ArevaEPRDCPEm Resource

From:	WILLIFORD Dennis (AREVA) [Dennis.Williford@areva.com]
Sent:	Tuesday, June 25, 2013 2:52 PM
To:	Snyder, Amy
Cc:	Miernicki, Michael; ANDERSON Katherine (EXTERNAL AREVA); DELANO Karen (AREVA); HONMA George (EXTERNAL AREVA); LEIGHLITER John (AREVA); LEWIS Ray (EXTERNAL AREVA); ROMINE Judy (AREVA); RYAN Tom (AREVA); SHEPHERD Tracey (AREVA); VANCE Brian (AREVA); ABAYAN Victor (AREVA)
Subject:	Advanced Response to U.S. EPR Design Certification Application FINAL RAI No. 580, FSAR Ch.3-- NEW PHASE 4, Questions 03.08.04-28, 03.08.04-29, and 03.08.04-30
Attachments:	Advanced Response to RAI 580 Question 03.08.04-28,-29,-30 US EPR DC.pdf

Amy,

Attached is an Advanced Response for RAI 580, Questions 03.08.04-28, 03.08.04-29, and 03.08.04-30 in advance of the August 30, 2013 final date. Note that the response to Question 03.08.04-28 references the response to RAI 155, Question 03.08.04-6 for details related to the design of the vent stack. The advanced response to RAI 155, Question 03.08.04-6 will be submitted later this week (by June 28th).

To keep our commitment to send a final response to this question by the commitment date, we need to receive all NRC staff feedback and comments no later than August 16, 2013.

Please let me know if NRC staff has any questions or if the response to this question can be sent as final.

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Wednesday, May 01, 2013 5:32 PM
To: Amy.Snyder@nrc.gov
Cc: Michael.Miernicki@nrc.gov; ANDERSON Katherine (External AREVA NP INC.); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); HONMA George (EXT)
Subject: Response to U.S. EPR Design Certification Application FINAL RAI No. 580, FSAR Ch.3-- NEW PHASE 4

Amy,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 580 Response US EPR DC.pdf," provides a schedule since a technically correct and complete response to the three questions cannot be provided at this time.

The following table indicates the respective pages in the response document, "RAI 580 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page

RAI 580 — 03.08.04-28	2	3
RAI 580 — 03.08.04-29	4	5
RAI 580 — 03.08.04-30	6	6

The schedule for a technically correct and complete response to these questions is provided below.

Question #	Advanced Response Date	NRC Comment Request Date	Final Response Date
RAI 580 — 03.08.04-28	June 28, 2013	August 16, 2013	August 30, 2013
RAI 580 — 03.08.04-29	June 28, 2013	August 16, 2013	August 30, 2013
RAI 580 — 03.08.04-30	June 28, 2013	August 16, 2013	August 30, 2013

Sincerely,

Dennis Williford, P.E.
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From: Snyder, Amy [mailto:Amy.Snyder@nrc.gov]
Sent: Thursday, April 04, 2013 3:56 PM
To: ZZ-DL-A-USEPR-DL
Cc: Miernicki, Michael; Xu, Jim; Segala, John
Subject: U.S. EPR Design Certification Application FINAL RAI No. 580, FSAR Ch.3-- NEW PHASE 4

Attached please find the subject request for additional information (RAI). Draft RAI was provided to you on March 18, 2013. On March 26, 2013, you requested a clarification call. On April 2, 2013, the draft RAI was discussed with your staff. As a result of this discussion, the draft RAI was revised and you informed us that with the change the revised RAI is clear and does not contain AREVA Proprietary information. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of this Final RAI or by **May 6, 2013**. If this RAI question cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30-day period so that the staff can assess how this information will impact the published schedule

Thank You,
Amy

Amy Snyder, U.S. EPR Design Certification Lead Project Manager
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Division of New Reactor Licensing
Office of New Reactors
U.S. Nuclear Regulatory Commission
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Subject: Advanced Response to U.S. EPR Design Certification Application FINAL RAI No. 580, FSAR Ch.3-- NEW PHASE 4, Questions 03.08.04-28, 03.08.04-29, and 03.08.04-30

Sent Date:	6/25/2013 2:52:13 PM
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MESSAGE	4303	6/25/2013 2:52:47 PM
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Options

Priority:	Standard
Return Notification:	No
Reply Requested:	No
Sensitivity:	Normal
Expiration Date:	
Recipients Received:	

Advanced Response to

Request for Additional Information No. 580, Questions 03.08.04-28, -29 & -30

3/18/2013

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.08.04 - Other Seismic Category I Structures
Application Section: SRP

Question 03.08.04-28:

The EPR vent stack, located atop the roof of the Fuel Building, is classified as seismic Category I and is included in FSAR Tier 2, Appendix 3E, as one of the EPR critical structural sections for which an essentially complete design should be provided in accordance with 10 CFR 52.47(c). During the audit conducted on February 25 – 28, 2013, the staff reviewed calculation number 32-9023524-004 “U.S. EPR Standard Plant DC Fuel Building Design - Vent Stack Design & Reaction Loads (CS-36).” A number of technical issues were identified as a result of this review, which the staff believes are important to its evaluation of the design for meeting 10 CFR Part 50, General Design Criteria (GDC) 1 and 2, as they relate to the stack being designed to perform its intended functions under natural phenomenon loads. Therefore, the staff requests that the applicant to address the following issues:

1) The structural design of the seismic Category I vent stack is based on the standard ASME STS-1-2006 “Steel Stacks,” which has not been endorsed by the NRC. The guidance in SRP 3.8.4 indicates that an acceptable design code for the seismic Category I steel structures is ANSI/AISC N690-1994, including the 2004 supplement, and for the seismic Category I concrete structures, ACI 349 with certain additional criteria. The applicant is therefore requested to provide comparisons between the ASME STS-1-2006 and the SRP 3.8.4 acceptance criteria to demonstrate that the use of ASME STS-1-2006 for the seismic Category I stack design is consistent with the acceptance criteria in SRP 3.8.4. This should include materials, loads, load combinations, and allowable stresses considered in the design. In addition, for wind and tornado-induced pressure loads, including vortex shedding, explain how the ASME STS-1-2006 methodology for determining these loads is consistent with the methodology in ASCE/SEI7-05 and the guidance in SRP 3.3.1 and 3.3.2.
2) The stack design relies on tuned mass dampers (TMD) to reduce the vortex shedding loads. The applicant is requested to describe the conceptual design of the TMD (location, mass, stiffness, damping) and explain how they were credited in the design analysis. In addition, provide performance requirements in the FSAR that ensure the TMD will be seismically qualified.
3) The stack design considers steel material with 70ksi yield strength (ASTM A913 Grade 70), which falls outside of the range of the application of the ASME STS-1-2006 code equations. The staff understands that the applicant has requested the ASME STS-1-2006 code committee to approve the use of 70ksi steel in the application of ASME STS-1-2006 code equations. The applicant is requested to provide alternative means to demonstrate the adequacy of the design in case the code committee does not approve the applicant’s request.
4) The vent stack is anchored to the supporting concrete roof slab of the Fuel Building by means of 76 two-inch diameter through-bolts (ASTM A354, 130ksi yield strength). Heavy plates and anchor chairs provide the necessary strength and stiffness for load transfer. However, the design calculation does not include a check for the adequacy of bearing stresses on the concrete slab. The applicant is requested to evaluate these stresses. In addition, the through-bolts appear to have a substantial length, approximately 100 inches. The applicant is requested to identify if these through-bolts will be preloaded and if so, to identify the corresponding preload. Finally, the applicant is requested to evaluate the impact of any potential elongation of the through-bolts on the rotational flexibility of the vent stack base and, in particular, on the overall dynamic response and on the horizontal displacement at the top of the vent stack.

The applicant is requested to provide an update to the relevant sections of the FSAR Tier 1, Tier 2, and ITAAC, to include the vent stack design information, TMD description and performance requirements, and reference to the ASME STS-1-2006 standard.

Response to Question 03.08.04-28:

Item 1:

The design of the vent stack is performed in accordance with ASME STS-1-2006, ASCE7-05, AISC N690-1994, and the applicable codes, standards and steel specifications described in U.S. EPR FSAR Tier 2, Section 3.8.4.2. The guidance in SRP 3.8.4 endorses the ANSI/AISC N690-1994 design code for design of seismic Category I structures; however ASME STS-1-2006 "Steel Stacks" was used for the design of the seismic Category I vent stack. While ANSI/AISC N690-1994 contains allowables for standard structural shapes, the vent stack is a slender shell type structure that requires special considerations for wind effect, such as vortex shedding, ovalling, circumferential stresses, combined longitudinal and circumferential stresses, and compression stresses in stiffeners. Guidance and allowables for these checks are provided in ASME STS-1-2006. Due to the slender, flexible nature of the steel stacks, the ASME STS-1-2006 includes safety factors to add a design margin. The ASME STS-1-2006 directs all design not covered by its provisions to ANSI/AISC N690, while specifically prohibiting the increase of allowables. ASME STS-1-2006 not only provides design methodologies specific to the steel stack structure, but also reduces the allowable stresses, providing an increased safety margin. A comparison between ASME STS-1-2006 and ANSI/AISC N690-1994 design checks and allowable stresses is provided in Table 03.08.04-28-1 illustrating the applicability of the ASME code and the additional margin of safety gained by its use. The use of ASME STS-1-2006 is therefore deemed consistent with SRP 3.8.4 criteria.

- Materials: The vent stack design uses ASTM A588 steel, which is approved for use in accordance with Q1.0.3 of ANSI/AISC N690-1994.
- Loads: The loads considered within ASME STS-1-2006 are consistent with those specified in ANSI/AISC N690-1994. The following applicable loads for the vent stack design are considered in accordance with Table Q1.5.7.1 of ANSI/AISC N690-1994, as well as Section 4.3 of ASME STS-1-2006.
  - Dead load.
  - Live load.
  - Wind load, including vortex shedding.
  - Extreme wind loads, i.e. tornado, hurricane, vortex shedding load.
  - Safe shutdown earthquake (SSE) load.
- Load Combinations: The load combinations used in ASME STS-1-2006 are consistent with the load combinations specified within ANSI/AISC N690-1994. The following load combinations used for the vent stack design are specified within Table Q1.5.7.1 of ANSI/AISC N690-1994, as well as in Table 4.4.6 of ASME STS-1-2006.
  - Dead + Live.
  - Dead + Live + Wind.
  - Dead + Live + Tornado/Hurricane.

  - Dead + Live + SSE.

- Wind Induced Pressure Loads: The wind pressure, including tornado and hurricane pressure, are considered in the vent stack design in accordance with ASCE/SEI 7-05 which is identical in the ASME STS-1-2006 guidance. The tornado and hurricane wind speed is based on RG1.76 and RG1.221, respectively. Vortex shedding is accounted for using the design guide from ASME STS-1-2006, because a similar design guide in ASCE/SEI7-05 does not exist.

Item 2:

The vent stack design includes the use of a tuned mass damper (TMD). The TMD is not required to function during or after an SSE, but must remain in place during and after an SSE. The TMD is classified as NS-AQ (non-safety related with supplemental grade quality). The NS-AQ classification is defined in U.S. EPR FSAR Tier 2, Section 3.2.

The TMD increases the wind damping value of the stack by 2 percent (0.02). The TMD is connected to the vent stack between elevations 202’ and 208’ and has an estimated weight of 2200 lbs. The design and performance requirements of the TMD are summarized below.

The tuned mass damper is a device attached to the inside or outside of the vent stack between elevations 202’ and 208’ that reduces the dynamic response of the entire structure during critical wind events. The TMD is tuned to the natural frequency of the vent stack, in such a way that when the structure is excited, it will resonate out of phase with the structural motion. Energy is then dissipated through the dampers acting on the structure, thereby reducing structural motion.

The TMD for the U.S. EPR is designed to reduce the oscillation of the vent stack in the event of extreme wind events by increasing the damping value of the vent stack. The TMD will not interfere with the flow of exhaust through the vent stack. If the TMD is located outside of the vent stack, it will not interfere with the neighboring Reactor Shield Building (RSB) as a result of maximum vent stack displacement during seismic events or extreme environmental conditions.

The concept of the TMD is to suspend a weight from several anchor points that is able to move in all directions. The TMD may consist of a ring girder, springs and a weight. The TMD shall be attached to the vent stack wall at locations that do not interfere with the access to the vent stack top elevations, if mounted outside. Rubber stops, or another suitable type of protection, shall be mounted on the vent stack wall to prevent damage from the TMD. The TMD may be designed such that it rests upon several springs or rubber dampers, which can be adjusted to provide the correct amount of damping. The TMD is not required to function during or after an SSE, but must remain in place during and after an SSE.

The design of the vent stack will be provided in the Response to RAI 155, Question 03.08.04-6. U.S. EPR FSAR Tier 2, Section 3.8.4.1.2 and Appendix 3E will be updated in the Response to RAI 155, Question 03.08.04-6 to include design information for the vent stack and the TMD.

ITAAC for the vent stack were provided in the Response to RAI 527, Question 14.03.02-61.

Item 3:

The stack design has been changed from ASTM A913 grade 70 steel to ASTM A588 grade 50 steel. The stack design, therefore, now falls within the application of ASME STS-1-2006.

Item 4:

A bearing capacity check for the fuel building roof is performed as part of the vent stack critical section design provided in the Response to RAI 155, Question 03.08.04-6.

For the bolted base chair to be considered as a fixed base, the A354 grade BD bolts are preloaded. According to Supplement 1 to ANSI/AISC N690-1994, Table Q1.6.3.1, high strength bolts pretension is 70 percent (0.70) of the bolt tensile strength. Preloading of the bolts will make sure that a considerable part of the bolt's elongation potential is removed prior to service, and will provide better fixation at the base of the vent stack. When the displacement of the vent stack is analyzed with a fixed condition base, the maximum displacement is approximately 5", and the clear distance to the Reactor Shield Building is 36". The application of preload on the bolts and the significant distance to the adjacent Reactor Shield Building will maintain there is no contact between the two structures.

The Response to RAI 155, Question 03.08.04-6 describes the vent stack and TMD design details.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this response.

Table 03.08.04-28-1 Comparison of ASME STS-1-2006 & ANSI/AISC N690-1994 Code Checks

Design Parameters Used for Comparison Purpose

$thk := 1.0in$		Vent Stack Wall thickness
$Height := 99.417ft$		Vent Stack Height

Material and Section Properties:

$\gamma_s := 490 \frac{lbf}{ft^3}$		Steel Density
$E_s := 29000ksi$		Modulus of Elasticity of Steel
$F_y := 50ksi$		Vent Stack Yield Strength
$OD := 12.5ft$		Outer diameter of stack
$ID := OD - thk \cdot 2$	$ID = 12.333 \cdot ft$	Inner diameter of stack
$Dia := 0.5 \cdot (OD + ID)$	$Dia = 12.417 \cdot ft$	Mean Diameter
$r := 0.707 \cdot \frac{Dia}{2}$	$r = 52.672 \cdot in$	Radius of Gyration=0.707R

ASME STS-1-2006 DESIGN PROVISIONS	MOST SIMILAR PROVISIONS FROM ANSI/AISC N690-1994
Thin Shell Check (Sec 4.4)	**Circular Tubes Width-Thickness Ratio (Q.1.9.2.3)**
$Check(t,D) := \begin{cases} \text{"Use STS Allowables"} & \text{if } \frac{thk}{Dia} \le \frac{10 \cdot F_y}{E_s} \\ \text{"Resize Shell"} & \text{otherwise} \end{cases}$ $\frac{thk}{Dia} = 0.007$ $\frac{10 \cdot F_y}{E_s} = 0.017$	$CheckDW(t,D) := \begin{cases} \text{"Section Fully Effective"} & \text{if } \frac{OD}{thk} \le \frac{3300 \cdot ksi}{F_y} \\ \text{"Use Appendix QC"} & \text{if } \frac{3300 \cdot ksi}{F_y} \le \frac{OD}{thk} \le \frac{13000 \cdot ksi}{F_y} \\ \text{"Resize Shell"} & \text{otherwise} \end{cases}$
$Check(thk, Dia) = \text{"Use STS Allowables"}$	$CheckDW(thk, OD) = \text{"Use Appendix QC"}$

ASME STS-1-2006 DESIGN PROVISIONS

1. Longitudinal Compression (Sec 4.4.1):

Factors of Safety for Design (Table 4.4.6)

Seismic & Wind Combinations: $FS := 1.50$

$L_e := 2 \cdot Height$ factor of 2 for cantilever $\frac{L_e}{r} = 45$

$$Y := \begin{cases} 1 & \text{if } \frac{L_e}{r} \le 60 \\ \dfrac{21600}{18000 + \left(\frac{L_e}{r}\right)^2} & \text{otherwise} \end{cases}$$

$$K_s := \left(\frac{\frac{10 \cdot F_y}{E_s} - \frac{thk}{Dia}}{\frac{7.2 \cdot F_y}{E_s}}\right)^2$$

$K_s = 0.72$

$Y = 1$

$\frac{thk}{Dia} = 0.007$ $\frac{2.8 \cdot F_y}{E_s} = 0.005$ $\frac{10 \cdot F_y}{E_s} = 0.017$

$$S_{c1}(Y, FS) := \begin{cases} \dfrac{E_s \cdot thk \cdot Y}{4 \cdot Dia \cdot (FS)} & \text{if } \frac{thk}{Dia} \le \frac{2.8 \cdot F_y}{E_s} \\ \dfrac{F_y \cdot (1 - 0.3K_s) \cdot Y}{FS} & \text{if } \frac{2.8 \cdot F_y}{E_s} < \frac{thk}{Dia} \le \frac{10 \cdot F_y}{E_s} \\ \text{"N/A"} & \text{otherwise} \end{cases}$$

Allowable stress: $S_{c1}(Y, FS) = 26.138 \cdot ksi$

MOST SIMILAR PROVISIONS FROM ANSI/AISC N690-1994

1. Longitudinal Compression (Sec Q1.5.1.3 & QC3):

Allowable Increase Factor (Table Q.1.5.7.1)

Seismic & Tornado/Hurricane Winds Combinations : $AI := 1.6$

Axial Capacity per Reference [5] Section Q1.5.1.3:

$K_{unbrace} := 2$ for cantilever

$klr := \frac{K_{unbrace} \cdot Height}{r}$ $klr = 45.3$ $C_c := \sqrt{\frac{2 \cdot \pi^2 \cdot E_s}{F_y}}$ $C_c = 106.999$

$$F_{a.Q1.5.3} := \begin{cases} \dfrac{\left(1 - \frac{klr^2}{2 \cdot C_c^2}\right) \cdot F_y}{\frac{5}{3} + \frac{3klr}{8 \cdot C_c} - \frac{klr^3}{8 \cdot C_c^3}} & \text{if } klr \le C_c \\ \dfrac{12 \cdot \pi^2 \cdot E_s}{23 \cdot klr^2} & \text{otherwise} \end{cases}$$

$F_{a.Q1.5.3} = 25.066 \cdot ksi$

Axial Capacity per Reference [5] Section QC3:

$F_{a.QC3} := \frac{662}{\frac{Dia}{thk}} \cdot ksi + 0.40 \cdot F_y$ $F_{a.QC3} = 24.443 \cdot ksi$

$F_a := \min(F_{a.Q1.5.3}, F_{a.QC3}) \cdot AI$

Allowable stress: $F_a = 39.109 \cdot ksi$

ASME STS-1-2006 DESIGN PROVISIONS	MOST SIMILAR PROVISIONS FROM ANSI/AISC N690-1994
2. Longitudinal Compression and Bending Combination (Sec 4.4.2) $Y_b := 1$ for bending $S_{bl} := S_{cl}(Y_b, FS)$ **Allowable stress:** $S_{bl} = 26.138 \cdot ksi$ $\dfrac{\dfrac{P}{A} + \dfrac{M \cdot D}{2 \cdot I}}{S_{bl}} \le 1$	**2. Longitudinal Compression and Bending Combination (Sec QC6 & Q1.6.1)** Not clear guidance on combined axial and bending from Sec QC6 for circular members, can possibly use minimum of Fa and Fb from Section Q.1.5.1.4.5: Bending Capacity per Reference [5] Section Q1.5.1.4.5 - 2(b): $F_{b.Q1.5.1} := 0.6 \cdot F_y = 30 \cdot ksi$ $F_b := \min(F_a, F_{b.Q1.5.1} \cdot AI) = 39.109 \cdot ksi$ **Allowable stress:** $F_b = 39.109 \cdot ksi$ $\dfrac{f_a}{F_a} + \dfrac{f_b}{F_b} \le 1$

ASME STS-1-2006 DESIGN PROVISIONS	MOST SIMILAR PROVISIONS FROM ANSI/AISC N690-1994
3. Circumferential Stress (Sec 4.4.3): Circumferential Stress Due to Wind/Tornado Between Stiffeners: $l_s := 20\ \text{ft}$ Spacing between circumferential stiffeners $K_{coeff} := \begin{cases} 1 \ \text{if} \ 0 < \frac{thk}{Dia} \le \frac{2.8 \cdot F_y}{E_s} \\ 1.68 \cdot \frac{F_y \cdot Dia}{E_s \cdot thk} + 0.465 - \frac{0.0232 \cdot E_s \cdot thk}{F_y \cdot Dia} \ \text{if} \ \frac{2.8 \cdot F_y}{E_s} < \frac{thk}{Dia} \le \frac{10 \cdot F_y}{E_s} \\ \text{"N/A"} \ \text{otherwise} \end{cases}$ $K_{coeff} = 0.806$ $S_{cc} := \frac{1.30 \cdot E_s \cdot K_{coeff} \cdot \left(\frac{thk}{Dia}\right)^{1.5}}{FS \cdot \left(\frac{l_s}{Dia}\right)}$ **Allowable stress:** $S_{cc} = 6.917 \cdot ksi$	**3. Circumferential Stress:** No equivalent check Possible use of Section Q1.5.1.4.3 for members bent about minor axis and solid cross section members: $F_{cir} := 0.66 \cdot F_y$ $F_{cir.inc} := F_{cir} \cdot AI$ **Allowable stress:** $F_{cir.inc} = 52.8 \cdot ksi$
4. Combined Longitudinal and Circumferential Circumferential Stress (Sec 4.4.4): $\frac{\frac{P}{A} + \frac{MD}{2I}}{S_{bl}} + \left(\frac{f_{circum}}{S_{cc}}\right)^2 \le 1$ $S_{bl} = 26.138 \cdot ksi$ $S_{cc} = 6.917 \cdot ksi$	**4. Longitudinal and Circumferential Circumferential Stress:** No equivalent check

ASME STS-1-2006 DESIGN PROVISIONS	MOST SIMILAR PROVISIONS FROM ANSI/AISC N690-1994
5. Shear: Per section 4.4, use applicable AISC codes, however, no increase of allowable permitted. Use Q1.5.1.2.1: $S_{shear} := 0.4 \cdot F_y$ **Allowable stress:** $S_{shear} = 20 \cdot ksi$	**5. Shear (Sec. Q1.5.1.2.1):** **Allowable Increase Factor (Table Q.1.5.7.1)** **Seismic & Tornado/Hurricane Winds Combinations :** $AI_{shear} := 1.4$ $S_{shear} := 0.4 \cdot F_y$ $S_{shear.incr} := S_{shear} \cdot AI_{shear}$ **Allowable stress:** $S_{shear.incr} = 28 \cdot ksi$
6. Circumferential Compression in Stiffeners (Sec 4.4.5): $I_{stiff} := 57.903 in^4$ $A_{stiff} := 19.19 \cdot in^2$ Max allowable circumferential compression in the stiffener $S_{stiff} := \frac{E_s \cdot I_{stiff}}{Dia^2} \cdot \frac{1}{A_{stiff}} \cdot \frac{1}{FS}$ **Allowable stress:** $S_{stiff} = 2.628 \cdot ksi$	**6. Circumferential Compression in Stiffeners:** No equivalent check Possible use of Section Q1.5.1.3.3 for plate girder stiffeners: $F_a := 0.60 \cdot F_y$ **Allowable stress:** $F_a = 30 \cdot ksi$

Question 03.08.04-29:

The liner plate for the concrete containment is identified as one of EPR critical structural sections for which an essentially complete design should be provided in accordance with 10 CFR 52.47(c). During the audit conducted on February 25 – 28, 2013, the staff reviewed calculation number 32-9029334-002 "U.S. EPR Standard Plant DC Containment Design – Typical Liner Plate & Liner Plate Anchorage System (CS-01)." A number of technical issues were identified as a result of this review, which the staff believes are important to its evaluation of the design for meeting 10 CFR Part 50, General Design Criteria (GDC) 1, 4, 16 and 50 as well as 10 CFR 50.44, as they relate to the containment liner's capability to maintain leak tightness under various postulated containment loads. Therefore, the staff requests the applicant to address the following issues:

1) The methodology for designing the liner plate and liner plate anchorage system described in the design calculations generally follows Bechtel Topical Report BC-TOP-1 [1], which addresses the implementation of Article CC-3810 of ASME Section III, Division 2, for containment liner designs. The liner plate anchors consist of WT 5x11 elements, which are different from the L3x2x1/4 angles specified in BC-TOP-1. The design of the liner plate anchorage system utilized the force-displacement characteristic relationship for the WT anchors; however, this relationship was developed from test results that were reported in a conference paper [2]. Since the staff cannot determine the quality and reliability of these test data from unverified information described in a conference paper, the applicant is requested to provide adequate documentation including description of test specimens, test conditions, quality controls, etc., which establishes the quality of the test data that is applicable to the configuration of the applicant's liner plate anchorage system. In addition, the applicant should describe how the force-displacement characteristic relationship is developed from the test data.

2) The design calculations for the liner plate anchorage system do not consider the liner plate strains associated with combustible gas loads (pressure and temperature conditions), which is inconsistent with FSAR Tier 2, Section 3.8.1.3.2 and SRP 3.8.1 acceptance criteria. Therefore, the staff cannot determine whether the liner design meets 10 CFR 50.44 as it relates to maintaining the leak tightness of the liner under pressure and temperature loads induced by postulated 100% metal-water reaction followed by the hydrogen burn. The applicant is requested to provide the technical basis for not considering these strains. The staff noted that the applicant has demonstrated that the liner plate can withstand the strains induced by combustible gas loads under the assumption that the liner plate is "glued" to the concrete containment shell. For this assumption to be valid, the applicant also needs to demonstrate the liner plate anchorage system is adequate to withstand the induced strains.

References

1. T.E. Johnson and B.W. Wedellsborg, "Topical Report BC-TOP-1 Revision 1: Containment Building Liner Plate Design Report," Bechtel Corp., 1972. Approved by the AEC on February 7, 1974.
2. P.L. Chang-lo, T.E. Johnson, and B.W. Pfeifer, "Containment liner plate anchors and steel embedments test results," Transactions of the 4thSMiRT Conference, pp. J5/9, 1977.

Response to Question 03.08.04-29:

Item 1:

The use of WT has been eliminated and the same section as BC-TOP-1 (L3x2x1/4 angles) is now used.

Item 2:

The hydrogen burn calculation has been updated to address the question of whether liner anchorage is adequate to withstand the induced strain from hydrogen burn.

The strains induced from hydrogen burn load combination are less than those considered in the CS-01 critical section calculation “US EPR™ Standard Plant DC Containment Design – Liner Plate & Liner Plate Anchorage System (CS-01)” [32-9029334-003]). CS-01 calculation qualifies the liner plate anchors system by using the liner strains as direct inputs to the energy equilibrium methodology that is described in BC-TOP-1 (Reference [2]). It is concluded that the anchorage design in CS-01 envelopes the hydrogen burn load combination because CS-01 qualified the anchorage using higher strains values. Therefore, it is established that the liner plate anchorage system is adequate to withstand the induced strains.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this response.

Question 03.08.04-30:

FSAR Tier 2, Appendix 3E, describes the methodology used to select the EPR critical structural sections. An integral part of this methodology is the “supplemental methodology” by which a number of critical structural sections were selected on the basis of engineering judgment as needed to comprise an essentially complete design of each seismic Category I structure and provide reasonable assurance of the EPR design adequacy, in accordance with 10 CFR 52.47(c).

During the audit conducted on February 25 – 28, 2013, the staff reviewed calculation number 32-7009704-000 “U.S. EPR Standard Plant DC General Design - Typical Beams and Columns for the Nuclear Island (CS-24).” The staff determined that the scope of the design calculations did not include representative connections between steel structural elements or between steel and concrete structural elements. Since connections are key elements in the structural load path, the applicant is requested to provide the following additional information:

1) Identify critical structural section designs that exclude steel-to-steel and steel-to-concrete connections as part of their scope. In each case, explain why such structural connections are excluded.
2) Since structural connections were excluded from the scope of critical structural section CS-24 “Typical Beams and Columns for the Nuclear Island,” explain why a separate critical structural section corresponding to structural connections was not selected per the “supplemental methodology”.

Response to Question 03.08.04-30:

Item 1:

CS-01, CS-24, and CS-36 contain connections and their associated calculations have been revised to include their connection designs.

Item 2:

32-7009704, “U.S. EPR™ Standard Plant DC General Design - Beams & Columns for the Nuclear Island (CS-24)”, has been revised to include a beam-to-column connection, and beam to concrete connection and a concrete-to-column connection.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this response.