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Your ref: Docket No. 52-006
Our ref: DCP_NRC_002975

July 20, 2010

Subject: AP1000 Response to Request for Additional Information

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section TR44. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following RAI(s):

RAI-TR44-008 R2
RAI-TR44-009 R2
RAI-TR44-016 R3
RAI-TR44-017 R3
RAI-TR44-025 R2

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,

for/ John DeBlasio

Robert Sisk, Manager
Licensing and Customer Interface
Regulatory Affairs and Strategy

/Enclosure

1. Response to Request for Additional Information on SRP Section TR44

DO63
NRO

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	C. Pierce	-	Southern Company	1E
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DCP_NRC_002975
July 20, 2010

ENCLOSURE 1

Response to Request for Additional Information on SRP Section TR44

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR44-008
Revision: 2

Question: (Revision 0)

As indicated in Table 2-3 of the report and the markup for DCD Table 9.1-1, one of the fuel handling accident loads that need to be considered is uplift force on the rack caused by a postulated stuck fuel assembly. Section 2.8.3 of the report states: "An evaluation of a stuck fuel assembly, leading to an upward load of 2,000 lb has been performed. The results from the evaluation show that this is not a bounding condition because the local stresses do not exceed 2,500 psi." The information provided is not sufficient for the staff to reach a conclusion that this load has been adequately considered. Please provide a detailed description of the assumptions, the analyses conducted, the results obtained, and the basis for the conclusion that this is not a bounding condition.

Staff Assessment (Revision 1): Response similar to response for spent fuel racks. See RAI-TR54-14.

Following the submittal of the Westinghouse Revision 1 response to RAI-TR54-14, the NRC staff requested additional information:

The following information is needed to ensure that the calculation in Westinghouse's response is adequate:

(1) Explain how the effective b_e and t_e are determined.

(2) Provide a calculation on the adequacy of the vertical welds along the height between adjoining cells and the horizontal welds at the base (cell walls to baseplate). If the stress levels are higher than those currently presented in the response, then revise the Technical Report accordingly.

(3) The two sentence description of the stuck fuel assembly is presented in Section 2.8.3- "Dead Load Evaluation" of the Technical Report. A more detailed description comparable to the information given in the RAI response should be included in a more appropriate section of the Technical Report since this loading is a fuel handling accident condition not a dead load evaluation.

(4) Explain why the Technical Report and the response describes the uplift force equal to 2,000 pounds is used, while DCD Section 9.1.2.2.1 indicates that an uplift force of 5,000 pounds is used in the analysis.

Additional Question: (Revision 2)

Clarify why the proposed DCD change quoted below from RAI Revision 1 was never implemented:

"Item Q, 'New Fuel Handling Crane', of Section 9.1.4.2.4, 'Component Description', is revised as follows:

> *'The new fuel handling crane is located in the fuel handling area. It is a standard commercial crane with an "L" shaped frame and an electric operated hoist. It is used to move the new fuel from the new fuel storage position to the new fuel elevator. The crane is positioned so that it cannot reach the spent fuel storage positions. The crane capacity is limited to a 4000 pound load.' "*

Westinghouse Response:

Westinghouse Response: (Revision 0) ***(Superseded by Revision 2)***

~~A nearly empty rack with one corner cell occupied is subject to an upward load of 2000 lbf, which is assumed to be caused by the fuel sticking while being removed. The ramification of the loading is two-fold:~~

> ~~1) The upward load creates a force and a moment at the base of the rack;~~
>
> ~~2) The loading induces a local tension in the cell wall.~~

~~The following calculation determines the maximum stress in the rack cell structure due to a postulated stuck fuel assembly. The terms p, Nx, Ny, Ixx2, and Iyy2 are defined as the cell pitch, the number of storage cells in the horizontal x-direction, the number of storage cells in the horizontal y-direction, the moment of inertia of the rack cell structure about the x-axis, and the moment of inertia of the rack cell structure about the y-axis, respectively.~~

SUPERSEDED

Calculation of the Effect of a Stuck Fuel Assembly

$P_{stuck} := 2000 \cdot lbf$ Per Westinghouse design input

Compute maximum stress at base of rack cell structure assuming rack behaves as a cantilever beam

$X := N_x \cdot \frac{p}{2}$ $X = 4.087\,ft$ $I_{xx2} = 6.653 \times 10^4\,in^4$

$Y := N_y \cdot \frac{p}{2}$ $Y = 3.633\,ft$

$\sigma_{grid} := P_{stuck} \cdot \frac{X^2}{I_{xx2}} + P_{stuck} \cdot \frac{Y^2}{I_{yy2}}$ $\sigma_{grid} = 118.032\,psi$

It is clear that the global stress due to a stuck fuel assembly is insignificant. Now, check local stress in cell in tension. Conservatively using the effective width

$A_{celllocal} := 4 \cdot b_e \cdot t_e$ $A_{celllocal} = 0.991\,in^2$

$\sigma_{local} := \frac{P_{stuck}}{A_{celllocal}}$ $\sigma_{local} = 2.018 \times 10^3\,psi$

~~This local stress is well below the yield stress of the cell wall material (i.e., 30,000 psi per Table 2-5.)~~

Westinghouse Supplemental Response from May 21 and 22, 2008 Technical Review: (Revision 1) (Superseded by Revision 2)

~~Item 1: During the October 8-12, 2007 audit, Westinghouse showed the NRC staff Appendix D (pg. D-13) of the equivalent structural/seismic calculation for the spent fuel racks, APP-FS02-S3C-002, Rev. 0, where the calculation of b_e and t_e was performed. The equations for the calculation of the effective width were taken from the ASME Code, Section III, Subsection NF, NF-3222.2, and the methodology used in the new fuel rack structural/seismic analysis is the same.~~

~~The effective thickness for a spent fuel rack cell uses one-half the actual thickness because each cell wall is shared by the adjacent two cells. During the May 21 and 22, 2008 technical review the NRC staff reviewed Revision 1 of APP-FS02-S3C-002, and determined that the calculation for the effective width is based on the provisions in the ASME Code, Section III, Subsection NF, and the effective wall thickness corresponds to one-half of the true wall thickness. Therefore, item 1 of RAI-TR54-14 for the spent fuel racks was found to be technically acceptable by the NRC staff.~~

~~The same approach was used in the new fuel rack structural/seismic analysis, APP-FS01-S3C-001, Revision 1; therefore, Westinghouse considers this item to be technically acceptable for the new fuel rack as well.~~

~~Item 2: The following calculations demonstrate the adequacy of the vertical welds along the height between adjoining cells and the horizontal welds at the base (cell walls to baseplate) to resist the stuck fuel assembly load.~~

SUPERSEDED

Cell to cell welds

Each storage cell in the new fuel rack is welded vertically along its height to the adjoining cells by a combination of 3" and 6" long intermittent fillet welds. The minimum length of weld over the height of a storage cell, along one corner of the cell, is 6". Therefore, for conservatism, the entire stuck fuel assembly load is assumed to be resisted by only two 3" long fillet welds at the very top of the rack. Based on this approach, the stress in the cell to cell welds is calculated as follows:

Stuck fuel assembly load $P_{stuck} := 4000 \cdot lbf$

Length of intermittent fillet weld $L_{weld} := 3 \cdot in$

Size of intermittent fillet weld $t_{weld} := \frac{1}{16} \cdot in$

Number of fillet welds that resist load $N_{ww} := 2$

Effective throat area of fillet welds $A_{weld} := N \cdot L_{weld} \cdot \frac{t_{weld}}{\sqrt{2}}$

$A_{weld} = 0.265\ in^2$

Shear stress in fillet welds $\tau := \frac{P_{stuck}}{A_{weld}}$

$\tau = 15085\ psi$

Per Section 2.3.4.1 of TR-44, the allowable weld stress under normal conditions is 0.3 times the material ultimate strength. From Table 2-5 of TR-44, the ultimate strength of SA240-304 material at 100F is 75,000 psi. Therefore, the allowable weld stress under normal conditions is 0.3 x 75,000 psi = 22,500 psi, which is greater than the weld stress calculated above.

SUPERSEDED

Cell to baseplate welds

Each storage cell in the new fuel rack is welded to the base plate by four 7" (min.) long fillet welds. Since the total length of weld associated with cell to baseplate connection (28") is greater than the length considered in the above cell to cell weld evaluation (6"), and the weld size is the same (1/16"), the stress in the cell to baseplate welds is bounded by the preceding stress calculation for the cell to cell welds.

~~Item 3: The description of the stuck fuel assembly evaluation will be deleted from Section 2.8.3 of the Technical Report and will be replaced by a more detailed description in the newly added Section 2.8.6 (Stuck Fuel Assembly Evaluation). See the Technical Report Revision section below.~~

~~Item 4: This item is not directly applicable to the new fuel racks as it is currently worded; however, in the TR an uplift force of 2,000 pounds was stated, but in Section 9.1.1.2.1 of the DCD it is stated that an uplift force of 2,027 will be evaluated. The uplift force was reevaluated in Revision 1 of the new fuel rack structural/seismic analysis, APP-FS01-S3C-001, for 4,000 pound because the hoist on the fuel handling machine is rated at 4,000 pounds. The resultant stress on the rack is within the allowable; the max stress is 4,046 psi (see below calculation) compared to an allowable stress of 30,000 psi. The consideration of a 4,000 lbf uplift force will be reflected revised in TR44 and the DCD; see the Technical Report and DCD Revision sections below.~~

SUPERSEDED

Calculation of the Effect of a Stuck Fuel Assembly

$P_{stuck} := 4000 \cdot lbf$ Per Westinghouse design input

Compute maximum stress at base of rack cell structure assuming rack behaves as a cantilever beam

$X := N_x \cdot \frac{p}{2}$ $X = 4.087\,ft$ $I_{xx2} = 6.644 \times 10^4\,in^4$

$Y := N_y \cdot \frac{p}{2}$ $Y = 3.633\,ft$ $I_{yy2} = 8.306 \times 10^4\,in^4$

$\sigma_{grid} := P_{stuck} \cdot \frac{X^2}{I_{xx2}} + P_{stuck} \cdot \frac{Y^2}{I_{yy2}}$ $\sigma_{grid} = 236.391\,psi$

It is clear that the global stress due to a stuck fuel assembly is insignificant. Now, check local stress in cell in tension. Conservatively using the effective width

$A_{celllocal} := 4 \cdot b_e \cdot t_e$ $A_{celllocal} = 0.989\,in^2$

$\sigma_{local} := \frac{P_{stuck}}{A_{celllocal}}$ $\sigma_{local} = 4045.588\,psi$

~~This local stress is well below the yield stress of the cell wall material (i.e., 30,000 psi per Table 2-5 of TR44.)~~

New Response: (Revision 2)

The piece of equipment called the New Fuel Handling Crane has been superseded by design and operations changes, limitations, and commensurate DCD changes as discussed in OI-SRP9.1.1-SBPA-03 R3. As noted in revisions to DCD Rev. 17 Section 9.1.4.2.4 Item B, the Fuel Handling Machine now performs fuel handling operations in the new and spent fuel handling area. The FHM is equipped with two 2-ton hoists, one of which is single failure proof.

The technical questions, DCD changes, and TR changes raised in previous revisions of this RAI remain bounded and answered in the current version of the structural analyses (Reference 2), applicable technical report (APP-GW-GLR-026 R3 (TR44)), and DCD Rev. 17.

For example, stresses from the maximum uplift force of 4,000 lbs are confirmed to be acceptable.

The DCD Rev. 17 Section 9.1.1.2.1.B on fuel handling clarifies that an analysis is performed to demonstrate that the rack can withstand a maximum uplift load of 4000 pounds. This load is applied to a postulated stuck fuel assembly. Resultant rack stresses are evaluated against the stress limits and are demonstrated to be acceptable. It is demonstrated that there is no change in rack geometry of a magnitude which causes the criticality criterion to be violated.

The DCD Rev. 17 Section 9.1.1.3, "Safety Evaluation", discusses that the rack is also designed with adequate energy absorption capabilities to withstand the impact of a dropped fuel assembly from the maximum lift height of the new fuel handling crane. Handling equipment (cask handling crane) capable of carrying loads heavier than fuel components is prevented from traveling over the fuel storage area. The fuel storage rack can withstand an uplift force of 4000 pounds.

References:

1. APP-GW-GLR-026, Revision 3, May 2010, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44, TR44)
2. ~~APP-FS02-S3C-002, Revision 1, May 2008, "Spent Fuel Storage Rack Structural/Seismic Analysis"~~ ***(Superseded by Revision 2)***
3. APP-FS01-S3C-001, Revision 3, May 2010, "New Fuel Storage Rack Structural/Seismic Analysis"

Design Control Document (DCD) Revision:

DCD Changes: (Revision 0)
None.

DCD Changes: (Revision 1) ***(Superseded by Revision 2)***
~~Item B, "New Fuel Handling Crane Uplift Analysis", of Section 9.1.1.2.1, "New Fuel Rack Design", is revised as follows:~~

~~An analysis is performed to demonstrate that the rack can withstand a maximum uplift load of 4000 pounds. This load is applied to a postulated stuck fuel assembly. Resultant rack stresses are evaluated against the stress limits and are demonstrated to be acceptable. It is demonstrated that there is no change in rack geometry of a magnitude which causes the criticality criterion to be violated.~~

~~Section 9.1.1.3, "Safety Evaluation", is revised as follows:~~

~~The rack is also designed with adequate energy absorption capabilities to withstand the impact of a dropped fuel assembly from the maximum lift height of the new fuel handling crane. Handling equipment (cask handling crane) capable of carrying loads heavier than fuel components is prevented from traveling over the fuel storage area. The fuel storage rack can withstand an uplift force greater than or equal to the uplift capability of the new fuel handling crane (4000 pounds).~~

~~Item Q, "New Fuel Handling Crane", of Section 9.1.4.2.4, "Component Description", is revised as follows:~~

~~The new fuel handling crane is located in the fuel handling area. It is a standard commercial crane with an "L" shaped frame and an electric operated hoist. It is used to move the new fuel from the new fuel storage position to the new fuel elevator. The crane is positioned so that it cannot reach the spent fuel storage positions. The crane capacity is limited to a 4000 pound load.~~

DCD Changes: (Revision 2)
None.

PRA Revision:
None

Technical Report (TR) Revision:

TR Changes: (Revision 0)
None.

TR Changes: (Revision 1) ***(Superseded by Revision 2)***
~~The two sentence description of the stuck fuel assembly evaluation in Section 2.8.3 of the Technical Report was replaced by the following newly added section:~~

~~2.8.6 Stuck Fuel Assembly Evaluation~~

~~A nearly empty rack with one corner cell occupied is subject to an upward load of 4,000 lbf, which is assumed to be caused by the fuel sticking while being removed. The ramification of the loading is two-fold:~~

~~1. The upward load creates a force and a moment at the base of the rack;~~
~~2. The loading induces a local tension in the cell wall and shear stresses in the adjacent welds.~~

~~Strength of materials calculations have been performed to determine the maximum stress in the rack cell structure due to a postulated stuck fuel assembly. The results are summarized in Table 2-16.~~

~~Table 2-16 was added to the Technical Report:~~

~~Table 2-16 Results from Stuck Fuel Assembly Evaluation~~			
~~Item~~	~~Calculated Stress (psi)~~	~~Allowable Stress (psi)~~	~~Safety Factor~~
~~Tensile Stress in Cell Wall~~	~~4,046~~	~~30,000~~	~~7.41~~
~~Shear Stress in Cell-to-Cell Weld~~	~~15,085~~	~~22,500~~	~~1.49~~

TR Changes: (Revision 2)
None.

AP1000 TECHNICAL REPORT REVIEW
Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR44-009
Revision: 2

***Question:* (Revision 0)**

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.

***(Revision 1)* Staff Assessment**: Response similar to response for spent fuel racks. See RAI - TR54-15.

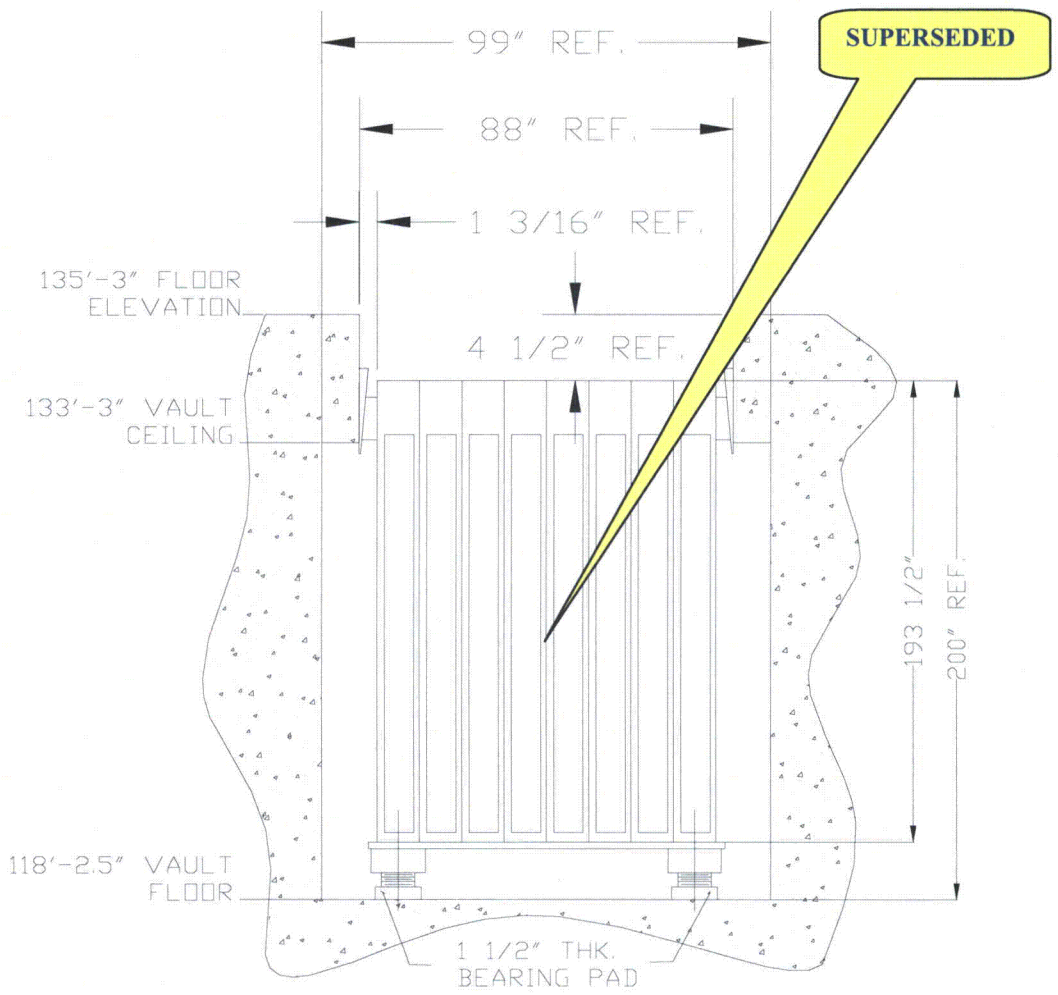
New Question: (Revision 2)

During the June 2010 audit, the NRC requested that dimension and gap information for the new fuel racks be clarified between the three similar RAIs (RAI-TR44-09, RAI-TR44-017, RAI-TR44-25) to show consistency and alignment to the current design basis shown in DCD Figure 9.1-1.

Westinghouse Response:

(Revision 0) ***(Superseded by Revision 2)***

~~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

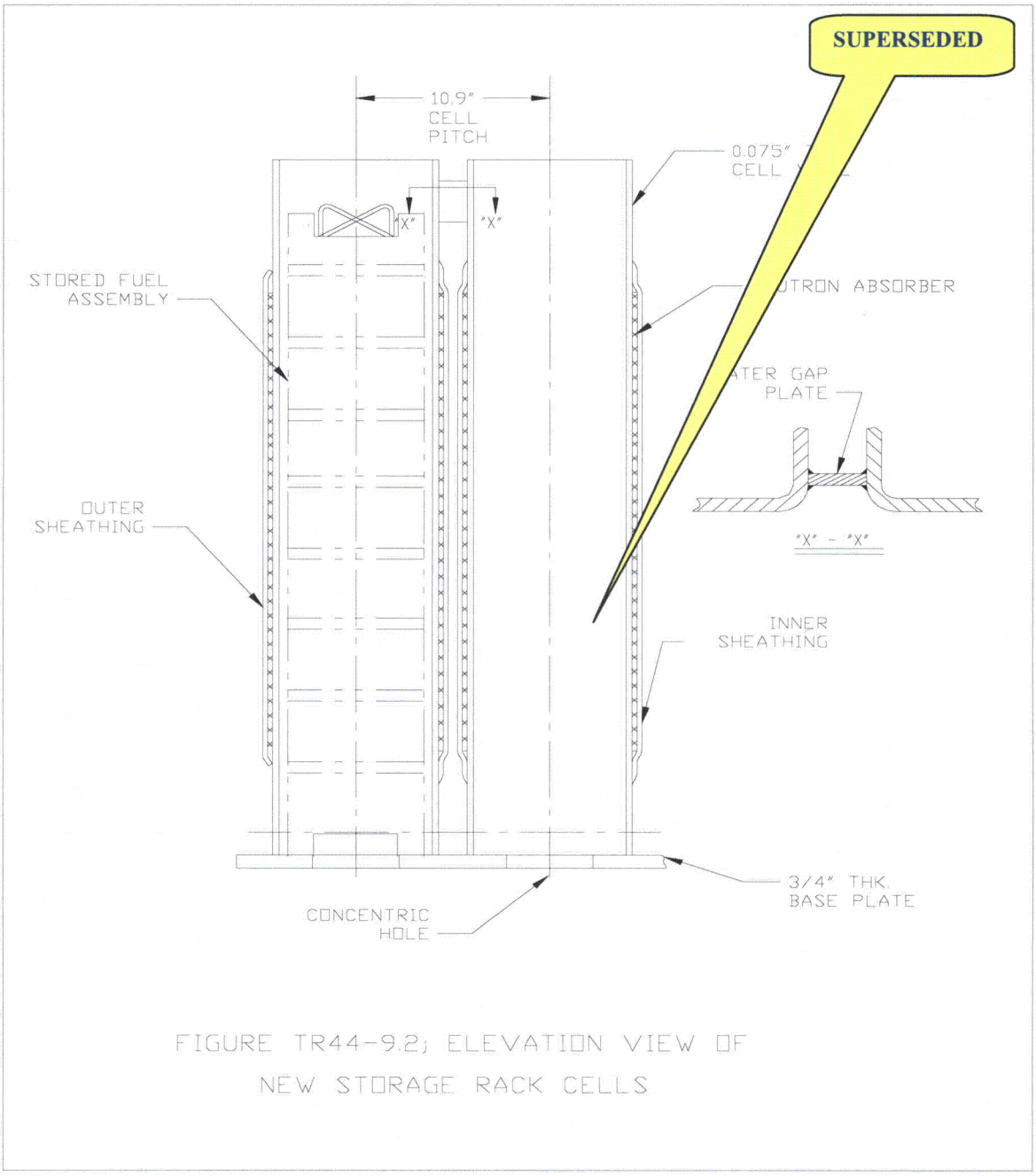


FIGURE TR44-9.2; ELEVATION VIEW OF
NEW STORAGE RACK CELLS

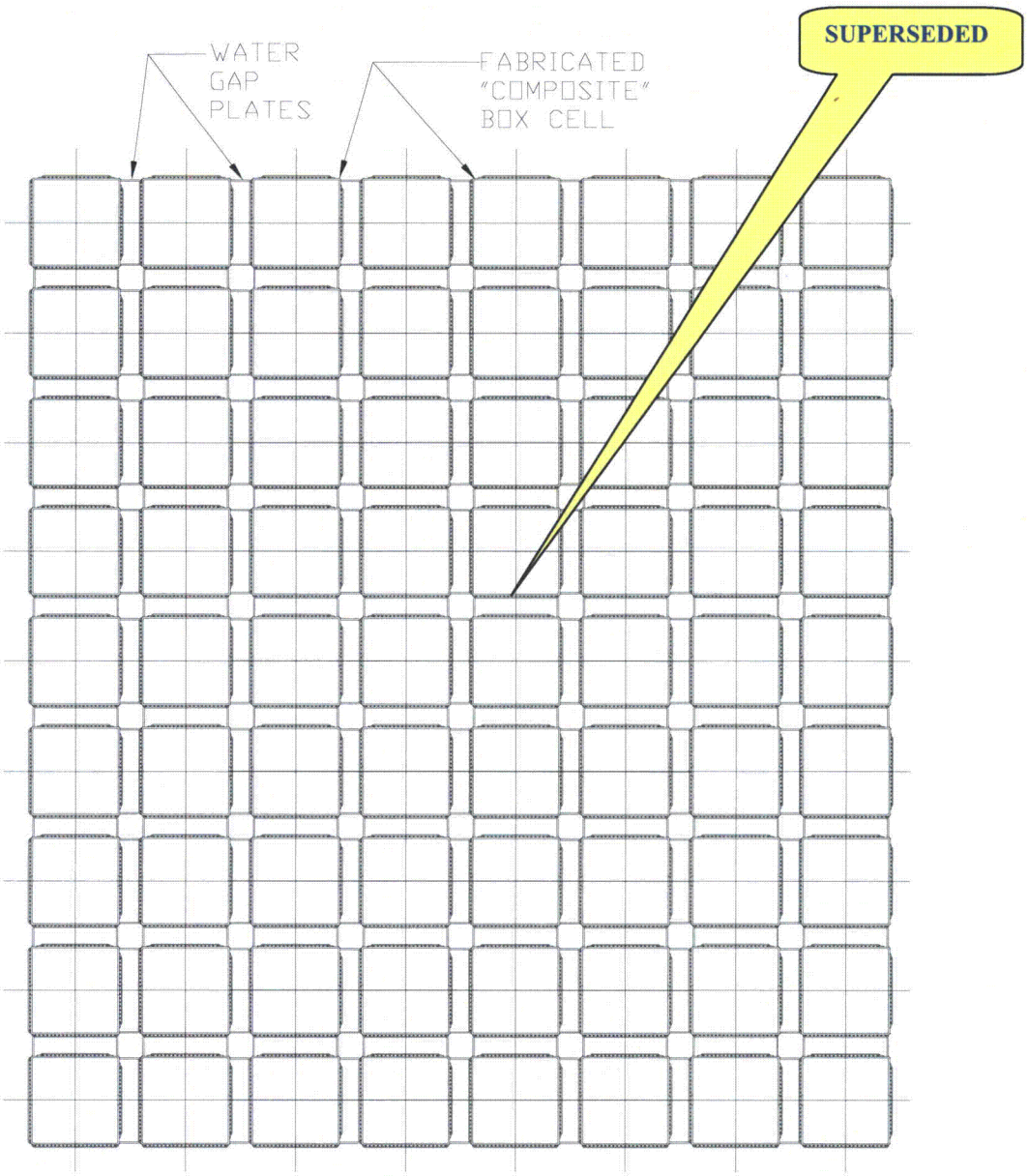


FIGURE TR44-9.3; STORAGE CELL ARRAY
FOR NEW FUEL STORAGE RACK

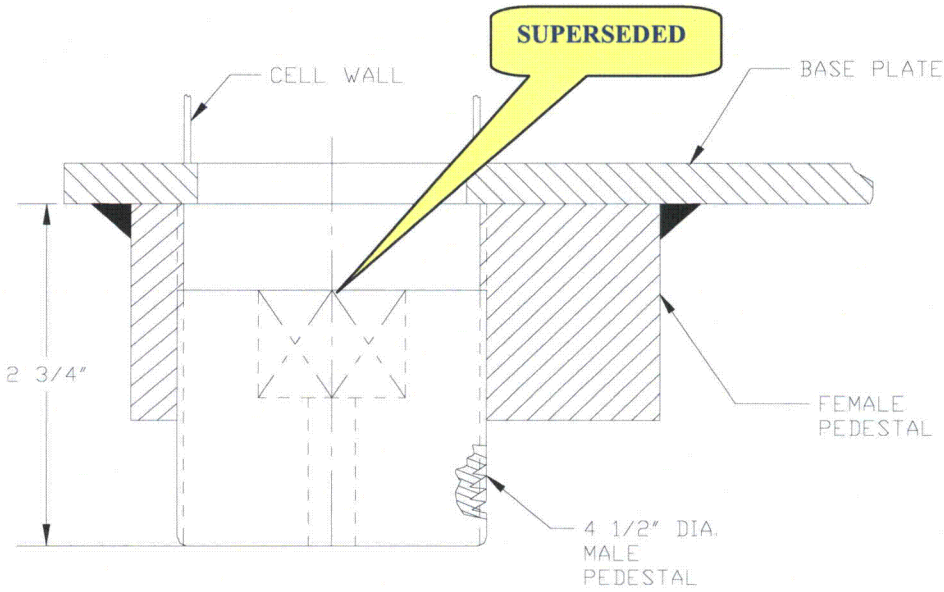
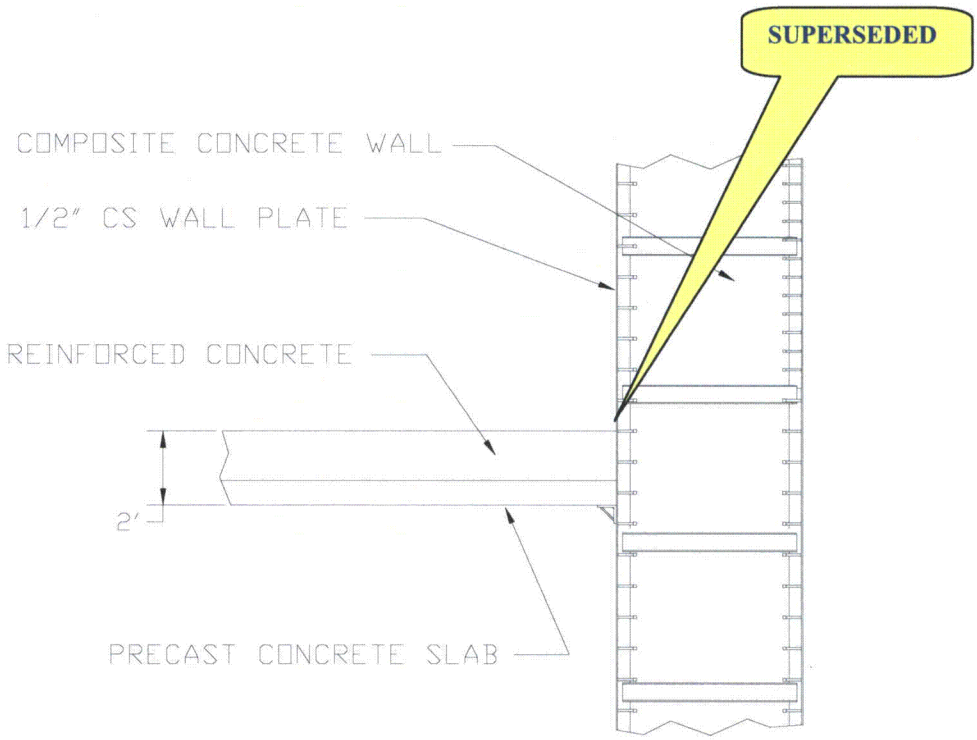


FIGURE TR44-9.4; CROSS SECTION OF ADJUSTABLE SUPPORT



~~Figure TR44-9.5 New Fuel Pit Floor and Wall Detail~~

Westinghouse Response (Revision 1): ***(Superseded by Revision 2)***

~~**Westinghouse Supplemental Response following May 21 and 22, 2008 Technical Review:**~~

~~The two figures shown in the DCD and TR markup sections provide updates of the layout and cross section of the new fuel storage rack. The figures replaced Figure 2-1 of TR44 and DCD Figure 9.1-1, Sheets 1 and 2; see the DCD and TR markup sections for details.~~

New Response: (Revision 2)

This response is provided to update information to be consistent with the current design and analysis. It supersedes RAI Revision 0 and Revision 1 responses, DCD changes, and TR changes with clarifications overviewed below.

The most recent change to DCD Figure 9.1-1 (Sheet 1 of 2) is included in the response to RAI-TR44-17 Revision 3.

The DCD Figure 9.1-1 (Sheet 2 of 2) is not modified by any revision of comments in this RAI response. This figure and page were included into DCD Revision 17 (Letter DCP/NRC 2202) and remain applicable to the new fuel rack design.

Reference:

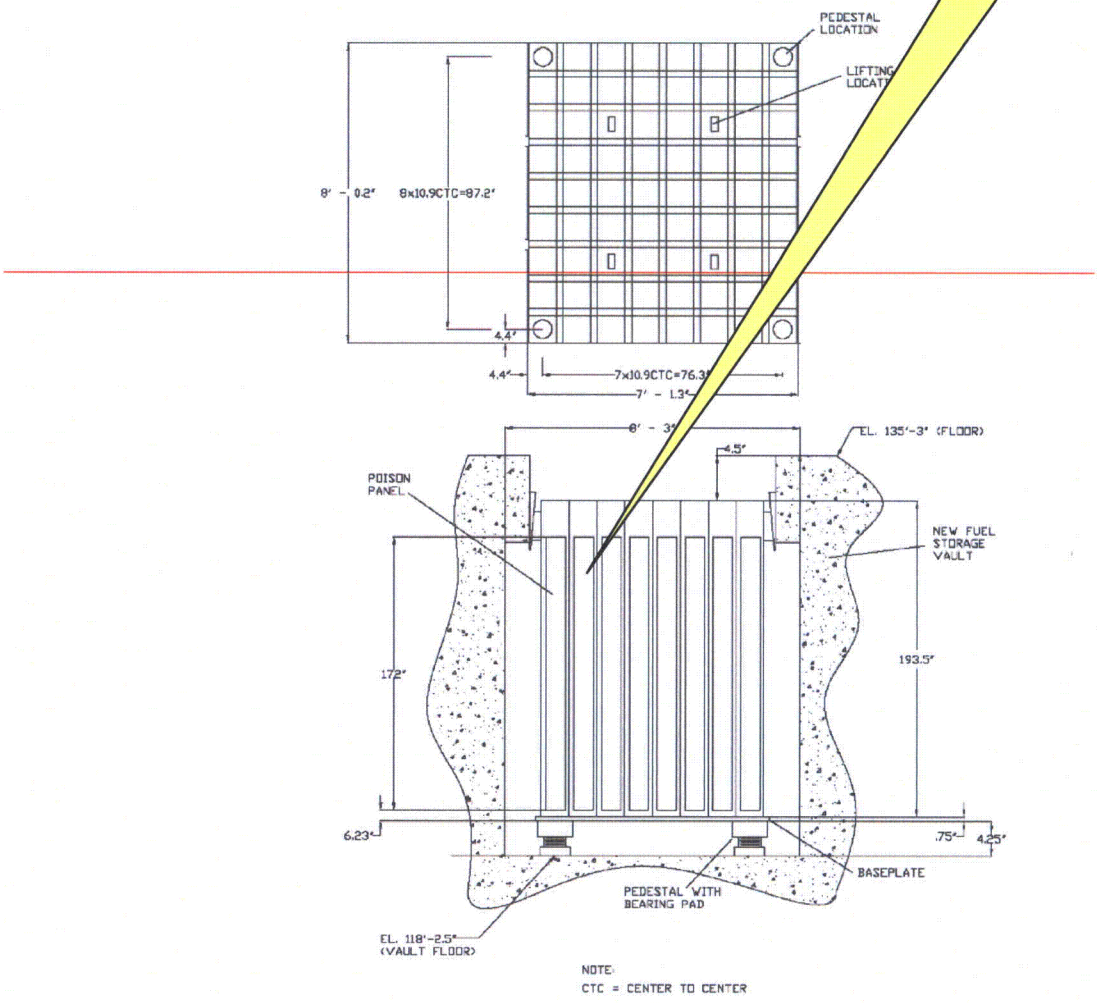
1. APP-GW-GLR-026, Revision 3, May 2010, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44, TR44)

Design Control Document (DCD) Revision:

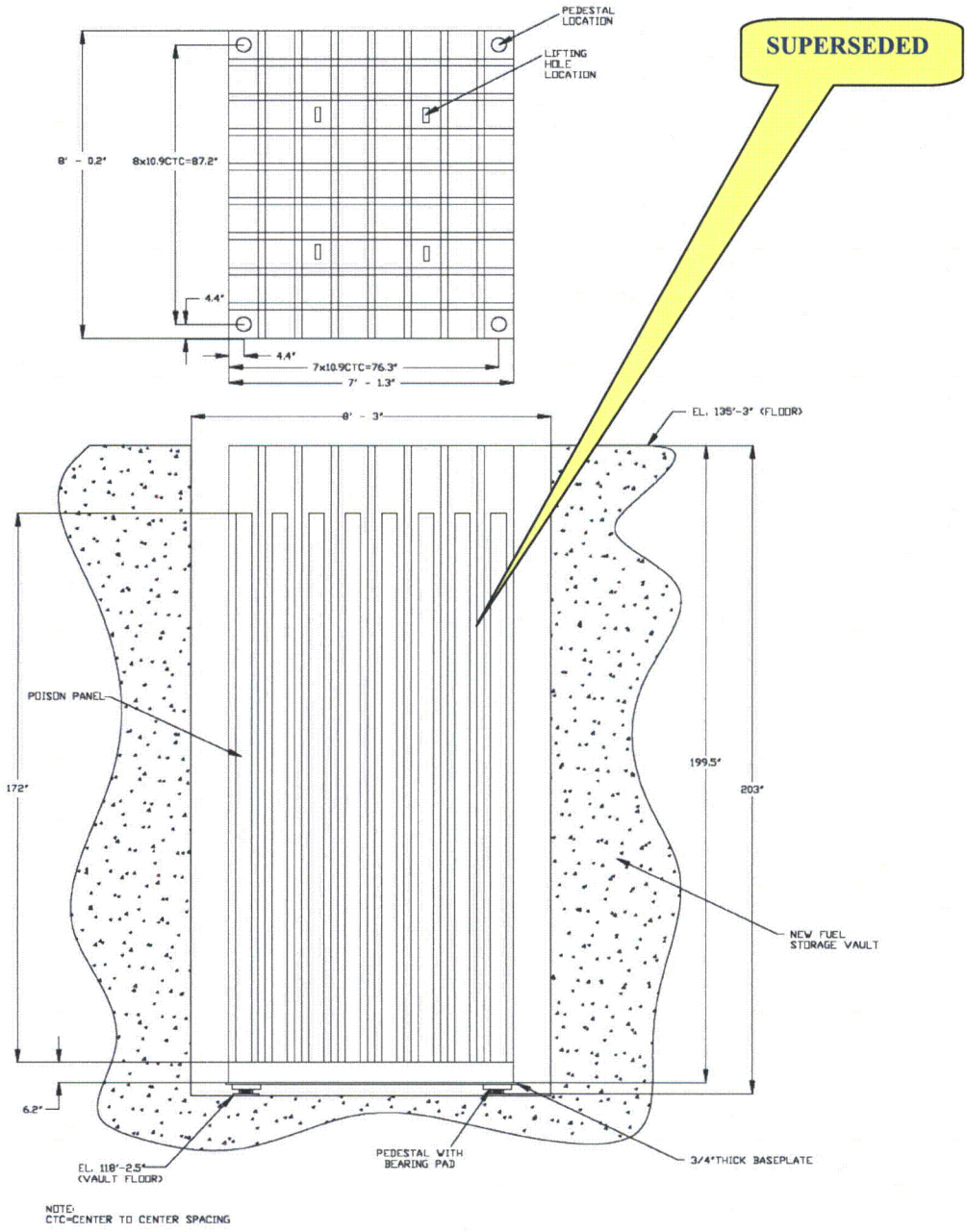
DCD Changes: (Revision 0 and Revision 1) ***(Superseded by Revision 2)***

~~Revise Figure 9.1-1, Sheets 1 and 2, as follows:~~

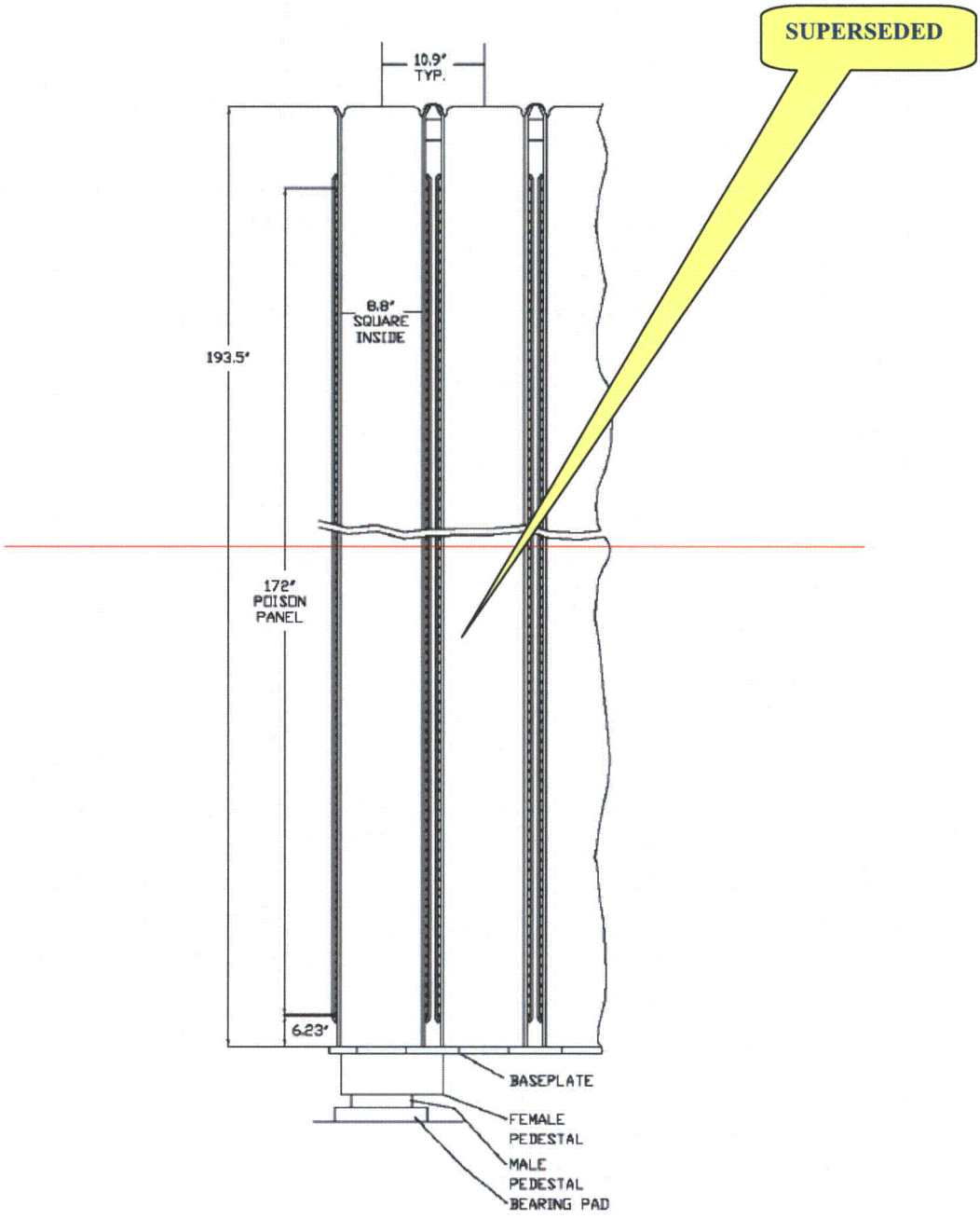
SUPERSEDED



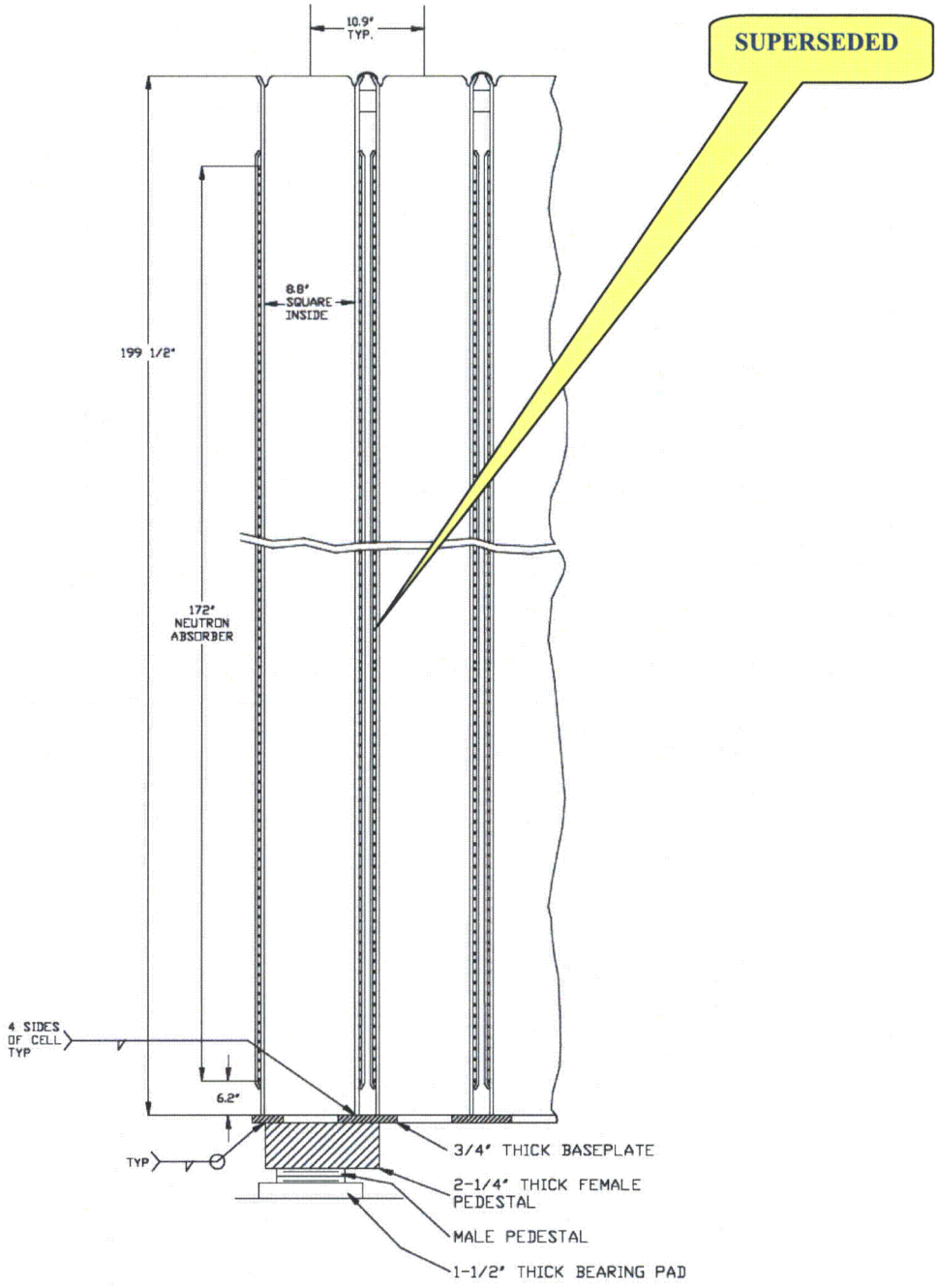
~~Figure 9.1-1 (Sheet 1 of 2)~~
~~New Fuel Storage Rack Layout (72 Storage Location)~~



~~Figure 9.1-1 (Sheet 1 of 2)~~
~~**New Fuel Storage Rack Layout (72 Storage Location)**~~



~~Figure 9.1-1 (Sheet 2 of 2)~~
~~New Fuel Storage Rack Cross Section~~



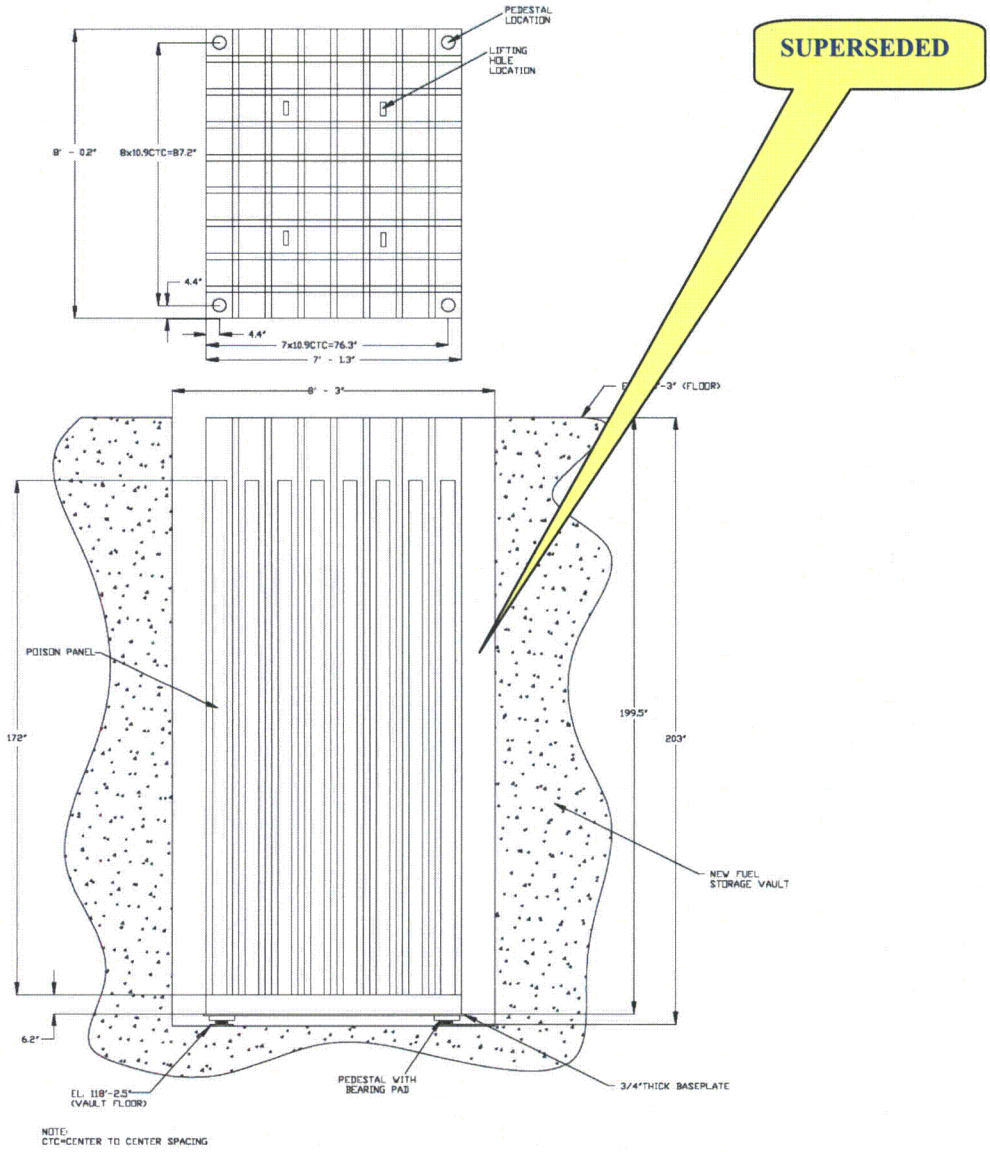
~~Figure 9.1-1 (Sheet 2 of 2)~~
~~**New Fuel Storage Rack Cross Section**~~

DCD Changes: (Revision 2)
None.

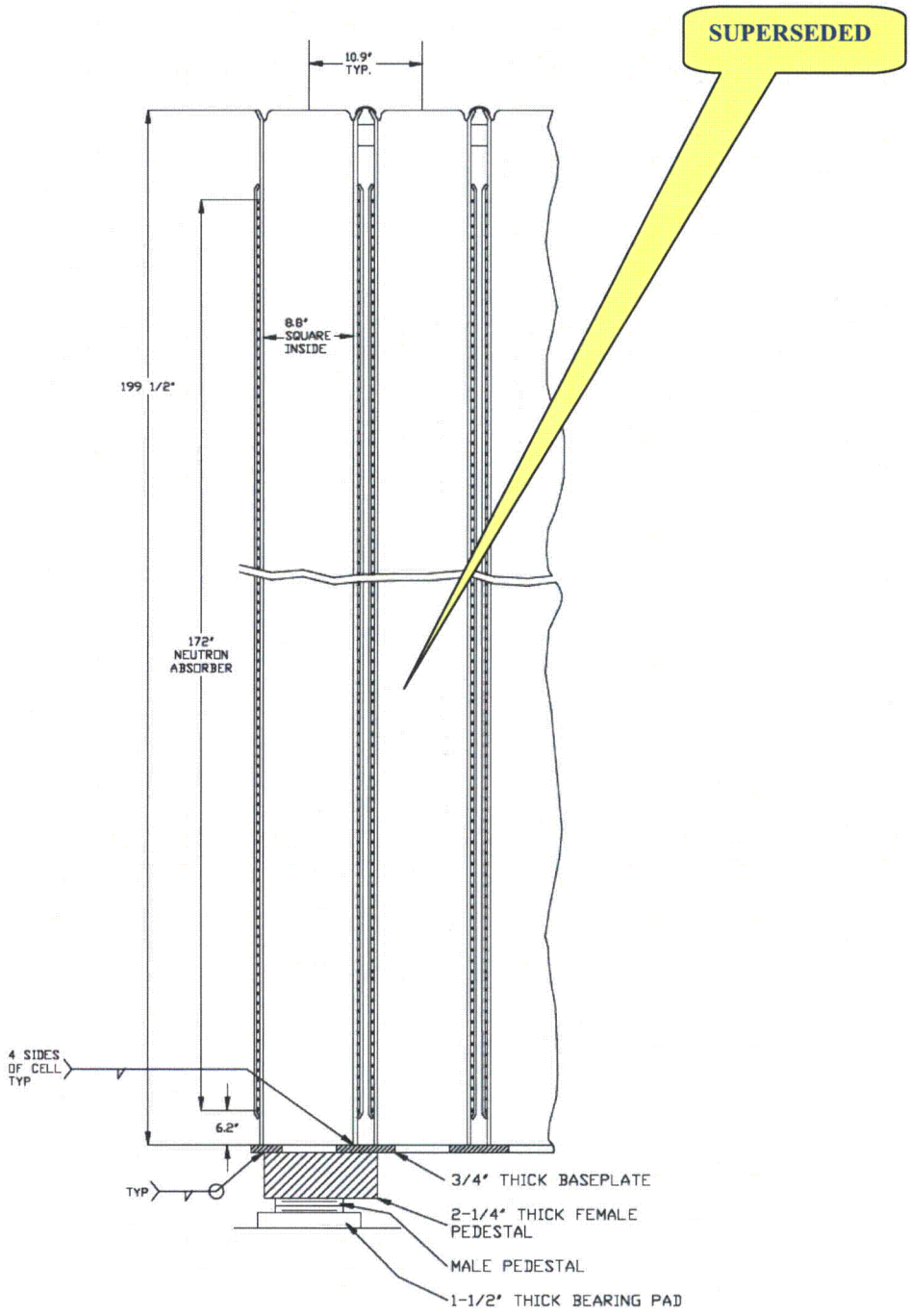
PRA Revision:
None

Technical Report (TR) Revision:

~~**TR Changes: (Revision 0 and 1)**~~ ***(Superseded by Revision 2)***
~~Figure 2-1 was renamed and replaced by the following 2-sheet figure:~~



~~Figure 2-1 New Fuel Storage Rack Layout (72 Storage Location) (Sheet 1 of 2)~~



~~Figure 2-1 New Fuel Storage Rack Cross Section (Sheet 2 of 2)~~

TR Changes: (Revision 2)
none

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR44-016
Revision: 3

Question: ***(Revision 0, 1, 2)***

Explain whether only a full fuel rack is considered in the simulation, or if several scenarios are considered; i. e., different fill ratios, from empty to full. Provide the technical justification if only a full rack is considered.

Staff Assessment: Response similar to response for spent fuel racks. See RAI-TR54-025.

New Question: (Revision 3)

After NRC reviewed the supplemental RAI response from the August 2009 audit, they requested that the RAI response be revised to delete the argument that the partial loading case is not controlling.

Westinghouse Response:

(Revision 0) ***(Superseded by Revision 3)***

~~The new fuel rack is assumed to be fully loaded with maximum weight fuel assemblies in all three simulations. This scenario bounds any partially loaded configuration since it (1) maximizes the vertical compression and lateral friction loads on the support pedestals and (2) produces the maximum rack displacements and fuel-to-cell wall impacts. The displacements are larger for a fully loaded rack, as opposed to a partially filled rack, because the dynamic model conservatively assumes that all stored fuel assemblies rattle in unison. Hence, the momentum transferred between the rattling fuel mass and the spent fuel rack is maximum for a fully loaded rack. For a partially filled rack, the decrease in rattling fuel mass outstrips the destabilizing effect of an eccentric fuel loading pattern.~~

Westinghouse Supplemental Response following May 21 and 22, 2008 Technical Review: (Revision 1) ***(Superseded by Revision 3)***

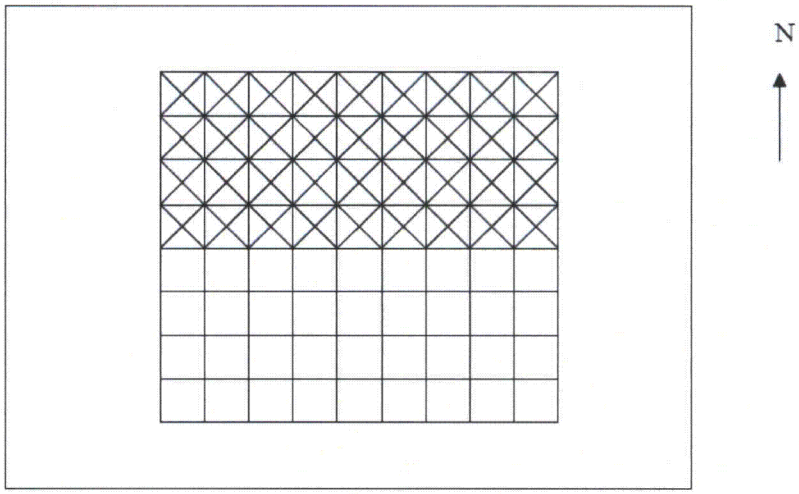
~~For the similar spent fuel racks RAI-TR54-025, the NRC found that the Westinghouse response "does appear to support the conclusion that generally the fully loaded racks would be expected to maximize impact forces and displacements." The NRC reviewer also concluded that "the use of the maximum weight for the fuel assemblies, the analysis assumption that all stored fuel assemblies rattle in unison, and consideration of the upper and lower bound coefficient of friction at all support legs provide added conservatism to bound the results from the other~~

~~possible variations." Therefore, Westinghouse considers the above response to RAI-TR44-016 to be resolved for the new fuel rack.~~

~~Section 9.1.1.2.1 of the DCD will be revised to eliminate the reference to performing seismic and stress analyses that evaluate partially full and empty fuel assembly loadings of the new fuel rack.~~

Additional Response: (Revision 2)

Following the August 2009 audit with the NRC, Westinghouse has completed an additional run (Run Number 4) to examine the effects of the worst possible partial rack loading scenario (half full, all on one side, as depicted in the following figure). The results of this additional run will be included in Revision 2 of TR-44. Also, DCD Section 9.1.1.2.1, Item A, is modified to indicate that a partially filled loading case was evaluated.



New Response: (Revision 3)

This response is provided to update information to be consistent with the current design and analysis in Reference 1. It supersedes responses in RAI Revision 0 and 1 with clarifications overviewed below.

Earlier discussions indicated that analysis of partial rack loading would be eliminated from the RAI discussions and DCD since they were not limiting. However, the partial rack loading scenario described in the Revision 2 response confirmed that partial loading does generate

limiting results for certain loading cases. Therefore, the current version of TR44 (Reference 1) includes these limitations; and the commensurate change to the DCD from Revision 2 is shown below.

Reference:

1. APP-GW-GLR-026, Revision 3, May 2010, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44, TR44)

Design Control Document (DCD) Revision:

DCD Changes: (Revision 0, 1) ***(Superseded by Revision 3)***
~~Changes have been included in DCD R17.~~

DCD Changes: Additional Response (Revision 2):

The first paragraph under Item A of Section 9.1.1.2.1 of Rev. 17 of the DCD is revised as follows:

The new fuel storage rack array center-to-center spacing of nominally 10.9 inches provides a minimum separation between adjacent fuel assemblies sufficient with neutron absorbing material to maintain a subcritical array. The seismic and stress analyses of the new fuel rack consider the conditions of full and partially filled fuel assembly loadings. The rack is evaluated for the safe shutdown earthquake condition against the seismic Category I requirements. A stress analysis is performed to verify the acceptability of the critical load components and paths under normal and faulted conditions. The rack rests on the pit floor.

DCD Changes: (Revision 3)

None

PRA Revision:
None

Technical Report (TR) Revision:

TR Changes: (Revision 1) ***(Superseded by Revision 3)***

~~The results of the ANSYS analysis of cell wall buckling at the base of the rack will be included in the next revision of TR-44. This revision is expected to be available in November, 2009.~~

TR Changes: Additional Response (Revision 2)

The results of the partial rack loading analysis will be included in the next revision of TR-44. This revision is expected to be available in November, 2009.

TR Changes: (Revision 3)

The results of the partial rack loading analysis were included in TR44 Revision 2 (November 2009) and have been carried forward into TR44 Revision 3 (Reference 1).

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR44-017
Revision: 3

Question: ***(Revision 0, 1, 2)***

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?

Staff Assessment: Response similar to response for spent fuel racks. See RAI-TR54-026.

New Question: (Revision 3)

During the June 2010 audit, the NRC requested that dimension and gap information for the new fuel racks be clarified between the three similar RAIs (RAI-TR44-09, RAI-TR44-017, RAI-TR44-25) to show consistency and alignment to the current design basis shown in DCD Figure 9.1-1.

Westinghouse Response:

Westinghouse Response: (Revision 0) ***(Superseded by Revision 3)***

~~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.

Westinghouse Supplemental Response following May 21 and 22, 2008 Technical Review: (Revision 1) (Superseded by Revision 3)

~~Since the Westinghouse submittal of the Revision 0 response to this RAI, the design of the new fuel storage pit was changed to remove the concrete corbels at the top of the pit and the stainless steel wedges that were to be welded in the interstitial space between the top of the new fuel storage rack and the pit opening following installation of the rack. As a result of the changes to the new fuel storage pit, the updated gap information is provided in the table below and was used in the dynamic analyses. Note that a conservative gap size was used for the fuel-to-cell wall gap in the dynamic analysis based on the smallest fuel assembly cross-section of 8.404 inches. The largest fuel assembly cross-section is 8.426 inches which equates to a 0.187 inch fuel-to-cell wall gap.~~

	~~Fuel-to-Cell Wall~~	~~Rack-to-Wall~~
~~Nominal Gap (inch)~~	~~(8.8"-8.404")/2 = 0.198"~~	~~North – 6.88"~~ ~~East – 28.93"~~ ~~South – 6.88"~~ ~~West – 28.93"~~

~~Per the structural/seismic calculation for the new fuel rack, APP-FS01-S3-001, Revision 1, the maximum displacement at the top of the new fuel rack is 6.35". Therefore, the minimum gap between the new fuel rack and the pit walls (at the top of rack elevation) will be specified on Rev. 1 of Drawing APP-FS01-V2-002 as 6-3/8".~~

Additional Response: (Revision 2) **(Superseded by Revision 3)**

~~Following the August 2009 audit, Westinghouse is updating DCD Figure 9.1-1 to include additional details related to the placement of the New Fuel Storage Rack within the New Fuel Pit. Figure 9.1-1 will be updated as shown in the DCD Revision section below to show the general position of the rack within the pit, including a definition of the minimum gaps. The only changes to the figure are that the rack is now shown within the vault and the 4 inch minimum typical gap dimension along with the clarifying note about where the gaps are measured from have been added. The 4 inch minimum gap is conservative based on the maximum rack displacement of 3.2 inches (which occurs at the top of the rack; the maximum displacement at~~

~~the baseplate elevation is only 0.5 inches) when the 0.2 COF is ignored (justification for ignoring the 0.2 COF case is discussed in the response to RAI-SRP9.1.2-SEB1-02, Revision 1).~~

Westinghouse Response: (Revision 3)

This response is provided to update information to be consistent with the current design and analysis. It supersedes RAI Revision 0, Revision 1, and Revision 2 responses, DCD changes, and TR changes with clarifications overviewed below.

The discussion about a statement being added to the Technical Report (TR44) to address the design-basis seismic event potential change in gaps between the new fuel rack and New Fuel Storage Pit walls was completed in the response to RAI-SRP9.1.2-SEB1-01 which noted that the appropriate place for such a statement is in the DCD. This statement was added to the DCD via RAI-SRP9.1.2-SEB1-01 and is no longer in the TR44 (Reference 1).

The current nominal placement of the New Fuel Storage Rack within the New Fuel Storage Pit based on current seismic analysis and drawings (References 2 and 3) is described below:

- The nominal rack-to-wall gap in the East direction is 6.88".
- The nominal rack-to-wall gap in the West direction is 61.97".

Additionally, the maximum displacement that results from the design-basis seismic event and the corresponding minimum rack-to-wall gap limitation was revised to be consistent with the current results of the seismic analysis and changes to the friction assumptions that affect rack movement. The current analysis now uses a credible lower-bound coefficient of friction (COF) of 0.24. Justification of this lower-bound COF is included in the latest revision of TR44 (Reference 1).

The updated analysis shows maximum rack-to-wall displacement is 5.54" at the top-of-rack location (note that this is equal to 4.92" at the baseplate location since the new fuel rack baseplate extends nominally 1" beyond the cell envelope in each horizontal direction.) Based on accessibility considerations, the rack-to-wall gaps are measured at the top-of-rack. To minimize/avoid the rack impacting the new fuel pool wall, the minimum rack-to-wall gap has been set to $\geq$6" which is slightly more than the maximum displacement.

To ensure that criticality safety assumptions are met, a maximum rack-to-wall gap of < 8" has been added to the North and South walls, where there are no neutron absorber panels. The 8" maximum gap precludes the possibility of a fuel assembly (with minimum nominal fuel assembly dimensions greater than 8.4" square) being inadvertently placed into the space next to the exterior of the New Fuel Storage Rack on the North and South faces where no neutron absorber panels exist. There are neutron absorber panels provided on the East and West faces; so there is no need to limit the maximum gap in these directions.

The attached DCD changes to Figure 9.1-1 (Sheet 1 of 2) reflects the current nominal placement of the New Fuel Storage Rack within the New Fuel Storage Pit per the seismic report, analysis, and drawings listed below (References 1, 2, and 3).

References:

1. APP-GW-GLR-026, Revision 3, May 2010, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44, TR44)

2. APP-FS01-S3C-001, Revision 3, May 2010, "New Fuel Storage Rack Structural/Seismic Analysis"

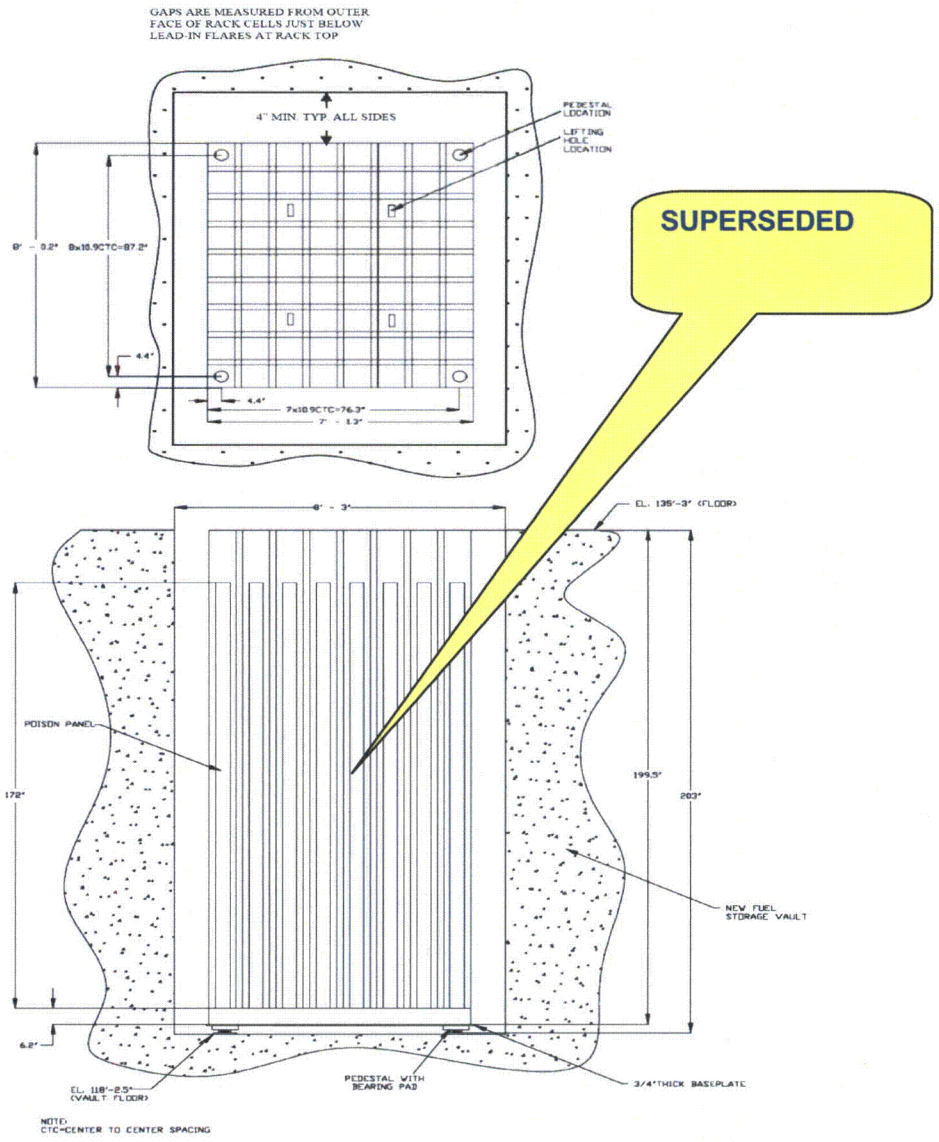
3. Westinghouse Drawing APP-FS01-V2-002, Revision 3, May 2010, "New Fuel Storage Rack Outline Drawing"

Design Control Document (DCD) Revision:

DCD Changes: (Revision 0, 1)
none

DCD Changes: (Revision 2) ***(Superseded by Revision 3)***

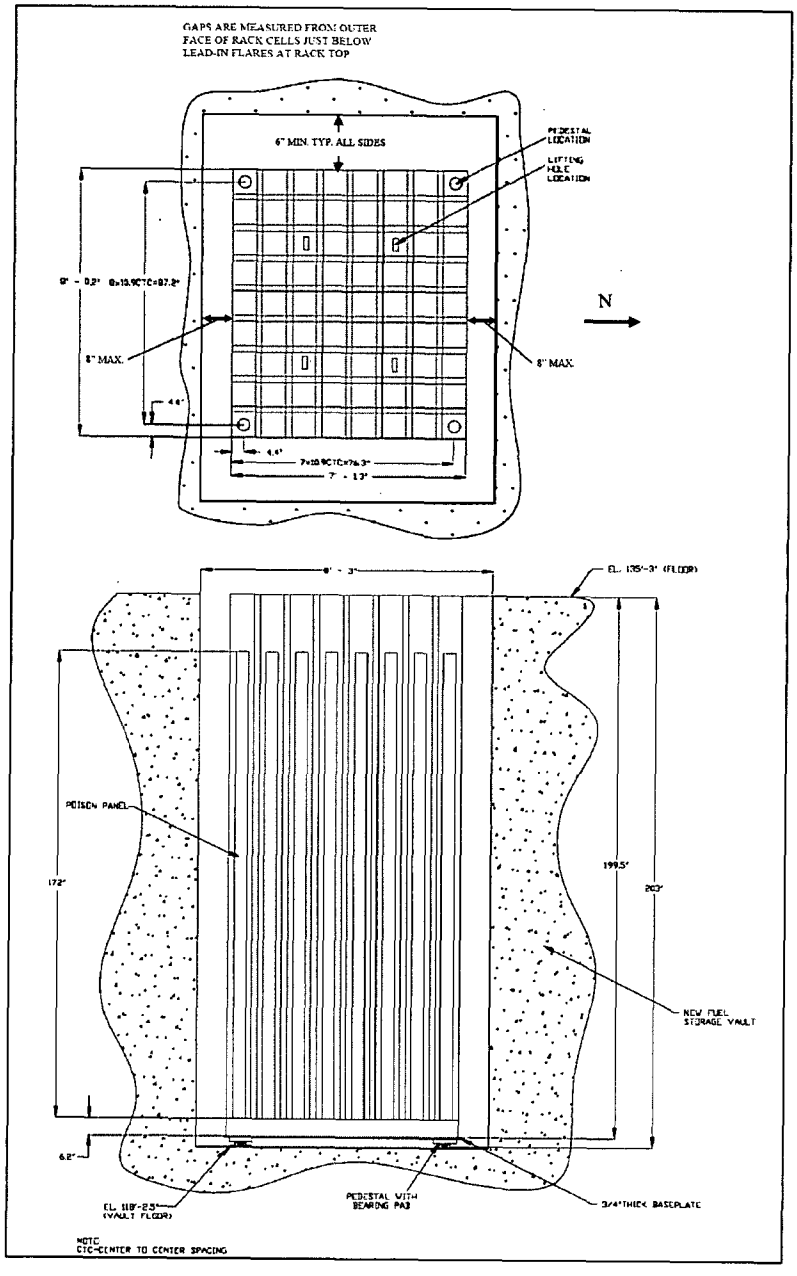
~~Replace DCD Figure 9.1-1 with the following figure:~~



DCD Changes: (Revision 3)

The following change to DCD Figure 9.1-1 (Sheet 1 of 2) represents the current design basis shown in TR44 (Reference 1).

Replace DCD Figure 9.1-1 (Sheet 1 of 2) entitled "New Fuel Storage Rack Layout (72 Storage Locations" with the following figure.


GAPS ARE MEASURED FROM OUTER FACE OF RACK CELLS JUST BELOW LEAD-IN FLARES AT RACK TOP
6" MIN. TYP. ALL SIDES
PEDESTAL LOCATION
LIFTING HOLE LOCATION
N
8" MAX.
8" MAX.
POISON PANEL
172"
199.5"
203"
NEW FUEL STORAGE VAULT
PEDESTAL WITH BEARING PAD
3/4" THICK BASEPLATE
NOTE:
CTC-CENTER TO CENTER SPACING

PRA Revision:
None

Technical Report (TR) Revision:

TR Changes: (Revision 0, 1)
none

TR Changes: (Revision 2) ***(Superseded by Revision 3)***

~~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."~~

TR Changes: (Revision 3)

None.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR44-025
Revision: 2

Question:

(Revision 0)
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.

(Revision 1) Supplemental Questions from May 2008 Meetings: general

New Question: (Revision 2)

During the June 2010 audit, the NRC requested that dimension and gap information for the new fuel racks be clarified between the three similar RAIs (RAI-TR44-09, RAI-TR44-017, RAI-TR44-25) to show consistency and alignment to the current design basis shown in DCD Figure 9.1-1.

Westinghouse Response:

Westinghouse Response: (Revision 0) ***(Superseded by Revision 2)***

~~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.~~

Westinghouse supplemental response from NRC Technical Meetings May 21 & 22, 2008 (Revision 1) ***(Superseded by Revision 2)***

~~The new fuel rack has been changed to have additional storage cell height to protect control elements that are stored in the new fuel assemblies. Also the rack is not wedged in place in the North - South directions and is free to move within the new fuel storage vault. Revision 17 of the DCD and TR-44 revision 1 will have figures showing significant features and dimensions of the new fuel rack. The format for the new fuel rack significant features and dimensions is the same format reviewed and accepted by the NRC for the spent fuel racks. See changes in DCD revision and TR revision.~~

New Response: (Revision 2)

This response is provided to update information to be consistent with the current design and analysis. It supersedes RAI Revision 0 and Revision 1 responses, DCD changes, and TR changes with clarifications overviewed below.

The most recent change to DCD Figure 9.1-1 (Sheet 1 of 2) is included in the response to RAI-TR44-17 Revision 3.

The DCD Figure 9.1-1 (Sheet 2 of 2) is not modified by any revision of comments in this RAI response. This figure and page were included into DCD Revision 17 (Letter DCP/NRC 2202) and remain applicable to the new fuel rack design.

References:

1. APP-GW-GLR-026, Revision 3, May 2010, "New Fuel Storage Rack Structural/Seismic Analysis," (Technical Report Number 44, TR44)

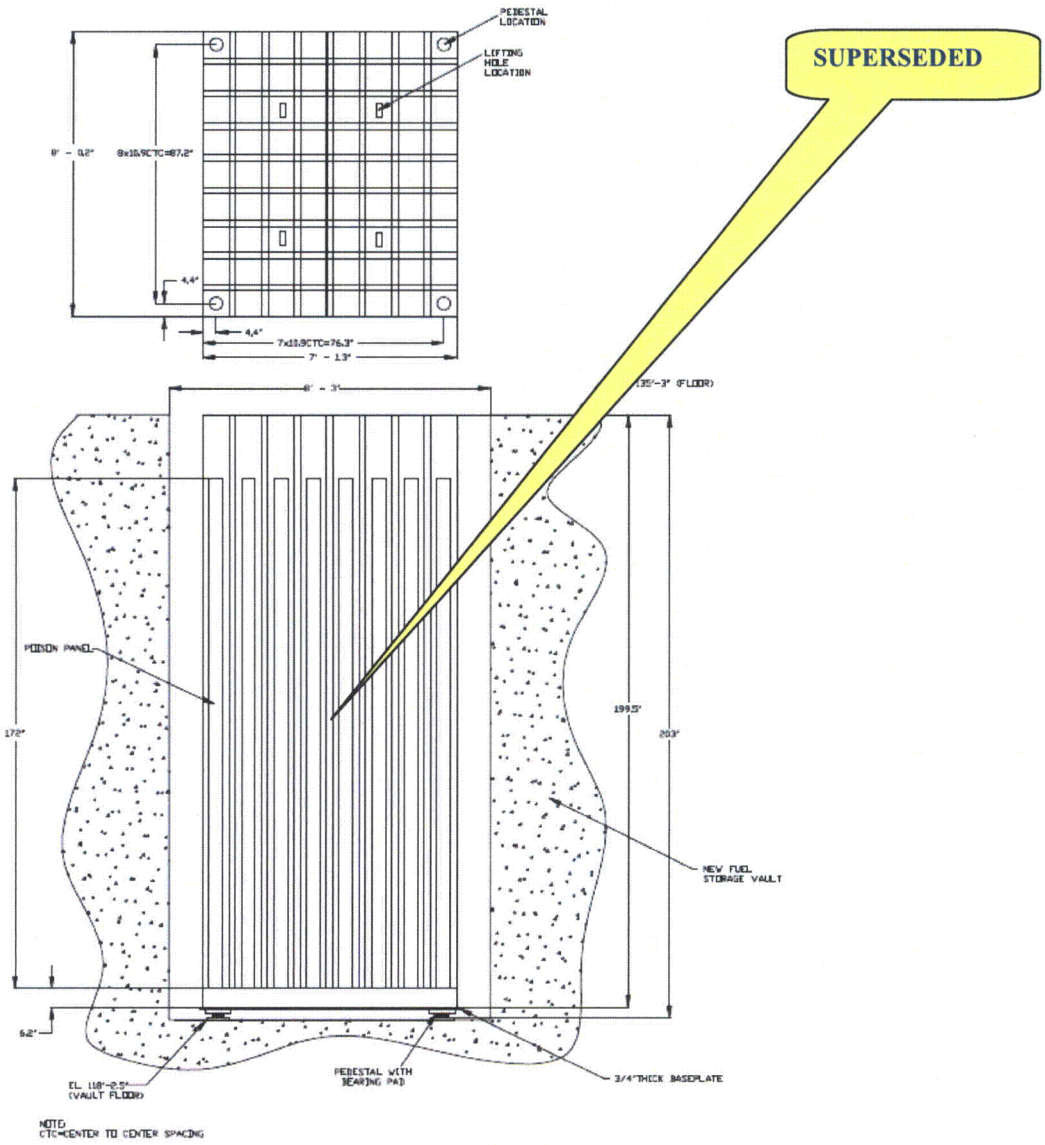
Design Control Document (DCD) Revision:

DCD Changes: (Revision 0) ***(Superseded by Revision 2)***

~~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.~~

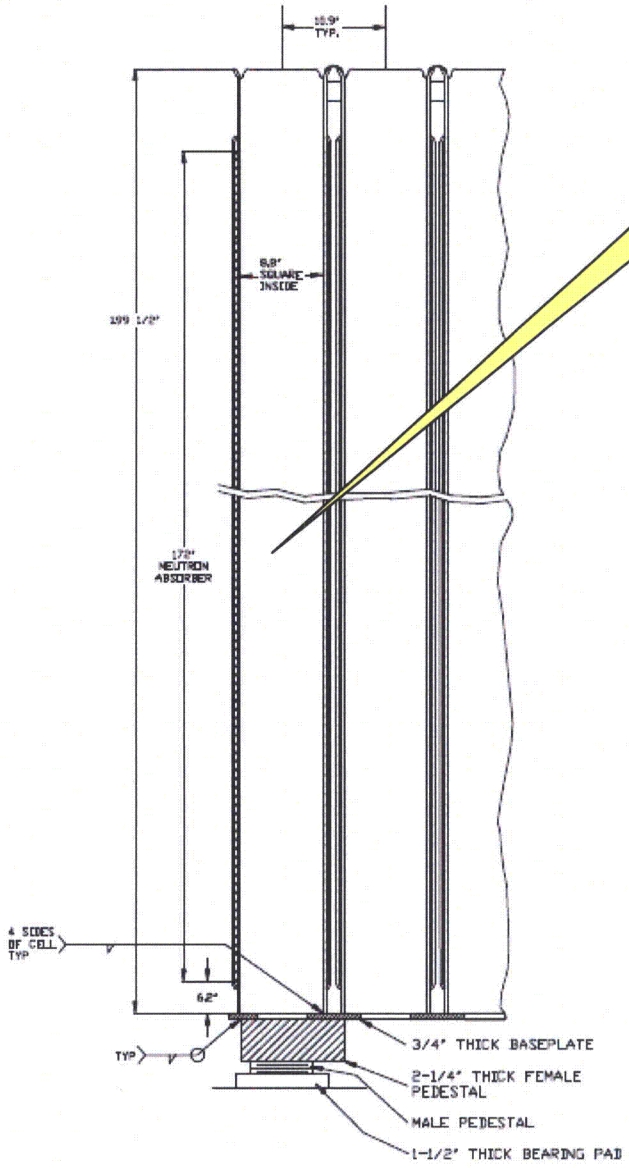
DCD Changes: Westinghouse supplemental response from NRC Technical Meetings May 21 & 22, 2008 (Revision 1) ***(Superseded by Revision 2)***

~~Figures 9.1-1 (Sheet 1 of 2) and Figures 9.1-1 (Sheet 2 of 2) are changed as shown below.~~



~~Figure 9.1-1 (Sheet 1 of 2)~~
~~New Fuel Storage Rack Layout (72 Storage Locations)~~

SUPERSEDED



~~Figure 9.1-1 (Sheet 2 of 2)~~
~~New Fuel Storage Rack Cross Section~~

DCD Changes: (Revision 2)

None.

PRA Revision:
None

Technical Report (TR) Revision:

TR Changes (Revision 0): (Superseded by Revision 2)

~~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).~~

TR Changes: Westinghouse supplemental response from NRC Technical Meetings May 21 & 22, 2008 (Revision 1) (Superseded by Revision 2)

~~Figures 9.1-1 (Sheet 1 of 2) and 9.1-1 (Sheet 2 of 2) shown in DCD revision are also placed in TR 44 Revision 1 subsection 2.1.1.~~

TR Changes: (Revision 2)

None.