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Your ref: Project Number 740
Our ref: DCP/NRC1861

April 10, 2007

Subject: AP1000 COL Response to Request for Additional Information (TR #54)

In support of Combined License application pre-application activities, Westinghouse is submitting a second set of responses to NRC requests for additional information (RAI) on AP1000 Standard Combined License Technical Report 54, APP-GW-GLR-033, Rev. 0, Spent Fuel Racks Design and Structural Analysis. These RAI responses are submitted as part of the NuStart Bellefonte COL Project (NRC Project Number 740). The information included in the responses is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification.

The responses are provided for Requests for additional information TR54-8, TR54-9, TR54-18, TR54-24, TR54-32, TR54-38, and TR54-39, transmitted in NRC letter dated March 29, 2007 from Steven D. Bloom to Andrea Sterdis, Subject: Westinghouse AP1000 Combined License (COL) Pre-application Technical Report 54 – Request for Additional Information (TAC NO. MD2551).

Pursuant to 10 CFR 50.30(b), the responses to requests for additional information on Technical Report 54 are submitted as Enclosure 1 under the attached Oath of Affirmation.

It is expected that when the RAIs on Technical Report 54 are complete, the technical report will be revised as indicated in the responses and submitted to the NRC. The RAI responses will be included in the document.

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

D. A. Lindgren / FOR

A. Sterdis, Manager
Licensing and Customer Interface
Regulatory Affairs and Standardization

00103-psa.doc

D079

/Attachment

1. "Oath of Affirmation," dated April 10, 2007

/Enclosure

1. Response to Requests for Additional Information on Technical Report No. 54

cc:	S. Bloom	-	U.S. NRC	1E	1A
	S. Coffin	-	U.S. NRC	1E	1A
	G. Curtis	-	TVA	1E	1A
	P. Grendys	-	Westinghouse	1E	1A
	P. Hastings	-	Duke Power	1E	1A
	C. Ionescu	-	Progress Energy	1E	1A
	D. Lindgren	-	Westinghouse	1E	1A
	A. Monroe	-	SCANA	1E	1A
	M. Moran	-	Florida Power & Light	1E	1A
	C. Pierce	-	Southern Company	1E	1A
	E. Schmiech	-	Westinghouse	1E	1A
	G. Zinke	-	NuStart/Entergy	1E	1A

ATTACHMENT 1

"Oath of Affirmation"

ATTACHMENT 1

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of:	)
NuStart Bellefonte COL Project	)
NRC Project Number 740	)

APPLICATION FOR REVIEW OF
"AP1000 GENERAL COMBINED LICENSE INFORMATION"
FOR COL APPLICATION PRE-APPLICATION REVIEW

W. E. Cummins, being duly sworn, states that he is Vice President, Regulatory Affairs & Standardization, for Westinghouse Electric Company; that he is authorized on the part of said company to sign and file with the Nuclear Regulatory Commission this document; that all statements made and matters set forth therein are true and correct to the best of his knowledge, information and belief.

W. E. Cummins
Vice President
Regulatory Affairs & Standardization

Subscribed and sworn to
before me this 10th day
of April 2007

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Debra McCarthy, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Aug. 31, 2009
Member, Pennsylvania Association of Notaries

Debra McCarthy
Notary Public

ENCLOSURE 1

Responses to Request for Additional Information on Technical Report No. 54

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR54-08
Revision: 0

Question:

For the drop case in which the impact occurs directly above a rack pedestal, Section 2.8.5 provides the concrete strength of the pool floor and the thickness of the stainless steel liner, but does not provide the thickness of the pool floor. There is a possibility that the impact could also cause damage to the concrete floor, and pose a more severe consequence than yield of the liner. The maximum Von Mises stress in the spent fuel pool liner is reported as 23.4 ksi, which is much larger than the concrete strength of 4 ksi; the concrete may crush and crack locally at this level of stress. Therefore, provide additional details on the modeling of the concrete floor (including a figure of the concrete model, element type, boundary conditions, material properties, etc.) and the analysis results for the concrete floor (in addition to Figure 2-11).

Westinghouse Response:

The spent fuel pool concrete floor is modeled only in the vicinity of the impacted rack pedestal with an assumed thickness of two feet and compressive strength of 4,000 psi. The pool liner and rack pedestal bearing pad are also modeled as shown in Figure TR54-8.1. The periphery surface nodes of the SFP pool liner and the underlying concrete slab in the LSDYNA model are restrained from moving in the vertical direction and in the horizontal direction normal to the periphery surface to simulate the confining effect of the surrounding structure.

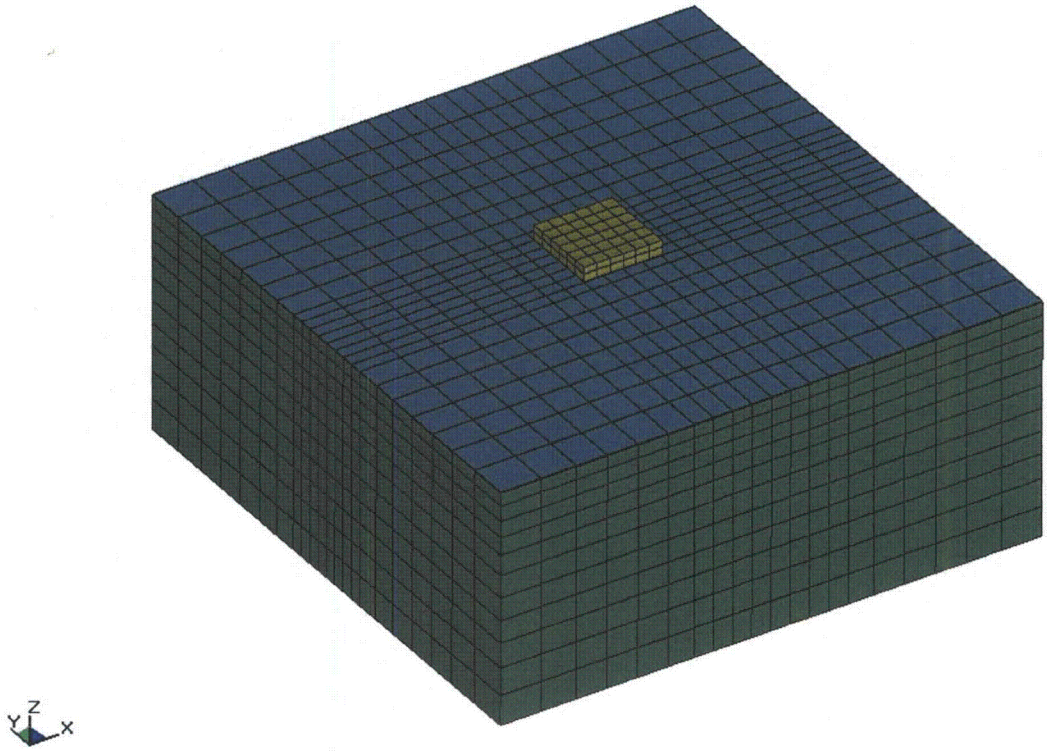

Figure TR54-8.1 LSDYNA Model of Pool Liner and Rack Pedestal Bearing

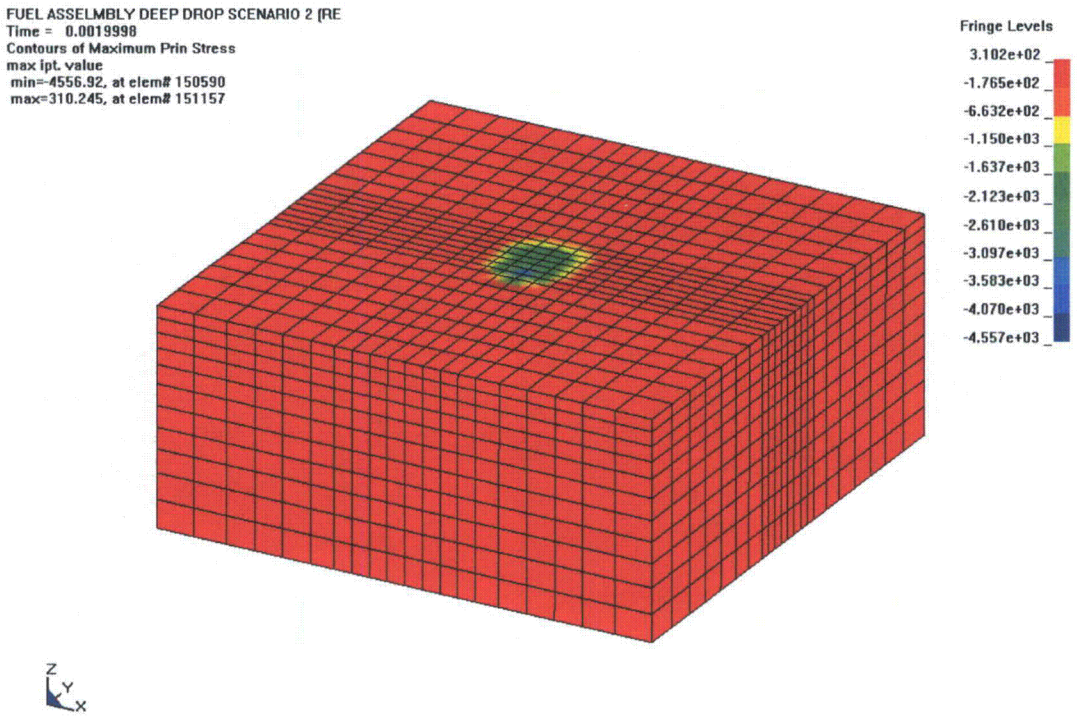

Figure TR54-8.2 LSDYNA Fuel Assembly Deep Drop Scenario 2

The maximum compressive stress in the concrete floor, resulting from the fuel assembly deep drop event in which the impact occurs directly above a rack pedestal, is predicted to be 4,557 psi as shown in the Figure TR54-8.2. This maximum compressive stress slightly exceeds the assumed concrete compressive strength and is limited to the top surface of the concrete near the bearing pad edge. The very limited local damage to the concrete floor surface is acceptable since the acceptance criterion for the fuel deep drop accident is no gross failure of the SFP floor leading to an uncontrolled loss of SFP water.

References:

1. APP-GW-GLR-033, Revision 0, "Spent Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 54)
2. APP-FS02-Z0C-001, Revision 0,"Analysis of AP1000 Fuel Storage Racks Subjected to Fuel Drop Accidents"

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR54-09
Revision: 0

Question:

Section 2.8.5 does not indicate whether other fuel assemblies are in place, when a fuel assembly drops through an empty cell and impacts the baseplate at its center. Depending on how the baseplate is designed, a full load of fuel assemblies may introduce progressive deformation after a fuel assembly impacts at the center of the baseplate. The maximum downward deformation of the baseplate is about 4.3", as shown in Figure 2-10. This may be significant enough to initiate a progressive deformation. Therefore, provide: (1) the assumption on the existing fuel assemblies when the impact occurs, (2) the design basis for the baseplate, and (3) a figure similar to Figure 2-10, that shows the cells together with the severely deformed baseplate.

Westinghouse Response:

(1) The spent fuel storage rack is assumed to be empty (i.e., no fuel assemblies in place) when a fuel assembly drops through an empty cell and impacts the baseplate at its center. This is a simplifying assumption, which is reasonable considering that the buoyant weight of a fuel assembly is approximately 1,525 lb whereas the impact load transmitted by the dropped fuel assembly is roughly 268,000 lb based on the LSDYNA solution.

(2) The design basis for the baseplate is to provide vertical support for the stored fuel assemblies and to protect the Spent Fuel Pool liner from a fuel assembly strike. In other words, a dropped fuel assembly should not pierce the baseplate and result in a direct impact with the liner.

(3) To be provided in latter set of RAI responses

References:

1. APP-GW-GLR-033, Revision 0, "Spent Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 54)
2. APP-FS02-Z0C-001, Revision 0,"Analysis of AP1000 Fuel Storage Racks Subjected to Fuel Drop Accidents"

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR54-18
Revision: 0

Question:

The seismic analyses only considered the bounding values for the coefficient of friction at 0.2 and 0.8 between the pedestal and the pool liner. Provide the technical basis for only considering these two bounding values and not other intermediate values. Also, what is assumed to slide: the pedestal to bearing plate or bearing plate to pool liner, and the basis for this? If it is the surface between the bearing plate and pool liner, how is damage to the pool liner due to horizontal forces avoided. Are there any physical provisions to prevent the bearing plate and pedestal to slide excessively to the point that the pedestal centerline would be at or beyond the edge of the bearing plate?

Westinghouse Response:

The coefficients of friction used in the seismic analyses, namely 0.2 and 0.8, are consistent with previous spent fuel rack license applications, and they are based on the experiments performed by E. Rabinowicz (Reference 21 in COLA Technical Report APP-GW-GLR-033 Revision 0 .) The lower value of 0.2 produces the maximum sliding displacement between the rack pedestals and the bearing plates. The higher value of 0.8 increases the rocking motion of the spent fuel racks and produces the maximum stress in the rack pedestals. Sliding occurs between the rack pedestal and the bearing plate since these two items are made of different materials (SA564-630 vs. SA240-304), whereas the pool liner and the bearing plate are made of the same material (SA240-304) and are more likely to gall. There are no physical provisions to prevent the rack pedestal from sliding beyond the edge of the bearing plate. The seismic analyses, however, demonstrate that the maximum sliding displacement at the base of the rack is less than the distance between the pedestal outside diameter and the edge of the bearing plate.

References:

1. APP-GW-GLR-033, Revision 0, "Spent Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 54)
2. Rabinowicz, E., "Friction Coefficients of Water Lubricated Stainless Steels for a Spent Fuel Rack Facility," MIT, a report for Boston Edison Company, 1976.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR54-24
Revision: 0

Question:

Section 2.2.2.2 refers to Figure 2-2 for the dynamic beam model of a single rack. The text and figure do not adequately describe the model. Therefore, explain the following:

a. Define what each series of nodal DOFs correspond to (i.e., nodes 1,2; P1, P2, ...; q4, q5, ..., 1*, 2*, ...). While some of these may be deduced by judgment the report should clearly define all of these.

b. Explain whether there are 5 nodes and 4 beams along the rack beam model to coincide with the 5 nodes and 4 elements of the fuel assemblies?

Westinghouse Response:

a. Table54-24.1 defines the nodal DOFs for the dynamic beam model of a single rack as depicted in Figure 2-2 of the Technical Report.

LOCATION (Node)	DISPLACEMENT			ROTATION		
	U_x	U_y	U_z	θ_x	θ_y	θ_z
1	p_1	p_2	p_3	q_4	q_5	q_6
2	p_7	p_8	p_9	q_{10}	q_{11}	q_{12}
Node 1 is assumed to be attached to the rack at the bottom most point. Node 2 is assumed to be attached to the rack at the top most point. Refer to Figure 2-2 of COLA Technical Report APP-GW-GLR-033 Revision 0 for node identification.						
2^*	p_{13}	p_{14}				
3^*	p_{15}	p_{16}				
4^*	p_{17}	p_{18}				
5^*	p_{19}	p_{20}				
1^*	p_{21}	p_{22}				
where the relative displacement variables q_i are defined as:						

$$
\begin{aligned}
p_i &= q_i(t) + U_x(t) && i = 1,7,13,15,17,19,21 \\
&= q_i(t) + U_y(t) && i = 2,8,14,16,18,20,22 \\
&= q_i(t) + U_z(t) && i = 3,9 \\
&= q_i(t) && i = 4,5,6,10,11,12
\end{aligned}
$$

p_i denotes absolute displacement (or rotation) with respect to inertial space

q_i denotes relative displacement (or rotation) with respect to the floor slab

* denotes fuel mass nodes

U(t) are the three known earthquake displacements

Table TR54-24.1Nodal DOF for the dynamic beam model for a single rack

b. The rack cell structure is modeled as a single beam between two nodes, which are located at the top of the rack and at the baseplate elevation. This is consistent with Holtec's standard model for seismic analysis of spent fuel racks, which has reviewed and approved by the NRC on numerous dockets. Although there is not a one-to-one correspondence between beam nodes and fuel assembly nodes, fuel-to-cell wall impact loads, which can occur at Elevation 0, 0.25H, 0.5H, 0.75H, and H (where H is the height of the cell structure), are properly transmitted to the rack beam in accordance with the methodology outlined in Reference 11 in COLA Technical Report APP- GW-GLR-033 Revision 0.

References:

1. APP-GW-GLR-033, Revision 0, "Spent Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 54)
2. Levy, S., and Wilkinson, John, "The Component Element Method in Dynamics," McGraw Hill, 1976.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR54-32
Revision: 0

Question:

Section 2.3.4.3, first paragraph, refers to 304L stainless steel material and uses 70 ksi for ultimate and 25 ksi for yield. Explain why these values are higher than the ultimate and yield given in Table 2-6 for type 304L stainless.

Westinghouse Response:

The yield and ultimate strengths of SA240-304L in Table 2-6 are associated with a metal temperature of 200°F, which bounds the SFP water temperature under normal operating conditions. The yield and ultimate strengths in Section 2.3.4.3 are higher because they are evaluated at room temperature. The conclusion reached in Section 2.3.4.3, namely that the "multiplier of 2.0 controls", is the same even if the lower values from Table 2-6 are used. Nonetheless, for consistency the yield and ultimate strengths in Section 2.3.4.3 will be revised to agree with Table 2-6.

Reference:

1. APP-GW-GLR-033, Revision 0, "Spent Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 54)

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
Subsection 2.3.4.3 of APP-GW-GLR-033, Revision 0, "Spent Fuel Storage Rack Structural/Seismic Analysis", (Technical Report Number 54) will be revised to agree with Table 2-6 of the same Technical Report

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR54-38
Revision: 0

Question:

A number of figures in the markup of the DCD, provided with this report, were eliminated. Even if the new configuration is different, basic outline sketches and key dimensions need to be provided in the DCD.

Westinghouse Response:

We are in agreement. Revision 16 of the DCD will have revised Figures: Figure 9.1-2 Region 1 Spent Fuel Rack Layout and Figure 9.1-3 Region 2 Spent Fuel Rack Layout

Reference:

1. APP-GW-GLR-033, Revision 0, "Spent Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 54)

Design Control Document (DCD) Revision:
Yes- Figure 9.1-2 Region 1 Spent Fuel Rack Layout and Figure 9.1-3 Region 2 Spent Fuel Rack Layout will be revised in DCD Revision 16 to show both new Region 1 and Region 2 rack configurations.

PRA Revision:
None

Technical Report (TR) Revision:
Yes- Figure 9.1-2 Region 1 Spent Fuel Rack Layout and Figure 9.1-3 Region 2 Spent Fuel Rack Layout will be will be added to the revision of APP-GW-GLR-033, Revision 0, "Spent Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 54).

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR54-39
Revision: 0

Question:

The computer code MR216 (a.k.a. DYNARACK) as well as the other computer analysis codes should have complete validation documentation and should be made available for review of selected package(s) during the audit. If any of the computer codes have been previously reviewed and approved by the staff on other licensing applications, for the same version of the code, these should be identified.

Westinghouse Response:

All computer analysis codes used to perform the seismic analysis of the spent fuel racks have been validated in accordance with Holtec's 10CFR50 Appendix B quality assurance program. The validation documentation will be available for review during the audit. The validation documentation for the computer code MR216 has been previously submitted by Holtec International to the NRC staff for review and approval several times. Most recently it was reviewed by the NRC in 1998 in Docket 50-382 for the Waterford 3 Steam Electric Station.

References:

1. APP-GW-GLR-033, Revision 0, "Spent Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 54)
2. APP-FS02-Z0C-001, Revision 0,"Analysis of AP1000 Fuel Storage Racks Subjected to Fuel Drop Accidents"
3. US NRC,"Amendment No. 144 to Facility Operating License No. NPF-38 for the Waterford Steam Electric Station, Unit 3," July 10, 1998.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None