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DCP/NRC1263
NSD-NRC-98-5579
Docket No.: 52-003

February 20, 1998

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 enclosures 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.

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

jml

Enclosure

E004

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

Table 1
List of FSER Open Items Included in Letter DCP/NRC1263

FSER Open Item	OITS Number	Westinghouse status in OITS
480.1105	6374	Action N
480.1108	6377	Action N

Enclosure to Westinghouse
Letter DCP/NRC1263

February 20, 1998

Question: 480.1105 (OITS 6374) Response Revision 1

No information can be found on the drag induced forces acting on structure or piping submerged in the IRWST. Since the AP600 has submerged piping within the IRWST, the drag forces acting on those structures would need to be addressed. Those forces would include both the standard drag load associated with a structure within a constant velocity fluid field and the acceleration drag load from forces associated with fluid acceleration. Please provide the methodology used to calculate the drag force on submerged piping and structural columns within the IRWST. Also, include the results of the analyses.

The following is from the NRC assessment of responses provided January 22, 1998.

No reference was provided and we have not found any discussion on drag forces acting on submerged structures within the IRWST pool. The discussion provided by Westinghouse states that piping drag loads are lower but structural columns with in close proximity of the sparger have a significant drag. No analytical basis was provided in the RAI response and the tail-pipe attached to the sparger would also be in close proximity and therefore experience similar loads to the structural columns. Also no basis was provided for the 7 psi acting on the structural columns.

Response: Revision 1

WCAP-13891, "AP600 Automatic Depressurization System Phase A Test Data Report," was intended to provide only the test results and therefore does not contain the results of analyses subsequently performed. The drag forces due to moving fluid and due to fluid acceleration are considered for both the structural columns and submerged piping as described below.

Drag and acceleration drag due to hydrodynamic forces resulting from sparger operation have been quantified as part of the analysis for the passive residual heat removal heat exchanger. These forces are very small and were not limiting in the structural analysis of the heat exchanger in the IRWST. The drag forces due to the movement/circulation of fluid in the IRWST were determined based on the circulation velocity and fluid behavior observed in numerous Phase A and B1 testing blowdowns performed over the full range of expected AP600 conditions. For the submerged piping, the drag forces are small compared to the dead weight, thermal, and seismic piping loads already considered, and therefore no specific analysis is required. Since the structural columns within the IRWST are closer to the sparger and are directly in the path of fluid movement induced by sparger operation, the drag forces can be significant. For these columns the drag forces have been considered in a sizing calculation by applying a conservative force of 7 psi on the entire projected area of these columns. The resultant applied shear force of 1512 lb. per foot of length conservatively accounts for both the drag forces and acceleration drag due to hydrodynamic forces resulting from sparger operation, and is combined with the other live and dead loads in determining the column stresses.

Subsequent to the sizing calculation, an analysis that provides a more accurate model of the hydrodynamic loads in the IRWST was completed. The determination of the hydrodynamic loads on the structural columns and piping in the IRWST follows the same approach as for the PRHR heat exchanger. This approach includes the velocity drag and the acceleration drag resulting from the forcing function of the hydrodynamic loads. The forcing function is developed as follows:

- The S'(t) function , bubble volumetric acceleration ft^3/sec^2, is evaluated for selected tests from the Phase B ADS blowdown testing, based on wall pressure measurements, taking into account one oscillating bubble.

- The time histories are integrated to obtain the S(t) function (ft^3/sec) which describes the evolution of the bubble volume as a function of time.

- The speed of the bubble surface is calculated using geometric consideration and assuming a suitable bubble reference volume.

- Development of the local forcing function on the support columns is made using the dependence from the distance of the force (proportional to the square of the distance). The data on the different elevation of the support columns is used for the structural analysis.

- Forces on the piping are provided at selected locations.

The structural analysis of the columns is done using the ANSYS code with the column modeled with 2D elements and fixed on both ends. A different time history is used for each of the hydrodynamic load cases evaluated. Since the loads are strongly dependent on the distance from the sparger, the column is divided into ten segments and the appropriate forcing function is applied to each segment. The applied loads and the moments in the column are well below the values determined in the sizing calculation which used the 7 psi pressure for the load.

The structural columns in the IRWST are sized to support the loads due to the integrated head assembly setting on the stand above the columns. During an ADS blowdown the head must be on the reactor vessel and the columns are therefore not heavily loaded.

The piping analysis is done using a conservative static analysis. The piping model includes the response of the sparger. The location of the highest stress due to the hydrodynamic loads is at the elbow at the top of the vertical section of pipe attached to the sparger. There are relatively small stress values due to forces on the vertical section of pipe. The highest loads are due to forces pushing up on the horizontal sections of pipe connected to the elbow. The horizontal sections are located just below the top of the tank. The distance between the sparger and the horizontal pipe significantly reduces the drag forces on the piping system. The stresses are less than allowable values.

The use of the 7 psi pressure in the sizing calculation was a conservative assumption based on experience and engineering judgement. Relatively simple design changes could have been made if the sizing calculation proved not to be conservative. These include bracing the columns, making the walls of the columns thicker, and adding a support for the piping.

The calculations for the forcing functions, analysis of the columns and piping analysis are available for review by the NRC staff.

SSAR Revision: None

Question: 480.1108 (OITS 6377) Response Revision 1

The IRWST attached piping and submerged structures such as the support columns, "Integrated HD Support" as shown on drawing 1030 P2 001, revision 7 could experience an acceleration and or drag force from the IRWST tank during a quencher discharge. Please provide a discussion on the magnitude for those accelerations and forces and explain how those accelerations and forces were developed.

Response: Revision 1

Please refer to the response for RAI 480.1105. The velocity drag and acceleration drag are included in the forcing function used to evaluate the loads on the structural columns and piping in the IRWST.

SSAR Revision: None