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NSD-NRC-96-4857
DCP/NRC0635
Docket No.: STN-52-003

October 23, 1996

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

ATTENTION: T. R. QUAY

SUBJECT: RESPONSES TO NRC MECHANICAL ENGINEERING BRANCH QUESTIONS INCLUDING HIGH-ENERGY LINE BREAK

Dear Mr. Quay:

Attached are responses to several open items discussed in NRC letter dated August 20, 1996. These items were Mechanical Engineering Branch questions in the ECGB scope of view. The synopsis of the NRC position comes from the NRC letter. The questions are identified by the numbers from the letter, DSER open item, and OITS number. The questions addressed in the attachment include questions related to high-energy line break, piping supports, and the initial test program.

This submittal will permit completion of the staff review for items included and preparation of the Final Safety Evaluation Report.

Please contact Donald A. Lindgren at (412) 374-4856 if you have additional questions.

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

/nja

Attachment

cc: D. T. Jackson, NRC
N. J. Liparulo, Westinghouse (w/o Attachments)

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Enclosed Responses to NRC Request for Additional Information
Letter NSD-NRC-96-4857

From NRC letter dated August 20, 1998

Question 13. - Open Item 3.6.2-1
Question 15. - RAI# 210.40
Question 18. - Open Item 3.6.2.3-5
Question 19. - Open Item 3.9.2.1-1
Question 26. - Open Item 3.9.3.3-1
Question 27. - Open Item 3.9.3.3-2

Confirmatory Items
Item 7. - DSER CN 3.9.2.1-4
Item 8. - DSER CN 3.9.2.3-1

13. Open Item 3.6.2-1 (592) - 3 inch line break in subcompartments --Action Westinghouse

In the DSER, the staff reported that Section 3.6.1 of the SSAR, Revision 0, indicated that structures inside containment containing high-energy piping are evaluated for pressurization loads due to a break area equivalent to a 7.6 cm (3-inch) nominal pipe size (NPS) primary system pipe. During the piping design review meetings, the staff informed Westinghouse that even if leak-before-break (LBB) is approved in a particular subcompartment, the 7.6 cm (3-inch) break might not be the controlling design criteria. The staff's position is that a minimum subcompartment design pressure must be determined for designing the subcompartment walls and floors. This pressure should bound the effects of a high energy intermediate pipe break, with consideration of LBB acceptance. This was DSER Open Item 3.6.2-1. In Revision 4 to the SSAR, Westinghouse responded to this open item by deleting the 3-inch break criterion from Section 3.6.1, and referencing SSAR Sections 3.8.3.4 and 3.8.4.3.1.4. Section 3.8.3.4 states that subcompartments inside containment containing high-energy piping are designed for a pressurization load of 5 psi, and Section 3.8.4.3.1.4 states that the main steam isolation valve (MSIV) and steam generator blowdown compartments are designed for a pressurization load of 5 psi. During a review meeting on July 25 & 26, 1995, in response to a staff request for justification for the 5 psi pressurization load, Westinghouse agreed to another SSAR revision to define the 5 psi criterion as the minimum design pressure and include provisions for compartments that require a higher design pressure. In particular, the last paragraph of SSAR Section 3.6.1 and the definition of pressure load in Section 3.8.4.3.1.4 should be revised to specify that (1) the MSIV compartments are designed for pressurization loads due to the worst case of the 5 psi load and the worst case 1.0 sq. ft. main steam or feedwater line break, and (2) the steam generator valve compartments are designed for pressurization loads due to the worst case of the 5 psi load and the worst case double ended pipe rupture in the four-inch diameter steam generator blow down piping. In addition, this SSAR revision will add a COL requirement to verify the adequacy of subcompartment design pressure. The staff has not yet received this revision. Therefore, DSER Open Item 3.6.2-1 is still unresolved.

Response

Subsection 3.6.1.2.2 of Revision 7 of the SSAR identifies that the pipe whip and jet impingement loads from a break in the MSIV compartment adjacent to the main control room must be considered along with pressurization from a 1 square foot break. The final paragraph of subsection 3.6.1 of the SSAR Revision 7 also notes that the floor and east wall of the compartment are evaluated for pipe whip and jet impingement loads.

The blowdown piping is not located in the MSIV compartment. The room in which it is located vents into an MSIV compartment. A break of the 4-inch blowdown pipe is evaluated to verify that the design pressure of the penetration room and MSIV compartment is not exceeded.

Westinghouse has completed the evaluation of the adequacy of the subcompartment design and has verified the adequacy of the 5 psi criterion except for one compartment. The pressure for the CVS room pipe tunnel is being changed to 7.5 psi. SSAR subsection 3.8.3.4 will be revised to reflect this change.

Subsection 3.6.4.1 addresses reconciliation of the pipe break hazard analysis by the Combined License applicant with as-built piping.

The sixth paragraph of subsection 3.8.3.5 of the SSAR will be revised as follows.

The determination of pressure and temperature loads due to pipe breaks is described in subsections 3.6.1 and 6.2.1.2. Subcompartments inside containment containing high energy piping are designed for a pressurization load of 5 psi. **The pipe tunnel in the CVS room (room 11209, Figure 1.2-6) is designed for a pressurization load of 7.5 psi.** The design for the effects of postulated pipe breaks is performed as described in subsection 3.6.2. Determination of pressure loads resulting from actuation of the automatic depressurization system is described in subsection 3.8.3.4.3.

This item is Resolved pending the formal SSAR revision.

15. RAI# 210.40 - (3702) Break exclusion in Steam Generator (SG) and Startup Feedwater (FW) Lines Action Westinghouse

The SG blowdown lines were not addressed in the response to Q210.40. In addition, Revision 4 to SSAR Section 3.6.2.1.1.4 added the outboard high-energy portion of the startup FW piping (located between the containment penetration and the first closed valve in the auxiliary building) to the list of break exclusion zones. During the meeting with Westinghouse on July 25 & 26, 1995, the staff requested a more detailed basis for the break exclusion zones in these two piping systems. In response to this request, Westinghouse stated that, in addition to the break exclusion criteria in SSAR Section 3.6.2.1.1.4, which is consistent with SRP 3.6.2, the 4 inch diameter SG blowdown and startup FW lines will be subjected to an augmented in-service inspection (ISI) program in the break exclusion zones, which is beyond the ISI requirements of the ASME Section XI Code. The staff requested that this commitment be included in the SSAR. Revision 7 does not contain this commitment. However, Revision 7 changed the start-up FW break exclusion zone to be between the containment penetration and the auxiliary building anchor upstream of the isolation valve. Westinghouse is requested to be prepared to discuss the length of piping included in this latest change in the startup FW break exclusion zone.

In SSAR Revision 4, Table 3.6-1 contained a footnote that stated, in part, that the start-up FW lines are classified as moderate energy based on the 1 percent of plant operating time criteria. In Revision 7, this part of the footnote was deleted, and Table 3.6-2, p. 6 was revised to identify the startup FW as being in the break exclusion zone. Westinghouse is requested to be prepared to discuss the significance of these changes during the next meeting.

Since this issue originated after the issuance of the DSER, it is not identified by a DSER Open Item Number. However, the issue remains unresolved until the staff understands the extent of the start-up FW changes and receives an acceptable revision to the SSAR.

Response

SSAR subsection 3.6.2.1.1.4, Revision 7 identifies the requirements for piping in the break exclusion areas. This section identified the portion of the startup feedwater line included in the break exclusion area. The extent of the startup feedwater lines included in the break exclusion zone is also defined in Figure 3E-1. Additional information on the startup feedwater line including the isometric drawings will be provided during the NRC staff audit of high energy piping.

SSAR subsection 3.6.2.1.1.4, Revision 7 commits to 100 percent volumetric inspection of welds in high energy pipe within the containment penetration areas. This is the augmented inspection. This requirement applies to pipe of 4-inch size and larger.

Design changes and reanalysis of the use of the startup feedwater line resulted in the determination that the startup feedwater line can not be excluded from classification as high energy pipe. Footnote a to Table 3.6-1 was changed to reflect this change. The startup feedwater line is included in the MSIV compartment in Table 3.6-1

No SSAR revision is required to resolve this item.

This item is closed.

18. Open Item 3.6.2.3-5 (599) - Separating structures - RAI# 210.76
    Action Westinghouse

Section B.1.c.(4) BTP MEB 3-1 states that in other than containment penetration areas, if a structure separates a high-energy line from an essential component, the separating structure should be designed to withstand the consequences of the pipe break in the high-energy line which produces the greatest effect at the structure, irrespective of the fact that the pipe rupture criteria in BTP MEB 3-1 might not require such a break location to be postulated. In Q210.76, the staff observed that: 1) Section 3.6.2 of the SSAR, Revision 0, did not appear to address this BTP MEB 3-1 guideline, and 2) Revision 1 to WCAP-13054 takes exception to this criterion and states that separating structures are designed for postulated terminal end breaks and breaks at the high stress locations. This exception is not completely acceptable. The staff requested Westinghouse to revise Section 3.6.2 of the SSAR to add a commitment to this position and delete the exception to this guideline in WCAP-13054. In the July 27, 1994 response to Q210.76, Westinghouse provided, in part, criteria for structures in the MS&FW system, and SG blowdown break exclusion zones for subcompartment pressurization effects. This part of the response has been evaluated in Open Items 3.6.2-1 and 3.6.2.2-1. However, the part of the response relative to structures outside the containment penetration area was not acceptable. In the DSER, the staff stated that Westinghouse should modify the SSAR to incorporate this BTP MEB-1 criterion for structures separating high-energy lines from essential components outside the containment penetration area and delete the exception to this guideline in WCAP-13054. This was DSER Open Item 3.6.2.3-5. The staff has determined that an acceptable procedure for resolving this open item would be for Westinghouse to (1) revise SSAR Section 3.6.2.5 as requested in Open Item 3.6.2.3-1, which is discussed above, and (2) further revise SSAR Section 3.6.2.5 to include in the description of the activities in the COL hazards analysis a commitment that will satisfy the BTP MEB 3-1 criterion.

In addition, the exception to this guideline in WCAP-13054 should be deleted. Pending receipt of an acceptable SSAR and WCAP revisions, DSER Open Item 3.6.2.3-5 remains open.

Response

The NRC staff has referred to the ABWR for an example of an acceptable commitment to MEB 3-1. Westinghouse reviewed these commitments for the ABWR. We understand that the criteria in question applies when physical separation is not possible and a structure is required for separation. The following revision to subsection 3.6.1.3.2 including a similar commitment to the criteria is proposed for the AP600.

3.6.1.3.2 Protection Mechanisms

The plant arrangement is based on maximizing the physical separation of redundant or diverse safety-related components and systems from each other and from nonsafety-related items. Therefore, in the event a pipe failure occurs, there is a minimal effect on other essential systems or components required for safe shutdown of the plant or to mitigate the consequences of the failure.

The effects associated with a particular pipe failure are mechanistically consistent with the failure. Thus, pipe dimensions, piping layouts, material properties, and equipment arrangements are considered in defining the specific measures for protection against the consequences of postulated failures.

Protection against the dynamic effects of pipe failures is provided by physical separation of systems and components, barriers, equipment shields, and pipe whip restraints. The precise method chosen depends largely upon considerations such as accessibility and maintenance. The preferred method of providing protection is by separation. When separation is not practical **pipe whip restraints** ~~barriers or shields~~ are used. **Barriers or shields** ~~Pipe whip restraints~~ are used when neither separation nor barriers or shields are practical. This protection is not required when piping satisfies leak-before-break criteria.

Separation

The plant arrangement provides separation, to the extent practicable, between redundant safety systems (including their appurtenances) to prevent loss of safety function as a result of events for which the system is required to be functional. Separation between redundant safety systems, with their related appurtenances, therefore, is the basic protective measure incorporated in the design to protect against the dynamic effects of postulated pipe failures.

In general, separation is achieved by:

- Safety-related systems located remotely from high-energy piping, where practicable
- Redundant safety systems located in separate compartments, where practicable

- Specific components enclosed to retain the redundancy required for those systems that must function to mitigate specific piping failures

- Drainage systems provided for flooding control

Where physical separation is not possible, the pipe rupture hazard analysis includes an evaluation to determine the systems and components that require a structure for separation from the effects of a break in a high energy line. For these structures specifically included to separate breaks from essential systems or components, the evaluation considers that the break may be at the closest point in the line to the separating structure; not only at the break locations identified in subsection 3.6.2.1.1. High energy lines qualified as leak-before-break lines and the lines in containment penetration break exclusion areas are not included as possible break locations in this evaluation. For a discussion of the information included in the pipe rupture hazard analysis see subsection 3.6.2.5.

Barriers and Shields

Protection requirements are met through the protection afforded by walls, floors, columns, abutments, and foundations. Where adequate protection does not already exist as a result of separation, a separating structure such as additional barriers, deflectors, or shields is ~~are~~ provided to meet the functional protection requirements.

Inside the containment, the secondary shield wall serves as a barrier between the reactor coolant loops and the containment. In addition, the refueling cavity walls, operating floor, and secondary shield walls minimize the possibility of an accident that may occur in any one reactor coolant loop affecting the other loop or the containment. Those portions of the steam and feedwater lines located within the containment are routed in such a manner that possible interaction between these lines and the reactor coolant piping is minimized. The direct vessel injection valves for train A and train B are separated by the secondary shield wall.

Barriers and shields that are identified as required by the pipe rupture hazard analysis are designed for loads from a break in the line at the closest location to the structure. This criterion is in conformance with the guidance of Branch Technical Position MEB 3-1, Rev. 2. Subsection 3.6.2.4 further discusses barriers and shields.

This item is Resolved pending formal revision of the SSAR.

19. Open Item 3.9.2.1-1 (780) - Scope of preoperational piping tests Action Westinghouse

Section 3.9.2 of the SRP states that the systems to be monitored during these tests should include

- ASME Code, Class 1, 2, and 3 piping systems

- high-energy piping systems inside seismic Category I structures

- high-energy portions of systems whose failure could reduce the functioning of seismic Category I plant features to an unacceptable safety level
- seismic Category I portions of moderate-energy piping systems located outside the containment

Section 3.9.2.1 of the SSAR, Revision 1 only stated that these tests will be conducted on ASME Class 1, 2, & 3 and other high energy piping systems, and Sections 14.2.8.1.77, 14.2.8.1.78, 14.2.8.1.82, 14.2.8.2.18, and 14.2.8.2.20 of the SSAR did not identify the systems to be tested. The staff's position is that all six of the above sections of the SSAR should be revised to state that all of the piping systems listed above will be included in the AP600 preoperational piping vibration, thermal expansion, and dynamic test programs. This was DSER Open Item 3.9.2.1-1. Revision 4 to the SSAR revised Section 3.9.2.1 to add a commitment to include all of the piping systems listed above in the AP600 pre-operational vibration and dynamics effects testing programs. This is acceptable for Section 3.9.2.1. However, in a letter from McIntyre to NRC dated July 16, 1996, Westinghouse submitted Draft Revision 9 of SSAR Chapter 14 dated July 31, 1996. This revision revised the format of Chapter 14 and added additional information. Relative to this open item, the staff has the following comment on Draft Revision 9:

> In Section 14.2.9.1.7 of this draft (was 14.2.8.1.49, 14.2.8.1.77, 14.2.8.1.78, and 14.2.8.1.82), only five systems are listed as being included in these tests. Sections 14.2.9.2 and 14.2.9.3 apparently do not include expansion, vibration, and dynamic effects testing. The staff's position is that, in applicable Chapter 14 sections, a commitment is required to include all of the four types of systems listed above in the expansion, vibration, and dynamic preoperational piping test programs.

Therefore, the Chapter 14 part of Open Item 3.9.2.1-1 remains open.

Response

The systems that meet the criteria in 3.9.2.1 that are not included in Chapter 14 are the main control room habitability system (VES) and the hot water heating system (VYS).

The high energy portion of the VYS is not located in the vicinity of safety-related systems and components. The VYS is not a safety-related system. The VYS is not required for safe shut down. All or portions of the systems can be turn off without adversely affecting the capability of the plant to shutdown in a controlled manner. The VYS does not need to be included in Chapter 14. The normal construction testing of the system will provide sufficient information on the system without making it a formal portion of the initial test program.

The VES is not expected to experience vibration due to low flow rates and does not need to be included in the Chapter 14 tests.

The following paragraph will be added to the end of SSAR subsection 14.2.9.1.7

The main control room habitability system is classified as a high energy system based on the pressure criteria not temperature. Tests that measure thermal movements and vibration testing are not required. See subsection 14.2.9.1.6 for information on the testing of the main control room habitability system.

This item is Resolved pending formal revision of the SSAR.

26. Open Item 3.9.3.3-1 (792) - Snubber criteria - RAI# 210.69 Action Westinghouse

In SSAR Section 3.9.3.4.3, Revision 4, the criterion for production operability tests of large bore snubbers, which states that these tests will include "a full service Level D load test to verify load capacity," needs to be clarified. It is not clear to the staff that such a test includes dynamic qualification testing. Section 3.9.3.4.3 should be revised to provide a more specific commitment that large bore snubbers will be subjected to dynamic qualification tests. A similar commitment should be provided in SSAR Section 1.9.4.2 under Generic Issue 113 as a part of the response to DSER Open Item 20.3-15.

Response

The statement referenced is in a paragraph discussing production testing; not operability testing. Westinghouse will add clarification to the second bullet under types of testing to clarify that dynamic testing is included.

The response for Generic Issue 113 refers to the requirements in 3.9.3.4 for snubber qualification testing. The AP600 practice is not to repeat requirements in multiple locations.

SSAR Revision:
Revise a portion of subsection 3.9.3.4.3 as shown below:

Two types of tests will be performed on the snubbers to verify proper operation:

- Production tests on every unit to verify proper operability

- Qualification tests, including dynamic testing, on randomly selected production models to demonstrate the required load performance (load rating)

This item is Resolved pending formal revision of the SSAR.

27. Open Item 3.9.3.3-2 (793) - Anchor bolts (App. B of ACI 349) - RAI# 210.107 & 220.8 Action Westinghouse

Draft Revision 3 of the SSAR, Section 3.9.3.4 is identical to the response to RAI# 210.107, and is not completely acceptable as stated in DSER Section 3.9.3.3. This issue is related to DSER Open Item 3.8.4.2-2.

Response

The eighth paragraph of SSAR subsection 3.9.3.4, Revision 9 commits to the use of flexibility requirements of Bulletin 79-02, Revision 2. Supplemental requirements for the use of anchor bolts are provided in subsection 3.8.4.5.1. These requirements modify the use of ACI-349.

No SSAR revision is required to resolve this item.

This item is Closed. The remaining anchor issues will be addressed by the ECGB branch review of 3.8.

Confirmatory Items

7. DSER CN 3.9.2.1-4 (1792) - Reference SSAR 3.9.2.1.1 in 14.2.7.8.1.78 - RAI # 210.57

The Draft Revision 9 for Chapter 14 replaced Section 14.2.8.1.78 with Section 14.2.9 1.7. However, the response to RAI# 210.57 does not appear to be in this Draft.

Response:

Subsection 14.2.9.1.7, paragraphs b) and c) will be modified as follows:

b) Vibration testing is performed on safety-related and high-energy system piping and components during both cold and hot conditions to demonstrate that steady-state vibrations are within acceptable limits. **See subsection 3.9.2.1.1 for the acceptable standard for alternating stress intensity due to vibration**. This testing includes visual observation and local and remote monitoring in critical steady-state operating modes. Results are acceptable when visual observations show no signs of excessive vibration and when measured vibration amplitudes are within acceptable limits.

c) Testing for significant dynamic events is conducted during hot functional testing and may be performed as part of other specified preoperational tests. This testing is conducted to verify that stress analysis of safety-related and high energy system piping under transient conditions are acceptable. **See subsection 3.9.2.1.1 for the acceptable standard for alternating stress intensity due to vibration.** These tests are performed to verify that the dynamic effects are within expected values during transients such as pump starts and stops, valve stroking, and significant process flow changes.

Deflection measurements during various plant transients are recorded and compared to acceptance limits.

This item is Resolved pending incorporation in a formal SSAR revision.

8. DSER CN 3.9.2.3-1 (1793) - Flow-induced vibration tests for all plants - RAI# 210.58

SSAR Revision 4 revised Section 3.9.2.4 to state that reactor internals of AP600 plants subsequent to the first plant will perform hot functional tests and post test inspection to ensure structural integrity and operability of the internals. This agrees with the response to RAI# 210.58 and is acceptable. However, Section 14.2.8.1.77 was replaced by proposed Section 14.2.9.1.9 in the Draft Revision 9 for Chapter 14, dated July, 1996. This proposed section only addresses the prototype plant (first plant only) tests to comply with that portion of RG 1.20. There should be another section in Chapter 14 to provide the same commitment as that in Section 3.9.2.4. Therefore, this issue remains open.

Response:

Subsection 14.2.9.1.9 will be modified to include inspections of subsequent plants as follows:

The title of the test abstract is revised as:

14.2.9.1.9 Reactor Internals Vibration Testing ~~(First Plant Only)~~

The paragraph under the heading **Purpose** is revised and a paragraph is added:

The AP600 reactor internals testing is part of a comprehensive vibration assessment program performed in accordance with Regulatory Guide 1.20 as discussed is subsection 3.9.2.4. This testing obtains data to verify the structural integrity of the AP600 reactor internals with regard to flow-induced vibrations, as part of an internals vibration assessment program. This program also includes visual examination of the reactor internals after testing is completed and analysis of the test data. Testing is performed for the first plant only.

AP600 plants subsequent to the first plant are visually inspected before and after the hot functional test to confirm that the internals are functioning correctly. The major features of the reactor internals outlined in subsection 3.9.2.4 are visually inspected for signs of abnormal wear and structural changes.

The first paragraph under the heading **General Test Method and Acceptance Criteria** is revised as:

~~The~~ Reactor vessel internals testing is performed for the first plant only by measuring and recording strains or accelerations of components in order to determine actual displacements that occur with the reactor coolant pumps operating. This testing is performed ....

The following concluding paragraph is added under the heading **General Test Method and Acceptance Criteria**:

A visual inspection plan is applied to all plants subsequent to the first. Visual inspections are performed before and after the hot functional test. When no indications of harmful vibrations or signs of abnormal wear are detected and no structural damage or changes are apparent, the core support structures are considered to be structurally adequate. If such indications are detected, further evaluation is required.

This item is Resolved pending incorporation in a formal SSAR revision.