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DCP/NRC1194
NSD-NRC-97-5499
Docket No.: 52-003

December 18, 1997

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

ATTENTION: T. R. QUAY

SUBJECT: AP600 RESPONSE TO FSER OPEN ITEMS

Dear Mr. Quay:

Enclosed with this letter are the Westinghouse responses to FSER open items on the AP600. A summary of the enclosed responses is provided in Table 1. Included in the table is the FSER open item number, the associated OITS number, and the status to be designated in the Westinghouse status column of OITS.

The NRC should review the enclosure and inform Westinghouse of the status to be designated in the "NRC Status" column of OITS.

Please contact me on (412) 374-4334 if you have any questions concerning this transmittal.

D. A. Lindgren / FOR
Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

jml

Enclosure

E004 /1

cc: W. C. Huffman, NRC (Enclosure)
T. J. Kenyon, NRC (Enclosure)
J. M. Sebrosky, NRC (Enclosure)
D. C. Scaletti, NRC (Enclosure)
N. J. Liparulo, Westinghouse (w/o Enclosure)

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Table 1
List of FSER Open Items Included in Letter DCP/NRC1194

FSER Open Item	OITS Number	Westinghouse status in OITS
220.115F	6302	Action N
220.125F	6312	Action N
220.122F	6309	Confirm W
410.381F	6258	Action N
410.385F	6262	Action N
650.18F	6320	Action N
650.20F	6322	Action N
720.415F	5897	Action N
720.421F	6133	Confirm W

Enclosure to Westinghouse
Letter DCP/NRC1194

December 18, 1997

Open Item 220.115F (OITS #6302)

As described in early revisions of the SSAR, floor response spectra at various elevations and locations of the NI structures were first generated for each of the three selected site conditions: hard rock site with fixed-base time domain modal time-history analysis (BSAP analysis), soft rock site with frequency-domain time-history analysis (SASSI analysis), and soft-to-medium stiff soil with frequency-domain time history analysis (SASSI analysis). Then, these floor response spectra were enveloped, peak-broadened by plus and minus fifteen percent (±15 percent), and smoothed to develop a set of design in-structure spectrum envelopes in accordance with RG 1.122. A set of 3D structural stick models (models for the steel containment vessel, the containment internal structures, and the combined shield and auxiliary buildings) combined with the support foundation mat were used for these analyses. The effects of the spatial combination of three components of the earthquake ground motion time history were considered in the analysis. As such, the coupling effects have been accounted for. The staff's evaluation of the adequacy of the approach for combining responses attributable to three components of the input ground motion is discussed in Section 3.7.2.6. Based on the staff's review of the SSAR, the review of Westinghouse's November 30, 1992, March 24, 1994, and May 11, 1994 submittal, and the discussions during the review meetings, the staff concludes that the methods used for the development of in-structure response spectra at different locations and the in-structure response spectrum envelopes are in conformance to the guideline of Section 3.7.2.II.5 of the SRP and RG 1.122, except that the issues related to the combined effects of insufficient participating mass, number of design site conditions, low cut-off frequency, non-conformance of 60 percent limitation of surface ground motion at foundation level, concrete cracking, and other SSI issues discussed above need to be resolved. This was Open Item 3.7.2.5-1.

The concerns of this open item are also addressed in Sections 3.7.2.3 and 3.7.2.4 of this report. On the basis of the resolution for Open Items 3.7.2.2-1 (cut-off frequency for seismic analyses), 3.7.2.3-5 (conformance of RG 1.122), 3.7.2.4-12 (number of design site conditions) and 3.7.2.4-1 (60 percent limitation of the ground motion at the foundation in the free field), and other open items related to SSI concerns, the technical concern of Open Item 3.7.2.5-1 is considered resolved. However, because technical issues were identified from the review of Westinghouse's seismic reanalysis as described in Section 3.7.2.4 of this report, Open Item 3.7.2.5-1 will not be closed until Westinghouse resolves these issues.

Response:

The technical issues identified from the review of Westinghouse's seismic reanalysis are addressed in the response to Open Iem 220.114F.

SSAR Revision:

None

Open Item 220.122F (OITS # 6309)

As stated in the SRP, the staff should review a design report in order to obtain design and construction information that is more specific than that contained in the SSAR. The design report can also assist the staff in planning and conducting a structural review. Nonetheless, Westinghouse was unable to provide a design report for the containment internal structures during previous review meetings. Thus, in the submittal dated June 30, 1994, Westinghouse committed to compile design summary reports using the format and attributes described in Appendix C to Section 3.8.4 of the SRP. In addition, these design summary reports would incorporate the criteria acceptable to the staff and would be made available for staff review. This commitment was identified as Open Item 3.8.3.4-12.

During the meeting on January 14 through 16, 1997, the staff reviewed samples of the draft design summary reports for the structural modules, including "Design Summary Report - Containment Internal Structures," No. 1100-S3R-001 (Draft), dated January 1997; and Design Summary Report - Auxiliary Building Structures," No. 1200-S3R-001, Revision 0 (Draft), dated January 1997. These draft summary reports described the components of the structural modules, structural loads, structural analysis and design, and results. Because the information included in the design summary reports is sufficiently detailed and the scope of these reports is in accordance with that described in Appendix C to Section 3.8.4 of the SRP, this issue is considered technically resolved.

In completing its response to this concern, Westinghouse presented two design reports for the staff's review during the meeting on April 14 through 18, 1997. However, neither of these reports was finalized. Westinghouse indicated that further information will be added to the design reports, such as the drawing details for the critical structural wall modules, stress/load/required steel area summary tables for the critical wall sections, and the comparison tables for the ADS pressure loading analyses. Open Item 3.8.3.4-12 will not be closed until Westinghouse finalizes these design summary reports.

Response:

Westinghouse had proposed that the critical sections details be provided in a summary report to be referenced from the SSAR. In a meeting Open Item from the January14, 1997 meeting (summarized in the March 18, 1997 Letter, Attachment 3), NRC staff identified that Westinghouse should include critical section details in a formal revision of the SSAR. Westinghouse has now prepared information for inclusion in the SSAR. Similar information is being provided for the auxiliary buildings in the response to open item 220.128F. The draft design summary reports that were reviewed by the staff in previous meetings are internal Westinghouse documents.

Drawing details for the critical structural wall modules and stress/load/required steel area summary tables for the critical wall sections are included in the SSAR. The comparison tables for the ADS pressure loading analyses were reviewed by the staff during the review meeting and are included in the design summary report.

SSAR Revision: see attachment

refueling cavity are also designed for the hydrostatic head due to the water in the refueling cavity and the hydrodynamic pressure effects of the water due to the safe shutdown earthquake.

Figure 3.8.3-8 shows the typical design details of the structural modules, typical configuration of the wall modules, typical anchorages of the wall modules to the reinforced base concrete, and connections between adjacent modules. Concrete-filled structural wall modules are designed as reinforced concrete structures in accordance with the requirements of ACI-349, as supplemented in the following paragraphs. The faceplates are considered as the reinforcing steel, bonded to the concrete by headed studs. The application of ACI-349 and the supplemental requirements are supported by the behavior studies described in subsection 3.8.3.4.1. The design of critical sections is described in ~~the design summary report (see~~ subsection 3.8.3.5.8~~7)~~.

3.8.3.5.3.1 Design for Axial Loads and Bending

Design for axial load (tension and compression), in-plane bending, and out-of-plane bending is in accordance with the requirements of ACI-349, Chapters 10 and 14.

3.8.3.5.3.2 Design for In-Plane Shear

Design for in-plane shear is in accordance with the requirements of ACI-349, Chapters 11 and 14. The steel faceplates are treated as reinforcing steel, contributing as provided in Section 11.5 of ACI-349.

3.8.3.5.3.3 Design for Out-of-Plane Shear

Design for out-of-plane shear is in accordance with the requirements of ACI-349, Chapter 11.

3.8.3.5.3.4 Evaluation for Thermal Loads

The effect of thermal loads on the concrete-filled structural wall modules is evaluated by using the working stress design method for load combination 3 of Table 3.8.4-2. This evaluation is in addition to the evaluation using the strength design method of ACI-349 for the load combination without the thermal load. Acceptance for the load combination with normal thermal loads, which includes the thermal transients described in subsection 3.8.3.3.1, is that the stress in general areas of the steel plate be less than yield. In local areas where the stress may exceed yield the total stress intensity range is less than twice yield. This evaluation of thermal loads is based on the ASME Code philosophy for Service Level A loads given in ASME Code, Section III, Subsection NE, Paragraphs NE-3213.13 and 3221.4.

3.8.3.5.3.5 Design of Trusses

The trusses provide a structural framework for the modules, maintain the separation between the faceplates, support the modules during transportation and erection, and act as "form ties" between the faceplates when concrete is being placed. After the concrete has cured, the trusses

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3.8.3.5.6 Steel Form Modules

The steel form modules consist of plate reinforced with angle stiffeners and tee sections as shown in Figure 3.8.3-16. The steel form modules are designed for concrete placement loads defined in subsection 3.8.3.3.2.

The steel form modules are designed as steel structures according to the requirements of AISC-N690. This code is applicable since the form modules are constructed entirely out of structural steel plates and shapes and the applied loads are resisted by the steel elements.

3.8.3.5.7 Design Summary Report

A design summary report is prepared for containment internal structures documenting that the structures meet the acceptance criteria specified in subsection 3.8.4.5. ~~Reference 49 provides the design summary report. Critical sections included in the report are:~~

- ~~South west wall of the refueling cavity~~
- ~~South wall of west steam generator cavity~~
- ~~North east wall of in-containment refueling water storage tank~~
- ~~In-containment refueling water storage tank steel wall~~
- ~~Column supporting operating floor~~

Deviations from the design due to as-procured or as-built conditions are acceptable based on an evaluation consistent with the methods and procedures of Section 3.7 and 3.8 provided the following acceptance criteria are met.

- the structural design meets the acceptance criteria specified in Section 3.8

- the amplitude of the seismic floor response spectra do not exceed the design basis floor response spectra by more than 10 percent

Depending on the extent of the deviations, the evaluation may range from documentation of an engineering judgement to performance of a revised analysis and design.

3.8.3.5.8 Design Summary of Critical Sections

3.8.3.5.8.1 Structural Wall Modules

This subsection summarizes the design of the following critical sections:

- South west wall of the refueling cavity (4′ 0″ thick)
- South wall of west steam generator cavity (2′ 6″ thick)
- North east wall of in-containment refueling water storage tank (2′ 6″ thick)

The thicknesses and locations of these walls which are part of the boundary of the in-containment refueling water storage tank are shown in Table 3.8.3-3 and Figure 3.8.3-18.

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They are the portions of the structural wall modules experiencing the largest demand. The structural configuration and typical details are shown in Figures 3.8.3-1, 3.8.3-2, 3.8.3-8, 3.8.3-14, 3.8.3-15, and 3.8.3-17. The structural analyses are described in subsection 3.8.3.4 and summarized in Table 3.8.3-2. The design procedures are described in subsection 3.8.3.5.3.

The three walls extend from the floor of the in-containment refueling water storage tank at elevation 103′ 0″ to the operating floor at elevation 135′ 3″. The south west wall is also a boundary of the refueling cavity and has stainless steel plate on both faces. The other walls have stainless steel on one face and carbon steel on the other. For each wall design information is summarized in Tables 3.8.3-4, 3.8.3-5 and 3.8.3-6 at three locations. Results are shown at the middle of the wall (mid span at mid height), at the base of the wall at its mid point (mid span at base) and at the base of the wall at the end experiencing greater demand (corner at base). The first part of each table shows the member forces due to individual loading. The lower part of the table shows governing load combinations. The steel plate thickness required to resist mechanical loads is shown at the bottom of the table as well as the thickness provided. The maximum principal stress for the load combination including thermal is also tabulated. If this value exceeds the yield stress at temperature, a supplemental evaluation is performed as described in subsection 3.8.3.5.3.4; for these cases the maximum stress intensity range is shown together with the allowable stress intensity range which is twice the yield stress at temperature.

3.8.3.5.8.2 In-containment refueling water storage tank steel wall

The in-containment refueling water storage tank steel wall is the circular boundary of the in-containment refueling water storage tank. The structural configuration and typical details are shown in sheet 3 of Figure 3.8.3-8. The structural analyses are described in subsection 3.8.3.4 and summarized in Table 3.8.3-2. The design procedures are described in subsection 3.8.3.5.3. The steel wall extends from the floor of the in-containment refueling water storage tank at elevation 103′ 0″ to the operating floor at elevation 135′ 3″. The wall is a 5/8″ thick stainless steel plate. It has internal vertical stainless steel T-section columns spaced 4′-8″ apart and external hoop carbon steel (L-section) angles spaced 18″ to 24″ apart. The wall is fixed to the adjacent modules and floor except for the top of columns which are free to slide radially and to rotate around the hoop direction.

The structural evaluation is performed separately for the central and end regions. The central region envelopes results for the wall except for the last four columns at each end. The end region envelopes results for the four columns at each end. The wall is evaluated as vertical and horizontal beams. The vertical beams comprise the T-section columns plus the effective width of the plate. The horizontal beams comprise the L-section angles plus the effective width of the plate. The evaluations are summarized in Table 3.8.3-7. Design loads and load combinations are shown on sheet 1. Sheet 2 shows the ratio of the design stresses to the allowable stresses. When thermal effects result in stresses above yield, the evaluation is in accordance with the supplemental criteria as described in subsection 3.8.3.5.3.4.

220.122-4

3.8.3.5.8.3 Column supporting operating floor

This subsection summarizes the design of the most heavily loaded column in the containment internal structures. The column extends from elevation 107′-2″ to the underside of the operating floor at elevation 135′-3″. In addition to supporting the operating floor, it also supports a steel grating floor at elevation 118′-0″.

The load combinations in Table 3.8.4-1 were used to assess the adequacy of the column. For load combination 1 in the table, the interaction factor due to biaxial bending and axial load is 0.38. For load combination 6 without thermal loads, the interaction factor is 0.42 and with thermal loads the interaction factor is 0.61. Since the interaction factors are less than 1, the column is adequate for all the applied loads.

3.8.3.6 Materials, Quality Control, and Special Construction Techniques

Subsection 3.8.4.6 describes the materials and quality control program used in the construction of the containment internal structures. The structural steel modules are constructed using A36 plates and shapes. Nitronic 33 (American Society for Testing and Materials 240, designation S24000, Type XM-29) stainless steel plates are used on the surfaces of the modules in contact with water during normal operation or refueling. The structural wall and floor modules are fabricated and erected in accordance with AISC-N690. Loads during fabrication and erection due to handling and shipping are considered as normal loads as described in subsection 3.8.4.3.1.1. Packaging, shipping, receiving, storage and handling of structural modules are in accordance with NQA-2, Part 2.2 (formerly ANSI/ASME N45.2.2 as specified in AISC N690).

3.8.3.6.1 Fabrication, Erection, and Construction of Structural Modules

Modular construction techniques are used extensively in the containment internal structures (Figure 3.8.3-1). Subassemblies, sized for commercial rail shipment, are assembled offsite and transported to the site. Onsite fabrication consists of combining the subassemblies in structural modules, which are then installed in the plant. A typical modular construction technique is described in the following paragraphs for Module M1, which is the main structural module in the containment internal structures.

The M1 module is a multicompartmented structure which, in its final form, comprises the central walls of the containment internal structures. The vertical walls of the module house the refueling cavity, the reactor vessel compartment, and the two steam generator compartments. The module (Figure 3.8.3-14) is in the form of a "T" and is approximately 50 feet long, 65 feet wide and 60 feet high. The module is assembled from about 40 prefabricated wall sections called structural submodules (Figure 3.8.3-15). The submodules are designed for railroad transport from the fabricator's shop to the plant site with sizes up to 12 feet by 12 feet by 80 feet long, weighing up to 80 tons. A typical submodule weighs between 9 and 11 tons. The submodules are assembled outside the nuclear island with full penetration welds between the faceplates of adjacent subunits. The completed M1 module is lifted to its final location within the containment vessel by the heavy lift construction crane.

220.122-5

39. Bhide and Collins, "Influence of Axial Tension on the Shear Capacity of Reinforced Concrete Members," ACI Structural Journal, September-October 1989.

40. K. Sorensen, O. Loset and T. O. Olsen, "Investigations of the Influence of Axial Tensile Forces on the Transverse Shear Strength", Report No. PP1-1-5, Det Norske Veritas, Oslo, June 1981.

41. S. B. Bhide and M. P. Collins, "Reinforced Concrete Elements in Shear and Tension," Publication No. 87-02, Department of Civil Engineering, University of Toronto, January 1987.

42. P. E. Adebar, "Shear Design of Concrete Offshore Structures," Doctoral Thesis in the University of Toronto, 1989.

43. M. W. Kani, M. W. Huggins, R. R. Wittkopp, "Kani on Shear and Torsion in Reinforced Concrete," Department of Civil Engineering, University of Toronto, 1979.

44. "Guide to Stability Design Criteria for Metal Structures," edited by B.G. Johnston, 3rd Edition.

45. Bressler, Lin and Scalzi, "Design of Steel Structures," Second Edition.

46. W. Fuchs, R. Eligehausen, and J. E. Breen, "Concrete Capacity Design (CCD) Approach to Fastening to Concrete," ACI Structural Journal, January-February 1995.

47. C. B. Farrow, I. Frigui, R. E. Klingner, "Tensile Capacity of Single Anchors in Concrete: Evaluation of Existing Formulas on an LRFD Basis," Report to the Tennessee Valley Authority, March, 1992.

48. C. B. Farrow, and R. E. Klingner, "Tensile Capacity of Anchors with Partial or Overlapping Failure Surfaces: Evaluation of Existing Formulas on an LRFD Basis," ACI Structural Journal, November - December, 1995.

49. ~~WCAP 14875, "Design summary report for containment internal structures"~~Deleted

50. ~~WCAP 14877, "Design summary report for auxiliary building"~~Deleted

51. Deleted

220.122-6

Table 3.8.3-3
Definition of Critcal Locations and Thicknesses for Containment Internal Structures[1]

Wall Description	Applicable Column Lines	Applicable Elevation Level or Elevation Level Range	Concrete Thickness[2]	Required Thickness of Surface Plates (inches)[3]	Thickness of Surface Plates Provided (inches)[4]
Containment Structures					
Module Wall 1	West wall of refueling cavity	Wall separating IRWST and refueling cavity from 2.3 to 5	4'-0" concrete-filled structural wall module with 0.5-in.- thick steel plate on inside and outside of wall	0.35	0.5
Module Wall 2	South wall of west steam generator cavity	Wall separating IRWST and west steam generator cavity from 3.1 to 5	2'-6" concrete-filled structural wall module with 0.5-in.-thick steel plate on inside and outside of wall	0.46	0.5
M-2 Module Wall	North east boundary wall of IRWST	Wall separating IRWST maintenance floor from 3 to 5	2'-6" concrete-filled structural wall module with 0.5-in.-thick steel plate on inside and outside of wall	0.46	0.5

Notes:

1. The applicable column lines and elevation levels are identified and included in Figures 1.2-9, 3.7.2-12 (sheets 1 through 12), 3.7.2-19 (sheets 1 through 3) and on Table 1.2-1.
2. The concrete thickness includes the steel face plates. Thickness greater than 3'-0" have a construction tolerance of + 1", -3/4". Thickness less than or equal to 3'-0" have a construction tolerance of + 1/2", -3/8".
3. These plate thicknesses represent the minimum thickness required for operating and design basis loads except for designed openings or penetrations. These values apply for each face of the applicable wall unless specifically indicated on the table.
4. These plate thicknesses represent the thickness provided for operating and design basis loads except for designed openings or penetrations. These values apply for each face of the applicable wall unless specifically indicated on the table.

230.122-7

Table 3.8.3-4 (Sheet 1 of 3)

**DESIGN SUMMARY OF WEST WALL OF REFUELING CAVITY
DESIGN LOADS, LOAD COMBINATIONS AND COMPARISON TO ACCEPTANCE CRITERIA
MID SPAN AT MID HEIGHT**

Load/Comb.	Sxx	Syy	Sxy	Mxx	Ny	Myy	Nx	Comments
	k/ft	k/ft	k/ft	kft/ft	k/ft	kft/ft	k/ft	
Dead (D)		-11.07						
Hydro (F)	0.78	1.85	0.66	21.99	0.61	21.15	0.69	
Live (L)		-7.2						
Live (Lo)		-1.8						
Live (ADS)	0.38	13.25	2.2	20.34	0.39	14.4	0.24	
Es (In Plane)	19.33	26.47	42 74					
Es (Out Plane)	0.53	18.55	3.08	28.48	0.55	20.16	0.34	
Thermal (To)	-202.4	-143.7	-16.7	386.2	-14.5	390.1	10.4	
LC (1)	1.09	-25.15	0.92	30.79	0.85	29.61	0.97	1.4D+1.4F+1.7L
LC (1)'	1.74	6.56	4.66	65.36	1.52	54.09	1.37	1.4D+1.4F+1.7Lo+1.7ADS
LC (3)	-221.48	-199.74	-61.86	457.01	-15.66	445.81	11.67	1.0D+1.0F-1.0Lo+1.0ADS+ 1.0To+1.0Es
LC (3)'	21.02	47.25	48.68	70.81	1.55	55.71	1.27	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0Es
LC (8)	21.02	50.16	48.68	70.81	1.55	55.71	1.27	0.9D+1.0F+1.0ADS+ 1.0Es

Notes: x-direction is horizontal, y-direction is vertical
element number 1877

Plate thickness required for load combinations excluding thermal:	0.17 inches
Plate thickness provided	0.5 inches
Maximum principal stress for load combination 3 including thermal:	23.8 ksi
Yield stress at temperature	42.5 ksi
Maximum stress intensity range for load combination 3 including thermal	23.8 ksi
Allowable stress intensity range for load combination 3 including thermal	85.0 ksi

220.122-8

Table 3.8.3-4 (Sheet 2 of 3)

DESIGN SUMMARY OF WEST WALL OF REFUELING CAVITY
DESIGN LOADS, LOAD COMBINATIONS AND COMPARISON TO ACCEPTANCE CRITERIA
MID SPAN AT BASE

Load/Comb.	Sxx k/ft	Syy k/ft	Sxy k/ft	Mxx kft/ft	Ny k/ft	Myy kft/ft	Nx k/ft	Comments
Dead (D)		-17.67						
Hydro (F)	0.98	3.39	2.1	2.62	14	35.68	0.51	
Live (L)		-7.2						
Live (Lo)		-1.8						
Live (ADS)	2.58	14.62	2.45	2.39	9.51	31.27	0.57	
Es (In Plane)	19.33	26.47	42.74					
Es (Out Plane)	3.61	20.47	3.43	3.35	13.31	43.78	0.80	
Thermal (To)	-406.9	-63.6	-138.0	510.5	-27.5	559.8	1.3	
LC (1)	1.37	-32.23	2.94	3.67	19.60	49.95	0.71	1.4D+1.4F+1.7L
LC (1)'	5.76	1.80	7.11	7.73	35.77	103.11	1.68	1.4D+1.4F+1.7Lo+1.7ADS
LC (3)	-428.86	-126.62	-18[illegible].07	516.47	-26.81	567.90	1.59	1.0D+1.0F+1.0Lo+1.0ADS+1.0 To+1.0Es
LC (3)'	26.50	45.48	50.72	8.36	36.82	110.73	1.88	1.0D+1.0F+1.0Lo+1.0ADS+1.0 Es
LC (8)	26.50	49.05	50.72	8.36	36.82	110.73	1.88	0.9D+1.0F+1.0ADS+1.0Es

Notes: x-direction is horizontal. y-direction is vertical
element number 1880

Plate thickness required for load combinations excluding thermal:	0.21 inches
Plate thickness provided	0.5 inches
Maximum principal stress for load combination 3 including thermal:	37.5 ksi
Yield stress at temperature	42.5 ksi
Maximum stress intensity range for load combination 3 including thermal	37.5 ksi
Allowable stress intensity range for load combination 3 including thermal	85.0 ksi

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Table 3.8.3-4 (Sheet 3 of 3)

DESIGN SUMMARY OF WEST WALL OF REFUELING CAVITY
DESIGN LOADS, LOAD COMBINATIONS AND COMPARISON TO ACCEPTANCE CRITERIA
CORNER AT BASE

Load/Comb.	Sxx	Syy	Sxy	Mxx	Ny	Myy	Nx	Comments
	k/ft	k/ft	k/ft	kft/ft	k/ft	kft/ft	k/ft	
Dead (D)		-17.67						
Hydro (F)	4.85	22.03	0.87	8.04	11.73	13.51	3.18	
Live (L)		-7.2						
Live (Lo)		-1.8						
Live (ADS)	6.82	49.5	1.46	9.73	16.52	17.28	3.57	
Es (In Plane)	26.78	44.38	56.68					
Es (Out Plane)	9.55	69.30	2.04	13.62	23.13	24.19	5.00	
Thermal (To)	-327.5	-182	-337.6	175.6	123.4	156.5	-11.4	
LC (1)	6.79	-6.14	1.22	11.26	16.42	18.91	4.45	1.4D+1.4F+1.7L
LC (1)'	18.38	67.19	3.70	27.80	44.51	48.29	10.52	1.4D+1.4F+1.7Lo-1.7ADS
LC (3)	-279.5	-16.26	-395.35	206.99	134.80	211.48	-13.22	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0To+1.0Es
LC (3)'	48.00	165.74	60.95	31.39	51.38	54.98	11.75	1.0D+1.0F+1.0Lo+1.0ADS+1.0 Es
LC (8)	48.00	169.31	60.95	31.39	51.38	43.98	11.	0.9D+1.0F+1.0ADS+1.0Es

Notes: x-direction is horizontal, y-direction is vertical
element number 1856

Plate thickness required for load combinations excluding thermal: 0.35 inches
Plate thickness provided 0.5 inches

Maximum principal stress for load combination 3 including thermal: 40.63 ksi
Yield stress at temperature 42.5 ksi

Maximum stress intensity range for load combination 3 including thermal 65.97 ksi
Allowable stress intensity range for load combination 3 including thermal 85.0 ksi

Table 3.8.3-5 (Sheet 1 of 3)

DESIGN SUMMARY OF SOUTH WALL OF STEAM GENERATOR CAVITY DESIGN LOADS, LOAD COMBINATIONS AND COMPARISON TO ACCEPTANCE CRITERIA MID SPAN AT MID HEIGHT

Load/Comb.	Sxx	Syy	Sxy	Mxx	Ny	Myy	Nx	Comments
	k/ft	k/ft	k/ft	kft/ft	k/ft	kft/ft	k/ft	
Dead (D)		-11.03						
Hydro (F)	1.67	0.94	4.63	16.77	1.22	18.25	0.7	
Live (L)		-3.2						
Live (Lo)		-0.8						
Live (ADS)	1.89	10.09	9.58	14.29	0.01	15.45	0.58	
Es (In Plane)	37.35	14.2	72.78					
Es (Out Plane)	2.65	14.13	13.41	20.01	0.01	21.63	0.81	
Thermal (To)	-187.4	-186.11	1.11	359.48	-7.87	343.07	-6.27	
LC (1)	2.34	-19.57	6.48	23.48	1.71	25.55	0.98	1.4D-1.4F+1.7L
LC (1)'	5.55	1.67	22.77	47.77	1.73	51.82	1.97	1.4D+1.4F+1.7Lo+1.7ADS
LC (3)	-230.96	-225.33	82.67	410.55	-9.10	398.40	-6.38	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0To+1.0Es
LC (3)'	43.56	27.53	100.40	51.07	1.24	55.33	2.09	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0Es
LC (8)	43.56	29.43	100.40	51.07	1.24	55.33	2.09	0.9D+1.0F+1.0ADS+1.0Es

Notes: x-direction is horizontal, y-direction is vertical
element number 1957

Plate thickness required for load combinations excluding thermal:	0.26 inches
Plate thickness provided	0.50 inches
Maximum principal stress for load combination 3 including thermal:	33.3 ksi
Yield stress at temperature	32.4 ksi
Maximum stress intensity range for load combination 3 including thermal	33.3 ksi
Allowable stress intensity range for load combination 3 including thermal	64.8 ksi

Table 3.8.3-5 (Sheet 2 of 3)

DESIGN SUMMARY OF SOUTH WALL OF STEAM GENERATOR CAVITY
DESIGN LOADS, LOAD COMBINATIONS AND COMPARISON TO ACCEPTANCE CRITERIA
MID SPAN AT BASE

Load/Comb.	Sxx k/ft	Syy k/ft	Sxy k/ft	Mxx kft/ft	Ny k/ft	Myy kft/ft	Nx k/ft	Comments
Dead (D)		-16.32						
Hydro (F)	0.39	0.52	8.84	2.68	12.7	29.1	0.17	
Live (L)		-3.2						
Live (Lo)		-0.8						
Live (ADS)	0.67	8.85	11.42	1.98	7.89	21.96	0.12	
Es (In Plane)	38.61	23.17	55.93					
Es (Out Plane)	0.94	12.39	15.99	2.77	11.05	30.74	0.17	
Thermal (To)	-426.8	-82.45	68.25	379.48	3.74	410.08	3.44	
LC (1)	0.55	-27.56	12.38	3.75	17.78	40.74	0.24	1.4D-1.4F+1.7L
LC (1)'	1.69	-8.44	31.79	7.12	31.19	78.07	0.44	1.4D+1.4F+1.7Lo+1.7ADS
LC (3)	-466.74	-134.62	131.33	379.57	35.38	411.72	3.44	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0To+1.0Es
LC (3)'	40.61	27.81	92.18	7.43	31.64	81.80	0.46	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0Es
LC (8)	40.61	30.24	92.18	7.43	31.64	81.80	0.46	0.9D+1.0F+1.0ADS+1.0Es

Notes: x-direction is horizontal, y-direction is vertical
element number 1960

Plate thickness required for load combinations excluding thermal:	0.27 inches
Plate thickness provided	0.50 inches
Maximum principal stress for load combination 3 including thermal:	36.3 ksi
Yield stress at temperature	32.4 ksi
Maximum stress intensity range for load combination 3 including thermal	54.6 ksi
Allowable stress intensity range for load combination 3 including thermal	64.8 ksi

Table 3.8.3-5 (Sheet 3 of 3)

DESIGN SUMMARY OF SOUTH WALL OF STEAM GENERATOR CAVITY
DESIGN LOADS, LOAD COMBINATIONS AND COMPARISON TO ACCEPTANCE CRITERIA
CORNER AT BASE

Load/Comb.	Sxx	Syy	Sxy	Mxx	Ny	Myy	Nx	Comments
	k/ft	k/ft	k/ft	kft/ft	k/ft	kft/ft	k/ft	
Dead (D)		-27.9						
Hydro (F)	0.58	12.67	7.93	6.03	1.48	9.2	1.4	
Live (L)		-3.2						
Live (Lo)		-0.8						
Live (ADS)	2.69	30.49	10.41	3.69	0.74	7.02	0.41	
Es (In Plane)	31.89	127.71	73					
Es (Out Plane)	3.77	42.69	14.57	5.17	1.04	9.83	0.57	
Thermal (To)	-341.26	-217.05	193.03	342.57	-143.86	563.1	-50.97	
LC (1)	0.81	-26.76	11.10	8.44	2.07	12.88	1.96	1.4D-1.4F+1.7L
LC (1)'	5.39	29.15	28.80	14.72	3.33	24.81	2.66	1.4D+1.4F+1.7Lo+1.7ADS
LC (3)	-303.49	-32.19	272.67	341.71	-143.42	563.73	-53.35	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0To+1.0Es
LC (3)'	38.93	184.86	105.91	14.89	3.26	26.05	2.38	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0Es
LC (8)	38.93	188.45	105.91	14.89	3.26	26.05	2.38	0.9D+1.0F+1.0ADS+1.0Es

Notes: x-direction is horizontal, y-direction is vertical
element number 2008

Plate thickness required for load combinations excluding thermal:	0.46 inches
Plate thickness provided	0.50 inches
Maximum principal stress for load combination 3 including thermal:	54.6 ksi
Yield stress at temperature	32.4 ksi
Maximum stress intensity range for load combination 3 including thermal	54.6 ksi
Allowable stress intensity range for load combination 3 including thermal	64.8 ksi

Table 3.8.3-6 (Sheet 1 of 3)

DESIGN SUMMARY OF NORTH EAST WALL OF IRWST
DESIGN LOADS, LOAD COMBINATIONS AND COMPARISON TO ACCEPTANCE CRITERIA
MID SPAN AT MID HEIGHT

Load/Comb.	Sxx	Syy	Sxy	Mxx	Ny	Myy	Nx	Comments
	k/ft	k/ft	k/ft	kft/ft	k/ft	kft/ft	k/ft	
Dead (D)		-9.64						
Hydro (F)	0.19	0.26	0.96	21.21	1.06	21.93	1.1	
Live (L)		-13.32						
Live (Lo)		-3.3						
Live (ADS)	0.73	4.87	1.37	22.05	0.49	18.58	1.04	
Es (In Plane)	20	46.53	55.44					
Es (Out Plane)	1.02	6.82	1.92	30.87	0.69	26.01	1.46	
Thermal (To)	-153.77	-77.26	63.99	316.91	-10.41	323.24	-14.16	
LC (1)	0.27	-35.78	1.34	26.69	1.48	30.70	1.54	1.4D+1.4F+1.7L
LC (1)'	1.51	-10.46	3.67	67.18	2.32	62.29	3.31	1.4D+1.4F+1.7Lo+1.7ADS
LC (3)	-132.56	-32.24	120.39	391.04	-12.16	389.76	-14.52	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0To+1.0Es
LC (3)'	21.94	45.54	59.69	74.13	2.24	66.52	3.60	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0Es
LC (8)	21.94	49.80	59.69	74.13	2.24	66.52	3.60	0.9D+1.0F+1.0ADS+1.0Es

Notes: x-direction is horizontal, y-direction is vertical
element number 2205

Plate thickness required for load combinations excluding thermal:	0.21 inches
Plate thickness provided	0.50 inches
Maximum principal stress for load combination 3 including thermal:	38.3 ksi
Yield stress at temperature	32.4 ksi
Maximum stress intensity range for load combination 3 including thermal	38.3 ksi
Allowable stress intensity range for load combination 3 including thermal	64.8 ksi

Table 3.8.3-6 (Sheet 2 of 3)

DESIGN SUMMARY OF NORTH EAST WALL OF IRWST
DESIGN LOADS, LOAD COMBINATIONS AND COMPARISON TO ACCEPTANCE CRITERIA
MID SPAN AT BASE

Load/Comb.	Sxx	Syy	Sxy	Mxx	Ny	Myy	Nx	Comments
	k/ft	k/ft	k/ft	kft/ft	k/ft	kft/ft	k/ft	
Dead (D)		-15.33						
Hydro (F)	0.65	0.89	3.04	3.2	14.24	33.86	0.04	
Live (L)		-13.32						
Live (Lo)		-3.3						
Live (ADS)	1.46	5.77	2.34	2.01	9.57	26.34	0.23	
Es (In Plane)	11.21	56.16	55.44					
Es (Out Plane)	[illegible]	8.08	3.28	2.81	13.40	36.88	0.32	
Thermal (To)	-403.23	22.75	134.29	377.57	-14.07	433.57	2.2	
LC (1)	[illegible]	-42.89	4.26	4.48	19.94	47.40	0.06	1.4D-1.4F+1.7L
LC (1)'	3.39	-16.05	8.23	7.90	36.21	92.18	0.45	1.4D+1.4F+1.7Lo+1.7ADS
LC (3)	-387.87	75.0	189.97	377.18	23.14	436.59	2.79	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0To+1.0Es
LC (3)'	[illegible]	52.25	64.10	8.02	37.21	97.08	0.59	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0Es
LC (8)	15.36	57.08	64.10	8.02	37.21	97.08	0.59	0.9D+1.0F+1.0ADS+1.0Es

Notes: x-direction is horizontal, y-direction is vertical
element number 2208

Plate thickness required for load combinations excluding thermal:	0.27 inches
Plate thickness provided	0.50 inches
Maximum principal stress for load combination 3 including thermal:	47.1 ksi
Yield stress at temperature	32.4 ksi
Maximum stress intensity range for load combination 3 including thermal	47.1 ksi
Allowable stress intensity range for load combination 3 including thermal	64.8 ksi

220.122-15

Table 3.8.3-6 (Sheet 3 of 3)

DESIGN SUMMARY OF NORTH EAST WALL OF IRWST
DESIGN LOADS, LOAD COMBINATIONS AND COMPARISON TO ACCEPTANCE CRITERIA
CORNER AT BASE

Load/Comb.	Sxx	Syy	Sxy	Mxx	Ny	Myy	Nx	Comments
	k/ft	k/ft	k/ft	kft/ft	k/ft	kft/ft	k/ft	
Dead (D)		-8.31						
Hydro (F)	2.81	24.94	3.82	7.85	16.92	24.04	1.96	
Live (L)		-13.32						
Live (Lo)		-3.3						
Live (ADS)	3.85	46.58	5.04	9.88	22.93	37.55	2.14	
Es (In Plane)	6.83	55.52	18.21					
Es (Out Plane)	5.39	65.21	7.06	13.83	32.10	52.57	3.00	
Thermal (To)	-281.25	-124.31	357.17	130.91	134.82	154.55	-8.51	
LC (1)	3.93	0.64	5.35	10.99	23.69	33.66	2.74	1.4D-1.4F+1.7L
LC (1)'	10.48	96.86	13.92	27.79	62.67	97.49	6.38	1.4D+1.4F+1.7Lo+1.7ADS
LC (3)	-262.37	56.33	591.30	162.47	150.00	258.71	-15.61	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0To+1.0Es
LC (3)'	18.88	180.64	34.13	31.56	71.95	114.16	7.10	1.0D+1.0F+1.0Lo+1.0ADS+ 1.0Es
LC (8)	18.88	184.77	34.13	31.56	71.95	114.16	7.10	0.9D+1.0F+1.0ADS+1.0Es

Notes: x-direction is horizontal, y-direction is vertical
element number 2240

Plate thickness required for load combinations excluding thermal:	0.46 inches
Plate thickness provided	0.50 inches
Maximum principal stress for load combination 3 including thermal:	49.2 ksi
Yield stress at temperature	32.4 ksi
Maximum stress intensity range for load combination 3 including thermal	64.8 ksi
Allowable stress intensity range for load combination 3 including thermal	64.8 ksi

Table 3.8.3-7 (Sheet 1 of 2)

DESIGN SUMMARY OF STEEL WALL OF IRWST

LOAD COMBINATIONS

L.C.#	DESCRIPTION	LOAD COMBINATION
1A	Refueling Condition	D+IR+LR
1B	Normal transient ADS_2	$D+IR+LN+ADS_2$
1C	Normal transient ADS_1	$D+IR+LN+ADS_1$
3A	SSE+refueling condition	D+IR+LR+SSE
3B	SSE+normal transient ADS_2	$D+IR+LN+T_0+\|ADS_2\|+\|SSE\|$
3C	SSE+normal transient ADS_1	$D+IR+LN+T_0+SRSS(ADS_1+SSE)$
5A	DBA pressure	$D+IR+LN+P_A$
5B	DBA thermal	$D+IR+LN+T_A$
5C	DBA thermal (empty pool)	$D + LN + T_A$
7A	SSE+DBA pressure	$D+IR+LN+P_A+SSE$
7B	SSE+DBA thermal	$D+IR+LN+T_A+SSE$
8A	1B+thermal load	$D+IR+LN+ADS_2+T_0$
8B	1C+thermal load	$D+IR+LN+ADS_1+T_0$

LOADS

D	=	deadweight
IR	=	hydrostatic load
ADS_2	=	equivalent internal pressure of 5 psi on walls and slab
ADS_1	=	equivalent internal pressure of 5 psi on walls
LR	=	live load of 800 psf on 135' slab in refueling condition
SSE	=	combined SRSS seismic load
T_0	=	thermal load in normal condition
P_A	=	accidental external pressure on steel wall equal to 5 psi
LN	=	live load in normal condition equal to 50 psf
T_A	=	thermal load in accidental condition

220.122-17

Table 3.8.3-7 (Sheet 2 of 2)

DESIGN SUMMARY OF STEEL WALL OF IRWST
STRESS RATIO SUMMARY

CENTRAL REGION

SECTION LOCATION	AXIAL PLUS BENDING AISC RATIO	3*Sm RATIO	LOAD COMB. #	SHEAR AISC RATIO	3*Sm RATIO	LOAD COMB. #
MECHANICAL LOADS ONLY (EXCLUDING THERMAL EFECTS)						
T-section bottom	0.36	-	1C	0.17	-	1B,1C
T-section mid height	0.10	-	1A	0.05	-	3A
L-section bottom	0.05	-	1B	0.07	-	3A
L-section mid height	0.39	-	1B	0.07	-	3A,7A
INCLUDING THERMAL EFFECTS						
T-section bottom	-	0.54	5B	-	0.58	7B
T-section mid height	0.33	-	7B	0.08	-	5C
L-section bottom	-	0.81	5C	0.08	-	3B
L-section mid height	0.42	-	5C	0.08	-	3C

END REGION

SECTION LOCATION	AXIAL PLUS BENDING AISC RATIO	3*Sm RATIO	LOAD COMB. #	SHEAR AISC RATIO	3*Sm RATIO	LOAD COMB. #
MECHANICAL LOADS ONLY (EXCLUDING THERMAL EFECTS)						
T-section bottom	0.98	-	1B	0.31	-	5A,7A
T-section mid height	0.26	-	1C	0.06	-	1B
L-section bottom	0.05	-	1C	0.44	-	1B,1C
L-section mid height	0.22	-	1B	0.48	-	1B,1C
L-section edge	0.20	-	1C	0.24	-	1B
INCLUDING THERMAL EFFECTS						
T-section bottom	-	0.98	8A	-	0.96	7B
T-section mid height	0.6	-	3C	0.12	-	7B
L-section bottom	-	0.86	5C	0.32	-	3B
L-section mid height	0.55	-	5C	0.35	-	3B
L-section edge	0.38	-	5C	-	0.79	5B

220.122-18

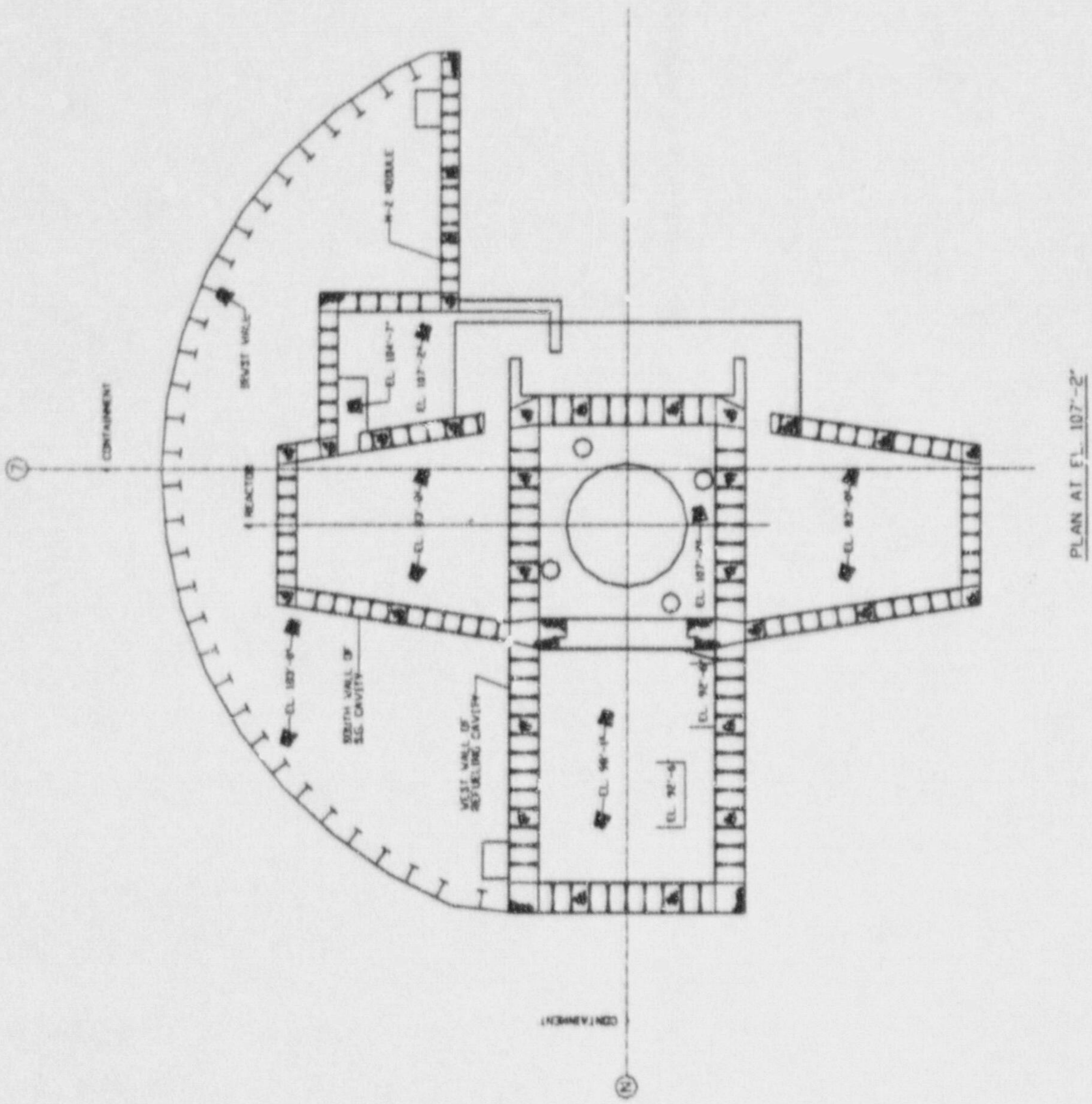

Figure 3.8.3-18

Location of Structural Wall Modules

Open Item 220.125F (OITS #6312)

Because a massive amount of water is to be contained in the PCCWS tank, the staff raised a concern that the COL applicant should monitor the vertical and radial deformation of the tank during initial filling, and compare the measured values with the tank deformation predicted by calculation. The staff identified this issue as Open Item 3.8.4.4-3 and COL Action Item 3.8.4.4-1.

At the meeting on June 12 through 16, 1995, Westinghouse stated that the water weight is small, in comparison with the total weight of the shield building roof structure (estimated to be about 10 percent). Westinghouse also showed that the deflection of the roof structure resulting from the first fill of water should be negligible. On that basis, Westinghouse contended that there is no need to monitor the tank deflections and compare the deflections against predictions.

During the meeting on December 9 through 13, 1996, Westinghouse repeated its justification concerning this issue. However, the staff did not agree with Westinghouse's basis for not monitoring the vertical and radial deformation of the tank during initial tank filling. Moreover, the staff asserted that post-construction testing is necessary to confirm the adequacy of the PCCWS tank. This is because the staff's review experience suggest that the excessive deformation resulting from the massive amount of water may cause cracking of the tank wall and base slab, as well as water leakage from reinforced concrete tanks with steel liners.

In Revision 17 of SSAR Section 3.8.4.1.1, Westinghouse added a statement that leak chase channels are provided over the liner welds to permit monitoring for leakage and to prevent degradation of the reinforced concrete wall which might result from the freezing and thawing of leakage. Also, Westinghouse indicated that the exterior face of the reinforced concrete boundary of the PCCWS tank is designed to control cracking, in accordance with Paragraph 10.6.4 of ACI-349, with reinforcement steel stress based on sustained loads (including thermal effects). However, Westinghouse still did not commit to monitor the vertical and radial deformation of the tank during initial filling and compare the measured values with the tank deformation predicted by analysis. On the basis of the above discussion, the staff concluded that Westinghouse's response to the staff's concern (as stated in Revision 17 of SSAR Section 3.8.4.1.1) is not acceptable. Therefore, Open Item 3.8.4.4-3 and COL Action Item 3.8.4.4-1 remain unsolved.

Response:

Open item 3.8.4.4-3 (OI#751) was discussed during the August 4 -15, 1997 meeting. At this meeting the staff provided a position on the design of the tank liner (meeting summary, NRC letter of September 30, 1997, attachment 6). Westinghouse provided markups (NRC letter of September 30, 1997, attachment 9) for SSAR subsection 3.8.4.1.1 which were later incorporated in Revision 17. These markups committed to leak chase channels and to control of cracking. It was Westinghouse's understanding at the meeting, that these commitments were in lieu of measuring tank deformation during filling of the tank. This understanding is supported by the staff's meeting notes (NRC letter of September 30, 1997, attachment 11), which identifies open item # 751 as Confirm-W.

The Westinghouse position remains as described in the open item. The calculated deflections of the roof structure due to the first fill of water are small. The actual deflections would be difficult to measure with sufficient accuracy for comparison against predictions. There is no need to monitor the deflections to confirm structural adequacy. Tank function is confirmed by monitoring the water level in the tank during the first fill of water and by checking the leak chase system to confirm no leakage.

SSAR Revision:

None

ITAAC Revision:

This response is also applicable to RAI 640.10. An ITAAC is not required for measurement of tank deformation.

410.381F (OITS #6258)

Discuss the approach taken in the AP600 design to protect regulatory treatment of non-safety-related systems (RTNSS) and defense in depth (DID) systems from internal and external floods. (OI 3.4.1-2)

Response:

As indicated in Section 3.4.1.1, safety-related structures, systems and components (SSC's) provide safe shutdown following internal and external floods. As a result, nonsafety-related SSC's are not required to mitigate design basis flood events.

In addition, the safety importance of nonsafety-related SSC's was evaluated in WCAP-13856, "AP600 Implementation of the Regulatory Treatment of Nonsafety-Related Systems Process". The RTNSS evaluation process included PRA and deterministic considerations which included flooding. None of the nonsafety-related SSC's were found to be RTNSS important based on flooding considerations. As a result, nonsafety-related SSC's, including systems found to be important by the RTNSS process and DID systems, are not important in mitigation of flood events and are not required to be protected from internal or external floods.

Although RTNSS important and DID systems are not required to be protected from internal or external floods, they are expected to be available following the more likely events. Based on good design practice, floor drains and sumps are provided to remove water resulting from anticipated leakage from the nonsafety-related RTNSS important and DID equipment. In addition, the buildings which contain the nonsafety-related RTNSS and DID equipment have entrances which are located above the maximum external flood elevation.

SSAR Change:

None

ITAAC Change:

None

410.385F (OITS #6262)

Identify what safety-related, RTNSS, and DID systems are in each of the following areas within the auxiliary building: non-radiologically controlled area (NRCA), the mechanical equipment area, the non-Class 1E electrical equipment area, the Class 1E electrical equipment area, radiologically controlled area (RCA). (OI 3.4.1-6)

Response:

The safety-related components located in the auxiliary building are listed in SSAR Table 9A-2 (Safe Shutdown Components). This table identifies the fire area / zones where this equipment is located. SSAR Figure 9A-1 shows the AP600 buildings and the location of the fire area / zone.

The nonsafety-related RTNSS important and the DID components are not required to be protected from flood events (internal or external) as discussed in the response to question 410.381F. Since nonsafety-related component's, including RTNSS important and the DID SSC's, are not required to be protected from floods, their location is not important for flooding evaluations and it is not necessary to identify the location of these components.

SSAR Change:

None

ITAAC Change:

None

650.18F: Issue 82: Beyond-Design-Basis Accidents in Spent Fuel Pools (OITS #6320)

The risks of beyond-design-basis accidents in the spent fuel storage pool were examined in WASH-1400, "Reactor Safety Study, An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," dated October 1975, and it was concluded in the report that these risks were orders of magnitude below those involving the reactor core. Issue 82 in NUREG-0993 was the reexamination of accidents in the spent fuel storage pool. The reasons are two-fold. First, spent fuel is being stored instead of reprocessed. This issue, however, is not required for the AP600 design to meet 52.47(a)(1)(ii) or (iv).

This has led to the expansion of onsite fuel storage by means of high-density-storage racks, which results in a larger inventory of fission products in the pool, a greater heat load on the pool cooling system, and less distance between adjacent fuel assemblies. Second, some laboratory studies have offered evidence of the possibility of fire propagation between assemblies in an air-cooled environment. These two reasons, in combination, provide the basis for an accident scenario that was not previously considered.

As stated in NUREG-0933, because of the large inherent safety margins in the design and construction of spent fuel pools, this issue was resolved and no new requirements were established.

In Section 1.9.4 of the SSAR, Westinghouse states that the AP600 includes design provisions that preclude draining of the spent fuel pool. Also, provisions are available to supply water to the pool in the event the water covering the spent fuel begins to boil off. In the DSER, the staff requested that Westinghouse address probabilistic risk assessment for accidents in the spent fuel pool for the AP600 design. This was designated as Open Item 20.3-10. Open Item 20.3-10 (650.18F) is still unresolved because the probabilistic risk assessment has not been addressed.

Therefore, Issue 82 is not resolved for the AP600 design.

Response:

In the DSER, under Issue 82, the staff wrote: "Westinghouse ... concluded, in Table 1.9-2 of that [May 28, 1993] letter, that this issue was not relevant to the AP600 design because this issue was resolved without any new requirements. Although the staff agrees that no new requirements were established, the staff requests that Westinghouse address probabilistic risk assessment for accidents in the spent fuel pool for the AP600 design."

As postulated in this open item, a fire may occur between fuel assemblies in an air-cooled environment. Thus, the initiator of the postulated accident is that the water in the fuel pool drains, and that a fire occurs once the pool is drained. The discussion which follows explores the various paths that the spent fuel pool could drain.

As discussed in SSAR subsection 9.1.2.2, the connections to the spent fuel pool are located to preclude the draining of the pool due to a break in a line. Specifically:

1. The connection for the spent fuel cooling pump suction line is located below the normal water level and above the level needed to provide sufficient water for shielding and for cooling of the fuel if the spent fuel pool cooling system is unavailable. Note the normal water level is over 18 feet above the top of the spent fuel assemblies.

2. The pipe which discharges into the spent fuel pool includes a siphon break between the normal water level and the level of the spent fuel cooling system pump suction connection.

3. A metal gate with gasket assembly connects the spent fuel pool and fuel transfer canal. The gate is located on the pool wall a few feet above the top of the fuel assemblies. The spent fuel transfer operation is completed underwater, and the waterways are of sufficient depth to maintain a minimum of 10 feet of shielding water above the spent fuel assemblies.

4. The bottom of the fuel transfer canal has one locked-closed safety-related drain valve. During normal operation, the metal gate separating the spent fuel pool and the fuel transfer canal remains open. The gate is only closed to drain the canal without reducing the water level in the spent fuel pool.

For items 1 and 2 above, there are no failure mechanisms of these connections to model within a PRA that would drain the spent fuel pool to the point that there is insufficient water to cool the fuel. Even if the spent fuel cooling system pump line were to break, the water level would be more than 14 feet above the top of the fuel assemblies.

For item 3 above, the design is such that a minimum of 10 feet of shielding water is maintained above the spent fuel assemblies, so again, the design is such to preclude a PRA failure mechanism.

For item 4, the chance that plant personnel would attempt to drain the fuel transfer canal via the drain valve without first closing the gate, or if they did start to drain the canal with the gate open and ignored indications that the gate is open, is considered to be an extremely unlikely event. In addition, even if the gate is left open, the water level in the spent fuel pool would be above the top of the spent fuel assemblies. In addition, the spent fuel pool level is monitored and alarmed in the control room. Thus, there is not a failure mechanism to model in a PRA analysis from item 4.

Another mechanism to drain the pool is a catastrophic failure of the fuel pool structure. The spent fuel pool is a liner within concrete walls that are an integral part of the seismic Category I auxiliary building structure. This type of catastrophic failure mechanism is not modeled in conventional PRAs.

From the discussion above, it is concluded that the potential to drain the spent fuel pool is improbable. This addresses the first part of this FSER open item postulated initiating event.

The second part of the postulated initiating event is that a fire occurs between fuel assemblies. This second portion of the initiating event is discussed below.

The open item states "some laboratory studies have offered evidence of the possibility of fire propagation between assemblies in an air-cooled environment" however, the open item does not provide specific reference to a laboratory study report, nor does it explain how the fire started, the conditions that were simulated during the laboratory study, or what is the probability of possible fire propagation. However, since the spent fuel pool can only drain in one way to cause a PRA accident scenario, the likelihood that the spent fuel pool is drained (by catastrophic failure), coupled with a fire occuring within the area such that propagation between fuel assemblies occurs, would be an even smaller frequency.

Given the potential for the open item postulated initiating event is extremely small, a probabilistic risk assessment of this type of event is unnecessary.

In conclusion, the staff acknowledged in the associated DSER open item that Westinghouse does not need to meet any new requirements, although the staff is asking for a probabilistic risk assessment which does go beyond existing requirements. As the likelihood of the open item postulated initiating event is extremely small for AP600, a probabilistic risk assessment of this type of event is unnecessary and will not be provided. The deterministic design evaluation of the spent fuel pool discussed in SSAR section 9.1 provides sufficient information to the staff to resolve Issue 82.

SSAR Revision: None.

PRA Revision: None.

Question: 650.20F (OITS #6322)

Issue 124: Auxiliary Feedwater System Reliability

Following the loss of feedwater event at Davis Besse in 1985, as discussed in NUREG-0933, Issue 124 addressed increasing reliability of the auxiliary or EFW system to 10-4 unavailability/demand. In 1985, operating experience as well as staff and industry studies indicated that these systems failed at a high rate. A function of this system in the majority of current plants is to supply water to the secondary side of the SGs during system fill, normal plant heatup, normal plant hot standby, and normal plant cold shutdown. The EFW system also functions following loss of normal feedwater flow, including loss due to offsite power failure, and supplies EFW following such postulated accidents as a MFW line break or a MSLB. Therefore, the reliability of this system is important to plant safety.

The NRC investigation of the Davis Besse event indicated that the potential inability to remove decay heat from the reactor core was due to the questionable reliability of the EFWS caused by any or all of the following:

- loss of all EFW due to common-mode failure of the pump discharge isolation valves to open
- excessive delay in recovering EFW because of a difficulty in restarting the pump steam-driven turbines once they tripped
- interruption of EFW flow because of failures in steamline break and feedline break accident mitigation features

In addition, the investigation of the event indicated that (1) a two-train system with a steam turbine-driven EFW pump may not be able to achieve the desired level of reliability and (2) the provision to automatically isolate EFW from a SG affected by a main steamline or feedwater-line break may tend to increase the risk that adequate DHR is not available, rather than to decrease it.

In Section 1.9.4 of the SSAR, Westinghouse states that this issue is not applicable to the AP600 design because the design does not have a safety-related auxiliary feedwater system. The passive core cooling system is stated to provide the safety-related function of cooling the RCS in the event of loss of feedwater to the SGs. The startup feedwater system (SFS), which has no safety-related function beyond containment isolation, provides the SGs with feedwater during plant conditions of startup, hot standby, cooldown, and when the main feedwater pumps are unavailable.

This issue required the use of a plant PRA to demonstrate the reliability of the auxiliary feedwater system (AFS), or EFW system, to have a minimum reliability of 1.0E-4 unavailability/demand to ensure its reliability/availability. Westinghouse contended that this issue is not applicable to the AP600 design because the design does not have a safety-related AFS and the passive core cooling system for the design provides the safety related function of cooling the RCS in the event of loss of feedwater. The SFS has no safety-related function.

The staff in SECY-94-084, however, has established a process of regulatory treatment of non-safety systems (RTNSS) for identifying risk significant non-safety-related active systems for regulatory treatment. Therefore, the SFS reliability remains an open issue as it will be subject to this RTNSS evaluation. This is Open Item 20.3-19 (650.20F).

The resolution of Issue 124 for the AP600 design will be addressed after the staff completes its review of the reliability of the SFS.

Therefore, Issue 124 is not resolved for the AP600 design.

Response:

Note - SFS represents the spent fuel cooling system for AP600. The startup feedwater is part of the main and startup feedwater system (FWS).

The RTNSS evaluation was provided in WCAP-13856, "AP600 Implementation of the Regulatory Treatment of Nonsafety-Related Systems Process." Short-term availability controls are the outcome of the RTNSS process, and are placed on those nonsafety-related SSCs determined to be RTNSS important. The availability controls are located in SSAR section 16.3. The startup feedwater system was not identified as requiring any further regulatory treatment.

The design-reliability assurance program (D-RAP) (SSAR section 17.4) identifies the startup feedwater pumps as a risk-important SSC. Note that the startup feedwater system is included in the D-RAP only as a result of the expert panel and not as an outcome of the PRA insights or of the quantitative PRA risk-important measures used in the D-RAP.

The startup feedwater system was not identified as risk-important by the RTNSS process. No further analysis is required to resolve Issue 124.

SSAR Revision: None.

Question: 720.415F (OITS # 5897)

Question 720.415F

EQUIPMENT SURVIVABILITY

The instrumentation and equipment required for severe accident mitigation and recovery should be demonstrated to operate in the applicable environment by inspections, tests, and acceptance criteria (ITAAC). The demonstration process used to provide reasonable assurance that the instrumentation and equipment will operate will include one or more of the following factors: limited time period in or exposure to the environment, the use of similar equipment in commercial industry exposed to a similar environment, the use of analytical extrapolations, the use of vendor performance data, the use of procurement specifications imposed on the vendor, or the results of tests performed in the nuclear industry or at independent laboratories. This demonstration has not been incorporated into the ITAAC and is an open item.

Response:

The PRA has identified the equipment and instrument required for severe accident mitigation, the environment for each location, and the post-event time frames when performance is expected. Installed equipment and instrumentation that may be utilized during a severe accident scenario and exposed to the severe accident environment is qualified for design basis event environments and has been included in the AP600 Certified Design Material (CDM).

An industry test program (EPRI NP-4354) has provided the high confidence discussed in SECY-90-016 that equipment and instrumentation qualified for design basis events will survive the effects of a severe accident and perform satisfactorily. Based on the results of the industry test program and the required performance time frames, it has been determined that the AP600 design basis event qualification programs are sufficient to provide a reasonable level of assurance that the required equipment and instrumentation will function during the severe accident time frames specified. Therefore, no special procurement requirements other than the 1E qualification program are necessary for equipment expected to perform during severe accidents.

For example, for the Reactor Coolant System (RCS), CDM Section 2.1.2, item 7.a) of the Design Description (DD) states "The Class 1E equipment identified in Table 2.1.2-1 as being qualified for a harsh environment can withstand the environmental conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function." Referring to Table 2.1.2-1, the equipment listed includes sensors that have been identified as Class 1E, e.g., system pressure from the RCS Wide Range Pressure Sensors and hot leg temperature from the RCS Hot Leg Wide Range Temperature Sensors. These same sensors have been identified in the Probabilistic Risk Assessment (PRA) as required for severe accident mitigation and recovery.

Although the Design Commitment is related to a design basis accident scenario, an additional ITAAC for environmental conditions is not required as the environmental envelope for the design basis accident scenario provides reasonable assurance that the same equipment and instrumentation will continue to operate under severe accident conditions.

Thus, an ITAAC for equipment and instrumentation needed for severe accident mitigation and recovery is not required because the same equipment is used during a design basis accident scenario, is already included in the AP600 Certified Design Material, and is identified with respect to Class 1E and harsh environment qualification as a Design Commitment.

SSAR Revision: None

PRA Revision: None

ITAAC Revision: None

Question: 720.421F (OITS # 6133)

Accident Management (19.2.5)

Westinghouse has adequately addressed design features to facilitate (or eliminate the need for) accident management in the AP600 design with the exception of containment venting. Although venting is not expected to be necessary in most sequences in AP600, it may be needed in the event of reactor vessel failure (since deterministic calculations indicate that early containment failure from steam explosion is not likely). Westinghouse has indicated that the AP600 has no containment vent. However, in Appendix D of the PRA (equipment survivability, Table D.6-1) high level actions to vent and to depressurize containment are called out, but related equipment is not identified or discussed. Also, in WCAP-13914, Revision 2 (Section 5.9), it is indicated that methods that may be used to vent the AP600 containment will be investigated during a later phase of the development of the severe accident management guidance, but nothing more has been provided. Although the development of detailed guidance and procedures is the responsibility of the COL applicant, the capability to vent and any associated equipment specifications should be established by the designer prior to Design Certification. This is Open Item 19.2.5-1.

Response:

A containment vent path is available with the AP600 design configuration. The pathway was presented in the response to FSER open item 720.414F (Westinghouse letter DCP/NRC1179, December 11, 1997) and discussed in detail with the staff during a telecon on December 16, 1997.

The containment vent path has been added to the equipment survivability assessment in Appendix D of PRA Revision 11.

WCAP-13914 will be revised to include a discussion to vent, as requested by the NRC in FSER open item 720.422F.

SSAR Revision: None.

PRA Revision: A markup of Appendix D for PRA Revision 11 will be provided under separate cover.