (22) The COL applicant may provide construction tolerance acceptance criteria and the basis for the criteria (e.g., through the use of analysis, industry research, or testing) for cases where the tolerances in ACI 117 and ANSI/AISC 303, for structural concrete and structural steel, respectively, may be exceeded.

3.8.7 References

1. 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” U.S. Nuclear Regulatory Commission.

2. ASME Section III, Subsection NE, “Class MC Components,” The American Society of Mechanical Engineers, the 2007 Edition with the 2008 Addenda.

3. ASME Section III, Division 2, “Code for Concrete Containments,” Subsection CC, American Society of Mechanical Engineers, 2001 Edition with 2003 Addenda.

69. ANSI/ANS 8.17, "Criticality Safety Criteria for Handling, Storage, and Transportation of LWR Fuel Outside Reactors," American Nuclear Society, 1984.

70. ASTM C750, "Standard Specification for Nuclear Grade Boron Carbide Power," American Society for Testing and Materials.

71. ASTM E3, "Preparation of Metallographic Specimems," American Society for Testing and Materials.

72. ASTM E190, "Guided Bend Test for Ductility of Weld," American Society for Testing and Materials.

73. ANSI/ANS 57.2, "Design Requirements for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plants," American Nuclear Society, 1983.

74. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," U.S. Nuclear Regulatory Commission.

75. 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," U.S. Nuclear Regulatory Commission.

76. AWS D1.3, "Structural Welding Code-Sheet Steel Structure," American Welding Society, 2008.

77. ACI 340R, "Design of Structural Reinforced Concrete Elements in accordance with the Strength Design Method of ACI 318-95," American Concrete Institute.

78. ACI 117, "Specification for Tolerances for Concrete Construction and Materials and Commentary," American Concrete Institute, 2010.

79. ANSI/AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," American Institute of Steel Construction, 2010.

Table 3.8-1 (2 of 3)

Document Reference No.	Document Designation	Edition	Document Title
19	ASTM A576	1990	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
20	ASTM A416	2002	Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
21	ASTM C191	2013	Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
22	ASTM C109	2013	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
23	ASTM A36	2012	Standard Specification for Carbon Structural Steel
24	ASME IWE	2007 with 2008 Addenda	Requirements for Class MC and Metallic Liners of Class CC Components of Lightwater Cooled Plants
25	ASME IWL	2007 with 2008 Addenda	Requirements for Class CC Concrete Components of Light-water Cooled Plants
26	ASME IX	2007 with 2008 Addenda	Welding and Brazing Qualifications
Specifications:			
27	AISC 360	2005	Specification for Structural Steel Buildings
28	ACI 301	2010	Specifications for Structural Concrete for Building
29	AWS D1.1	2010	Structural Welding Code – Steel Structure
30	AWS D1.3	2008	Structural Welding Code - Sheet Steel Structure
31	AISI S100	2012	Specification for the Design of Cold-Formed Steel Structural Members
32	ACI 211.1	1991 (R2007)	Standard Practice for Selecting Proportions for Normal, Heavy Weight, and Mass Concrete
33	ACI 214	1991 (R1997)	Recommended Practice for Evaluation of Strength Test Results of Concrete
34	ACI 304 R	2000 (R2009)	Guide for Measuring, Mixing, Transporting, and Placing Concrete
35	ACI 305 R	1999	Hot Weather Concreting
36	ACI 306 R	1998 (R2002)	Cold Weather Concreting
37	ACI 308	1992 (R1997)	Standard Practice for Curing Concrete
38	ACI 309 R	2005	Guide for Consolidation of Concrete

##	ANSI/AISC 303	2010	Code of Standard Practice for Steel Buildings and Bridges

Table 3.8-1 (3 of 3)

Document Reference No.	Document Designation	Edition	Document Tit1e
39	ACI 311.1 R	1999	ACI Manual of Concrete Inspection
40	ACI 315	1999	Details and Detailing of Concrete Reinforcement
41	ACI 340R		Design of Structural Reinforced Concrete Elements in Accordance with the Strength Design Method of ACI 318-95
42	ACI 347	2004	Guide to Formwork for Concrete
43	ANSI/ANS 8.1	1988	Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors
44	ANSI/ANS 8.17	1984	Criticality Safety Criteria for Handling, Storage, and Transportation of LWR Fuel Outside Reactors
45	ANSI/ANS 57.2	1983	Design Requirements for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plants
U.S. Regulations			
46	10 CFR Part 50	-	Domestic Licensing of Production and Utilization Facilities
47	10 CFR Part 52	-	Domestic Licensing of Production and Utilization Facilities
48	10 CFR Part 100	-	Reactor Site Criteria

Abbreviation

ACI American Concrete Institute
AISC American Institute of Steel Construction
AISI American Iron and Steel Institute
ANS American Nuclear Society
ASME American Society of Mechanical Engineers
ASTM American Society of Testing and Materials
AWS American Welding Society

##	ACI 117	2010	Specification for Tolerances for Concrete construction and Materials and Commentary

Table 1.8-2 (9 of 39)

Item No.	Description
COL 3.8(19)	The following items should be considered by the COL applicant: 1) The surveyed soil profiles will be developed. 2) Based on the surveyed soil characteristics, differences from the DCD soil profiles may exist. These differences may include: a. Stiff or soft soil areas; b. Different soil types (e.g, cohesive); c. Potential for loss of cement in the mudmat; d. Non-uniformity of soil layers, or e. Other differences in the soil profile from the properties assumed in design certification. If any of these items and/or conditions are identified, then a site-specific evaluation[1)] shall be performed and checked for adequacy. 3) The time (i.e, short term and long term) instantaneous settlement and time-consolidation effects shall be evaluated in accordance with surveyed soil profiles regardless if a site-specific evaluation is needed under Item 2) above. The bearing pressure shall be checked to demonstrate acceptability with the acceptance criteria in DCD Table 2.0-1. Settlements shall be checked in Table 3.8-12 thru Table 3.8-14, and section 3.8.5.4.2.2.d. 4) The COL applicant will build the seismic Category I structure according to the construction sequence used in the site-specific construction sequence analysis. 5) If a site-specific evaluation[1)] is required, the COL applicant should perform a construction sequence analysis based on the site-specific parameters. If the settlement including results of construction sequence analysis exceeds the acceptance criteria described in Table 3.8-12 thru Table 3.8-14, and section 3.8.5.4.2.2.d., the construction sequence will be modified to meet the acceptance criteria described in Table 3.8-12 thru Table 3.8-14, and section 3.8.5.4.2.2.d. by COL applicant. 6) The effect on the design of seismic Category I structures due to construction sequence analysis shall be accounted for by the COL applicant.
COL 3.8(20)	The COL applicant shall perform site-specific evaluations if the shear wave velocity is less than the shear wave velocity profile used in the various basemat evaluations for design certification. The site-specific evaluations ([settlement (maximum vertical displacement, tilt, differential settlement between structures, angular distortion), overturning, and sliding]) and 3D FEM global analysis for basemat design of seismic Category I structures shall be performed using the site-specific parameters (measured E_{static}, $E_{dynamic}$ consistent with soil strain assumed in SSI analysis) and the methodology described in Subsection 3.8.5 and Technical report APR1400-E-S-NR-14006-P, Subsection 4.
COL 3.8(21)	The COL applicant is to confirm that the parking position of the crane and trolley when the crane is not being used is: location of polar crane: Az.280º, trolley location: 12ft 7in away from end of east part. The COL applicant is to confirm that this requirement is included in the technical specification of the COL application for the use of the polar crane.
COL 3.8(22)	The COL applicant may provide construction tolerance acceptance criteria and the basis for the criteria (e.g., through the use of analysis, industry research, or testing) for cases where the tolerances in ACI 117 and ANSI/AISC 303, for structural concrete and structural steel, respectively, may be exceeded.

1) evaluation includes basemat and superstructure design (forces/stresses), settlement evaluations, soil bearing pressure evaluation, and stability evaluation.

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personnel air locks and an equipment hatch. Penetrations are provided for electrical and mechanical components and for the transport of nuclear fuel.

The containment internal structures consist of reinforced concrete and structural steels that support reactor vessel and reactor coolant system. The primary shield wall supports and laterally surrounds the reactor vessel. The secondary shield wall laterally surrounds the primary shield wall and is structurally connected to the primary shield wall by reinforced concrete slabs, beams, and walls. The secondary shield wall supports steam generators and pressurizer. The containment internal structures enclose a reactor cavity area below the reactor vessel which can be flooded during a postulated accident. An indirect gas vent path is provided between the reactor cavity and the free volume of the containment.

The reactor cavity has a corium debris chamber. And the reactor cavity floor is constructed with a fill concrete on steel liner plate. The reactor cavity floor area is free from obstructions to corium debris spreading.

The AB is a reinforced concrete structure which consists of the electrical and control area, the fuel handling area, the chemical and volume control system area, the main steam valve house, and the emergency diesel generator area. The AB laterally surrounds the RCB and is divided by divisional walls.

The NI structures ~~are~~ , including the critical sections and design attributes listed in Table 2.2.1-4, ~~are~~ seismic Category I, and are designed and constructed to withstand the design basis loads associated with:

1. Normal plant operation (including dead loads, live loads, lateral earth pressure loads, hydrodynamic loads, and equipment loads, including the effects of temperature and equipment vibration)

2. External events (including rain, snow, wind, flood, tornado or hurricane, tornado or hurricane generated missiles, and earthquake)

3. Internal events (including flooding, pipe rupture, equipment failure, and equipment failure generated missile)

Seismic classification of the building is shown in Table 2.2.1-3.

1. The basic configuration of the NI structure is as shown in Figure 2.2.1-1 through Figure 2.2.1-13.

2.a The containment is designed and constructed to meet the requirements of ASME Section III, Div. 2.

2.b The containment penetrations are designed and constructed to meet ASME Section III.

2.c The containment and its penetrations retain their pressure boundary integrity associated with the design pressure.

2.d The containment and its penetrations maintain the containment leakage rate less than or equal to the maximum allowable leakage rate associated with the peak containment pressure for the design basis accident.

3. The NI structures are seismic Category I, and are designed and constructed to withstand the design basis loads.

4. ~~The key dimensions of the NI structures are described in Table 2.2.1-1.~~ The dimensions and elevations of the NI structures are as described in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13.

6. The critical sections and design attributes of the NI structures are ~~described in~~ in accordance with Table 2.2.1-4.

2.2.1.2 Inspections, Tests, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for nuclear island structures are specified in Table 2.2.1-2.

The dimensions and elevations of the NI structures are as described in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13.

~~critical section layout and elevations, including wall and slab thickness~~

Table 2.2.1-2 (2 of 2)

as-built

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
3. The NI structures are seismic Category I, and are designed and constructed to withstand the structural design basis loads.	3. A structural analysis will be performed to reconcile the as-built NI structures with the structural design basis loads.	3. A report exists and concludes that the NI structures can withstand the design basis loads.
4. ~~The key dimensions of the NI structures are described in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13.~~	4. ~~Inspection will be performed to verify that the as-built wall and slab thickness conform with the structural configuration.~~	4. ~~A report exists and concludes that the NI structure as-built wall and slab thickness conform with the structural configuration as described in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13.~~

Add item 6 in next page

~~critical section layout and elevations, including wall and slab thickness~~

~~, Table 2.2.1-4,~~

A report exists and concludes that the as-built dimensions and elevations of the NI structures are as described in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13.

Inspection will be performed of the dimensions and elevations of the as-built NI structures.

A review of the as-built design and construction documentation will be performed to verify the critical sections and design attributes are in accordance with Table 2.2.1-4.

6. The critical sections and design attributes of the NI structures are described in Table 2.2.1-4.	6. ~~Inspection will be performed to verify that the as-built NI structural design, including critical sections and design attributes are in accordance with codes and standards approved in the design certification. Deviations from the design due to as-built conditions will be reconciled for the design basis loads.~~	~~6.i A reports exists and concludes that the as-built NI structural design conform with the critical sections and design attributes as described in Table 2.2.1-4.~~ ~~6.ii A report exists which reconciles deviations during construction and concludes that as-built NI structures, including the critical sections and design attributes, conform to the approved design in the design certification and will withstand the design basis loads.~~

6. A reports exists and concludes the critical sections and design attributes of the NI structures are in accordance with Table 2.2.1-4.

Table 2.2.1-4 (1 of 4)

Critical Sections and Design Attributes

Critical Sections	Design Attributes $R^{(1),(2),(3),(4),(5)\text{ (as appropriate)}} \leq D/C$ {Maximum} Ratio ≤ Demand/Capacity	
Containment Wall and Dome		
Cylindrical Wall-Basemat Junction Area	Meridional Direction	0.80 (Inside Layers)
		0.99 (Outside Layers)
	Hoop Direction	0.60 (Inside Layers)
		0.96 (Outside Layers)
	Shear Reinforcement	0.79
Thickened Sections Around Large Penetrations (Equipment Hatch and Personnel Airlocks)	Meridional Direction	0.73 (Inside Layers)
		1.00 (Outside Layers)
	Hoop Direction	0.60 (Inside Layers)
		0.96 (Outside Layers)
	Shear Reinforcement	0.85
Polar Crane Brackets Area Level and Springline	Meridional Direction	0.51 (Inside Layers)
		0.88 (Outside Layers)
	Hoop Direction	0.80 (Inside Layers)
		0.81 (Outside Layers)
	Shear Reinforcement	0.79
Containment Dome	Meridional Direction	0.09 (Inside Layers)
		0.93 (Outside Layers)
	Hoop Direction	0.37 (Inside Layers)
		0.94 (Outside Layers)
	Shear Reinforcement	N/A
Mid-Height of Wall	Meridional Direction	0.87 (Inside Layers)
		0.85 (Outside Layers)
	Hoop Direction	0.73 (Inside Layers)
		0.93 (Outside Layers)
	Shear Reinforcement	0.74
Containment Liner Plate/Anchorage	Liner Plate	1.00
	Liner Anchorage	0.33
Containment Internal Structures		
North wall of Primary Shield Wall	Meridional Direction	0.87
	Hoop Direction	0.80
	Shear Reinforcement	0.92
East wall of Primary Shield Wall	Meridional Direction	0.75
	Hoop Direction	0.89
	Shear Reinforcement	0.65

Add new Table

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Table 2.2.1-4 (2 of 4)

Critical Sections	Design Attributes $R^{(1),(2),(3),(4),(5)\text{ (as appropriate)}} \leq$ D/C {Maximum} Ratio ≤ Demand/Capacity	
Containment Internal Structures (cont.)		
South wall of Primary Shield Wall	Meridional Direction	0.83
	Hoop Direction	0.79
	Shear Reinforcement	0.19
Secondary Shield Wall	Meridional Direction	0.86
	Hoop Direction	0.92
	Shear Reinforcement	0.72
Refueling Pool Wall (S/N & W Wall)	Meridional Direction	0.88
	Hoop Direction	0.89
	Shear Reinforcement	0.91
Steam Generator Enclosure Wall (Circular & Straight Wall)	Meridional Direction	0.78
	Hoop Direction	0.9
	Shear Reinforcement	0.85
Pressurizer Enclosure Wall	Meridional Direction	0.82
	Hoop Direction	0.76
	Shear Reinforcement	0.91
Top Slab and Outer Wall in IRWST	Meridional Direction	0.94
	Hoop Direction	0.68
Operating Floor Slab at Elevation 156 ft 0 in	Radial Direction (at SSW Area)	0.85
	Radial Direction (at Central Area)	0.98
	Tangential Direction	0.93
Nuclear Island (NI) Common Basemat		
Tendon Gallery Outside Area of RCB Basemat (Section–01)	Flexural Rebar	0.91
	Shear Reinforcement	0.84
Tendon Gallery Upper Area of RCB Basemat (Section–02)	Flexural Rebar	0.81
	Shear Reinforcement	0.73
Tendon Gallery Below Area of RCB Basemat (Section–03)	Flexural Rebar	0.42
	Shear Reinforcement	0.46
R = 63.25’ to 70.5’ at El. 45’ to El. 78’ of RCB Basemat (Section-04)	Flexural Rebar	0.73
	Shear Reinforcement	0.1
R = 42.5’ to 63.25’ exclude Design Sections -06, -07, -08 (Section-05)	Flexural Rebar	0.99
	Shear Reinforcement	0.53
Cavity Area at El. 55’ to 66’ of RCB Basemat (Section-06)	Flexural Rebar	0.57
	Shear Reinforcement	0.9
x = 22’ to 39’ and y = 0’ to 18.75’ at El. 55’ to 76’ of RCB Basemat (Section-07)	Flexural Rebar	0.67
	Shear Reinforcement	0.74
x,y = 0’ to 42.5’ exclude Design Sections -06, 07 of RCB Basemat (Section-08)	Flexural Rebar	0.95
	Shear Reinforcement	0.81

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Table 2.2.1-4 (3 of 4)

Critical Sections	Design Attributes $R^{(1),(2),(3),(4),(5)\text{ (as appropriate)}} \leq D/C$ {Maximum} Ratio ≤ Demand/Capacity	
Nuclear Island (NI) Common Basemat (cont.)		
NI Basemat Below Auxiliary Building	EW Direction of Each Element Set (15)	0.93 (Top Layer)
		0.93 (Bottom Layer)
	NS Direction of Each Element Set (15)	0.94 (Top Layer)
		0.94 (Bottom Layer)
	Shear Reinforcement	0.97
Auxiliary Building (AB)		
Nort+A59:C63h wall of north MSIV house (column line AK, column line 17 to 20), Elevation 55 ft. to 174 ft.	Horizontal Direction of Each Zone	0.98
	Vertical Direction of Each Zone	0.85
	Shear Reinforcement	0.74
North wall of north AFWST (column line AJ, column line 15 to 22), Elevation 100 ft. to 137.5 ft.	Horizontal Direction of Each Zone	0.76
	Vertical Direction of Each Zone	0.71
	Shear Reinforcement	N/A
West wall of MCR (column line AE to AG, column line 12), Elevation 55 ft. to 195 ft.	Horizontal Direction of Each Zone	0.91
	Vertical Direction of Each Zone	0.87
	Shear Reinforcement	0.71
West wall of SFP (column line AF to AH, column line 23), Elevation 114 ft. to 156 ft.	Horizontal Direction of Each Zone	0.80
	Vertical Direction of Each Zone	0.77
	Shear Reinforcement	0.61
East wall of FHA (column line AF to AK, column line 26), Elevation 156 ft. to 213 ft. 6 in	Horizontal Direction of Each Zone	0.81
	Vertical Direction of Each Zone	0.63
	Shear Reinforcement	0.20
Floor slab of EDG-1 room at Elevation 100 ft.	EW Direction	0.54 (Top Layer)
		0.59 (Bottom Layer)
	NS Direction	0.82 (Top Layer)
		0.44 (Bottom Layer)
Floor slab of EDG-2 room at Elevation 100 ft.	EW Direction	0.78 (Top Layer)
		0.99 (Bottom Layer)
	NS Direction	0.78 (Top Layer)
		0.78 (Bottom Layer)

Add new Table

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Table 2.2.1-4 (4 of 4)

Critical Sections	Design Attributes R(1),(2),(3),(4),(5) (as appropriate) ≤ D/C {Maximum} Ratio ≤ Demand/Capacity	
Auxiliary Building (AB) (cont.)		
Bottom Slab of SFP at Elevation 114 ft.	EW Direction	0.94 (Top Layer)
		0.94 (Bottom Layer)
	NS Direction	1.00 (Top Layer)
		1.00 (Bottom Layer)
Floor slab of MSE at Elevation 137 ft. 6 in	EW Direction	0.75 (Top Layer)
		0.46 (Bottom Layer)
	NS Direction	0.49 (Top Layer)
		0.68 (Bottom Layer)
Emergency Diesel Generator Building (EDGB)		
West wall, Elevation 100 ft. to 135 ft.	Horizontal Direction	0.75
	Vertical Direction	0.86
Center wall, Elevation 100 ft. to 135 ft.	Horizontal Direction	0.42
	Vertical Direction	0.91

(1) Provided Reinforecement vs Required Reinforcement

(2) Allowable Stress vs Rebar Stress

(3) Allowabe Stress vs Maximum Stress

(4) Allowabe Stress vs Concrete Stress

(5) For Liner/Anchorage: Allowable Stress vs Maximum Stress / Allowable Displacement vs Maximum Displacement

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Table 2.2.1-4 (1 of 5)

Critical Sections and Design Attributes

Critical Sections	Design Attributes Ratio(R) ≤ Demand/Capacity		
Containment Wall and Dome			
Cylindrical Wall-Basemat Junction Area	Meridional Direction (1)	Inside	0.78 / 0.80
		Outside	0.66 / 0.99
	Hoop Direction (1)	Inside	0.60 / 0.54
		Outside	0.67 / 0.96
Equipment Hatch	Meridional Direction (1)	Inside	0.73 / 0.73
		Outside	0.73 / 1.00
	Hoop Direction (1)	Inside	0.75 / 0.70
		Outside	0.61 / 0.91
Personnel Airlock	Meridional Direction (1)	Inside	0.59 / 0.53
		Outside	0.70 / 1.00
	Hoop Direction (1)	Inside	0.95 / 0.81
		Outside	0.85 / 0.98
Polar Crane Brackets Area Level and Springline	Meridional Direction (1)	Inside	0.51 / 0.31
		Outside	0.35 / 0.88
	Hoop Direction (1)	Inside	0.80 / 0.67
		Outside	0.42 / 0.81
Containment Dome	Meridional Direction (1)	Inside	0.09 / 0.05
		Outside	0.43 / 0.93
	Hoop Direction (1)	Inside	0.38 / 0.30
		Outside	0.58 / 0.94
Mid-Height of Wall	Meridional Direction (1)	Inside	0.87 / 0.72
		Outside	0.63 / 0.85
	Hoop Direction (1)	Inside	0.73 / 0.58
		Outside	0.63 / 0.93
Containment Liner Plate/Anchorage	Liner Plate (2)	Construction	0.82
	Liner Plate (3)	Service (membrane strain)	0.60
		Service (membrane & bending strain)	1.00
		Factored (membrane strain)	0.48
		Factored (membrane & bending strain)	0.44
	Liner Anchorage (4)	0.33	
Containment Internal Structures			
North wall of Primary Shield Wall	Meridional Direction (9)	0.87	
	Hoop Direction (9)	0.80	
East wall of Primary Shield Wall	Meridional Direction (9)	0.75	
	Hoop Direction (9)	0.89	
South wall of Primary Shield Wall	Meridional Direction (9)	0.83	
	Hoop Direction (9)	0.79	
Secondary Shield Wall	Meridional Direction (9)	0.86	
	Hoop Direction (9)	0.92	
Refueling Pool Wall (North /South Wall)	Meridional Direction (9)	0.88	
	Hoop Direction (9)	0.88	
Refueling Pool Wall (West Wall)	Meridional Direction (9)	0.79	
	Hoop Direction (9)	0.82	
Steam Generator Enclosure Wall (Circular Wall)	Meridional Direction (9)	0.78	
	Hoop Direction (9)	0.90	

Table 2.2.1-4 (2 of 5)

Critical Sections and Design Attributes

Critical Sections	Design Attributes Ratio(R) ≤ Demand/Capacity		
Steam Generator Enclosure Wall (Straight Wall)	Meridional Direction (9)	0.78	
	Hoop Direction (9)	0.87	
Pressurizer Enclosure Wall	Meridional Direction (9)	0.82	
	Hoop Direction (9)	0.76	
Top Slab in IRWST	Meridional Direction (7)	0.84	
	Hoop Direction (7)	0.34	
Outer Wall in IRWST	Meridional Direction (7)	0.05	
	Hoop Direction (7)	0.57	
Operating Floor Slab at Elevation 156 ft 0 in	Radial Direction (7) (at SSW Area)	2ft Thickness	0.85
	Radial Direction (7) (at Central Area)		0.81
	Tangential Directions (7)		0.90
	Radial Direction (7) (at SSW Area)	3ft Thickness	0.68
	Radial Direction (7) (at Central Area)		0.98
	Tangential Directions (7)		0.93
Nuclear Island (NI) Common Basemat			
Tendon Gallery Outside Area of RCB Basemat (Section–01)	Flexural Rebar (5)	0.91 / 0.76	
	Shear Reinforcement (6)	0.84	
Tendon Gallery Upper Area of RCB Basemat (Section–02)	Flexural Rebar (5)	0.81 / 0.43	
	Shear Reinforcement (6)	0.73	
Tendon Gallery Below Area of RCB Basemat (Section–03)	Flexural Rebar (5)	0.42 / 0.33	
	Shear Reinforcement (6)	0.46	
R = 63.25’ to 70.5’ at El. 45’ to El. 78’ of RCB Basemat (Section-04)	Flexural Rebar (5)	0.36 / 0.73	
	Shear Reinforcement (6)	0.01	
R = 42.5’ to 63.25’ exclude Design Sections -06, -07, -08 (Section-05)	Flexural Rebar (5)	0.47 / 0.99	
	Shear Reinforcement (6)	0.53	
Cavity Area at El. 55’ to 66’ of RCB Basemat (Section-06)	Flexural Rebar (5)	0.25 / 0.57	
	Shear Reinforcement (6)	0.90	
x = 22’ to 39’ and y = 0’ to 18.75’ at El. 55’ to 76’ of RCB Basemat (Section-07)	Flexural Rebar (5)	0.25 / 0.67	
	Shear Reinforcement (6)	0.74	
x,y = 0’ to 42.5’ exclude Design Sections -06, 07 of RCB Basemat (Section-08)	Flexural Rebar (5)	0.37 / 0.95	
	Shear Reinforcement (6)	0.81	
NI Basemat Below Auxiliary Building	EW Direction (7)	Element Set 1 (8)	0.76
	NS Direction (7)		0.88
	Shear Reinforcement (7)		0.72
	EW Direction (7)	Element Set 2 (8)	0.93
	NS Direction (7)		0.75
	Shear Reinforcement (7)		0.35
	EW Direction (7)	Element Set 3 (8)	0.78
	NS Direction (7)		0.83
	Shear Reinforcement (7)		0.65
	EW Direction (7)	Element Set 4 (8)	0.90
	NS Direction (7)		0.87
	Shear Reinforcement (7)		0.74

Table 2.2.1-4 (3 of 5)

Critical Sections and Design Attributes

Critical Sections	Design Attributes Ratio(R) ≤ Demand/Capacity		
NI Basemat Below Auxiliary Building	EW Direction (7)	Element Set 5 (8)	0.76
	NS Direction (7)		0.73
	Shear Reinforcement (7)		0.72
	EW Direction (7)	Element Set 6 (8)	0.89
	NS Direction (7)		0.81
	Shear Reinforcement (7)		0.88
	EW Direction (7)	Element Set 7 (8)	0.71
	NS Direction (7)		0.70
	Shear Reinforcement (7)		0.52
	EW Direction (7)	Element Set 8 (8)	0.80
	NS Direction (7)		0.68
	Shear Reinforcement (7)		0.97
	EW Direction (7)	Element Set 9 (8)	0.92
	NS Direction (7)		0.87
	Shear Reinforcement (7)		0.93
	EW Direction (7)	Element Set 10 (8)	0.79
	NS Direction (7)		0.78
	Shear Reinforcement (7)		0.58
	EW Direction (7)	Element Set 11 (8)	0.81
	NS Direction (7)		0.94
	Shear Reinforcement (7)		0.65
	EW Direction (7)	Element Set 12 (8)	0.70
	NS Direction (7)		0.71
	Shear Reinforcement (7)		0.66
	EW Direction (7)	Element Set 13 (8)	0.83
	NS Direction (7)		0.68
	Shear Reinforcement (7)		0.29
	EW Direction (7)	Element Set 14 (8)	0.68
	NS Direction (7)		0.75
	Shear Reinforcement (7)		0.19
	EW Direction (7)	Element Set 15 (8)	0.83
	NS Direction (7)		0.70
	Shear Reinforcement (7)		0.19
Auxiliary Building (AB)			
North wall of north MSIV house (column line AK, column line 17 to 20)	Horizontal Direction (7)	Zone 1 Elevation 55'-0" to 100'-0"	0.97
	Vertical Direction (7)		0.85
	Shear Reinforcement (7)		0.75
	Horizontal Direction (7)	Zone 2 Elevation 100'-0" to 120'-0"	0.84
	Vertical Direction (7)		0.86
	Shear Reinforcement (7)		0.31
	Horizontal Direction (7)	Zone 3 Elevation 120'-0" to 137'-6"	0.78
	Vertical Direction (7)		0.66
	Shear Reinforcement (7)		N/A
North wall of north MSIV house (column line AK, column line 17 to 20)	Horizontal Direction (7)	Zone 4 Elevation 137'-6" to 174'-0"	0.40
	Vertical Direction (7)		0.46
	Shear Reinforcement (7)		0.22

Table 2.2.1-4 (4 of 5)

Critical Sections and Design Attributes

Critical Sections	Design Attributes Ratio(R) ≤ Demand/Capacity		
North wall of north AFWST (column line AJ, column line 15 to 22)	Horizontal Direction (7)	Zone 1 Elevation 100'-0" to 137'-6"	0.76
	Vertical Direction (7)		0.71
	Shear Reinforcement (7)		N/A
West wall of MCR (column line AE to AG, column line 12)	Horizontal Direction (7)	Zone 1 Elevation 55'-0" to 100'-0"	0.85
	Vertical Direction (7)		0.77
	Shear Reinforcement (7)		0.70
	Horizontal Direction (7)	Zone 2 Elevation 100'-0" to 137'-6"	0.83
	Vertical Direction (7)		0.87
	Shear Reinforcement (7)		N/A
	Horizontal Direction (7)	Zone 3 Elevation 137'-6" to 156'-0"	0.94
	Vertical Direction (7)		0.80
	Shear Reinforcement (7)		N/A
	Horizontal Direction (7)	Zone 4 Elevation 156'-0" to 174'-0"	0.82
	Vertical Direction (7)		0.52
	Shear Reinforcement (7)		0.61
	Horizontal Direction (7)	Zone 5 Elevation 174'-0" to 195'-0"	0.91
	Vertical Direction (7)		0.72
	Shear Reinforcement (7)		N/A
West wall of SFP (column line AF to AH, column line 23)	Horizontal Direction (7)	Zone 1 Elevation 114'-0" to 156'-0"	0.80
	Vertical Direction (7)		0.78
	Shear Reinforcement (7)		0.61
East wall of FHA (column line AF to AK, column line 26)	Horizontal Direction (7)	Zone 1 Elevation 156'-0" to 174'-0"	0.66
	Vertical Direction (7)		0.46
	Shear Reinforcement (7)		0.20
	Horizontal Direction (7)	Zone 2 Elevation 174'-0" to 213'-6"	0.79
	Vertical Direction (7)		0.63
	Shear Reinforcement (7)		N/A
Floor slab of EDG-1 room at Elevation 100 ft.	EW Direction (7)	Top Layer	0.54
		Bottom Layer	0.60
	NS Direction (7)	Top Layer	0.82
		Bottom Layer	0.44
Floor slab of EDG-2 room at Elevation 100 ft.	EW Direction (7)	Top Layer	0.78
		Bottom Layer	0.99
	NS Direction (7)	Top Layer	0.78
		Bottom Layer	0.78
Bottom Slab of SFP at Elevation 114 ft.	EW Direction (7)	Top Layer	0.93
		Bottom Layer	0.93
	NS Direction (7)	Top Layer	1.00
		Bottom Layer	1.00
Floor slab of MSE at Elevation 137 ft. 6 in	EW Direction (7)	Top Layer	0.75
		Bottom Layer	0.46
	NS Direction (7)	Top Layer	0.49
		Bottom Layer	0.68
Emergency Diesel Generator Building (EDGB)			
West wall, Elevation 100 ft. to 135 ft.	Horizontal Direction (7)	0.75	
	Vertical Direction (7)	0.86	
Center wall, Elevation 100 ft. to 135 ft.	Horizontal Direction (7)	0.41	
	Vertical Direction (7)	0.91	

Table 2.2.1-4 (5 of 5)

Critical Sections and Design Attributes

Critical Sections	Design Attributes Ratio(R) ≤ Demand/Capacity	
Basemat, Elevation 100 ft	E-W Direction (7)	0.67
	N-S Direction (7)	0.93
	Shear Bar (7)	0.48

Note,

(1) For containment reinforcement : calculated demand stress vs allowable stress for mechanical load combination followed by mechanical plus thermal load combination

(2) For liner plate : calculated demand stress vs allowable stress for construction case

(3) For liner plate : calculated demand strain vs allowable strain ~~for service case followed by factored case~~

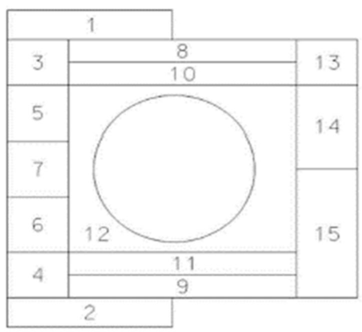
(4) For liner anchorage : calculated demand displacement vs allowable displacement

(5) For containment reinforcement : calculated demand stress vs allowable stress for service load combination followed by factored load combination

(6) For containment reinforcement : required reinforcement area vs provided reinforcement area for service load combination followed by factored load combination

(7) For reinforcement in other concrete structure : required reinforcement area vs provided reinforcement area

(8) The element sets of the auxiliary building basemat are composed as the following figure:



(9) For containment internal structure reinforcement : required reinforcement area vs provided reinforcement area for each face

2.2.2 Emergency Diesel Generator Building

2.2.2.1 Design Description

The emergency diesel generator (EDG) building block is located adjacent to east side of the Nuclear Island with seismic isolation gap, and comprises two buildings, one that houses additional two generators and the other for the diesel fuel oil tank (DFOT). Both EDG and DFOT buildings are single-story structures which are composed of reinforced concrete basemat, shearwalls and slabs. The two basemats are horizontally separated by seismic isolation gap.

, including the critical sections and design attributes listed in Table 2.2.1-4,

The EDG building block is designed and constructed to withstand the structural design basis loads associated with:

1. Normal plant operation (including dead loads, live loads, lateral earth pressure loads, and equipment loads, including the effects of temperature and equipment vibration)

2. External events (including rain, snow, wind, flood, hurricane generated missiles, and earthquake)

3. Internal events (including flooding, pipe rupture, equipment failure, and equipment failure generated missile)

a) The basic configuration of the EDG building block is as shown in Figures 2.2.2-1 and 2.2.2-2.

b) The EDG building block is designed and constructed to withstand the structural design basis loads.

c) ~~The key dimensions of the EDG building block are described in Table 2.2.2-1.~~ The dimensions and elevations of the EDG building block are as described in Table 2.2.2-1, Figure 2.2.2-1 and Figure 2.2.2-2.

e) ~~5.~~ The critical sections and design attributes of the EDG building block are ~~described in~~ in accordance with Table 2.2.1-4.

2.2.2.2 Inspection, Test, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the EDG building block are specified in Table 2.2.2-2.

Table 2.2.2-2

Emergency Diesel Generator Building Block (1) ITAAC

as-built

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The basic configuration of the EDG building block is as shown in Figures 2.2.2-1 and 2.2.2-2.	1. Inspection of the basic configuration of the as-built EDG building block will be conducted.	1. The EDG building block conforms with the basic configuration as shown in Figures 2.2.2-1 and 2.2.2-2.
2. The EDG building block is designed and constructed to withstand the structural design basis loads.	2. A structural analysis will be performed to reconcile the as-built EDG building block structure with the structural design basis loads.	2. A report exists and concludes that the EDG building block can withstand the structural design basis loads.
3. ~~The key dimensions of the EDG building block are as described in Table 2.2.2-1, Figure 2.2.2-1, and Figure 2.2.2-2.~~	3. ~~Inspection will be performed to verify that the as-built wall and slab thickness conform to the structural configuration.~~	3. ~~A report exists and concludes that the EDG building block as-built wall and slab thickness conform with the structural configuration as described in Table 2.2.2-1, Figure 2.2.2-1, and Figure 2.2.2-2.~~

as-built

(1) EDG building block includes EDG building and DFOT building.

Add item 5 in next page

~~Table 2.2.1-4,~~

~~critical section layout and elevations, including wall and slab thickness~~

~~critical section layout and elevations, including wall and slab thickness~~

The dimensions and elevations of the EDG building block are as described in Table 2.2.2-1, Figure 2.2.2-1 and Figure 2.2.2-2.

Inspection will be performed of the dimenisons and elevations of the as-built EDG building block.

A report exists and concludes that the as-built dimensions and elevations of the EDG building block are as described in Table 2.2.2-1, Figure 2.2.2-1 and Figure 2.2.2-2.

5. The critical sections and design attributes of the EDG building block are described in Table 2.2.1-4.	5. ~~Inspection will be performed to verify that the as-built EDG Building block, including critical sections and design attributes are in accordance with codes and standards approved in the design certification. Deviations from the design due to as-built conditions will be reconciled for the design basis loads.~~	~~5.i A reports exists and concludes that the as-built EDG building block structural design conform with the critical sections and design attributes as described in Table 2.2.1-4.~~ ~~5.ii A report exists which reconciles deviations during construction and concludes that as-built EDG building block structures, including the critical sections and design attributes, conform to the approved design in the design certification and will withstand the design basis loads.~~

A review of the as-built design and construction documentation will be performed to verify the critical sections and design attributes are in accordance with Table 2.2.1-4.

5. A reports exists and concludes the critical sections and design attributes of the EDG building block are in accordance with Table 2.2.1-4.

Table 3.8A-4 (1 of 5)

Rebar and Concrete Stresses with Margins of Safety for RCB Wall and Dome Design Sections

Wall-Basemat Junction Area (Rebar)

Meridional				Hoop			
Mechanical		Mech. + Thermal		Mechanical		Mech. + Thermal	
Inside (ksi)	Outside (ksi)	Inside (ksi)	Outside (ksi)	Inside (ksi)	Outside (ksi)	Inside (ksi)	Outside (ksi)
41.7	35.3	43.2	53.2	32.2	36.1	28.8	51.4
Ratio (1)				Ratio (1)			
1.29	1.53	1.25	~~1.18~~ 1.02	1.68	1.50	1.88	1.05

Mid-Height Level of Wall (Rebar)

Meridional				Hoop			
Mechanical		Mech. + Thermal		Mechanical		Mech. + Thermal	
Inside (ksi)	Outside (ksi)	Inside (ksi)	Outside (ksi)	Inside (ksi)	Outside (ksi)	Inside (ksi)	Outside (ksi)
46.8	33.8	38.4	45.6	39.4	33.6	31.2	50.2
Ratio (1)				Ratio (1)			
1.15	1.60	1.41	1.18	1.37	1.61	1.73	1.08

Polar Crane Bracket Level and Springline (Rebar)

Meridional				Hoop			
Mechanical		Mech. + Thermal		Mechanical		Mech. + Thermal	
Inside (ksi)	Outside (ksi)	Inside (ksi)	Outside (ksi)	Inside (ksi)	Outside (ksi)	Inside (ksi)	Outside (ksi)
27.2	18.5	16.4	47.4	43.1	22.4	36.1	43.5
Ratio (1)				Ratio (1)			
1.99	2.92	3.29	1.14	1.25	2.41	1.50	1.24

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2.2.10 Seismic Analysis Methods

The seismic Category I safety-related structures of the APR1400 standard plant design are modeled as three-dimensional finite element models to perform seismic analyses for the safe shutdown earthquake. The structures for which seismic analyses are performed are as follows:

The time-history analyses with complex frequency response method considering the soilstructure interaction effects for the generic site conditions are performed to generate the seismic responses of above structures such as story shear forces and in-structure response spectra (ISRS). For structural design of the reactor containment building containment structure and internal structure, the response spectrum analyses with ISRS at the reactor containment building El. 78′-0″ are performed to determine design member forces and moments due to seismic loads. For structural design of the auxiliary building, emergency diesel generator building and diesel fuel oil storage tank room, the equivalent static analyses to story shear forces are performed to determine design member forces and moments due to seismic loads.

Table 2.2.10-1 shows the key locations where comparisons of ISRS are needed by a COL applicant if a site-specific seismic analysis evaluation is required. The key locations are locations that are expected to represent the minimum and maximum seismic responses in the structure and include the basemat and roof slab elevations and the support elevation of the major equipment.

Add Tier 1, Subsection 2.2.10

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Table 2.2.10-1

ISRS Output Locations

Structures	Elevation	Remarks
Reactor Containment Building Internal Structure for primary shield wall and secondary shield wall	78'-0" 100'-0" 156'-0" 191'-0"	Basemat elevation Support elevation of major equipment Operation floor elevation Top of internal structure
Reactor Containment Building Containment Structure	104'-0" 160'-0" 332'-0"	Ground floor elevation Operation floor elevation Top of dome
Auxiliary Building	55'-0" 100'-0" 156'-0" 213'-0" 216'-9"	Basemat elevation Ground floor elevation Main control room floor elevation Roof of auxiliary building (1) Roof of auxiliary building (2)
Emergency Diesel Generator Building	100'-0" 135'-0"	Basemat elevation Roof slab elevation
Diesel Fuel Oil Storage Tank Room	63'-0" 100'-0"	Basemat elevation Roof slab elevation

Add Tier 1, Subsection 2.2.10