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Energy Systems

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NSD-NRC-96-4883
DCP/NRC0659
Docket No.: STN-52-003

November 11, 1996

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

ATTENTION: T. R. QUAY

SUBJECT: RESPONSES TO DSER OPEN ITEMS 3.6.2.3-2 AND 3.12.3-1

Dear Mr. Quay:

Attached are responses to DSER open items 3.6.2.3-2 and 3.12.3-1. These items are related to the pipe rupture hazard analysis and piping analysis.

The response to 3.6.2.3-2 presents a significant revision of SSAR subsection 3.6.2.5 and a new Table 3.6-3. The information presented in the new Table 3.6-3 is still being finalized. The list of equipment may change. The final resolution of leak-before-break issues may affect the rooms and equipment in the rooms included on the table. The table is provided in this preliminary form so that the staff may use it to understand the approach to the AP600 pipe rupture hazard evaluation and the scope of the information to included in the table. We expect that the table can be finalized before and during the scheduled meeting on pipe rupture and LBB issues.

This transmittal completes the Westinghouse responses to items related to pipe rupture hazard analysis and the piping analysis in anticipation of an NRC meeting and audit of these subjects.

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

/nja

Attachment

E004 1/1

cc: D. Jackson, NRC
N. Liparulo, Westinghouse (w/o attachments)

16. Open Item 3.6.2.3-1 (OITS #595) - Sketches of break locations & stress summary Action Westinghouse

These sketches and data summaries are currently not available. Westinghouse plans to complete the AP600 pipe break analyses some time in the future as part of design certification, subsequent to which the sketches and data summaries will be available. In the DSER, Westinghouse was requested to inform the staff when these analyses will be available for staff review. This was DSER Open Item 3.6.2.3-1. Revision 7 to Section 3.6.2.5 of the SSAR added a description of the pipe rupture hazards analysis that will be performed as a part of the design certification scope. Revision 7 also revised SSAR Section 3.6.4.1 to state that the COL applicants referencing the AP600 certified design will address as built reconciliation of this hazards analysis. The description of the hazards analysis in SSAR Section 3.6.2.5 includes the information requested by the staff in this open item, and is acceptable. Therefore, this part of Open Item 3.6.2.3-1 is resolved. However, SSAR Section 3.6.2.5 should be further revised in accordance with the request which is discussed as a part of Open Item 3.6.2.3-5.

As discussed in Section 3.6.2.3 of the DSER, part of Open Item 3.6.2.3-1 included a staff review of AP600 Document No. GW-N1-001, "Pipe Rupture Design Criteria," Revision B dated April 26, 1991, which was transmitted to the staff in a letter dated April 14, 1994. The staff's preliminary review has determined that, because this document was issued in 1991, there are several inconsistencies between this document and the SSAR. It is the staff's understanding that the piping designers will use the criteria in GW-N1-001 for the postulation of pipe breaks. Therefore, the staff will require a commitment in the SSAR that the criteria in GW-N1-001 and applicable portions of SSAR Sections 3.6.1, 3.6.2 and 3.6.3 are identical. The OITS for Item 595 implies that Revision 7 to SSAR Section 3.6 contains this commitment. However, the location of this change in Section 3.6 is not apparent to the staff. In a letter from McIntyre to NRC dated June 11, 1996, part of the response to Open Item 3.6.3.6-3 stated that reference to an internal Westinghouse design criteria document is not appropriate for Design Certification. Since the staff's review determined that GW-N1-001 is not consistent with the SSAR, the staff needs a commitment similar to that stated above. Therefore, this part of Open Item 3.6.2.3-1 remains open.

Response

Open Item 3.6.2.3-5 was addressed previously in Westinghouse Letter NSD-NRC-96-4857, dated October 23, 1996 which committed to a revised criteria in 3.6.1 of the SSAR similar to the ABWR criteria. Revision of SSAR subsection 3.6.2.5 is not required as part of that response.

Westinghouse will provide a copy of the latest revision of GW-N1-001 for review during the NRC audit of piping analysis and LBB evaluation. The revision will update the criteria to be consistent with the criteria in the SSAR which have been accepted by the NRC.

SSAR subsection 3.6.2.5 will be revised as shown below to provide additional information on pipe break hazard analysis.

This item is Resolved pending the staff audit of the piping analysis and pipe break hazards analysis and incorporation of the SSAR changes into a final SSAR revision.

Revise subsection 3.6.2.5 as shown below.

3.6.2.5 Evaluation of Dynamic Effects of Pipe Ruptures ~~on As-Built Piping Systems~~

The preceding information provides the criteria and methods for the evaluation of the dynamic effects of pipe ruptures ~~on piping systems~~. The pipe rupture hazard analysis includes the following:

- Prepare a stress summary
- Identify pipe break locations in high energy piping.
- Identify through-wall crack locations in high and moderate energy piping
- Identify and locate essential structures, systems, and components
- Evaluate consequences of pipe whip and jet impingement
  - For rooms with both high energy breaks and essential items, confirm that there is no adverse interaction between the essential items and the whipping pipe or jet.
  - The plant layout is modified as required to provide separation to protect essential systems.
- Evaluate consequences of flooding, environment, and compartment pressurization
- Design and locate protective hardware
  - Prepare isometric piping sketches that identify the break locations, the basis for these locations and the protective hardware which mitigates the consequences of these breaks
- Reconciliation of as-built condition.

Pipe breaks that are larger than 1 inch nominal diameter are evaluated for pipe whip and jet impingement. Lines that are located in a break exclusion zone or are qualified to leak-before-break are not evaluated for pipe whip and jet impingement effects on systems and components, except for the portions of the lines in the MSIV compartment adjacent to the main control room as noted in subsection 3.6.1.2.2.

Where these systems are qualified for mechanistic pipe break and pipe rupture loads prior to fabrication, the qualification is based on design information, not on as-built information. As-built information and the final configuration of valves and other equipment ~~included in the piping system~~ is used to verify the design analysis.

High energy Break Locations

High energy break locations evaluated are on the nuclear island and and in the turbine building for evaluation of the wall loadings in the south end of the turbine building adjacent to the main control room.

For ASME Class 1 piping terminal end locations are determined from the piping isometric drawings. Intermediate break locations depend on the ASME Code stress report fatigue analysis results. These results are not available at design certification. For the design of the AP600, breaks are postulated at locations typically associated with a high cumulative fatigue usage factor. These locations are at valves, tees, and branch connections which have significant structural discontinuities. The combined license applicant will evaluate these locations as part of the as-built reconciliation, (see subsection 3.6.4.1). The following ASME Class 1 lines are evaluated for terminal end and intermediate high energy break locations if applicable.

Line	Diameter (inches)
Automatic Depressurization Stage 1	4
Chemical and Volume Control Letdown	3
Chemical and Volume Control Makeup	3
Pressurizer Auxiliary Spray	2

For ASME Class 2 and 3 piping, terminal end break locations are determined from the piping isometric drawings. The intermediate break locations depend on the stress level. The AP600 ASME Class 2 and 3 lines do not have intermediate breaks based on the low stress. The following ASME Class 2 and 3 lines have terminal end high energy break locations.

Line	Diameter (inches)
Startup Feedwater	6
Steam Generator Blowdown	4

For B31.1 piping, terminal end break locations are determined from the piping isometric drawings. The intermediate break locations in seismically analyzed pipe depend on the stress level. The AP600 ASME seismically analyzed B31.1 piping does not have intermediate breaks based on the low stress. For nonseismically analyzed high-energy ASME B31.1 piping, intermediate breaks locations are postulated at each fitting.

Rooms that contain high energy pipe break locations are listed in Table 3.6-2.

Essential Systems and Components

In rooms that contain high energy pipe breaks, the systems and components that are needed to mitigate the postulated break and achieve a safe plant shutdown are identified. Rooms that

contain both high energy pipe break locations and essential systems and components are listed in Table 3.6-3.

Essential Target Evaluation

To complete the essential target evaluation jet parameters, volumetric area of affected compartments, plant layout, and separating structures are considered. Parameters that determine the shape of the jet and the magnitude of the jet and thrust loads include pressure, temperature, and friction losses between the break and the reservoir. The volumetric area affected is determined by considering jet shape and loads at the postulated location of the breaks. Where an initial evaluation of essential targets indicated adverse effects, layout may be changed to relocate the target or postulated break. If necessary, the location of whip restraints and jet shields is established to protect essential systems and components. Essential equipment protected by pipe whip restraints or jet shields is listed in Table 3.6-3

Verification of the Pipe Break Hazard Analysis

The ASME Code, Section III, requires that each plant have a Design Report for the piping system that includes as-built information. Included in the Design Reports are the loads and loading combinations used in the analysis. Where mechanistic pipe break requirements are used to eliminate the evaluation of dynamic effects of pipe rupture in ASME Code, Section III, Class 1, 2, and 3 piping system, the basis for the exclusion is documented in the Design Report.

As-built reconciliation of the pipe break hazard analysis is addressed by the Combined License applicant.

Add Table 3.6-3 as follows:

Table 3.6-3

Rooms with High Energy Pipe Breaks and Potential Essential Target Interaction

Elevation	Room Numbers*	Essential Equipment Protected by Whip Restraints or Jet Shields
66'-6"	None	
82'-6"	11204	None
	11209	None
96'-6"	11204	None
	11209	None

100'-0" and 107'-2"	11209 Pipe tunnel	CVS and SGS steam generator blowdown piping
	11300	PXS PRHR valves PXS-PL-V108A & B PRHR flow instruments RCS cold leg flow instruments
	11301	None
	11303/11304	SGS Piping
117'-6"	11400	None
	11401	None
	11402	Steam Generator supports are protected from a break located in room 11400
	11403	None
135'-3"	None	
160'-6" and 153'-0"	11601	RCS head vent piping
	11602	None
	11603	RCS ADS valves 002B, 003B, 012B, & 013B Cables for ADS Stage 2 & 3
	11703	RCS ADS valves 002A, 003A, 012A, & 013A Cables for ADS Stage 2 & 3

* See Figures 1.2-1 through 1.2-8, 1.2-10, and 1.2-11 for room numbers

3.12.3-1 (OITS #822)

1. 100-40-40 method is not used for piping systems
   W Status **Closed** NRC Status Resolved
2.a. Size of integration time step
   W Status **Closed** - SSAR Rev. 9 subsection 3.7.3.17 paragraph 2 addressed this issue
2.b. Provide a description of the method to account for modeling uncertainties such as time history broadening
   W Status Action W - Revise 3.7.3.17 to address broadening

Response

The reactor coolant loop is analyzed for the range of soil cases included in the building seismic analyses described in subsection 3.7.1.4. A response spectrum analysis is performed for the three soil cases using floor response spectra that envelope the results of the soft-to-medium soil, upper bound to the soft-to-medium soil, and soft rock cases broadened by ± 15%. A time history analysis is performed for the hard rock case using a coupled model of the reactor coolant loop and the containment internal structures stick model with time history input at the base of the stick model. The responses of the containment internal structures for the four design soil profiles are shown in Figure 3.7.2-17. The floor response spectra at elevation 98.1' (sheets 1 and 2) show the horizontal input to the reactor vessel and steam generator lower lateral supports. The floor response spectra at elevation 135'3" (sheets 4 and 5) show the horizontal input to the steam generator upper lateral supports. The containment internal structures are stiff. The key responses to be included in the soil cases are the rocking of the building at frequencies between 2 and 4 hertz. This is well represented by the envelope of the floor response spectra for the soil cases. The broadening of the spectra by ± 15% accounts for uncertainty. The key responses to be included in the hard rock case are the fundamental frequencies of the containment internal structures around 15 hertz. The variability in this response is accounted for by varying the building stiffness by ± 30%. The time history input at the bottom of the stick model is almost the same as the ground input time history and uncertainties in developing this time history from the ground response spectra are negligible.

Subsection 3.7.3.17, paragraph 3, of the SSAR will be revised as follows:

~~For seismic analysis, there are two methods for accounting for uncertainties.~~ Four separate soil cases, as described in subsection 3.7.1.4 are considered in the seismic analysis. One approach is to perform time history analysis for each soil case. Another approach is to perform time history analysis for the hard rock soil case and a single response spectra analysis for the remaining three soil cases. For time history analysis of piping system models that include a dynamic model of the supporting concrete building either the building stiffness is varied by + or - 30 percent, or the time scale is shifted by + or - 15 percent, to account for uncertainties ~~, three separate analyses are performed for each soil case to account for uncertainties. The three analyses correspond to three different time scales: normal time, time expanded by 15 percent, and time compressed by 15 percent.~~ Alternately, when uniform enveloping time history analysis is performed, modelling uncertainties are accounted for by the spreading that is included in the

broadened response spectra. In this case, the four soils are accounted for in the broadened response spectra.

This item is Resolved pending formal revision of the SSAR.

2.c. The application of composite modal damping should be limited to account for variations of damping with pipe size.
W Status **Closed** - SSAR Rev. 9 subsection 3.7.3.17 paragraph 5 addressed this issue