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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

South Texas Project
Units 1 and 2
Docket Nos. STN 50-498, STN 50-499
Responses to Questions Regarding License Amendment
Request Concerning an Increase in Spent Fuel Pool Heat Loads

Reference: Correspondence from T. H. Cloninger to NRC Document Control Desk dated February 8, 1996 (ST-HL-AE-5233)

The South Texas Project submits this correspondence in response to questions from the Nuclear Regulatory Commission staff regarding a proposed change to the licensing basis for spent fuel pool heat loads. The questions resulted from the staff's review of the most recent submittal of the license amendment request referenced above. The questions and their responses are provided in the attachments to this letter.

If there are any questions, please contact Mr. P. L. Walker at (512) 972-8392, or me at (512) 972-7162.

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Attachments: 1. Response to Question on UFSAR Table 9.1-1
2. Response to Questions on Structural Effects of Increase in Spent Fuel Pool Heat Load

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RESPONSE TO QUESTION ON UFSAR TABLE 9.1-1

Why does the abnormal maximum case listed in the proposed UFSAR Table 9.1-1 have a higher heat load than does the rapid refueling case, but a lower peak temperature?

RESPONSE

The results of calculations performed for the two cases reflect the different assumptions used as the basis for the calculations.

The analysis for the Abnormal Maximum case considers heat exchanger properties defined by an adjusted component cooling water flow rate and heat transfer effectiveness. The revised component cooling water flow rate was obtained from the component cooling water process flow diagram which is based on design calculations. The heat exchanger effectiveness was calculated by using an empirical correlation developed by Kays and London (referenced below) with conservatively low overall heat transfer coefficient based on design fouling factors.

Using the modified heat exchanger data for the Abnormal Maximum case is acceptable because this gives a better representation of the spent fuel pool conditions. Calculations performed with the modified data give temperatures that are higher than the actual spent fuel pool temperatures encountered during past refueling cycles. Therefore, use of these assumptions in calculations still gives conservative results.

The analysis for the Rapid Refueling case used equipment design data to calculate a conservatively low spent fuel pool heat exchanger heat transfer effectiveness. If the modified heat exchanger data had been used in the analysis of the Rapid Refueling case, the calculated bulk water temperatures would have been a few degrees lower. However, since the spent fuel pool equipment design temperature of 200°F was met by using the design heat exchanger data, further calculation was not necessary.

The other cases presented in Table 9.1-1 use the heat exchanger manufacturer's design data which give conservative results.

Reference: W. M. Kays and A. L. London, Compact Heat Exchangers, McGraw-Hill Book Co., New York, Second Edition, 1964

RESPONSE TO QUESTIONS ON STRUCTURAL EFFECTS OF INCREASE IN SPENT FUEL POOL HEAT LOAD

1. For the proposed 'Normal Maximum' and 'Rapid Refueling' cases of thermal loadings (Ref. 1), show that (1) the spent fuel pool (SFP) walls and floors meet the licensing basis load combinations and acceptance criteria; and (2) the SFP liner and its anchors will not experience significant deformations, for example, relative expansion of the liner from the concrete wall or slab causing stresses at the anchor points to the liner in the plane of the liner. For the liner evaluation, consider the effects of the expected thermal cycling.

   For the purpose of the liner assessment, you may use the acceptance criteria in Tables CC-3720-1 and CC-3730-1 (Service and Normal Categories) of Ref. 2. In utilizing the acceptance criterion for displacement of Table CC-3730-1, the maximum strains and displacements generated by the Operating Basis Earthquake should be combined with those due to the steady state temperature gradients.

2. For the proposed 'Peak SFP Temperature,' and 'Abnormal Maximum Case' of the thermal loadings (Ref.1), show that (1) the SFP floor and walls meet the licensing basis load combinations and acceptance criteria; and (2) the integrity of the SFP liner and its anchors will be maintained. For the liner evaluation consider the effects of duration of the thermal loads.

   For the purpose of the liner assessment, you may use the acceptance criteria in Tables CC-3720-1 and CC-3730-1 (Factored and Abnormal/Extreme Environmental Categories) of Ref. 2. For this evaluation, the maximum strains and displacements generated by the Safe Shutdown Earthquake should be combined with those due to the temperature transients.

<u>References:</u>

1. Attachment 1 to the Proposed Licensing Amendment from Houston Lighting and Power Company Concerning an Increase in Spent Fuel Pool Heat Loads, Undated, Ref. ST-HL-AE-5015.

2. Section III, Division 2 of the ASME Boiler and Pressure Vessel Code, 1995 Edition.

RESPONSE:

Reference: ST-HL-AE-2417, dated March 8, 1988; "Expansion of the Spent Fuel Pool Storage Capacity Using High Density Spent Fuel Racks"

The spent fuel pool structural design was revised in 1988 when the pool was re-racked with high density spent fuel storage racks as addressed in the referenced correspondence. The spent fuel pool concrete walls and floors were evaluated for T_o = 155° F and for T_a = 212° F.

The current spent fuel pool Operating Thermal Loads or "Normal Maximum"/"Rapid Refueling" (T_o=155°F) and the Design Basis Accident Thermal Loads or "Peak SFP Temperature"/"Abnormal Maximum Case" (T_a = 200° F) are bounded by the evaluations that were performed for the spent fuel pool re-racking in 1988.

The analysis and design of the spent fuel pool concrete and liner address both questions submitted by the NRC and are discussed below:

SPENT FUEL POOL CONCRETE FLOORS AND WALLS:

The spent fuel pool walls and floors were analyzed utilizing the loads as described in UFSAR Section 3.8.4. The loading included the dead, live, operating basis earthquake, safe shutdown earthquake as well as thermal (T_o & T_a) loadings. The load combinations utilized are in accordance with UFSAR Table 3.8.4-1. The structural analysis and design were performed utilizing the BSAP and OPTCON computer programs. BSAP was used for the finite element analysis to obtain the forces and moments on the walls and floors. OPTCON was used to model the concrete and liner sections to obtain the stresses in the liner and the concrete based on BSAP output results. The stresses were determined to be within acceptable limits as required in UFSAR Section 3.8.4.

SPENT FUEL POOL STEEL LINER PLATES:

Similarly, the steel liner plate was evaluated based on the T_o and T_a. The results of the evaluation concluded that, as stated in section 6.5.1.2 of the referenced correspondence:

> The liner and liner anchorages are considered ductile enough to safely self-relieve temperatures stresses and redistribute tension and axial stresses by pre- and post-buckling membrane action. Therefore, at points of liner anchorage (i.e., at embedded plate boundaries, specific anchor points, etc.) and points of applied loads from the racks, no detailed analyses were considered necessary.

At the specific request of the NRC during the review of the spent fuel pool re-racking, extensive evaluations were performed on the liner mainly regarding the interaction between the spent fuel racks and the liner. The evaluation included consideration of the seismic input imparted to the racks and the resulting effects on the liner. Parameters addressed included: i) checking in-plane forces due to horizontal seismic pedestal loads; ii) checking effects due to postulated depressions in concrete beneath the liner plate; and iii) checking liner plate due to curvature of spent fuel pool slab. These evaluations conservatively address the loading effects to the liner floor plate and demonstrate the integrity of the liner.

Additional studies to support this response have been performed to evaluate the stresses and resulting strains/displacements to the liner and to evaluate the weld to the stiffeners for the following cases: stresses to the liner as determined from the concrete structural analyses results (BSAP analysis output); and the potential buckled conditions of the typical liner panel. Although the liner plate may buckle, the conditions were also evaluated assuming no buckling in the panel.

A hand calculation was performed utilizing the liner stresses for the above cases to determine total elongation in the panel based on the calculated strains including T_o and T_a. The elongation is then imparted to the attachment welds as if there were no adjacent panel. The resulting strains and displacements were compared to the associated strains and attachment displacements extracted from ASME Tables CC-3720-1 and CC-3730-1 and shown to be within the allowable requirements (See Summary Table). An additional check for the total elongation for T_o and T_a was calculated on a typical panel.

LOADING CONDITION	SUMMARY TABLE DISPLACEMENT/STRAINS			
	MEMBRANE LINER		DISPLACEMENT @ ANCHOR WELD	
	ACTUAL	ALLOWABLE	ACTUAL	ALLOWABLE
Service, Severe Environmental	$\varepsilon = 0.0006''/''$	$\varepsilon = 0.002''/''$	$\delta = 0.0135''$	$\delta_a = 0.25\delta_u = 0.0140''$
Non-Service, Abnormal, Extreme Env.	$\varepsilon = 0.0011''/''$	$\varepsilon_c = 0.005''/''$	$\delta = 0.0225''$	$\delta_a = 0.5\delta_u = 0.0281''$

SPENT FUEL POOL LINER CYCLIC/DURATION LOADS:

Under thermal transient conditions, the liner will normally be subjected to compressive stresses which are considered beneficial in regards to cyclic fatigue resistance; however, the liner may buckle as it heats up. The resulting tensile strains associated with buckling are evaluated. Based on the fatigue data in ASME Report "Criteria of the ASME Boiler and Pressure Vessel Code for Design by Analysis in Sections II and VIII Division 2" and the associated strains considered in the above described evaluation, the number of cycles to failure during normal operating conditions are significantly higher than will be experienced in the South Texas Project spent fuel pool.

The structural design considered long durations of thermal loading by conservatively assuming steady state thermal gradient through the walls and slabs. The moment and forces obtained on the liner were converted to strains. These strains were determined to be acceptable as described previously. Therefore, duration of thermal load will have no impact on the function of the liner.

SUMMARY:

The leaktight integrity has been demonstrated considering the effects from T_o and T_a, operating basis earthquake, and safe shutdown earthquake. Based on the evaluation and analyses performed at the time of the re-racking and supplemented by the additional recent evaluations, it is demonstrated that the liner will perform its intended function of a leaktight barrier for the spent fuel pool.