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Your ref: Project Number 740
Our ref: DCP/NRC1962

July 17, 2007

Subject: AP1000 COL Responses to Requests for Additional Information (TR #44)

In support of Combined License application pre-application activities, Westinghouse is re-submitting the non-proprietary 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 non-proprietary responses are provided for requests for additional information TR44-5, TR44-9, TR44-17, TR44-19, TR44-23, and TR44-24, 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). These responses supersede those provided under Westinghouse letter DCP/NRC1953 dated July 5, 2007.

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.

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

DO79
DO63

00204psa.doc

NRO

/Attachment

1. "Oath of Affirmation," dated July 17, 2007

/Enclosure

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

cc:	D. Jaffe	-	U.S. NRC	1E	1A
	E. McKenna	-	U.S. NRC	1E	1A
	S. Adams	-	Westinghouse	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
	J. Iacovino	-	Westinghouse	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

B. W. Bevilacqua, being duly sworn, states that he is Vice President, New Plants Engineering, 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.

Bruce Bevilacqua

B. W. Bevilacqua
Vice President
New Plants Engineering

Subscribed and sworn to
before me this 17th day
of July 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 Requests for Additional Information on Technical Report No. 44

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR44-005
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 3.8 inches, 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 new 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 the degree of conservatism associated with the postulated 36" drop height. Note that the response to RAI TR44-001 indicates that it is unlikely that the drop height will ever be 36 inches, as the top of the rack is less than 6 inches below the floor elevation. Based on a realistic carry height above the floor of 12 inches, the drop height above the new fuel storage rack is not likely to exceed 18 inches.

2) The design basis for the baseplate is to provide vertical support for the stored fuel assemblies and to protect the New Fuel Storage Pit 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 reinforced concrete floor of the New Fuel Storage Pit.

(3) Figure TR44-005.1 below shows the cells together with the severely deformed baseplate for the same LS-DYNA solution as shown in Figure 2-10. Note that the deformation of the cells is not significant compared to the baseplate. This is because the cell-to-baseplate weld connections break as a result of the postulated fuel impact load before the cell walls are permanently deformed.

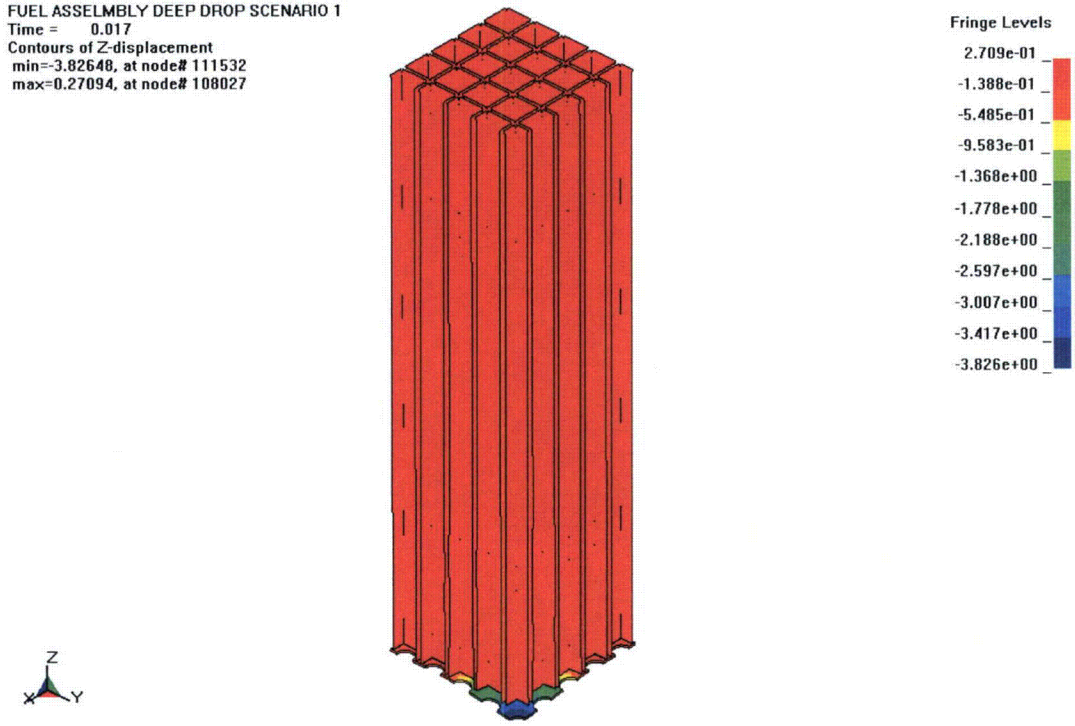


Figure TR44-005.1 Fuel Assembly Deep Drop Scenario 1 for New Fuel Rack

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)

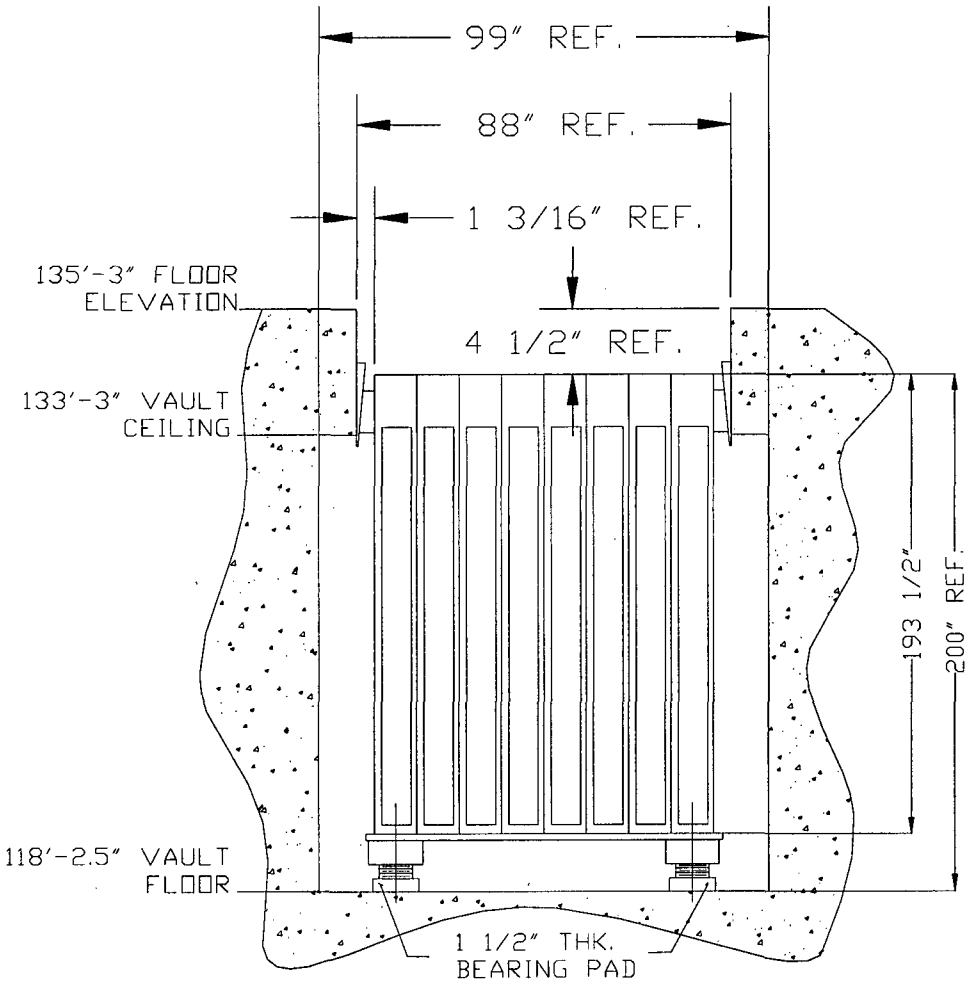
RAI Response Number: RAI-TR44-009
Revision: 0

Question:

Insufficient descriptive information has been included in the new fuel report to permit an adequate review of the structural/seismic analysis of the new fuel rack. Please provide descriptive information including plans and sections showing the new fuel rack and vault walls. All of the major features of the rack including the cell walls, baseplate, pedestals, bearing pads, neutron absorber sheathing, any impact bars, welds connecting these parts, and any other elements in the load path of the rack should be shown on one or several sketches. These sketches should also indicate related information which includes key: cutouts, dimensions, material thicknesses, and gaps (fuel to cell, rack to walls). In addition to the above, for review of postulated fuel handling drop accident and quantification of the drop parameters, sketches with sufficient details for the fuel handling system should be provided.

Westinghouse Response:

Figures TR44-9.1 through TR-44-9.5 provide additional descriptive information on the new fuel rack and New Fuel Storage Pit floor and walls. The new fuel handling system is still in final design and no sketches are available. The quantification of the drop parameters has been established and analyzed in Technical Report Number 44. A conservative drop height of 36 inches has been assumed even though the most likely drop height will not exceed 18 inch above the new fuel rack. The total drop weight is 2,027 pounds, which consist of a new fuel assembly, control assembly and new fuel handling tool.



ELEVATION VIEW OF NEW FUEL STORAGE RACK

(EAST WALL VIEW LOOKING WEST)

FIGURE TR44-9.1

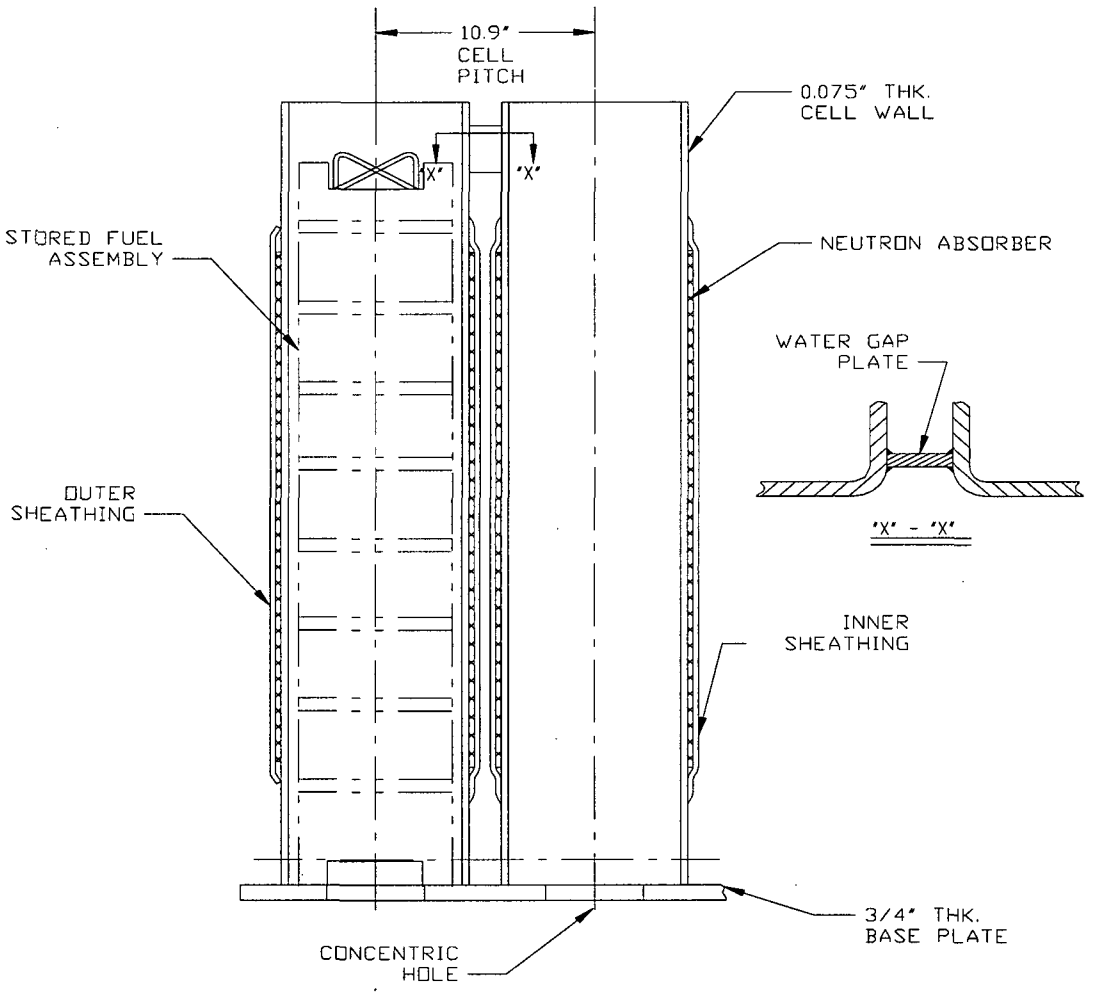


FIGURE TR44-9.2; ELEVATION VIEW OF
NEW STORAGE RACK CELLS

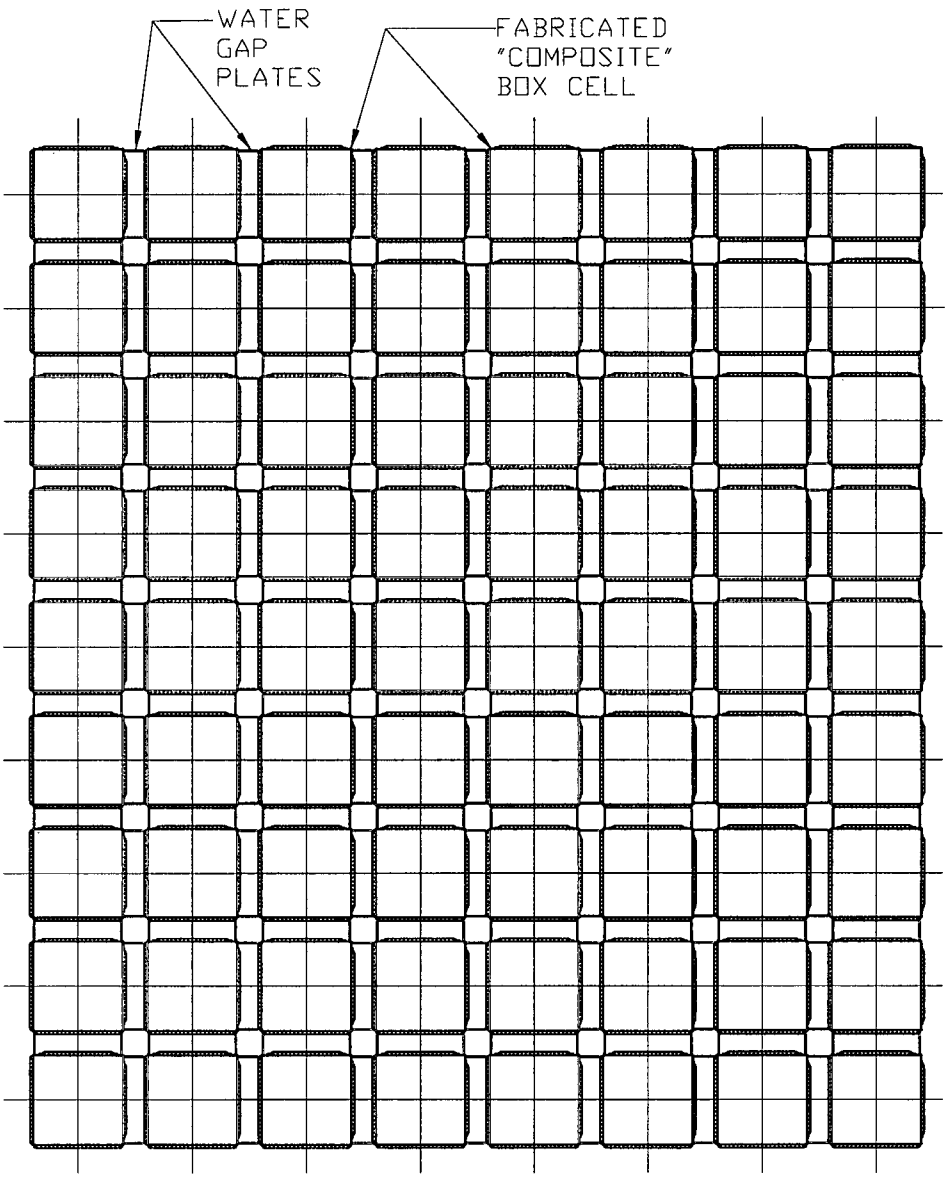


FIGURE TR44-9.3; STORAGE CELL ARRAY
FOR NEW FUEL STORAGE RACK

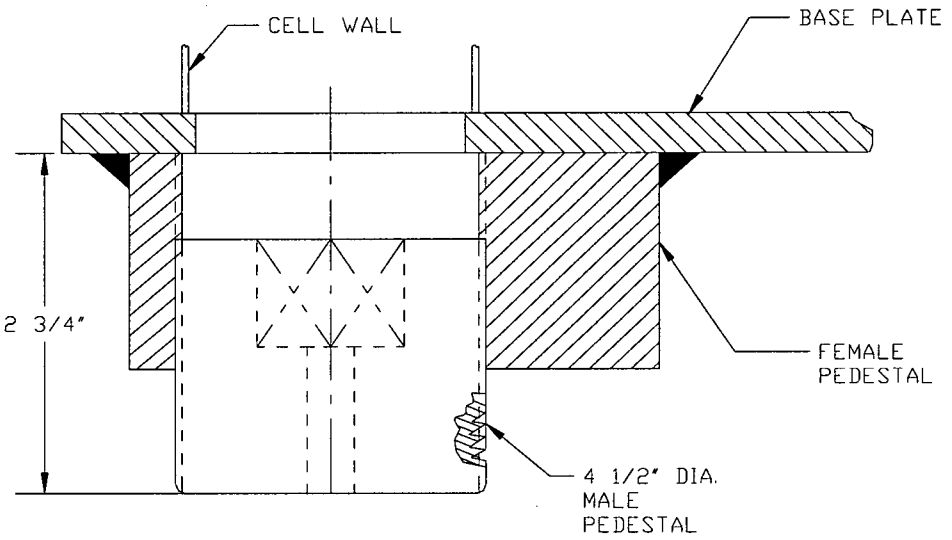


FIGURE TR44-9.4; CROSS SECTION OF ADJUSTABLE SUPPORT

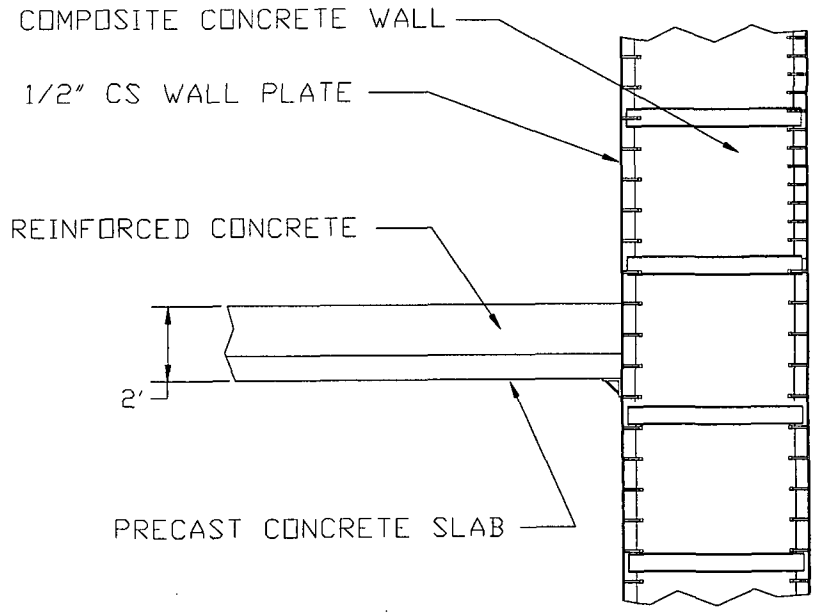


Figure TR44-9.5 New Fuel Pit Floor and Wall Detail

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-TR44-017
Revision: 0

Question:

What are the gaps and tolerances for each of the gaps between the fuel assembly and cell wall, and between the rack and vault wall? What are the assumed initial locations of the various components (fuel assemblies and rack) and what is the technical basis for this assumption. Were any studies done for different initial conditions (considering tolerances); if not, explain why it was not necessary. Are there requirements in the DCD to ensure that the assumed gaps (considering tolerances) are maintained throughout the operating license period?

Westinghouse Response:

All gaps between fuel assemblies and cell walls and between the rack and vault walls are set to match the nominal gaps provided on the layout drawing. Table TR44-017.1 summarizes the gap information used in the dynamic analyses.

	Fuel-to-Cell Wall	Rack-to-Wall
Nominal Gap (inch)	(8.8"-8.404")/2 = 0.198"	North – 0" (see note 1) East – 28.7" South – 0" (see note 1) West – 28.7"

Table TR44-017.1 Gap Information used in the Dynamic Analysis of the New Fuel Rack

Note:
1. The new fuel storage rack is braced against the north and south walls of the New Fuel Storage Pit by inserting stainless steel wedges in the interstitial space between the top of the new fuel storage rack and the New Fuel Storage Pit opening (see TR44-009 RAI Response Figure TR44-9.1).

Fuel is assumed centrally located in cell. This is conservative since minimizing gap on one or two walls will generally produce a larger hydrodynamic coupling effect.

Some numerical studies were done on other rack projects; the results generally showed a small influence on results. A larger influence occurs if the gaps are assumed to be displacement dependent, rather than always being held constant at their initial value. The neglect of this effect is conservative.

Once the new fuel rack is installed, the "as-built" gaps are reconciled with the gaps initially used for analysis by evaluation of the numerical results and the predicted motions. The new fuel rack will be positioned in the New Fuel Storage Pit per the gap information provided in Table TR44-017.1. The only way the gaps would change over time would be by the action of a seismic event. Combined License applicants will have a procedure in place to address measurement of the post design-basis seismic event gaps, and to evaluate the acceptability of the configuration showing it is acceptable, or to take appropriate corrective actions. A statement will be added to the Technical Report addressing the design-basis seismic event potential change in gaps between the new fuel rack and New Fuel Storage Pit walls.

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:
The following statement will be added to Technical Report 44 addressing the design-basis seismic event potential changes in gaps between the new fuel rack and walls of the new fuel storage pit " Per DCD subsection 3.7.5.2, Combined License applicants will prepare site-specific procedures for activities following an earthquake. These procedures will be used to accurately determine both the response spectrum and cumulative absolute velocity of the recorded earthquake ground motion from the seismic instrumentation system. An activity will be to address measurement of the post-seismic event gaps between the new fuel rack and walls of the new fuel storage pit and to take appropriate corrective actions."

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR44-019
Revision: 0

Question:

The load combinations specified in Table 2-3 of the subject report and Table 9.1-1 (markup version of the DCD provided in Section 5 of the subject report) do not appear to be consistent. Therefore, please explain the apparent inconsistencies and/or modify these tables to be consistent.

Westinghouse Response:

Table 2-3 of Technical Report Number 44 will be revised as follows (which is derived from Appendix D to SRP Section 3.8.4):

Table 2-3 Loading Combinations for AP1000 New Fuel Storage Rack	
Loading Combination	**Service Level**
$D + L$ $D + L + T_o$	Level A
$D + L + T_o + P_f$	Level B
$D + L + T_a + E'$	Level D
$D + L + F_d$	The functional capability of the fuel rack should be demonstrated.

Notes:

1. There is no operating basis earthquake (OBE) for the AP1000 plant.
2. The fuel rack is freestanding; thus, there is minimal or no restraint against free thermal expansion at the base of the rack. As a result, thermal loads applied to the rack (T_o and T_a) produce only local (secondary) stresses.

Abbreviations are those used in Reference 6:

D = Dead weight induced loads (including fuel assembly weight)

L = Live load (not applicable to fuel racks since there are no moving objects in the rack load path)

F_d = Force caused by the accidental drop of the heaviest load from the maximum possible height

P_f = Upward force on the racks caused by postulated stuck fuel assembly

E' = Safe Shutdown Earthquake (SSE)

T_o = Differential temperature induced loads based on the most critical transient or steady state condition under normal operation or shutdown conditions

T_a = Differential temperature induced loads based on the postulated abnormal design conditions

DCD Table 9.1-1 Loads and Load Combinations for Fuel Racks has been revised as follows:

Table 9.1-1

LOADS AND LOAD COMBINATIONS FOR FUEL RACKS

Load Combination	Service Level
D + L D + L + T_o	Level A
D + L + T_o + P_f	Level B
D + L + T_a + E'	Level D
D + L + F_d	The functional capability of the fuel racks should be demonstrated.

Notes:

1. There is no operating basis earthquake (OBE) for the AP1000 plant.
2. The fuel racks are freestanding; thus, there is minimal or no restraint against free thermal expansion at the base of the rack. As a result, thermal loads applied to the rack (T_o and T_a) produce only local (secondary) stresses.

Abbreviations are those used in NUREG-0800, Section 3.8.4 (including Appendix D) of the Standard Review Plan (SRP):

D = Dead weight induced loads (including fuel assembly weight)

L = Live load (not applicable to fuel racks since there are no moving objects in the rack load path)

F_d = Force caused by the accidental drop of the heaviest load from the maximum possible height

P_f = Upward force on the racks caused by postulated stuck fuel assembly

E' = Safe Shutdown Earthquake (SSE)

T_o = Differential temperature induced loads based on the most critical transient or steady state condition under normal operation or shutdown conditions

T_a = Differential temperature induced loads based on the postulated abnormal design conditions

Reference:

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

Design Control Document (DCD) Revision:
Table 9.1-1 as shown above has been revised in DCD Revision 16.

PRA Revision:
None

Technical Report (TR) Revision:
Table 2-3 as shown above will revised in Technical Report Number 44.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR44-023
Revision: 0

Question:

Section 2.3.5 of the report discusses dimensionless stress factors. It states that "R_1 is the ratio of direct tensile or compressive stress on a net section to its allowable value (note pedestals only resist compression)." Explain why this indicates that pedestals only resist compression, since horizontal forces are also generated due to friction during a seismic event? These forces could be quite high and also would introduce shear and moments into the pedestal and rack structure.

Westinghouse Response:

Section 2.3.5 of Technical Report Number 44 defines seven stress factors (R_1 through R_7), which correspond to the ASME Code Section III, Subsection NF stress limits for Class 3 components. R_1 is defined as the ratio of direct tensile or compressive stress on a net section to its allowable value. Since the new fuel rack is freestanding, the *net cross section* of the support pedestals can only be subjected to direct compressive stress. This is the explanation for the note in parentheses. Moreover, it is absolutely true that horizontal forces are generated due to friction between the support pedestals and the SFP floor and that these forces produce shear and bending stresses in the pedestals. The shear and bending stresses in the support pedestals, as well as the combined compression and bending stress, are measured by the other six stress factors (i.e., R_2 through R_7), which are defined in Section 2.3.5 of Technical Report Number 44.

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-TR44-024
Revision: 0

Question:

Some of the information provided in Section 2.8.2 (Rack Structural Evaluation) and Tables 2-6 through 2-14 (stress results) is not clear. Therefore, describe/explain the following:

(a) Section 2.8.2.1, 2nd paragraph, indicates that the tables also report the stress factors for the AP1000 New Fuel Storage Rack cellular cross section just above and below the baseplate. This implies that the fuel cells continue below the baseplate. Please explain.

(b) The same paragraph refers to "pedestal five in the first sheet of the summary tables for each simulation (that is, 9.M.0 where M stands for run number)." Please explain what this means since the tables do not reflect this terminology.

(c) The same paragraph refers to "ensures that the overall structural criteria set forth in subsection 2.2.3 are met." Structural criteria are not presented in subsection 2.2.3.

(d) Section 2.8.2.2 a., refers to a stress factor of 2.1516 which it states is given in the tables. However, no such stress factor is given, please explain. Also, are all cells welded to the baseplate on all four sides?

(e)Section 2.8.2.2 b., indicates that a separate finite element model is used to check the baseplate to pedestal welds. Provide a short description of the model, computer code, loading, and location of the maximum tabulated stress in the weld referred to in Table 2-12.

(f) Section 2.8.2.2 c., indicates that for calculation of cell welds, the fuel assemblies in adjacent cells are conservatively calculated by assuming that the fuel assemblies in adjacent cells are moving out of phase with one another. It then states that cell to cell weld calculations are based on the maximum stress factor from all runs. However, elsewhere in the report, it was stated that all of the fuel assemblies in the simulation are assumed to vibrate in phase. Provide more information to explain this.

(g) Section 2.8.2.3 refers to Tables 2-6 through 2-13 for limiting thread stresses under faulted conditions for every pedestal. These tables do not seem to apply to pedestal thread shear stress. Therefore, clarify or correct this information.

(h) For Table 2-6, Results Summary, please identify what rack component/element applies to each of the column headings (i.e., Max Stress Factor, Max. Shear Load, Max Fuel to Cell Wall Impact). Similarly, for Tables 2-11, 2-13, and 2-14, identify what rack component/element the table applies to.

(i) Why is Table 2-14 labeled, "Allowable Shear Stress for Level D"? This is inconsistent with other tables. Please explain.

Westinghouse Response:

(a) The fuel cells do not continue below the baseplate. Stress factors are computed just above the baseplate, where the fuel cells are welded to the baseplate, and just below the baseplate where the support pedestals are welded. Section 2.8.2.1 (2nd paragraph, 2nd sentence) will be revised as follows:

> "The tables also report the stress factors for the AP1000 New Fuel Storage Rack cellular cross section just above the baseplate."

(b) The computer code DYNAPOST, which is listed in Table 2-15, computes the stress factors for the four support pedestals and for the cellular structure just above the baseplate based on the time history analysis results. For convenience, these five locations are identified as pedestal numbers 1 through 5 in the DYNAPOST output tables, which are not included in Technical Report APP-GW-GLR-026. Therefore, the sentence, "The locations above the base plate ... are referred to as pedestal five in the first sheet of the summary tables for each simulation (that is, 9.M.0 where M stands for run number).", is not relevant to the report and will be deleted.

(c) The reference to subsection 2.2.3 is a typo. The correct reference is subsection 2.3.3.

(d) The factor of 2.1516 is not provided in the tables as stated in text. Section 2.8.2.2 a. (2nd paragraph) will be revised as follows:

> "Weld stresses are determined through the use of a simple conversion (ratio) factor (based on area ratios) applied to the corresponding stress factor in the adjacent rack material. This conversion factor is developed from the differences in base material thickness and length versus weld throat dimension and length:"

All fuel cells are welded to the baseplate on all four sides.

(e) The finite element code ANSYS is used to resolve the tension and compression stresses in the pedestal weld due to the combined effects of a vertical compressive load in the pedestal and a bending moment caused by pedestal friction. The compression interface between the baseplate and the pedestal is modeled using contact elements. The perimeter nodes on the pedestal are connected to the baseplate by spring elements in order to simulate tension in the weld. The maximum instantaneous friction force on a single pedestal from the rack seismic analysis is conservatively applied to the finite element model in the horizontal x- and y-directions simultaneously, along with the concurrent vertical load, at the appropriate offset location. The perimeter nodes on the pedestal are restrained to move only in the vertical direction so that the spring elements only resist bending. The limiting ANSYS results are combined with the maximum

horizontal shear loads to obtain the maximum weld stress. The maximum weld stress reported in Table 2-12 occurs at the corner of the pedestal where the tensile stress in the weld due to bending is maximum.

(f) All stored fuel assemblies within a rack are assumed to rattle in phase for the seismic analysis of the new fuel rack using the Holtec proprietary computer code MR216 (a.k.a. DYNARACK). This analysis yields the maximum impact force between a single fuel assembly and the surrounding cell walls. When evaluating the weld connection between adjacent storage cells, the maximum fuel-to-cell impact force from the dynamic analysis is conservatively multiplied by a factor of 2 to consider out-of-phase fuel rattling.

(g) The reference to "Tables 2-6 through 2-13" in Section 2.8.2.3 is incorrect. The first sentence in Section 2.8.2.3 should be revised as follows: "Table 2-14 provides the limiting thread stress under faulted conditions."

(h) In Table 2-6, the "Max. Stress Factor" column applies to the rack cell structure. The "Max. Vertical Load" and "Max. Shear Load" columns apply to a single rack pedestal. The "Max. Fuel-to-Cell Wall Impact" column provides the maximum impact force between a single fuel assembly and the surrounding cell wall at any of the five rattling fuel mass elevations (refer to Figure 2-5 of the report).

Table 2-11 applies to the base metal adjacent to the baseplate to cell welds. Table 2-13 provides the shear stress in the cell to cell welds as well as the adjacent base metal. Table 2-14 applies to the pedestal internal threads.

(i) Table 2-14 should be labeled "Pedestal Thread Shear Stress" instead of "Allowable Shear Stress for Level D". The allowable stresses reported in Tables 2-10 through 2-14 are Level D stress limits since the design basis ASB99 earthquake is a faulted condition (Level D).

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:
Revisions will be made to Technical Report Number 44 as shown below:

(a) Section 2.8.2.1 (2nd paragraph, 2nd sentence) will be revised as follows:

> "The tables also report the stress factors for the AP1000 New Fuel Storage Rack cellular cross section just above the baseplate."

(b) Section 2.8.2.1, 2nd paragraph, the entire sentence, "The locations above the base plate ... are referred to as pedestal five in the first sheet of the summary tables for each simulation (that is, 9.M.0 where M stands for run number)." is not relevant to the report. This sentence will be deleted.

(c) Section 2.8.2.1, 2nd paragraph will be revised to reference subsection 2.3.3.

(d) Section 2.8.2.2 a. (2nd paragraph) will be revised as follows:

> "Weld stresses are determined through the use of a simple conversion (ratio) factor (based on area ratios) applied to the corresponding stress factor in the adjacent rack material. This conversion factor is developed from the differences in base material thickness and length versus weld throat dimension and length:"

(g) The first sentence in Section 2.8.2.3 will be revised as follows:

> "Table 2-14 provides the limiting thread stress under faulted conditions."

(i) Table 2-14 will be revised to "Pedestal Thread Shear Stress"