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Ref. # 10 CFR 52

October 30, 2009

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555
ATTN: David B. Matthews, Director
Division of New Reactor Licensing

SUBJECT: COMANCHE PEAK NUCLEAR POWER PLANT, UNITS 3 AND 4
DOCKET NUMBERS 52-034 AND 52-035
RESPONSES TO REQUESTS FOR ADDITIONAL INFORMATION
NO. 2883, 3127, 3193, 3219, AND 3559

Dear Sir:

Luminant Generation Company LLC (Luminant) herein submits responses to Requests for Additional Information No. 2883, 3127, 3193, 3219, and 3559 for the Combined License Application for Comanche Peak Nuclear Power Plant Units 3 and 4. The affected Final Safety Analysis Report pages are included with the responses.

Attachment 6 provides the XOQDOQ files requested by RAI No. 3559. These files are in their native format as required by the NRC so they do not meet the requirements of "Guidance for Electronic Submissions to the NRC," Revision 5.

Should you have any questions regarding these responses, please contact Don Woodlan (254-897-6887, Donald.Woodlan@luminant.com) or me.

There are no commitments in this letter.

I state under penalty of perjury that the foregoing is true and correct. Executed on October 30, 2009.

Sincerely,

Luminant Generation Company LLC

Donald R. Woodlan for

Rafael Flores

Attachments
1. Response to Request for Additional Information No. 2883 (CP RAI #64)
2. Response to Request for Additional Information No. 3127 (CP RAI #65)
3. Response to Request for Additional Information No. 3193 (CP RAI #62)
4. Response to Request for Additional Information No. 3219 (CP RAI #63)
5. Response to Request for Additional Information No. 3559 (CP RAI #61)
6. Input and Output files "CPNPP EP EVAL.DAT" and "XOQ_OUT.DAT" (on CD)

D090
NRO

cc: Stephen Monarque w/all Attachments (on CD)

Electronic Distribution w/Attachments 1-5

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Attachment 1

Response to Request for Additional Information No. 2883 (CP RAI #64)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Comanche Peak, Units 3 and 4

Luminant Generation Company LLC

Docket Nos. 52-034 and 52-035

RAI NO.: 2883 (CP RAI #64)

SRP SECTION: 03.07.03 - Seismic Subsystem Analysis

QUESTIONS for Structural Engineering Branch 1 (AP1000/EPR PROJECTS) (SEB1)

DATE OF RAI ISSUE: 9/18/2009

QUESTION NO.: 03.07.03-1

In combined license application (COLA), FSAR, Appendix 3KK (page 3KK-3), it is stated that the hydrodynamic effects of the water in the in the ultimate heat sink (UHS) structures is analyzed using the methodology of American Concrete Institute (ACI) 350.3-06. Describe the differences between the methodology of ACI 350.3-06 and the guidance provided in NUREG-0800 Standard Review Plan, (SRP) Section 3.7.3.II.14.A, and the references therein, and describe how the methodology used in the hydrodynamic analysis of the UHS basins differs from or complies with the SRP guidance.

ANSWER:

NUREG-0800 SRP 3.7.3.II.14.A references ASCE 4-98, TID-7024, and NUREG/CR-1161 for acceptable techniques to assess hydrodynamic effects. ACI 350.3-06 was used for calculation of the hydrodynamic convective and impulsive masses, and associated heights and modeling was performed following the analysis procedures of ASCE 4-98. The procedures from ACI 350.3-06 used for design of the UHS are very similar or more conservative than the NUREG and associated documents as shown in the comparisons presented in Tables 1 and 2 and Figures 1 and 2 (attached). There is one part of Item F in Table 1 that was not included in the UHS hydrodynamic analysis. The omitted requirement is the influence of the vertical ground shaking on the lateral pressures on the basin walls. The increase in demands due to this omission is very small with no resulting impact on the adequacy of the design because it is accommodated by available margin.

Impact on R-COLA

See attached marked-up of FSAR Draft Revision 1 page 3KK-7.

Impact on S-COLA

None.

Impact on DCD

None.

Attachments

Table 1 - Comparison of Specifications for Seismic Analysis of Above Ground Tanks

Table 2 - Comparison of Equations of Key Parameters

Figure 1 - Height from Bottom of Basin to Centroid of Impulsive Pressure Distribution

Figure 2 - Sloshing Heights Calculated by ACI 350.3-06 and TID-7024

Table 1 Comparison of Specifications for Seismic Analysis of Above Ground Tanks

NUREG-0800, Section 3.7.3 Criteria	ACI 350.3-06	TID-7024, NUREG/CR-1161, and ASCE 4-98	Method Used for Hydrodynamic Analysis of UHS Structures
A. A minimum acceptable analysis must incorporate at least two horizontal modes of combined fluid-tank vibration and at least one vertical mode of fluid vibration. The horizontal response analysis must include at least one impulsive mode in which the response of the tank shell and roof are coupled together with the portion of the fluid contents that moves in unison with the shell. In addition, the fundamental sloshing (convective) mode of the fluid must be included in the horizontal analysis.	ACI 350.3-06 determines the effects of the combination of 2 horizontal modes that includes one impulsive mode that accounts for interaction between the structure and contained liquid and the convective mode.	ASCE 4-98 Section 3.5.4.1 requires at least one horizontal impulsive mode including basin and fluid interaction and the fundamental convective (sloshing) mode two total horizontal modes.	The hydrodynamic effects are explicitly modeled in a detailed finite element model in ANSYS using modeling requirements of ASCE4-98 Section 3.1.6 and hydrodynamic properties based on ACI 350.3-06. The fundamental horizontal sloshing (convective) mode is explicitly modeled using springs and masses in ANSYS. The UHS basins do not have roofs. Demands are calculated using a response spectrum analysis method. Calculating modes using the detailed FE model and calculating response from the response spectrum analysis procedure considers horizontal impulsive and convective modes of the basin. The hydrodynamic properties calculated using ACI 350.3-06 and applied in the ANSYS model are described below: • Impulsive water weight, w_i • Convective water weight, w_c • Frequency of convective mode, f_c • Height from bottom of basin to centroid of impulsive pressure distribution, h_i • Height from bottom of basin to centroid of convective pressure distribution, h_c The expressions from ACI 350.3-06 used to calculate these values are compared to the values from TID-7024 in Table 2.

Table 1 Comparison of Specifications for Seismic Analysis of Above Ground Tanks

NUREG-0800, Section 3.7.3 Criteria	ACI 350.3-06	TID-7024, NUREG/CR-1161, and ASCE 4-98	Method Used for Hydrodynamic Analysis of UHS Structures
B. The fundamental natural horizontal impulsive mode of vibration of the fluid-tank system must be estimated giving due consideration to the flexibility of the supporting medium and to any uplifting tendencies for the tank. It is unacceptable to assume a rigid tank unless the assumption can be justified. The horizontal impulsive-mode spectral acceleration, S_{a1} , is then determined using this frequency and the appropriate damping for the fluid-tank system. Alternatively, the maximum spectral acceleration corresponding to the relevant damping may be used.	ACI 350.3-06 does not require consideration of the supporting soil flexibility or the influence of uplifting in the calculation of the horizontal impulsive mode. This document does note in the Commentary of Section 9.2.4 that the peak spectral acceleration may be used in which calculation of the impulsive frequency is not required.	TID-7024 does not discuss methods of calculating the impulsive mode frequency including soil flexibility or uplifting tendencies. NUREG/CR-1161 Section 2.2.6.1 does note that tanks experiencing uplift should be evaluated using an appropriate analysis.	The ANSYS FE model considers flexibility of the basin walls and a range of flexibility of the supporting medium in the response spectrum analysis and calculates the corresponding design spectral acceleration value (at the base of the tank) for the impulsive modes. The design spectra with 5% damping is scaled up below 1 Hz for 0.5% damping. This composite damping spectra is used to represent the following damping values in the analysis: • 5% damping (the inherent damping of the basin's concrete walls in accordance with ASCE 4-98) is used for all frequencies above 1Hz. This includes all impulsive hydrodynamic and structural modes. • 0.5% damping for all frequencies below 1Hz. This includes hydrodynamic convective modes. Uplifting of the basin is not a concern for such a squat reinforced concrete tank subjected to a small intensity base excitation. Bounding of the design forces with a fixed-base model and a model with soil flexibility is expected to have a larger influence on the total response than the uplifting.

Table 1 Comparison of Specifications for Seismic Analysis of Above Ground Tanks

NUREG-0800, Section 3.7.3 Criteria	ACI 350.3-06	TID-7024, NUREG/CR-1161, and ASCE 4-98	Method Used for Hydrodynamic Analysis of UHS Structures
C. Damping values used to determine the spectral acceleration in the impulsive mode shall be based upon the system damping associated with the tank shell material as well as with the SSI, as specified in NUREG/CR-1161 and Veletsos and Tang (1989).	ACI 350.3-06 (Section 9.5) recommends use of 5% damping for the impulsive mode. The increase in damping provided by SSI is conservatively not considered, limiting the damping to that of the shell material.	ASCE 4-98, Section 3.5.4.2 states that the impulsive mode damping value shall equal the damping value of the tank shell material as defined in Section 3.1.2.2. Section 3.1.2.2 allows use of 7% damping for concrete structures responding below their elastic limit.	The response spectrum analysis conservatively used a 5% damped spectrum for the impulsive modes to account for the dissipation of energy in the dynamic system.
D. In determining the spectral acceleration in the horizontal convective mode, S_{a2} , the fluid damping ratio shall be 0.5% of critical damping unless a higher value can be substantiated by experimental results.	ACI 350.3-06, Section 9.5 specifies a damping of 0.5% for all hydrodynamic convective modes.	ASCE 4-98, Section 3.5.4.3 specifies a damping of 0.5% for all hydrodynamic convective modes.	The response spectrum analysis used a 0.5% damped spectrum for all hydrodynamic convective modes by increasing the spectrum low frequency range (below 1Hz, only includes convective modes).

Table 1 Comparison of Specifications for Seismic Analysis of Above Ground Tanks

NUREG-0800, Section 3.7.3 Criteria	ACI 350.3-06	TID-7024, NUREG/CR-1161, and ASCE 4-98	Method Used for Hydrodynamic Analysis of UHS Structures
E. The maximum overturning moment, M_o, at the base of the tank should be obtained by the modal and spatial combination methods discussed in subsection II of SRP Section 3.7.2. The uplift tension resulting from M_o must be resisted either by tying the tank to the foundation with anchor bolts, etc., or by mobilizing enough fluid weight on a thickened base skirt plate. The latter method of resisting M_o must be shown to be conservative.	ACI 350.3-06 does not address spatial combination of hydrodynamic effects. Calculation of the overturning moment combines the impulsive water mass mode and basin wall mode as an absolute sum and the convective water mass using an SRSS combination.	ASCE 4-98, Section 3.2.7.1.1 allows use of the grouping method (among others) for periodic (flexible) mode combination with SRSS combination with the in-phase (rigid) response. Spatial combination (Section 3.2.7.1.2) can be performed using either SRSS or Newmark 100-40-40 combination.	SRP Section 3.7.2 references RG 1.92 that describes acceptable spatial and modal seismic combination methods. In accordance with RG 1.92, spatial combination was performed using the Newmark 100-40-40 percent combination rule and modal combination was performed using Combination Method B for combination of periodic and rigid modes. Periodic modal response was combined using the grouping method. Uplifting of the basin is not a concern for this type of tank since the basin walls are 4 ft thick concrete and has full moment resistance to the 4 ft thick base slab.

Table 1 Comparison of Specifications for Seismic Analysis of Above Ground Tanks

NUREG-0800, Section 3.7.3 Criteria	ACI 350.3-06	TID-7024, NUREG/CR-1161, and ASCE 4-98	Method Used for Hydrodynamic Analysis of UHS Structures
F. The seismically induced hydrodynamic pressures on the tank shell at any level can be determined by the modal and spatial combination methods in SRP Section 3.7.2. The maximum hoop forces in the tank wall must be evaluated with due regard for the contribution of the vertical component of ground shaking. The effects of soil-structure interaction should be considered in this evaluation unless justified otherwise. The hydrodynamic pressure at any level must be added to the hydrostatic pressure at that level to determine the hoop tension in the tank shell.	ACI 350.3-06 Section 4.1.4 requires the contribution of the vertical ground shaking to be included by multiplying the hydrostatic by the vertical seismic response coefficient and the Importance factor.	ASCE 4-98 Section 3.5.4.4 considers the contribution of the lateral hydrodynamic pressures caused by vertical ground shaking to the tank shell by multiplying the hydrodynamic pressure by the vertical spectral acceleration of the tank base. NUREG/CR-1161 Section 2.2.5 considers the contribution of the lateral hydrodynamic pressures caused by vertical ground shaking to the tank shell by multiplying the hydrodynamic pressure by the vertical zero period acceleration.	The analysis of the UHS uses modal and spatial combination methods that are in accordance with SRP Section 3.7.2 as described in the previous response. The increase in the lateral fluid pressure due to vertical ground acceleration was not included in the design analysis. Based on ASCE 4-98, the increase in the hydrostatic fluid pressure on the walls should have been by a factor of 1.10; however the critical load combination for the walls is expected to be due to the horizontal motion. Therefore the contribution of this vertical seismic effect will be multiplied by 0.40 using the Newmark 100-40-40 spatial combination rule resulting in a 4% increase from the hydrostatic pressure. The impact on the total design force will be even less than 4% since many other loads (seismic, lateral soil pressure, etc.) are combined to determine the total design force. The resulting change will be approximately 1% to 2% and will not impact the adequacy of the design because it is accommodated by available margin.

Table 1 Comparison of Specifications for Seismic Analysis of Above Ground Tanks

NUREG-0800, Section 3.7.3 Criteria	ACI 350.3-06	TID-7024, NUREG/CR-1161, and ASCE 4-98	Method Used for Hydrodynamic Analysis of UHS Structures
G. Either the tank top head must be located at elevation higher than the slosh height above the top of the fluid or else must be designed for pressures resulting from fluid sloshing against this head.	The maximum sloshing height is calculated in ACI 350.3-06 using the expression in Table 2.	The sloshing height from TID-7024 is defined by the expression in Table 2.	This is not a concern in the UHS basins or Cooling Towers since they do not have roofs. The pump house slab is 4 ft above Normal Water Level. The maximum sloshing height was calculated using the expression from ACI 350.3-06 which is compared to the expression from TID-7024 in Figure 2 and shown to be conservative. The maximum sloshing height when accounting for wave height from both directions of motion in each sloshing region using Newmark 100-40-40 spatial combination is equal to 1.91 ft and thus does not impact the pump house slab which is 4 ft. above water level.

Table 1 Comparison of Specifications for Seismic Analysis of Above Ground Tanks

NUREG-0800, Section 3.7.3 Criteria	ACI 350.3-06	TID-7024, NUREG/CR-1161, and ASCE 4-98	Method Used for Hydrodynamic Analysis of UHS Structures
H. At the point of attachment, the tank shell must be designed to withstand the seismic forces imposed by the attached piping. An appropriate analysis must be performed to verify this design.	Seismic forces from attached piping are not discussed in ACI 350.3-06.	ASCE 4-98 Section 3.5.4.5.5 states that the basin should be designed for seismic forces from the attached piping and that these forces may be combined using the SRSS method. TID-7024 recommends designing equipment supports to carry the entire tributary horizontal seismic forces and to provide sufficient flexibility in the piping to accommodate the differential movements involved without overstress.	Piping only penetrates the upper pump room wall on the tunnel side and does not penetrate the basin walls. The tributary mass of the attached piping in the pump room (and its fluid) was included in the ANSYS FE model and the response spectrum analysis. Design of the piping attachments in the upper pump room and secondary response of the piping system and its influence on structural design should be evaluated in final design when more details of the piping system are established. However, seismic forces imposed on the piping attachments are likely to be limited by the flexibility needed in the piping system to accommodate thermal expansion (as noted in TID-7024).

Table 1 Comparison of Specifications for Seismic Analysis of Above Ground Tanks

NUREG-0800, Section 3.7.3 Criteria	ACI 350.3-06	TID-7024, NUREG/CR-1161, and ASCE 4-98	Method Used for Hydrodynamic Analysis of UHS Structures
I. The tank foundation (see also SRP Section 3.8.5) must be designed to accommodate the seismic forces imposed on it. These forces include the hydrodynamic fluid pressures imposed on the base of the tank as well as the tank shell longitudinal compressive and tensile forces resulting from M_o.	ACI 350.3-06 Section 3.3.1 states that the walls, floors, and roof shall be designed to withstand the effects of both the design horizontal acceleration, design vertical accelerations, and the effects of all applicable design static loads.	ASCE 4-98 Section 3.5.4.5.6 requires the tank foundation be analyzed for the seismic forces imposed by the base of the tank including the forces resulting from the base overturning moment defined in Section 3.5.4.5.1.	The ANSYS FE model was developed following ASCE 4-98 for considering hydrodynamic effects. The model considers hydrodynamic fluid pressures on the base of the basin by including the vertical water mass across the basin mat and application of the vertical response spectrum in the response spectrum analysis. The hydrodynamic forces causing M_o (impulsive and convective horizontal modes) are included as part of the horizontal modes in the response spectrum analysis. Modal and spatial combination is performed in accordance with RG 1.92. A range of soil support flexibility is considered beneath the basins and base slab element forces for all load combinations are enveloped for design.
J. In addition to the above, a consideration must be given to prevent buckling of tank walls and roof, failure of connecting piping, and sliding of the tank.	Buckling of tank walls or roof, failure of connecting piping, and sliding are not considered by ACI 350.3-06. Although a method to determine the total tank base shear is provided that can be used to evaluate sliding.	ASCE 4-98 Section 3.5.4.5 requires that tank shell buckling be evaluated for the demands imposed by vertical and horizontal response modes.	Buckling of the 4 ft thick concrete tank walls is not a concern. UHS basins do not have a roof. UHS resistance to sliding is calculated in the global stability calculation and shown not to slide. Piping only enters and exits through the upper pump house wall (not any basin walls). Failure of this connecting piping was not considered since piping details are not known at this time however the relative displacements between adjacent structures (tunnel and UHS) are minimal and pipe connections can be evaluated in final design.

Table 2 Comparison of Equations of Key Parameters

Parameter	ACI 350.3-06	TID-7024, NUREG/CR-1161, and ASCE 4-98	Equation used in Hydrodynamic Analysis of UHS Structures
W_i: impulsive water weight	$\frac{\tanh\left[0.866\left(\frac{L}{H_L}\right)\right]}{0.866\left(\frac{L}{H_L}\right)} \cdot W_L$ (Eq. 9-1)	$\frac{\tanh\left[\sqrt{3}\cdot\left(\frac{l}{h}\right)\right]}{\sqrt{3}\cdot\left(\frac{l}{h}\right)} \cdot W$ (TID-7024, Eq. 6.1, see Note 1)	ACI 350.3-06 (identical to TID-7024)
W_c: convective water weight	$0.264\cdot\left(\frac{L}{H_L}\right)\cdot\tanh\left[3.16\left(\frac{H_L}{L}\right)\right]\cdot W_L$ (Eq. 9-2)	$0.527\cdot\left(\frac{l}{h}\right)\cdot\tanh\left[1.58\left(\frac{h}{l}\right)\right]\cdot W$ (TID-7024, Eq. 6.5, see Note 1)	ACI 350.3-06 (identical to TID-7024)
f_c: 1st convective mode frequency	$T_c = \frac{2\pi\sqrt{L}}{\lambda}$ $Eq\,9-14$ $\lambda = \sqrt{3.16\cdot g\cdot\tanh\left[3.16\left(\frac{H_L}{L}\right)\right]}$ $Eq\,9-13$ $f_c = \frac{1}{T_c}$ ▷ $f_c = \frac{\sqrt{3.16g\cdot\tanh\left[3.16\left(\frac{H_L}{L}\right)\right]}}{2\pi\cdot\sqrt{L}}$ (derived from Eq. 9-14, 9-13)	$\omega^2 = \frac{1.58\cdot g}{l}\cdot\tanh\left[1.58\left(\frac{h}{l}\right)\right]$ $Eq\,6.8$ $f_c = \frac{\omega}{2\pi}$ ▷ $f_c = \frac{\sqrt{3.16g\cdot\tanh\left[3.16\left(\frac{H_L}{L}\right)\right]}}{2\pi\cdot\sqrt{L}}$ (derived from TID-7024, Eq. 6.8, see Note 1)	ACI 350.3-06 (identical to TID-7024)

Table 3 Comparison of Equations of Key Parameters

Parameter	ACI 350.3-06	TID-7024, NUREG/CR-1161, and ASCE 4-98	Equation used in Hydrodynamic Analysis of UHS Structures
h_i: Height from bottom of basin to centroid of impulsive pressure distribution (excluding base pressure, EBP)	$\left[0.5-0.09375\left(L/H_L\right)\right]\cdot H_L$ for $L/H_L<1.333$ (*Eq.* 9-3) 0.375 for $L/H_L>1.333$ (*Eq.* 9-4)	$3/8\cdot H_L$ (*Eq.* 6.2, see Note 2)	ACI 350.3-06 requires greater height of distribution compared to TID-7024 (See Figure 1) which conservatively results in higher bending moment demands on the walls.
h_c: Height from bottom of basin to centroid of convective pressure distribution (excluding base pressure, EBP)	$\left[1-\dfrac{\cosh\left(3.16\cdot\frac{H_L}{L}\right)-1}{3.16\cdot\frac{H_L}{L}\sinh\left(3.16\cdot\frac{H_L}{L}\right)}\right]\cdot H_L$ (*Eq.* 9-5)	$\left[1-\dfrac{\cosh\left(1.58\cdot\frac{H_L}{L/2}\right)-1}{1.58\cdot\frac{H_L}{L/2}\sinh\left(1.58\cdot\frac{H_L}{L/2}\right)}\right]\cdot H_L$ (*Eq.* 6.6, see Note 2)	ACI 350.3-06 (identical to TID-7024)
d_{max}: maximum convective (sloshing) water height (freeboard)	$\frac{1}{2}\cdot L\cdot C_c\cdot I$ (*Eq.* 7-1)	$\left[\dfrac{0.527\cdot L/2\cdot\coth\left(1.58\cdot\frac{H_L}{L/2}\right)}{\frac{g}{\omega^2\cdot\theta_h\cdot L/2}-1}\right]$ (*Eq.* 6.11, see Note 2)	ACI 350.3-06 conservatively calculates larger sloshing height for all slosh zones (see Figure 2)

Table 4 Comparison of Equations of Key Parameters

Parameter	ACI 350.3-06	TID-7024, NUREG/CR-1161, and ASCE 4-98	Equation used in Hydrodynamic Analysis of UHS Structures

1 All variables presented above from the two references, except for lengths, are equivalent (e.g., $h = H_L$). The tank lengths in the two codes are defined differently. TID-7024 derives the expressions with 'l' equal to one-half the length of the rectangular tank wall while ACI 350.3 derives the expressions with 'L' equal to the inside dimension of the rectangular tank, therefore "l" = "L"/2.

2 Substitutions have been made for equations from TID-7024, NUREG/CR-1161, and ASCE 4-98 to equate tank dimensions with those of ACI 350.3: $h = H_L$ and "l" = "L"/2.

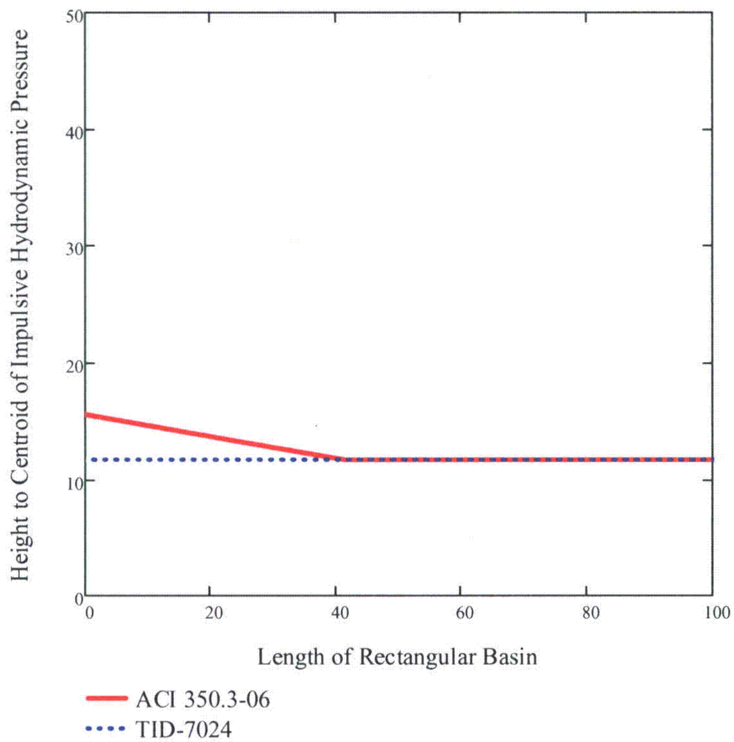
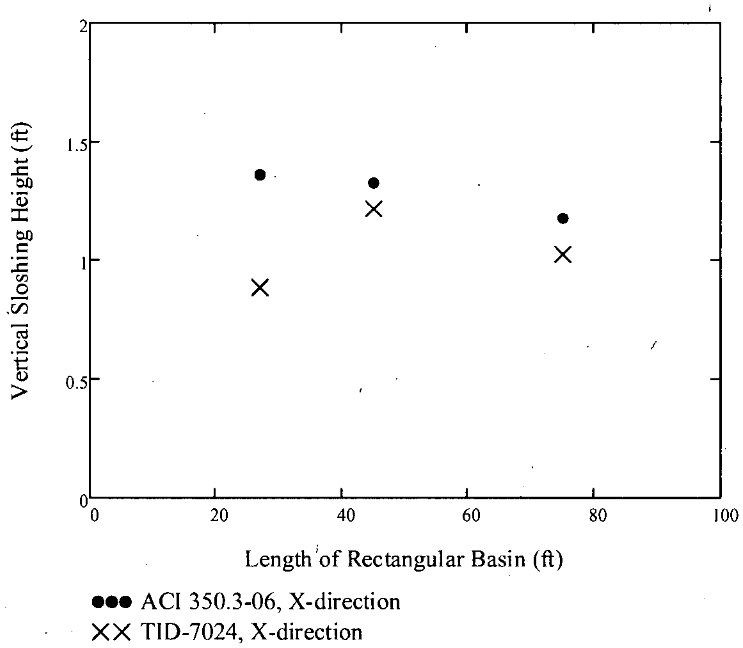
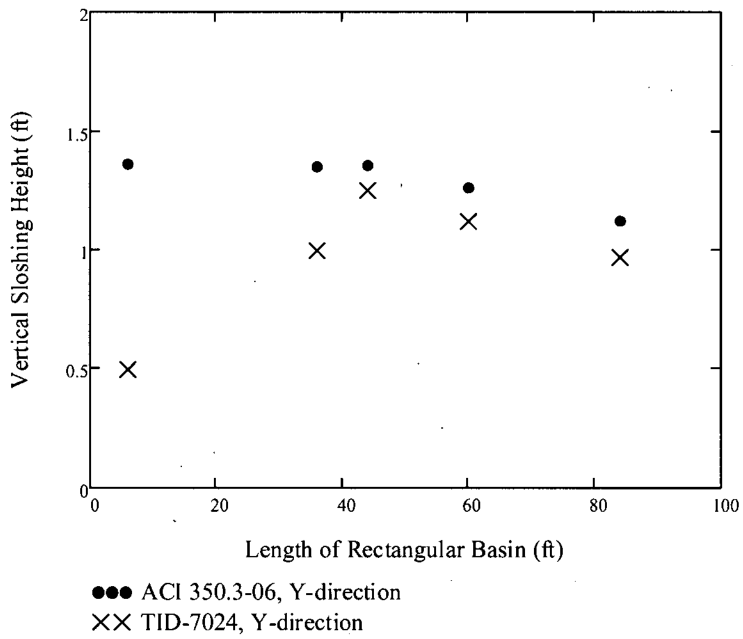


Figure 1 Height from Bottom of Basin to Centroid of Impulsive Pressure Distribution (Excluding Base Effects) for 31 ft deep Basin considering Expressions from ACI 350.3-06 and TID-7024 (note ACI 350.03 is equal to or greater than TID-7024 for all values of Basin Length)



(a)



(b)

Figure 2 Sloshing Heights Calculated by ACI 350.3-06 and TID-7024 for each slosh zone considered (a) X-direction sloshing and (b) Y-direction sloshing (note the sloshing heights calculated for UHS using ACI 350.3-06 are all greater than the values calculated using TID-7024) mounted to the UHSRS walls, it is required to account for the effects of out-of-plane wall flexibility.

3KK.5 References

3KK-1 *An Advanced Computational Software for 3D Dynamic Analysis Including Soil Structure Interaction,* ACS SASSI Version 2.2, Ghiocel Predictive Technologies, Inc., July 23, 2007.

3KK-2 ANSYS Release 11.0, SAS IP, Inc. 2007.

3KK-3 *Seismic Analysis of Safety-Related Nuclear Structures,* American Society of Civil Engineers, ASCE 4-98, Reston, Virginia, 2000.

3KK-4 *Damping Values for Seismic Design of Nuclear Power Plants*, Regulatory Guide 1.61, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

3KK-5 *Seismic Design of Liquid-Containing Concrete Structures and Commentary,* ACI 350.3, American Concrete Institute, Farmington Hills, Michigan, 2006.

3KK-6 *Combining Responses and Spatial Components in Seismic Response Analysis*, Regulatory Guide 1.92, Rev. 2, U.S. Nuclear Regulatory Commission, Washington, DC, July 2006.

3KK-7 *Development of Floor Design Response Spectra for Seismic Design of Floor-supported Equipment or Components*, Regulatory Guide 1.122, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, DC, February 1978.

3KK-8 Morante, R. and Wang, Y. *Reevaluation of Regulatory Guidance on Modal Response Combination Methods for Seismic Response Spectrum Analysis*, NUREG/CR-6645, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC, December 1999.

3KK-9 Seismic Subsystem Analysis, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, United States Nuclear Regulatory Commission Standard Review Plan 3.7.3, Revision 3, March 2007. RCOL2_03.07.03-1

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Comanche Peak, Units 3 and 4

Luminant Generation Company LLC

Docket Nos. 52-034 and 52-035

RAI NO.: 2883 (CP RAI #64)

SRP SECTION: 03.07.03 - Seismic Subsystem Analysis

QUESTIONS for Structural Engineering Branch 1 (AP1000/EPR PROJECTS) (SEB1)

DATE OF RAI ISSUE: 9/18/2009

QUESTION NO.: 03.07.03-2

In COLA, FSAR Appendix 3KK (page 3KK-3), it is stated that the water within each rectangular region of the UHS structures is separated into impulsive and convective masses, but it is not required that the convective mass of the water in the UHS structures be modeled in the response spectra analysis to obtain seismic demands because the fundamental convective frequency is much lower than structural and soil frequencies.

Because the separation between the convective frequencies, and the structural and soil frequencies is not uncommon, additional justification is requested for deviating from the guidance provided in SRP Section 3.7.3.II.14.A.

In order for the NRC staff to evaluate the analysis of the hydrodynamic effects on the UHS structures, the applicant should provide the following information:

1. Clarification of how the convective mass of the water is treated in the analysis.
2. A description of each of the rectangular regions used in the analysis.
3. The convective frequencies for each of the regions.
4. The convective mass of the water for each of the regions.
5. The critical response parameters for the hydrodynamic analysis of the UHS basins.

Provide estimates of the convective effects on the each of the critical response parameters. That is, the applicant should provide quantitative estimates of the error introduced into the critical response parameters by neglecting the convective effects.

ANSWER:

The last paragraph of FSAR Section 3KK.2 states that "For the response spectra analyses performed to obtain seismic design demands, the sloshing mass is not required to be modeled since its fundamental frequency is much lower than the structural or soil frequencies." This statement is incorrect. Sloshing effects are considered in the response spectra analysis to obtain seismic demands, as explained in Section 3KK.3. Further detailed explanation is provided as follows.

The fundamental convective frequencies are included in the response spectrum analysis in accordance with the modeling procedures of ASCE 4-98 and the hydrodynamic properties of ACI 350.3-06. As described in the response to Question 03.07.03-1 above, use of ACI 350.3-06 and the procedure for design of the UHS meets or exceeds the criteria set forth in SRP 3.7.3.

The response of the convective water mass of each rectangular region described below is included in the analysis by a series of mass-spring systems that match the fundamental convective frequencies (calculated with ACI 350.3-06) within each rectangular region. The convective modes are included in the response spectrum analysis and a composite damped spectrum is used in the analysis that has 5% damping for all frequencies above 1Hz (only structural modes) and 0.5% damping for all frequencies below 1Hz (only convective modes). These levels of damping are consistent with the procedures of SRP 3.7.3.

<u>Response to Information Item 1</u>

The convective mass is included in the ANSYS response spectrum analysis using point masses and uni-directional springs. The mass is equal to the convective mass in Table 3KK-7 in the attached FSAR markup and the springs are assigned stiffness such that the mass-spring system has a frequency equal to the convective frequency in Table 3KK-7. Separate mass-spring systems are provided for all sloshing regions shown in Figure 1 below.

<u>Response to Information Item 2</u>

The rectangular regions used for hydrodynamic calculations are shown in Figure 1. The regions were selected based on the clear dimensions of walls separating the basins, cooling tower cells, and pump room. Note the L-shaped region of basin 1 is separated differently for X- and Y-direction motion to adequately represent the conditions of a rectangular hydrodynamic region for which the expressions developed from ACI 350.3-06 or TID-7024 were derived.

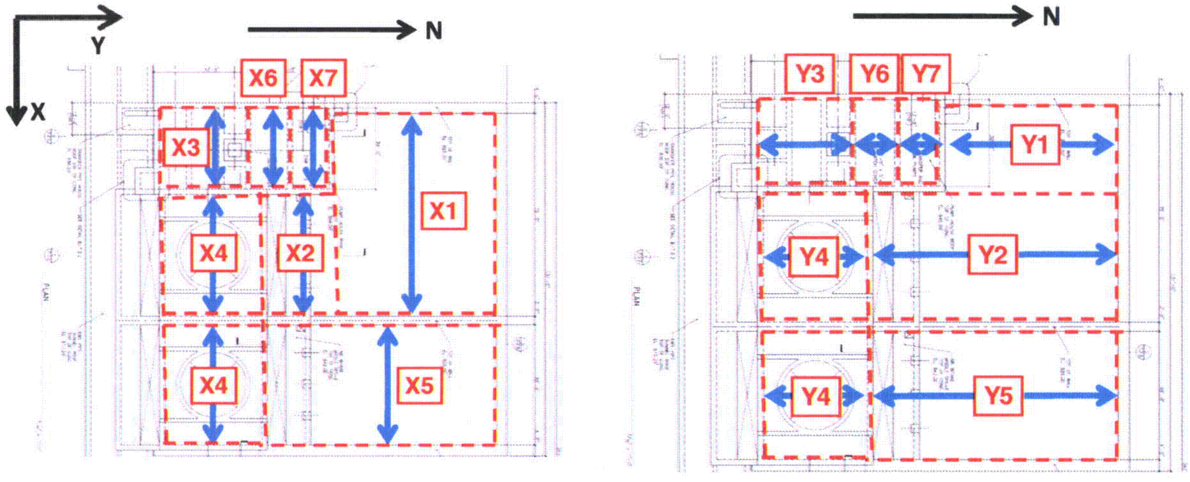


Figure 1 Rectangular Hydrodynamic Regions used for Analysis

Response to Information Items 3, 4, and 5

The hydrodynamic properties (fundamental convective frequencies, convective water mass, and critical response parameters) for each region are provided in Table 3KK-7 in the attached FSAR markup.

All forces resulting from seismic response of the convective water mass are included in the response spectrum analysis performed and thus the effects of the convective water mass are included in the design.

Impact on R-COLA

See attached marked-up of FSAR Draft Revision 1 pages 3KK-3 through 3KK-5, 3KK-14, and 3KK-31.

Impact on S-COLA

None.

Impact on DCD

None.

properties at the centerline. All roof slabs and elevated slabs (pump room, fan slab, missile shield protection) are considered as cracked with an out-of-plane bending stiffness of ½ of the gross section stiffness. The properties assigned to the slab elements are modified to account for cracked out-of plane flexural stiffness and non-cracked in-plane axial and shear stiffness of the slabs as follows:

$$E_{cracked} = [1/(C_F)^{0.5}] \cdot E_{concrete}$$

$$t_{cracked} = (C_F)^{0.5} \cdot t$$

$$\gamma_{cracked} = [1/(C_F)^{0.5}] \cdot \gamma_{concrete}$$

where:

C_F = the factor for the reduction of flexural stiffness, taken as 1/2,

$t_{cracked}$ = the effective slab thickness to account for cracking

t = the gross section thickness

$\gamma_{cracked}$ = the effective unit weight to offset the reduced stiffness and provide the same total mass

$\gamma_{concrete}$ = unit weight of concrete

$E_{cracked}$ = effective modulus to account for the reduction in thickness that keeps the same axial stiffness while reducing the flexural stiffness by C_F

$E_{concrete}$ = modulus of elasticity of concrete.

Density of the structural walls and slabs is modified to include the dynamic masses of self-weight plus equivalent dead load and 25 percent of live load. Equivalent dead load is 50 psf on all interior surfaces above water (except inside the air-intake or the cooling tower walls at locations beneath the fan slab). Live load on the elevated floor slabs is 200 psf, and live load on roof slabs is taken as 100 psf. Weights are applied in the model at appropriate locations to represent the following equipment and component masses: transfer pump, essential service water (ESW) pump, tile fill located below the cooling tower fans, distribution nozzles and system, fan, fan motor, gear-reducer, driveshaft, steel grating.

~~The hydrodynamic effects of the water contained in the basins, cooling towers, and pump room of the UHS are considered in the model. The water is separated into rectangular regions in which water sloshing can develop under horizontal seismic excitation. Using the methodology specified in ACI 350.3-06 (Reference 3KK-5), the water within each region is separated into impulsive (fixed) and~~ RCOL2_03.07.03-2

~~convective (sloshing) masses. The impulsive mass of the water is lumped uniformly along the height of the walls at each end of the rectangular region in the direction perpendicular to the wall. For the response spectra analyses performed to obtain seismic design demands, the sloshing mass is not required to be modeled since its fundamental frequency is much lower than the structural or soil frequencies. The vertical mass of the water is distributed uniformly across the basemat.~~The hydrodynamic effects of the water contained in the basins, cooling towers, and pump room of the UHS are considered for dynamic analyses used in development of dynamic demands in accordance with requirements of SRP 3.7.3 (Reference 3KK-9). The hydrodynamic properties are calculated using the methodology specified in ACI 350.3-06 (Reference 3KK-5) and modeling is performed following the procedures of ASCE 4-98 (Reference 3KK-3). The properties calculated using ACI 350.3-06 meet or exceed relevant requirements of SRP 3.7.3. For the purposes of hydrodynamic analysis, the water is separated into rectangular regions to calculate hydrodynamic properties per ACI 350.3-06. The rectangular regions shown in Figure 3KK-4 are chosen since they are bounded by structural walls such that their behavior conforms to the equations derived in the above referenced documents. The key hydrodynamic properties of each region are listed in Table 3KK-7. Due to the embedment, squat dimensions, and small intensity base excitations, uplifting of this structure is not considered in the UHSRS model. RCOL2_03.07.03-2

Following the recommended modeling procedures of ASCE 4-98 (Reference 3KK-3), the water mass within each region is separated into impulsive and convective components (W_i and W_c in Table 3KK-7). The impulsive mass of the water is applied to nodes of walls at each end of the rectangular region, in the direction perpendicular to the wall, and applied uniformly along the walls using directional masses from the bottom of the basin to a height of twice the impulsive pressure distribution (h_i, values in Table 3KK-7). The convective mass is included in the analysis using point masses and uni-directional springs which are attached to the end walls of each hydrodynamic region at the height of the convective pressure distribution centroid, hc (see Table 3KK-7). The mass is equal to the convective mass (W_c) noted in the attached table and the springs are assigned stiffness such that the mass-spring system has a frequency equal to the convective frequency (f_c) noted in the table. Separate mass-spring systems are provided for all hydrodynamic regions. The vertical mass of the water is distributed uniformly across the base mat using directional mass elements. Support flexibility is considered by enveloping demands of a fixed-base model and a model supported on flexible soil springs.

Response spectra analyses are performed in ANSYS (Reference 3KK-2) to obtain seismic design demands, which include all structural and hydrodynamic effects as described above. The impulsive hydrodynamic modes include the basin flexibility directly in the FE analysis. All structural and impulsive modes (frequencies > 1Hz) are assigned 5% damping (although 7% is allowed by RG 1.61, Reference 3KK-4). The convective modes are assigned 0.5% damping by increasing the input response spectrum for frequencies less than 1 Hz (only includes the convective modes). Modal combination is performed in accordance with RG 1.92 (Reference 3KK-6), using Combination Method B for combination of periodic and rigid modes, using the low frequency correction $\alpha=0$ for frequencies below the peak of the spectra. Periodic modal response is combined using the grouping method. Spatial combination is performed using the Newmark 100-40-40 percent combination rule. RCOL2_03.07.03-2

The peak sloshing height in any hydrodynamic region is equal to 1.91 ft. This height includes spatial combination of sloshing in each region using the Newmark 100-40-40 percent directional combination rule. The nominal freeboard height to the top of the basin walls and underside of the pump room slab is equal to 4 feet. Therefore, loss of water or uplifting pressures on the pump house slab is not a concern since adequate clearance is provided to allow this amount of sloshing.

3KK.3 Seismic Analysis Results

Table 3KK-2 presents the natural frequencies of the UHSRS FE structural model used for the SASSI analysis. Table 3KK-3 presents a summary of SSI effects on the seismic response of the UHSRS. The maximum absolute nodal accelerations obtained from the SASSI analyses are presented in Table 3KK-4 for key UHSRS locations. The results envelope all site conditions considered. The maximum accelerations have been obtained by combining cross-directional contributions in accordance with RG 1.92 (Reference 3KK-6) using the square root sum of the squares (SRSS) method.

The dynamic horizontal soil pressure of the backfill on the basin walls varied depending on the soil case considered as the soil frequency approached that of the wall. The peak soil pressures varied along the height of the wall from values of approximately 0.5 ksf to almost 2ksf. The dynamic horizontal soil pressure used for design varied linearly from a value of 0.50ksf at the base slab to 1.5ksf at soil grade. The base shear and moment demands on walls, calculated in SASSI calculated lateral dynamic soil pressures and equivalent pressure used for design analysis, were compared and the design pressure profile shown to be conservative. The peak design vertical soil pressure calculated under the base slab is 11.7 ksf, which reduces away from edges. This value excludes the peak corner pressure of 23.0 ksf calculated on a single element, representing less than 0.2 percent of the total base slab area. The average peak vertical seismic pressure calculated under the base slab is 1.6 ksf.

For design of the UHSRS per the loads and load combinations given in Section 3.8, response spectra analysis is performed to obtain seismic demands. The response spectra analysis includes sloshing effects on the basins considering 0.5 percent damping, and follows the Lindley-Yow method (Reference 3KK-8) and 10 percent modal combination method. Note that the rigid response coefficient is set to zero for frequencies below the spectral peak acceleration (2.5 Hz for horizontal directions, 3.5 Hz for vertical direction) in accordance with RG 1.92 (Reference 3KK-6). Since the sloshing modes are well separated from all structural modes, the decreased level of damping is accounted for by increasing the spectrum for

RCOL2_03.07.03-2

Table 3KK-7

UHS Hydrodynamic Properties

Hydrodynamic Region	N-S dimension (ft)	E-W dimension (ft)	Total Water Weight in Region (kip)	Impulsive Water Weight (W_i)/Total Water Weight	Convective Water Weight (W_c)/Total Water Weight	Convective Frequency (f_c, Hz)	Height from bottom of basin to Centroid of Impulsive Pressure (h_i, ft)	Height from bottom of basin to Centroid of Convective Pressure (h_c, ft)
X1	60	75	8705	0.46	0.55	0.17	11.6	17.4
Y1	60	30	3482	0.56	0.47	0.20	11.6	18.2
X2	24	45	2089	0.68	0.37	0.24	11.6	19.7
Y2	84	45	7312	0.42	0.59	0.16	11.6	17.0
X3	44	27	3188	0.92	0.16	0.31	20.2	37.0
Y3	44	27	3188	0.82	0.26	0.24	18.6	32.6
X4	36	45	3134	0.68	0.37	0.24	11.6	19.7
Y4	36	45	3134	0.76	0.30	0.27	12.1	21.0
X5	84	45	7312	0.68	0.37	0.24	11.6	19.7
Y5	84	45	7312	0.42	0.59	0.16	11.6	17.0
X6	6	27	313	0.85	0.23	0.31	13.0	22.9
Y6	6	27	313	0.99	0.05	0.66	14.9	29.1
X7	6	27	313	0.85	0.23	0.31	13.0	22.9
Y7	6	27	313	0.99	0.05	0.66	14.9	29.1

RCOL2_03.07.03-2

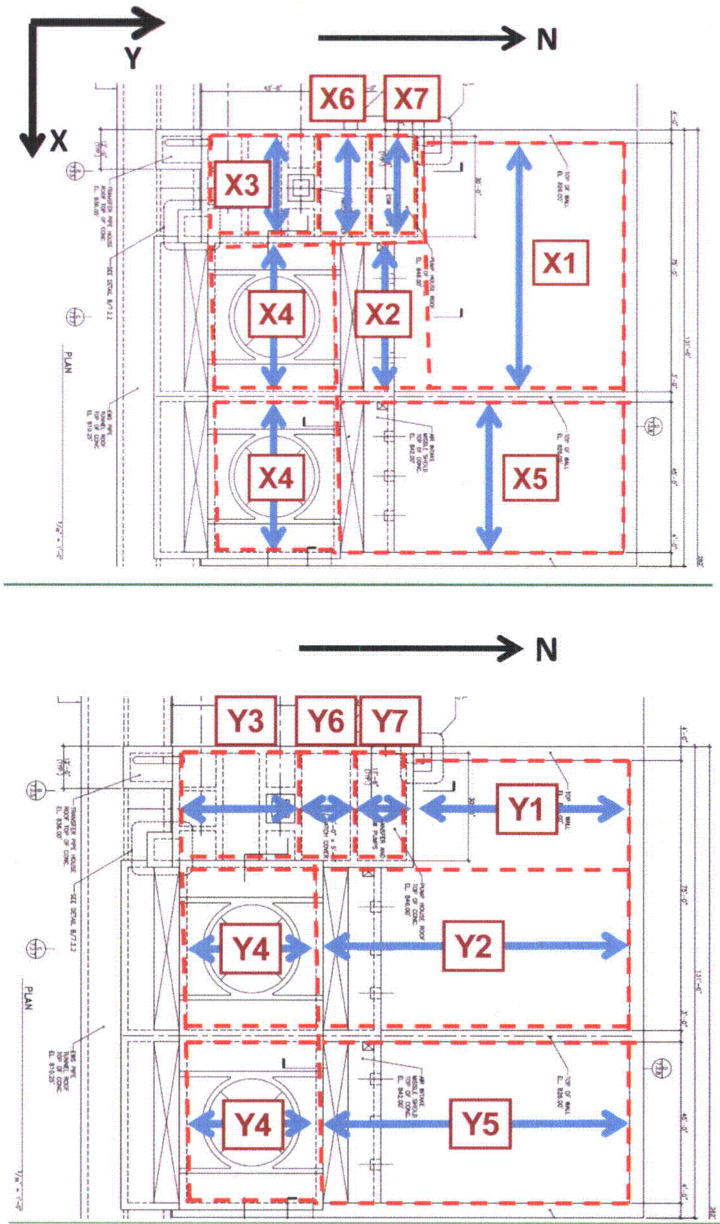


Figure 3KK-4 Rectangular Hydrodynamic Regions Used for Analysis

Attachment 2

Response to Request for Additional Information No. 3127 (CP RAI #65)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Comanche Peak, Units 3 and 4

Luminant Generation Company LLC

Docket Nos. 52-034 and 52-035

RAI NO.: 3127 (CP RAI #65)

SRP Section: SRP SECTION: 05.03.01 - Reactor Vessel Materials

QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects) (CIB1)

DATE OF RAI ISSUE: 9/18/2009

QUESTION NO.: 05.03.01-2

The regulatory basis for this question is 10 CFR Part 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements."

COL FSAR Section 5.3 states that this section of the referenced design certification document (DCD) is incorporated by reference except for the listed departures and/or supplements.

a) Section 5.3.1.6.1 of the US-APWR DCD states that the reactor vessel surveillance program (RVSP) test specimens for the base metal are taken from locations near the fracture toughness test specimens required in Section 5.3.1.5. Section 5.3.1.5.1 of the US-APWR DCD states that the fracture toughness specimens are removed from the production material of ferritic pressure boundary forgings in accordance with American Society of Mechanical Engineers Code Section III NB-2220. Confirm that the RVSP test specimens are taken from material used for the reactor vessel beltline.

b) Section 5.3.1.6.1 of the US-APWR DCD also states that the RVSP test specimens, dosimeters and thermal monitors are assembled into the capsules and then the capsules are sealed and leak tested. Confirm that the RVSP test specimens are sealed in an inert environment.

ANSWER:

a) Luminant confirms that test specimens for the RVSP are taken from the base metal of the reactor vessel beltline region forgings, from locations near the fracture toughness test specimens.

b) Luminant confirms that the capsules for the RVSP are sealed so that the test specimens are in an inert environment.

<u>Impact on R-COLA</u>

See marked-up FSAR draft Revision 1 page 5.3-1.

Impact on S-COLA

None.

Impact on DCD

None.

5.3 REACTOR VESSEL

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

5.3.1.6 Material Surveillance

STD COL 5.3(2) Replace the second paragraph with the following in DCD Subsection 5.3.1.6.

The reactor vessel material surveillance program is implemented as an operational program. As the reactor vessel materials do not begin to be affected by neutron fluence until the reactor begins critical operation, this program is implemented prior to initial criticality, as identified in Table 13.4-201.

5.3.1.6.1 Surveillance Capsules

STD SUP 5.3(1) Insert the following at the end of the second paragraph in DCD Subsection 5.3.1.6.1. RCOL2_05.03.01-2

Test specimens are taken from material used for the reactor vessel beltline.

STD SUP 5.3(2) Insert the following after the first sentence in the fifth paragraph in DCD Subsection 5.3.1.6.1.

The capsules are sealed in an inert environment.

CP COL 5.3(3) Replace the last sentence in the fifth paragraph with the following in DCD Subsection 5.3.1.6.1.

These lead factors and the capsule orientation shown in DCD Figure 5.3-1 are applicable for CPNPP Units 3 and 4.

CP COL 5.3(2) Replace the last sentence in the sixth paragraph with the following in DCD Subsection 5.3.1.6.1.

Attachment 3

Response to Request for Additional Information No. 3193 (CP RAI #62)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Comanche Peak Units 3 and 4

Luminant Generation Company LLC

Docket No. 52-034 and 52-035

RAI NO.: 3193 (CP RAI #62)

SRP SECTION: 05.03.01 - Reactor Vessel Materials

QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects) (CIB1)

DATE OF RAI ISSUE: 9/18/2009

QUESTION NO.: 05.03.01-1

SECY 05-197, "Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria," dated October 28, 2005, describes the need for combined license (COL) applications to include license conditions addressing implementation milestones and operational readiness for operational programs including the reactor vessel surveillance program.

Based on the policy established in SECY 05-197, please revise FSAR 5.3.1 and Table 13.4-201 "Operational Programs Required by NRC Regulation and Program Implementation," to include the following license conditions:

- The licensee shall implement reactor vessel material surveillance prior to initial criticality.
- The licensee will submit to the NRC a schedule, no later than 12 months after issuance of the COL, that supports the planning for and conduct of NRC inspections of operational programs, including reactor vessel surveillance.

ANSWER:

As described in FSAR 5.3.1.6 and Table 13.4-201, the implementation of the reactor vessel material surveillance program prior to initial criticality is already identified as a license condition and has been specified in COLA Part 10. COLA Part 10 was provided to the NRC in Luminant letter TXNB-09053, “Combined License Application Update Tracking Report Parts 4, 10, and 11,” dated October 21, 2009. The relevant pages are attached.

Rather than propose a license condition for the operational program schedule, Luminant commits to submit a schedule to the NRC that supports the planning and conduct of NRC inspections of operational programs, including the reactor vessel surveillance program, no later than 12 months after issuance of the COL or at the start of construction as defined in 10 CFR 50.10a, whichever is later. This is similar to the approach for the ITAAC schedule required in 10 CFR 52.99(a).

Impact on R-COLA

None.

Impact on S-COLA

None.

Impact on DCD

None.

Attachment

COLA Part 10 Section 2.3 pages 4 - 6

2.3 Operational Programs

Operational Programs are identified in Table 13.4-201 and their implementation by the milestones indicated in the Table is a potential condition to the license. Some of these programs may be adequately controlled by other methods such as the regulations, the technical specifications or a commitment tracking system and will not need to be addressed in a license condition. A proposed license condition is provided in section 3 below based upon the current information in Chapter 13 of the COLA FSAR. CTS-00841

2.4 Environmental Protection Plan

The Environmental Protection Plan (EPP) and its implementation may also be a potential condition to the license. The EPP has typically been an appendix to the operating license and that precedent may be followed for COLs as well. No plant specific environmental items have been identified which are not adequately controlled by regulations, the appropriate permits, etc. and thus an EPP has not been proposed and is not needed. CTS-00841

2.5 Technical Specifications

Implementation of Technical Specifications prior to fuel load could also constitute a potential condition to the license. The Technical Specifications have typically been an appendix to the operating license and that precedent may be followed for COLs as well.

2.6 Others

The current operating licenses have some typical license conditions in areas such as security, fire protection and others. These current license conditions may or may not apply to COLs.

3. Specific Proposed License Conditions

The ~~only~~ license conditions identified thus far during the COL development and review are ~~is~~:

Proposed License Condition	Source	
		CTS-00841
The plant-specific PTS evaluation of the as-procured reactor vessel material properties will be submitted to the NRC within 12 months following acceptance of the reactor vessel.	Answer to RAI 2353 (CP RAI #8) question 05.03.02-3 as provided in TXNB-09028 dated August 7, 2009.	RCOL2_05.03.02-3
The licensee shall implement the programs or portions of programs identified in the table below on or before the associated milestones.	COLA FSAR Table 13.4-201 Items 3, 5, 6, 8, 9, 10, 12, 15, 18, and 19.	

Operational Programs to be implemented per License Condition above: CTS-00841

Program Title	Milestone
Environmental Qualification Program	Prior to Initial Fuel Load
Reactor Vessel Material Surveillance Program	Prior to Initial Criticality
Preservice Testing Program	Prior to Initial Fuel Load
Fire Protection Program	Prior to fuel receipt for elements of the Fire Protection Program necessary to support receipt and storage of fuel on-site. Prior to initial fuel load for elements or the Fire Protection Program necessary to support fuel load and plant operation.
Process and Effluent Monitoring and Sampling Program – Radiological Effluent Technical Specifications/Standard Radiological Effluent Controls	Prior to receipt of radioactive material on-site
Process and Effluent Monitoring and Sampling Program – Offsite Dose Calculation Manual	Prior to receipt of radioactive material on-site
Process and Effluent Monitoring and Sampling Program – Radiological Environmental Monitoring Program	Prior to receipt of radioactive material on-site
Process and Effluent Monitoring and Sampling Program – Process Control Program	Prior to receipt of radioactive material on-site
Radiation Protection Program	Prior to initial receipt of by-product, source, or special nuclear materials (excluding Exempt Qualities as described in 10 CFR 30.18) for those elements of the Radiation Protection (RP) Program necessary to support such receipt Prior to fuel receipt for those elements of the RP Program necessary to support receipt

CTS-00841

Program Title	**Milestone**
	and storage of fuel on-site. Prior to fuel load for those elements of the RP Program necessary to support fuel load and plant operation Prior to first shipment of radioactive waste for those elements of the RP Program necessary to support shipment of radioactive waste.
Reactor Operator Training Program	18 months prior to scheduled fuel load.
Security Program – Physical Security Program	Prior to receipt of fuel on site.
Security Program- Safeguards Contingency Program	Prior to receipt of fuel on site.
Security Program – Training and Qualification Program	Prior to receipt of fuel on site.
Motor-Operated Valve Testing	Prior to initial fuel load.
Initial Test Program	Prior to the first construction test for the Construction Test Program. Prior to the first preoperational test for the Preoperational Test Program. Prior to initial fuel loading for the Startup Test Program.
Fitness for Duty Program – Construction Mgt & Oversight personnel	Prior to on site construction of safety or security related SSCs.
Fitness for Duty Program – Construction Workers & first Line Supv.	Prior to on site construction of safety or security related SSCs.
Fitness for Duty Program – Operations Phase Program	Prior to fuel receipt

Attachment 4

Response to Request for Additional Information No. 3219 (CP RAI #63)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Comanche Peak Units 3 and 4

Luminant Generation Company LLC

Docket No. 52-034 and 52-035

RAI NO.: 3219 (CP RAI #63)

SRP SECTION: 09.04.01 - Control Room Area Ventilation System

QUESTIONS for Containment and Ventilation Branch 1 (AP1000/EPR Projects) (SPCV)

DATE OF RAI ISSUE: 9/18/2009

QUESTION NO.: 09.04.01-1

In combined license application (COLA) FSAR subsection 9.4.1.2 and FSAR Table 9.4-201, Luminant assigns a heating coil capacity value of 37 kW to the heaters of the four Main Control Room (MCR) Air Handling Units (AHU).

During its review, using the guidance of NUREG-800 Standard Review Plan (SRP) 9.4.1, the NRC staff found that Luminant did not include a reference in COLA FSAR Section 9.4.8 that would provide the basis and calculations used in the sizing of the heaters (i.e. 37 KW) for the MCR AHU. Luminant is requested to either establish clear performance criteria for the heaters and a means (ITAAC and/or startup testing) of verifying that heaters have been sized adequately or provide the following to justify the value selected.

- What is the basis for the sizing of the heaters?
- What is the design basis MCR temperature that the heaters are designed to maintain? The design basis should be clearly stated in the COLA FSAR.

In order to facilitate confirmatory calculations, please provide the inputs to the design calculations used in the derivation of the heating coil capacity value for the heater of the four MCR AHU.

ANSWER:

Two of four 50% capacity Main Control Room (MCR) air handling units (AHUs) are operated during normal operation and the accident condition (LOCA). The heating requirement is determined by the differential air temperature between the return air temperature from the MCR and the supply air temperature to the MCR. The MCR AHU heating requirement is calculated by the following equation and is determined by the following design condition.

$q = 60 \times \rho \times Cp \times Q \times (ti - to) \times 1.15 = 240{,}948$ BTU/h (use 251,000 for conservatism) where,

q : Heating requirement (BTU/h)
ρ : Density (0.075 lb/ft^3)
Cp: Specific heat (0.24 BTU/lb-F)
Q : Total airflow rate across the heating coils (20,000 CFM with two AHU operating)
ti : Supply air temperature (78 deg F)
to : Return air temperature (68.3 deg F) (Site-specific)
1.15: factor for margin

The heating requirement per AHU is 126,000 Btu/h (or 36.914kW). Thus the MCR AHU heating coil capacity will be 37kW.

As noted above, the capacity of the MCR AHU heating coils is dependent on the differential air temperature between the return and supply air. The supply air temperature [78 deg F] is determined to maintain the maximum MCR air temperature as described in DCD Table 9.4-1. When the heat loss from the MCR structure is considered, the 18,200 CFM recirculating air from MCR is calculated to be 75.2 deg F. The return air temperature is a site-specific condition based on outside temperature. The site-specific outside air of 1,800 CFM is -0.5 deg F. The return air mixed with outside air is calculated to be 68.3 deg F. The return air temperature is calculated by the recirculating air from MCR and outside air. The design basis is clearly stated in the modified COLA FSAR (see attached marked-up page).

The capacity of the AHU heating coils is determined based on independent operation from the AHU cooling coils. However, the AHU cooling coils and the AHU electric heating coils could be manually operated at the same time during seasonal change. (i.e. spring or autumn season), not exceed the MCR temperature range described in DCD Table 9.4-1.

<u>Impact on R-COLA</u>

See attached marked-up FSAR Draft Revision 1 page 9.4-1.

<u>Impact on S-COLA</u>

None.

<u>Impact on DCD</u>

None.

9.4 AIR CONDITIONING, HEATING, COOLING, AND VENTILATION SYSTEMS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

9.4.1.2 System Description

CP COL 9.4(4) Replace the second sentence of the first paragraph in DCD Subsection 9.4.1.2 with the following.

The capacity of heating coils that are affected by site specific conditions is shown in Table 9.4-201. The site specific design basis for the heating coils is described in DCD Subsections 9.4.1.1 and 9.4.1.2 with the following site specific information. While the temperatures ranges for the Main Control Room is provided in DCD Table 9.4-1 and the design data for the air handling units is provided in DCD Table 9.4.1-1, the outside air temperature for CPNPP used to calculate the heater capacity is -0.5°F. The outside air is blended with the return air from the Main Control Room. RCOL2_09.04.01-1

9.4.3.2.1 Auxiliary Building HVAC System

CP COL 9.4(4) Replace the second sentence of the first paragraph in DCD Subsection 9.4.3.2.1 with the following.

The capacity of cooling and heating coils that are affected by site specific conditions is shown in Table 9.4-201.

9.4.3.2.2 Non-Class 1E Electrical Room HVAC System

CP COL 9.4(4) Replace the second sentence of the first paragraph in DCD Subsection 9.4.3.2.2 with the following.

The capacity of cooling and heating coils that are affected by site specific conditions is shown in Table 9.4-201.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Comanche Peak Units 3 and 4

Luminant Generation Company LLC

Docket No. 52-034 and 52-035

RAI NO.: 3219 (CP RAI #63)

SRP SECTION: 09.04.01 - Control Room Area Ventilation System

QUESTIONS for Containment and Ventilation Branch 1 (AP1000/EPR Projects) (SPCV)

DATE OF RAI ISSUE: 9/18/2009

QUESTION NO.: 09.04.01-2

In COLA FSAR subsection 9.4.1.2 and FSAR Table 9.4-201, Luminant assigns a heating coil capacity value of 37 kW to the heaters of the four MCR AHU to satisfy the requirements of US-APWR COL Information Item US-APWR COL 9.4(4) which states:

"The COL Applicant is to determine the capacity of cooling and heating coils that are affected by site specific condition."

Item 2.C of SRP 9.4.1 Section III "Review Procedures" pertains to the subject in-service inspection and functional testing of system components important to safety. The NRC staff notes that neither COLA FSAR 9.4 nor US-APWR design certification document (DCD) subsection 9.4.1.4 "Inspection and Testing Requirements" contain any type of testing or inspections of the MCR heaters for demonstrating/maintaining operability of the heaters.

The NRC staff notes that each AHU heater is safety related; is of significant size (i.e. 37kW) and performs a significant safety related function.

Luminant did not provide in the COLA a site-specific ITAAC that includes the MCR AHU heaters in Tier 1 DCD subsection 2.7.5.1 "Main Control Room HVAC System". Similarly, Luminant did not provide in the application an update of the pre-operational test 14.2.12.1.101 "MCR HVAC System Preoperational Test (including MCR Habitability)" to reflect the addition of these AHU heaters for the Comanche Peak Nuclear Power Plant.

The NRC staff requests that a justification be provided why the heater capacity need not be verified through ITAAC or startup testing. Alternatively, appropriate ITAAC and startup testing should be submitted.

ANSWER:

Luminant considers that testing of the MCR AHU heaters is adequately addressed in the US-APWR DCD as modified (see below).

Preoperational test 14.2.12.1.101 "MCR HVAC System Preoperational Test (including MCR Habitability)" has been significantly modified per MHI's response to DCD RAI No. 33, Question 14.02-82, submitted on September 4, 2008 (ML082520230). The modified preoperational test abstract verifies performance of heater coils in Test Method item C.12:

As revised in response to DCD RAI 184, Question 14.03.07-26, submitted on April 9, 2009 (ML091040177), ITAAC Item 4.a in DCD Tier 1, Table 2.7.5.1-3, requires tests and analyses to verify the as-built MCR HVAC system is capable of maintaining the control room envelope (CRE) within design limits for temperature and relative humidity during all plant operating conditions, including normal plant operations, abnormal and accident conditions. ITAAC Item 4.a in DCD Tier 1, Table 2.7.5.1-3, applies to performance of the as-built MCR HVAC system, including heater performance as necessary to maintain CRE temperature and relative humidity within design limits.

Impact on R-COLA

None.

Impact on S-COLA

None.

Impact on DCD

None.

Attachments

DCD RAI No. 33 Question 14.02-82, DCD RAI No. 184-1912 Question 14.03.07-26, and their responses (pages 14.02-110 through 14.02-112, 14.03.07-25, and 14.03.07-26)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/4/2008

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 33 REVISION 0**

SRP SECTION: **14.02 – Initial Plant Test Program – Design Certification and New License Applicants**

APPLICATION SECTION: **14.2**

DATE OF RAI ISSUE: **7/21/2008**

QUESTION NO.: 14.02-82

DCD Subsection 14.2.12.1.101, MCR HVAC System Preoperational Test, tests the MCR HVAC System and MCR habitability. This System is described in DCD Subsection 9.4.1. Two important functions of the system in DCD Subsection 9.4.1 do not appear in the test abstract: proper automatic switching to the emergency pressurization mode and to the emergency isolation mode. These functions should be added to the test abstract. The test abstract should also include a requirement that the system design per DCD Subsection 9.4.1 will be verified. Additionally, DCD Subsection 9.4.1 and Tables 1.9.1-1 & 14.2-2 commit to RG 1.196 which specifies, among other items, testing guidance for the MCR envelope integrity. Please include a reference to 1.196 test guidance in this test abstract.

In summary, please revise DCD Subsection 14.2.12.1.101 to: (1) address proper automatic switching to the emergency pressurization mode and to the emergency isolation mode; (2) require that the system design as specified in DCD Subsection 9.4.1 will be verified, and (3) include relevant RG 1.196 test guidance.

(BNL RAI 14.2-69)

ANSWER:

RG 1.196 refers to RG 1.197 for performing a control room envelope integrated leak test. RG 1.197 in turn refers to ASTM E-741-00 as an acceptable test method. This integrated testing is included in Subsection 14.2.12.1.101 in item C.6. MHI will revise Subsection 14.2.12.1.101 to clarify the integrated control room envelope testing requirements and bases.

MHI will revise Subsection 14.2.12.1.101 to include testing of automatic switching to the emergency pressurization mode and to the emergency isolation mode, and verification that the system performs as described in Subsection 9.4.1 in all operating modes.

Impact on DCD

This revision impacts revision 1 of the DCD in Subsection 14.2.12.1.101 on pages 14.2-118 and 14.2-119, Subsection 14.2.14 on page 14.2-164, and Table 14.2-2 on page 14.2-165.

Revise Subsection 14.2.12.1.101 as follows:

A. Objectives

1. To demonstrate operation of the MCR HVAC system **in normal, isolation and emergency pressurization modes**.

2. To verify that the system components perform their safety-related functions, including:

   a. Providing sufficient breathable quality air to the MCR

   b. Maintaining the MCR at positive pressure

3. **To perform integrated control room envelope leak testing.**

C. Test Method

1. Verify manual and automatic controls.

2. Verify that alarms and indications are functional.

3. Performance of the MCR HVAC and habitability systems are observed and recorded during component and integrated system testing.

4. Verify design air flow.

5. The ability of the emergency air supply to maintain the MCR at the proper positive pressure is demonstrated.

6. ~~The ability of the emergency air supply to limit air~~**Air** inleakage to the MCR is verified in accordance with **RG 1.196 (Reference 14.2-28) and** ASTM E-741-00 (Reference 14.2-23).

7. **Demonstrate automatic switching to isolation mode upon the receipt of the initiation signal.**

8. **Demonstrate automatic switching to pressurization mode upon the receipt of the MCR isolation signal.**

9. **Demonstrate Smoke Purge Operation mode.**

10. **Perform system and component testing in accordance with RG 1.52 (Reference 14.2-26),**

11. **Testing of high-efficiency particulate air filters and charcoal adsorbers performed per Subsection 14.2.12.1.79 is coordinated with this test.**

12. **Testing of prefilters, fans and fan motors, heaters, dampers, and ductwork is performed in accordance with RG 1.52 (Reference 14.2-26), and standards referenced by RG 1.52.**

D. Acceptance Criteria

1. The AHUs ~~and~~, fans **and dampers** ~~operate on the proper signals~~**perform as described in Subsections 6.4.2 and 9.4.1.**

2. All **indications and** alarms ~~annunciate properly~~ **operate as described in Subsection 9.4.1.5.**

3. ~~A positive pressure is maintained in the MCR with respect to the surrounding area, including during accident conditions, as specified in Section 6.4.~~ **The MCR HVAC system automatically switches to pressurization mode and establishes pressurization mode conditions upon the receipt of the MCR isolation signal in accordance with Subsections 6.4.2 and 9.4.1.2.2.1.**

4. The system maintains proper control room air quality.

5. The MCR tornado depressurization protection dampers operate as designed.

6. ~~The emergency air supply limits air inleakage to the MCR as specified in Subsection 6.4.~~**The ASTM E741 tests confirm total system leakage in the pressurization mode and air exchange rate in the pressurization mode in accordance with Subsection 6.4.2.3.**

7. **The MCR HVAC system automatically switches to isolation mode and establishes isolation mode conditions upon the receipt of the initiation signal in accordance with Subsections 6.4.2 and 9.4.1.2.2.2.**

Revise Subsection 14.2.14, References, as follows:

14.2-28 <u>Control Room Habitability at Light-Water Nuclear Power Reactors</u>, Regulatory Guide 1.196, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, DC January 2007

Revise Table 14.2-2 as follows:

21 Regulatory Guide 1.196, "Control Room Habitability at Light-Water Nuclear Power Reactors, Rev. 1, January 2007

Impact on COLA
There is no impact on the COLA.

Impact on PRA
There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

04/09/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 184-1912 REVISION 0**
SRP SECTION:	**14.03.07 - Plant Systems- Inspections, Tests, Analyses, and Acceptance Criteria**
APPLICATION SECTION:	**DCD SECTION 2.7 AND 2.8**
DATE OF RAI ISSUE:	**02/09/2009**

QUESTION NO.: 14.03.07-26

Identify the proper environmental condition to be maintained in the control room envelope in the Acceptance Criteria for item 4.a identified in US-APWR DCD Tier 1 Table 2.7.5.1-3.

No definition of the proper environmental condition to be maintained in the control room envelope is provided in Tier 1 Section 2.7.5.1 in a text discussion or a tabular form. Without a definition of the proper environmental condition, an inspector will be unable to provide an acceptable verification of the design commitment.

Also applicable to following ITAAC:

ITAAC item 4.a in Table 2.7.5.2-3.

ANSWER:

1. MHI's response to RAI 54 Question No. 14.03.07-2, RAI 14.3.7.3.2-16 (MHI's Responses to US-APWR DCD RAI No. 54 Revision 0, dated September 19, 2008) addresses ITAAC to demonstrate the proper environmental conditions for the MCR by a combination of tests and analyses. Specific values of the acceptable environmental parameters are contained in DCD Table 9.4-1, and are considered to be below the level of detail for Tier 1. The revised ITAAC are provided below.

2. MHI's response to RAI 54 question 14.3.7.3.6-14 (MHI's Responses to US-APWR DCD RAI No. 54 Revision 0, dated September 19, 2008) addresses ITAAC to demonstrate the individual functions provided by all the sub-systems of the Engineered Safety Features Ventilation System by a combination of tests and analyses. The functions are maintaining proper environmental conditions in all areas serviced by the ESFVS subsystems and maintaining less than 2% hydrogen concentration in the Class 1E Electrical room. Specific values of the acceptable environmental parameters are contained in DCD Table 9.4-1, and are considered to be below the level of detail for Tier 1. The revised ITAAC are provided below.

Impact on DCD

ITAAC Item 4.a in Tier 1 Table 2.7.5.1-3 will be revised as follows:

4.a The MCR HVAC system provides conditioning air to maintain the proper **design temperature and relative humidity limits for** ~~environmental condition of~~ the CRE during all plant **operating** conditions, **including normal plant operations, abnormal and accident conditions**.	4.a Tests **and analyses** of the as-built MCR HVAC system will be performed.	4.a The as-built MCR HVAC system ~~provides conditioning~~ **is capable of providing conditioned** air to maintain the proper **design temperature and relative humidity limits for** ~~environmental condition of~~ the CRE during all plant **operating** conditions, **including normal plant operations, abnormal and accident conditions**.

ITAAC Item 4 in Tier 1 Table 2.7.5.2-3 will be revised as follows:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
~~4.a The ESFVS provides conditioning air to maintain the proper environmental conditions within the respective area.~~	~~4.a Tests and analyses of the as-built ESFVS will be performed.~~	~~4.a The as-built ESFVS provides conditioning air to maintain the proper environmental condition within the respective area.~~
4.a~~b~~ The Annulus Emergency Exhaust System is capable of meeting the selected numerical performance values used in the safety analysis listed in Section 2.7.5.2.1.	4. a~~b~~.i Type tests, tests and analyses of filter efficiencies for the Annulus Emergency Exhaust System will be performed.	4. a~~b~~.i The Annulus Emergency Exhaust System is capable of meeting the filter efficiencies identified in this Subsection 2.7.5.2.1.
	4. a~~b~~.ii A Test of negative pressure arrival time for the as-built Annulus Emergency Exhaust System will be performed.	4. a~~b~~.ii The as-built Annulus Emergency Exhaust System is capable of meeting the negative pressure arrival time identified in this Subsection 2.7.5.1.1.
4.b The Class 1E electrical room HVAC system provides conditioning air to maintain area design temperature limits within the Class 1E electrical rooms during all plant operating conditions, including normal plant operations, abnormal and accident conditions.	**4.b Tests and analyses of the as-built Class 1E electrical room HVAC system will be performed for all four divisions.**	**4.b The as-built Class 1E electrical room HVAC system is capable of providing conditioning air to maintain area design temperature limits within the Class 1E electrical rooms during all plant operating conditions, including normal plant operations, abnormal and accident conditions.**

Attachment 5

Response to Request for Additional Information No. 3559 (CP RAI #61)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Comanche Peak Units 3 and 4

Luminant Generation Company LLC

Docket No. 52-034 and 52-035

RAI NO.: 3559 (CP RAI #61)

SRP SECTION: 02.03.05 - Long-Term Atmospheric Dispersion Estimates for Routine Releases

QUESTIONS for Siting and Accident Conseq Branch (RSAC)

DATE OF RAI ISSUE: 9/18/2009

QUESTION NO.: 02.03.05-1

By letter dated March 31, 2009, Luminant submitted the XOQDOQ input and output files to the NRC staff. The NRC staff has reviewed these XOQDOQ input files and found these files appear to be based on a joint frequency distribution of only one year (less than 8760 meteorological entries make up the joint frequency distribution).

Please submit the XOQDOQ input files containing data from Years 2001 – 2006. Also, make any necessary changes to the FSAR that may result from updated XOQDOQ runs.

ANSWER:

The methodology used to generate the XOQDOQ joint frequency distribution tables was based on obtaining averages for five years of meteorological data (2001-2004 and 2006) and presenting the data on a representative year basis. The joint frequency tables therefore represent not a single year but the composite of five years of data. Because the joint frequency tables were generated as integer hours for the representative year, rounding of the average values does not result in data for exactly 8760 hours in the distribution. Artificially manipulating the data to achieve exactly 8760 hours of entries in the joint frequency distribution is neither necessary nor valid. The composite joint frequency distribution contained in the XOQDOQ input and output files previously sent to the NRC via Luminant letter TXNB-09004 dated March 31, 2009 (ML091120524) is unchanged as are the results presented in the FSAR. The raw meteorological data files for years 2001-2004 and 2006, in ASCII format in accordance with Appendix A of RG 1.23, Rev. 1, were submitted in letter TXNB-09017 on May 8, 2009 (ML091330346) in the response to RAI No. 2584 (CP RAI #3), Question 02.03.03***.

Impact on R-COLA

None.

Impact on S-COLA

None.

Impact on DCD

None.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Comanche Peak Units 3 and 4

Luminant Generation Company LLC

Docket No. 52-034 and 52-035

RAI NO.: 3559 (CP RAI #61)

SRP SECTION: 02.03.05 - Long-Term Atmospheric Dispersion Estimates for Routine Releases

QUESTIONS for Siting and Accident Conseq Branch (RSAC)

DATE OF RAI ISSUE: 9/18/2009

QUESTION NO.: 02.03.05-2

Combined License FSAR Section 2.3.5.2.2 discusses the XOQDOQ modeling for the evaporation pond. Please provide XOQDOQ input and output files, as well as an explanation of the assumptions made for the evaporation pond modeling, along with dimensions of the evaporation pond.

ANSWER:

The XOQDOQ input and output files used to generate the evaporation pond X/Q and D/Q values are attached. The joint frequency distribution used is averaged from a five-year set (2001-2004 and 2006) of meteorological data and is presented as a joint frequency distribution for one representative year. Assumptions made for the evaporation pond modeling were (1) neglecting building wake effects and (2) modeling the pond as a ground point source. As shown on FSAR Figure 1.2-1R, the evaporation pond is approximately one acre and is located a sufficient distance away from large structures to exclude credit for any building wake effects. The precise dimensions of the pond have not been established, but it is projected that the pond might be 350 - 450 ft long and 125 – 175 ft wide. Modeling the pond as a point source produces more conservative X/Q and D/Q values than modeling the pond as a diffuse area source.

Impact on R-COLA

None.

Impact on S-COLA

None.

Impact on DCD

None.

Attachments:

Input and output files “CPNPP EP EVAL.DAT” and “XOQ_OUT.DAT” (on CD as Attachment 6 to this letter)

Attachment 6

Input and Output files "CPNPP EP EVAL.DAT" and "XOQ_OUT.DAT" (on CD)