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Your ref: Project Number 740
Our ref: DCP/NRC1866

April 13, 2007

Subject: AP1000 COL Response to Request for Additional Information (TR #44)

In support of Combined License application pre-application activities, Westinghouse is submitting responses to NRC requests for additional information (RAI) on AP1000 Standard Combined License Technical Report 44, APP-GW-GLR-026, Rev. 0, New Fuel Storage Rack Structural/Seismic 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 TR44-1, TR44-2, TR44-3, TR44-4, TR44-6, TR44-10, TR44-14, and TR44-25, transmitted in NRC letter dated April 6, 2007 from Steven D. Bloom to Andrea Sterdis, Subject: Westinghouse AP1000 Combined License (COL) Pre-application Technical Report 44 – Request for Additional Information (TAC NO. MD2104).

Pursuant to 10 CFR 50.30(b), the responses to requests for additional information on Technical Report 44 are submitted as Enclosure 1 under the attached Oath of Affirmation.

It is expected that when the RAIs on Technical Report 44 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. F. Hutchings for

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

D079

/Attachment

1. "Oath of Affirmation," dated April 13, 2007

/Enclosure

1. Response to Requests for Additional Information on Technical Report No. 44

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 13th 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. 44

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR44-01
Revision: 0

Question:

Section 2.8.5 indicates that both drop scenarios are from 36 inches above the top of the AP1000 New Fuel Storage Rack. Describe the fuel handling operation that leads to this drop height

Westinghouse Response:

Fuel handling operations associated with new fuel drop scenarios in Section 2.5 deal with receipt inspection of new fuel, moving new fuel into the new fuel rack or removing it to place in the spent fuel pool. These operations are performed by a new fuel handling crane. The conservative drop height of 36 inches is used, however it is unlikely that the drop height will ever be 36 inches as the top of the rack is only six inches below the floor elevation and the fuel assembly will be close to the floor. Administrative control will be put in place to prevent raising the fuel assembly over 36 inches over the New Fuel Storage Rack..

References:

1. APP-GW-GLR-026, Revision 0, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44)
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)

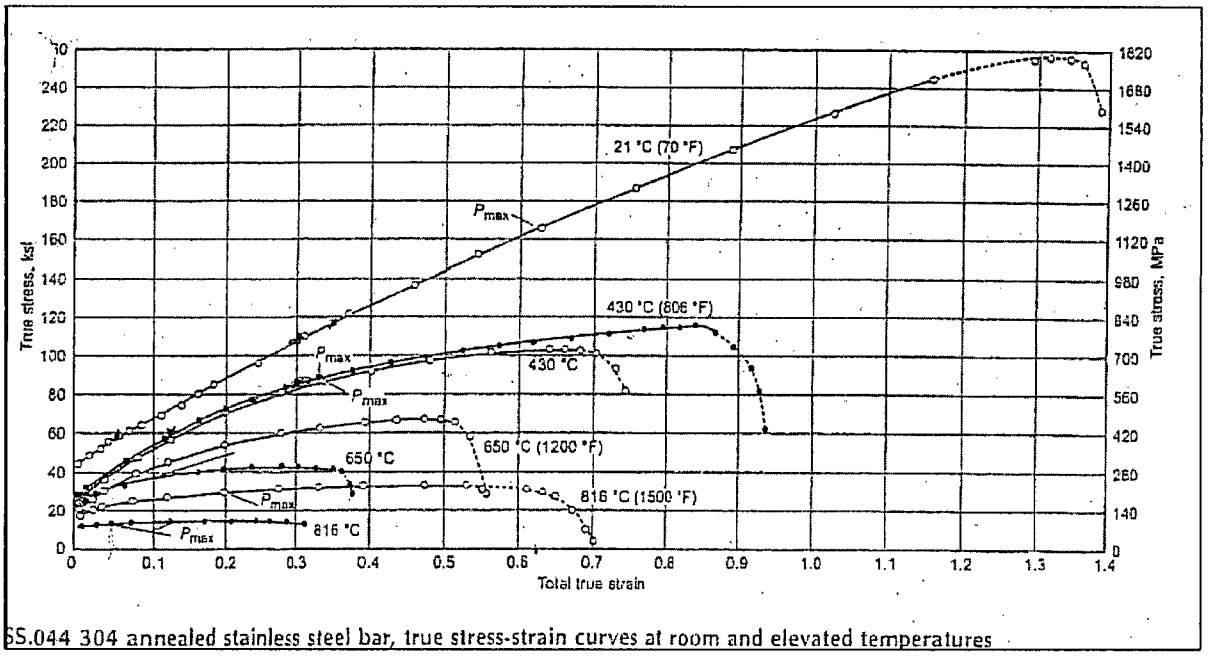
RAI Response Number: RAI-TR44-02
Revision: 0

Question:

Section 2.8.5 states that appropriate non-linear material properties have been applied to the rack components to permit yielding and permanent deformation. Table 2-6 only provides Young's modulus, yield strength, and ultimate strength, which are not sufficient to define an engineering stress-strain curve. In addition, LYDYNA requires true stress-strain relation for its nonlinear materials. Therefore, provide the following: (1) a complete description of the material stress-strain curve and confirm that a true stress-strain curve was used in these impact analyses and (2) a description of the fuel assembly model, including the element properties and material properties for the dropped fuel assembly.

Westinghouse Response:

1) The new fuel racks are fabricated from SA240-304 and SA564-630 stainless steel. For the impact analyses, a true-stress strain curve, which is obtained from Atlas of Stress Strain Curves (2nd Edition, ASM International) and reproduced below as Figure TR44-2.1, is used to define the strength properties of SA240-304 stainless steel.



SS.044 304 annealed stainless steel bar, true stress-strain curves at room and elevated temperatures

Figure 44-2.1 Stress Strain Curve for SA240-304 Stainless Steel

The properties of SA564-630, which is used to fabricate the adjustable support pedestals, are input in terms of engineering stress/strain based on material data taken from the ASME Boiler and Pressure Vessel Code. Also, the welds that connect the rack components are modeled as a bi-linear elasto-plastic material having the engineering stress/strain properties of the adjoining base metal (i.e., SA240-304). The material property values, which are used to define the engineering stress-strain curves for SA564-630 stainless steel and the structural welds, are summarized in the table below.

Material Properties	Material Types	
	SA240-304 (Welds)	SA564-630
Young's Modulus (10^6× psi)	27.87	28.77
Yield Stress (ksi)	26.7	109.2
Ultimate Stress (ksi)	73.0	140.0
Failure Strain (in/in)	0.4	0.14

2) The fuel assembly is modeled by a rigid bottom end fitting and a mass at the top (representing the weight of lifting tool) connected by an elastic beam (with a Young's modulus of 1.04×10^7 psi and a Poisson's ratio of 0.3 for typical rod material) that has an equivalent mass and total cross-sectional area of all fuel rods in an AP1000 fuel assembly. In addition, a very thin rigid shell is attached to the bottom end fitting to represent the side surfaces of the fuel assembly that might be in contact with rack cell walls in a shallow drop event. To maximize the damage in the rack, the fuel assembly is only allowed to move in the vertical direction.

References:

1. APP-GW-GLR-026, Revision 0, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44)
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-TR44-03
Revision: 0

Question:

The baseplate in Figure 2-8 appears to have only one layer of 8 node brick element through its thickness. It is not clear if a solid or a thick shell element is used. Clarify the type of element used for the baseplate.

Westinghouse Response:

The baseplate is modeled using 8-noded solid elements arranged in a single layer.

Reference:

1. APP-GW-GLR-026, Revision 0, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44)

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-TR44-04
Revision: 0

Question:

Section 2.8.5 indicates that the baseplate of the rack is connected to the cells by appropriate welding. However, the cells are described in the second paragraph on page 2 of the topical report as resting on top of the baseplate. Welded connections between the cells and the baseplate would greatly increase the strength of the whole rack system. To assist the staff in its review:

(a) Confirm there is a welded connection between the baseplate and the cells.

(b) Describe the design details of this connection.

(c) Describe how this connection is modeled in LS-DYNA.

Westinghouse Response:

(a) The base of every storage cell is welded to the rack baseplate.

(b) Each cell is welded to the baseplate on four sides by 1/16" fillet welds having a minimum length of 7".

(c) The cell-to-baseplate weld connection is modeled in LS-DYNA by shell elements, which join the bottom of the cell and the baseplate top surface, with a thickness equal to the corresponding throat dimension of the weld.

References:

1. APP-GW-GLR-026, Revision 0, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44)
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-TR44-06
Revision: 0

Question:

A vertical movement of 2 inches of a fuel assembly is defined as the criticality limit in Section 2.8.5, and the impact analysis shows that quite a number of fuel assemblies will have more than 2 inches displacement. It appears that a rack design with only a 2 inches space between the bottom of the baseplate and the top of the floor would eliminate this risk. Please explain why the design has a space larger than 2 inches.

Westinghouse Response:

Each storage cell is 193.5 inches in length and rests on top of a base plate whose top is 5 inches above the concrete floor. Note that each Metamic poison panel is 172 inches long and has a bottom elevation that is 6.23 inches above the top of the base plate. The active fuel region of each fuel assembly begins at an elevation 8.23 inches above the base plate. Therefore, the bottom elevation of the Metamic poison panel is positioned to be two inches lower than the bottom elevation of the active fuel.

Therefore, the results of the criticality analyses are bounding even if the fuel assembly is vertically displaced downward by up to two inches as a result of the hypothetical fuel assembly drop. The two inch vertical displacement of the fuel assemblies, mentioned in Technical Report 44 is not a criticality limit.

The criticality analyses summarized in COL Technical Report APP-GW-GLR-030 Rev.0 "New Fuel Storage Rack Criticality Analysis" addressed the hypothetical fuel assembly drop in subsection 2.4.2 as follows:

"The resulting deformation on the base plate following a drop of fuel assembly straight through an empty cell impacting the rack baseplate is discussed in subsection 2.8.5 of Reference 4. To conservatively bound the deformation results for the base plate, the bottom elevations of 25 fuel assemblies were lowered by 5 inches. (Note that the base plate is 3/4 inches thick and is normally 4.25 inches above the floor.) This is a five-by-five array of fuel assemblies centered on the empty cell impacted by the dropped fuel assembly (refer to Figure 2-10 of Reference 4). Even with the bottom elevation of the active fuel in 25 fuel assemblies lowered by 5 inches, the criticality design limits given in Section 2.1 are still met."

Since the criticality analysis demonstrates that the stored fuel assemblies remain subcritical following a hypothetical fuel assembly drop, the space between the bottom of the baseplate and the new fuel storage vault floor is not designed to control criticality, but to prevent the new fuel vault floor from an impact strike. In other words, the rack baseplate is raised high enough

above the new fuel storage vault floor (4.25") to prevent the baseplate from contacting the floor when it deforms under impact.

References:

1. APP-GW-GLR-026, Revision 0, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44)
2. APP-FS02-Z0C-001, Revision 0,"Analysis of AP1000 Fuel Storage Racks Subjected to Fuel Drop Accidents"
3. APP-GW-GLR-030 Revision 0, "New Fuel Storage Rack Criticality Analysis," (Technical Report Number 67)

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-TR44-10
Revision: 0

Question:

The Westinghouse Report APP-GW-GLR-026, Revision 0, appears to be a summary type report. However, to adequately perform a technical review of the analysis and design of the new fuel rack, a more detailed report should be submitted. Therefore, provide a detailed new fuel storage rack report/calculation for review.

Westinghouse Response:

The Westinghouse Report APP-GW-GLR-026, Revision 0, is a summary type report. This report is based on the calculations APP-FS01-S3C-001, Revision 0 "New Fuel Storage Rack Structural/Seismic Analysis" and APP-FS02-Z0C-001, Revision 0, "Analysis of AP1000 Fuel Storage Racks subjected to Fuel Drop Accidents." These calculations can be reviewed in the Westinghouse Energy Center or Westinghouse Rockville Office prior to the NRC mid-April audit. Please advise Westinghouse of you plan for review of these documents.

References:

1. APP-GW-GLR-026, Revision 0, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44)
2. APP-FS01-S3C-001, Revision 0, "New Fuel Storage Rack Structural/Seismic Analysis"
3. 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-TR44-14
Revision: 0

Question:

Section 2.2.2.2 of the report describes the modeling of a single rack. It indicates that the rack cellular structure elasticity is modeled by a 3-D beam having three translational and three rotational degrees-of-freedom (DOFs) at each end so that two-plane bending, tension/compression, and twist of the rack are accommodated. Explain why shear stiffness/deformation is not also included. Provide more detailed information about how the beam model of the rack was developed, considering that it is an assembly of many square-celled structures welded at discrete locations.

Westinghouse Response:

Shear deformation is included in the rack dynamic model. The beam model of the rack was developed based on the applicable Codes, Standards and Specifications given in Section IV(2) of the NRC guidance on spent fuel pool modifications entitled, "Review and Acceptance of Spent Fuel Storage and Handling Applications," dated April 14, 1978, which states that "Design ... may be performed based upon the AISC specification or Subsection NF requirements of Section III of the ASME B&PV Code for Class 3 component supports." The rack modeling technique is consistent with the linear support beam-element type members covered by these codes.

Reference:

1. APP-GW-GLR-026, Revision 0, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44)
2. NRC Letter Guidance on spent fuel pool modifications, Section IV(2) "Review and Acceptance of Spent Fuel Storage and Handling Applications," April 14,1978.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
TR44 will be revised to include the discussion on shear deformation presented in the RAI-TR-14 response.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR44-25
Revision: 0

Question:

In the markup of the DCD, provided in Section 5 of the topical report, Figure 9.1-1, New Fuel Storage Rack, is identified for deletion. Please explain why you are deleting this figure. This figure should be retained in the DCD.

Westinghouse Response:

We are in agreement. Revision 16 of the DCD will have a revised Figure 9.1-1 New Fuel Rack Layout. This figure will show the new fuel rack configuration in plan and elevation views identifying significant features and dimensions.

Reference:

1. APP-GW-GLR-026, Revision 0, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44)

Design Control Document (DCD) Revision:
Yes- Figure 9.1-1 New Fuel Rack Layout will be revised in DCD Revision 16 to show the new fuel rack configuration in plan and elevation views identifying significant features and dimensions.

PRA Revision:
None

Technical Report (TR) Revision:
Yes- Figure 9.1-1 New Fuel Rack Layout will be will be added to the revision of APP-GW-GLR-026, Revision 0, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44).