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John R. Eichenberger
Acting Director,
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1CAN120601

December 14, 2006

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

SUBJECT: Supplement to License Amendment Request to Support the Use of Metamic Poison Insert Assemblies in the Spent Fuel Pool
Arkansas Nuclear One, Unit 1
Docket No. 50-313
License No. DPR-51

REFERENCES:

1. Letter to the NRC dated July 27, 2006, "License Amendment Request to Support the Use of Metamic Poison Insert Assemblies in the Spent Fuel Pool" (1CAN070603)

2. Letter to the NRC dated October 4, 2006, "Supplement to License Amendment Request to Support the Use of Metamic Poison Insert Assemblies in the Spent Fuel Pool" (1CAN100601)

3. Letter to the NRC dated October 9, 2006, "Supplemental Information to License Amendment Request to Support the Use of Metamic Poison Insert Assemblies in the Spent Fuel Pool" (1CAN100602)

Dear Sir or Madam:

By letter (References 1, 2 and 3), Entergy Operations, Inc. (Entergy) proposed a change to the Arkansas Nuclear One, Unit 1 (ANO-1) Technical Specifications (TSs) to support the use of poison panel insert assemblies in the ANO-1 spent fuel pool.

On October 23, 2006, Entergy received a request for additional information regarding the proposed change. As a result, 10 questions were determined to need formal response. Entergy's response is contained in Attachment 1.

There are no technical changes proposed. The original no significant hazards consideration included in Reference 1 is not affected by any information contained in the supplemental letter. There are no new commitments contained in this letter.

A001

If you have any questions or require additional information, please contact Dana Millar at 601-368-5445.

I declare under penalty of perjury that the foregoing is true and correct. Executed on December 14, 2006.

Sincerely,

JRE/DM

Attachments:
1. Response to Request For Additional Information

cc: Dr. Bruce S. Mallett
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Attachment 1

To

1CAN120601

Response to Request for Additional Information

Response to Request for Additional Information Related to License Amendment Request to Support the Use of Metamic Poison Insert Assemblies in the Spent Fuel Pool

Structural/Seismic

Question 1

Referring to the last paragraph of page 6 of 50, discuss the fluid-structure analysis study performed and the results of the study that form the basis for Entergy's assertion that use of SOLVIA in seismic response modeling of the racks, fuel assemblies and inserts was adequate. Since both material property and seismic response characteristics of metamic panels are not as well defined as that of other commonly used materials (e.g., carbon steel. rebar and concrete), discuss any experimental data that were used as the basis for Entergy's conclusion that good agreement on the behavior of the beam/stick model was demonstrated.

Entergy's Response

The fluid-structure study consisted of modeling a 3D square structure (a box on feet) representative in general of one rack using shell elements. This study structure was effectively contained in a pool with fluid elements surrounding it. For comparison, the same methodology as used for the rack analysis was used to develop a beam model of the study structure, with hydrodynamic added mass effects also considered the same as for the rack analysis. The fluid/structure model and the associated beam model were analyzed using the same time-history input. Displacement results were comparable and in good agreement. Hence it was concluded the beam model representation of the racks for the dynamic analysis provided comparable results to consideration of a more detailed model including fluid elements.

The study was analytical with the goal of assessing the dynamic analysis modeling of the racks and no experimental data was considered. The Metamic material was not specifically included, and has no relevance to the conclusions.

Question 2

The last paragraph of Section 3.2, Equation of Motion (page 7 of 50) states that the WPMR is modeled by combining the eight modules and including the appropriate off-diagonal stiffness matrix and mass matrix terms... Discuss key non-linear attributes that were modeled in the WPMR analysis that reflect the interactions between the modules and, that between a module and its adjacent spent fuel wall. Discuss the extent of experimental verification implemented with respect to the above modeling of the non- linear attributes. Also, with respect to Section 3.5, "Impact Behavior" (page 8 of 50), discuss pertinent experimental results that support the validity of Entergy's use of the Gapped-Truss elements in SOLVIA code.

Entergy's Response

Non-linear attributes in the WPMR include gaps or clearances between the racks and between the racks and the pool, the free-sliding and lift-off potential for the racks relative to their support on the pool floor, and the accounting for potential impact effects. Experimental verification was not implemented. Methodology used is consistent with industry practice (Reference NUREG/CR-5912, "Review of the Technical Basis and Verification of Current Analysis Methods Used to Predict Seismic Response of Spent Fuel Storage Racks") for analysis of spent fuel racks, shielding blocks, and dry fuel casks. Use of the non-linear gap element (identified as a Gapped Truss element type) in SOLVIA simply provided a means to account for the gaps between the model components and impact forces if those gaps closed during the analysis. The "gapped truss" element is an axial force member, and hence is effectively a spring. The non-linear gap option allows it to be a compression-only element when the gap is closed, and to carry or transmit no loads when the gap is open.

Question 3

Referring to Section 3.8, Poison Insert Analysis Methodology (page 9 of 50), discuss the basis for treating the poison inserts as additional beam elements in the structural model considering the fact that the rattling space for poison inserts are much smaller than that of fuel assemblies within a rack cell. Additionally, with respect to the first paragraph of Section 4.8, Poison Insert Modeling, of page 16 of 50, provide basic material properties that are used for defining the metamic inserts modeled as a single elastic beam element in a single region 3 rack analysis. Specifically, discuss the appropriateness of the elastic beam element treatment of the metamic inserts accounting for its material characteristics (e.g., material brittleness), rack specific geometric layout, (e.g., gaps between cell walls and the inserts), constraints, and potential differences between the stress-strain relationship of the metamic inserts and that of the stainless steel cells.

Entergy's Response

The poison inserts were originally designed to be wedged in the flux traps. With redesign of the inserts, nominal gaps or clearances within the flux traps were possible and likely to exist. Because of potential for the inserts to now "rattle" within the flux traps during a seismic loading event, some manner to account for the impact loads on the inserts (which were presumed inevitable because of the smaller gaps compared to the fuel elements) was required, and including them explicitly in the model was an appropriate way to obtain these load effects. The inserts were modeled in the same manner as the fuel elements, which permitted them to slide, uplift, and close and open the lateral gaps between the inserts and the flux trap walls.

The Metamic inserts were modeled based on the full composite of all the components of the inserts. This included the stainless steel wrapper channels, the Metamic panels, the channel shaped bands which hold the inserts in the wrapper channels, and the stiffener plates which hold the two wrapper channel sections together. While the Metamic panels were modeled using their material properties, (S_y = 33.1 ksi, S_u=40.67 ksi, and E=12.4 x 10^6 psi) this was done only for completeness since the stiffness (structural) contribution to the overall properties of the assembled inserts is small. For example, the wrapper panels have a modulus of elasticity of about twice that of the Metamic panels. Additionally, because the Metamic panels are held in the wrapper channels by the bands without any significant clamping force, no shear transfer occurs between the Metamic panels and the wrapper channels and hence no composite action occurs (i.e. the behavior for bending of the panels and relative to the wrapper panels is analogous to stacked loose plates). This gives a relative EI (moment of inertia times modulus of Elasticity) relationship of about 30000:1 for the wrapper channel assembly compared to the Metamic panels. This means the wrapper channel assemblies control the structural behavior (they are much stronger and stiffer) with no significant contribution from the Metamic panels. Additionally, the yield stress of the stainless steel wrapper plates is about 70% of that for the Metamic panels. Since the wrapper plate assemblies control the displacement and deflections of the inserts including the Metamic panels, and because they did not yield, the Metamic panels are effectively protected by the wrapper panel assemblies and their relatively small ductility range (brittleness) is not a concern. Stress-Strain differences are appropriately considered by use of the proper modulus of elasticity for the different materials since everything remained elastic. Hence, consideration of Metamic insert assembly as a beam within the flux traps with the gaps modeled is appropriate.

Question 4

Discuss the specific studies that were performed to confirm that sloshing was negligible at the top of the rack as indicated in item j of page 13 of 50.

Entergy's Response

No specific study was performed relative to sloshing. This was an observation from the results of the fluid-structure study described in response to RAI question 1 above. The ANO-1 spent fuel pool is approximately 23 feet wide x 44 feet long x 42 feet deep. The spent fuel racks extend to about 15 feet above the floor. A conservative estimate of the sloshing wave height at the top of the pool is about 3.85 feet. The depth of influence for sloshing (convective) load effects can be considered as twice this or 7.7 feet. This is a significant distance above the top of the racks, and hence sloshing loads are not a concern.

Question 5

With respect to Section 6.1, Single Rack Analysis of page 21 of 50, elaborate more on the analysis results with a discussion of some numerical findings that support Entergy's assertion that the additional 2000 lbf mass rigidly attached to the rack 24" above the top of the cell structure has an insignificant effect on the rack module analysis results.

Entergy's Response

Due to the magnitude of the added mass to account for hydrodynamic effects, the 2000 lbf mass adds only a fractional increase to the mass of the racks dynamically, and analyses including the 2000 lb mass show no differences in results than the analyses without it.

Question 6

With respect to Figure 8.1 - Maximum Displacement Plots, clarify the meanings of "Original," "Max. Disp," and "Zone Z1." Regarding Figure 8.2, Cell Impact Force Plots, Single Rack Model, clarify the meaning of "EG 4 E P 1 Force -R."

Entergy's Response

"Original" refers to the original undisplaced model, and indicates that the original position is indicated by the dashed lines. "Max. Disp." is the maximum displacement of any part of the model at the time indicated. "Zone Z1" is the method by which a portion of the full model can be defined in SOLVIA for convenience of plotting and reviewing results.

"EG 4" indicates the element is part of Element Group 4 as defined in the SOLVIA input. "E P 1" indicates the results are at element integration point 1 (note these elements are of course one-dimensional and as such have only one integration point). "Force –R" indicates the axial force result for the element.

Question 7

Section 8.10, Comparison of Analysis Results to Westinghouse Ref. (9) Results, states that "This comparison is a further validation of the S&A Ref. (5) evaluation and that the use of Westinghouse results for the Wrapper welds, cell seam weld and cell-to-cell weld is justified." Explain any potential issues that may arise from the Entergy's use of the Westinghouse results for the Wrapper welds, cell seam weld and cell-to-cell weld, and their implication on the Region 3 rack seismic response. As applicable, discuss differences between the above mentioned Westinghouse welds and those used by Entergy's Region 3 racks with the inserted poison.

Entergy's Response

The Region 3 racks are Westinghouse racks, and the Westinghouse analysis is the basis for their original qualification. Because the S&A results show that the addition of the Metamic inserts effectively did not change the seismic behavior and response of the racks, the rack welds as qualified by Westinghouse are not subjected to additional forces due to the addition of the Metamic inserts to the racks, and hence the Westinghouse analysis and qualification of the welds remains valid. The Metamic insert components and welds were analyzed and qualified in the present calculation using the results of the present analysis.

Question 8

Referring to second paragraph of page 44 of 50, explain and justify with pertinent references for the method used by Holtec in specifying a conservative hydrodynamic pressure resulting from the seismic displacement of the racks.

Entergy's Response

Reference to Holtec's analysis in this paragraph was relative to the initial submittal, and should have been updated to reference the Stevenson & Associates analysis performed subsequent to Holtec's.

The pool structure analysis was updated using load results from the updated rack analyses done by Stevenson & Associates. Additionally, the 5000 lb loads indicated were also included in the pool structure analysis update. For consideration of hydrodynamic pressure loads from the rack movements on the walls, it was observed in the fluid/structure study described in response to RAI question 1 above, that the effective pressure on the pool walls during seismic loading was less than or equal to that for the pool water alone. Original design/qualification of the pool and the reanalysis performed for the reracking in 1982 both considered the effect of the water due to seismic inertial effects and the magnitude of this loading effectively covered pressure differences potentially caused by the movement of the racks.

Coupon Sampling Program

Question 1

On page 14 of your July 27, 2006 license amendment, you stated that measurements to be performed at each inspection will be as follows: physical observations, length, width, thickness, weight, density and neutron attenuation testing. Please provide your acceptance criteria for these parameters and the basis for this criteria.

Entergy's Response

The acceptance criterion for each of the parameters is as follows. The basis for the criterion is either existing coupon sampling programs or reasonable limits that assure further evaluation.

Physical observation – visual examination and photography

Upon receipt of a coupon for testing, the exposed coupon should be carefully examined and photographed to document the appearance of the coupon, noting any sign of degradation that may be observed. Special attention will be paid to any edge or corner defects and to any discoloration, swelling, or surface pitting that might exist.

Dimensional Measurements - length, width, and thickness

Measurements on post-irradiated coupons will be made at the same approximate locations used for pre-irradiation characterization measurements and recorded. Length and width dimensions shall not exceed ± 0.125 inches when compared to the initial width or length.

Thickness is used to monitor swelling and an increase in thickness at any point shall not exceed ± 0.01 inches of the initial thickness at that point.

Weight and density

The weight of each coupon should be obtained within ± 5% of the initial coupon weight.

Neutron Attenuation

Post-irradiated coupons that exhibit a decrease of no more than 5% in Boron-10 content, as determined by neutron attenuation or chemical analysis, is acceptable. This is the same as a requirement for no loss of boron within the accuracy of the measurement.

Changes in excess of any acceptance criteria may require investigation and engineering evaluation which may include early retrieval and measurement of one or more of the remaining coupons to provide corroborative evidence that the indicated change(s) is real. If the deviation is determined to be real, an engineering evaluation shall be performed to identify further testing or any corrective action that may be necessary.

Question 2

On page 13 of your July 27, 2006, your Sample Coupon Measurement Schedule calls for a coupon to be removed every two years for the first three intervals and thereafter every 4 to 5 years over the service life of the inserts. It is not clear to the staff whether you plan to remove a new coupon every interval in addition to the coupon removed the previous interval. Please clarify how many coupons you plan to remove every interval.

Entergy's Response

A different coupon is removed each sample period. For example, coupon #1 is removed and analyzed after two (2) years exposure in the Spent Fuel Pool (SFP) environment. Coupon #2 is removed and analyzed after four (4) years of exposure in the SFP or two (2) years elapsed time since the first sample. Coupon #3 is removed after six (6) years of exposure or two (2) years elapsed time since the last (2nd) sample. Coupons #4 through #10 will be removed at the intervals specified in the sample coupon measurement schedule on page 13. A minimum of ten (10) coupons were chosen to adequately cover the expected lifetime without reinserting a previously sampled coupon. When coupon #10 is removed, the accumulated exposure time will be forty (40) years; the expected lifetime of the poison insert assemblies. The sampled coupons may optionally be returned to the pool and remounted on the tree at the discretion of the reviewing engineer.