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Energy Systems

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

ATTENTION: T. R. QUAY

SUBJECT: RESPONSES TO NRC DSER SECTION 3.12 OPEN ITEMS

Dear Mr. Quay:

Attached are responses to open items related to DSER Section 3.12. These open items were discussed an NRC letter dated August 16, 1996.

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 on (412) 374-4856 if you have additional questions.

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

/nja

Attachments

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

E004/1

Enclosed response to NRC questions and comments
Letter NSD-NRC-96-4857

From NRC Letter dated August 16, 1996

DSER 3.12.3-1 (OITS #822)
DSER 3.12..4.2-1 (OITS #827)
DSER 3.12.4.3-1 (OITS #828)
DSER 3.12.4.4-1 (OITS #830)
DSER 3.12.5.3-1 (OITS #832)
DSER 3.12.5.3-2 (OITS #833)
DSER 3.12.5.9-1 (OITS #836)
DSER 3.12.5.10-1 (OITS #837)
DSER 3.12.5.12-1 (OITS #838)
DSER 3.12.5.16-1 (OITS #839)
DSER 3.12.5.19-2 (OITS #842)
DSER 3.12.5.19-5 (OITS #845)
DSER 3.12.5.19-7 (OITS #847)
DSER 3.12.6-1 (OITS #848)
DSER 3.12.6.3-1 (OITS #850)

Confirmatory Items
DSER CN 3.12.3.6-1 (OITS #1812)
DSER 3.12.5.5-1 (OITS #1814)

DSER Section 3.12 items

The following are responses to open items associated with Section 3.12 of the AP600 DSER. An NRC letter dated August 16, 1996 documented June 25 and 26 meetings between the staff and Westinghouse and updated the status. The subdivision numbers are from that letter. Open items statused as resolved in the letter are not included in this list. The remaining Section 3.12 items are closed (NRC Status - Resolved).

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 will be provided in a later submittal.

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

3.12.4.2-1 (OITS #827)

1. Incorporate piping modeling system requirements into 3.7.3.8 of the SSAR
W Status **Closed** - NRC Status Resolved

2. Provide an acceptable procedure to account for amplification of the floor response spectrum at a branch to run connection
W Status **Closed** - SSAR Revision 9 subsection 3.7.3.8.2 includes changes to address this issue

3.12.4.3-1 (OITS #828)

Include in the SSAR a commitment that the COL will comply with the requirements of the benchmark program.
W Status **Closed** - SSAR Revision 9 subsection 3.9.1.2 includes changes to address this issue

3.12.4.4-1 (OITS #830)

Provide a criterion or other means to account for response spectrum amplification at the branch line to run line connection in a decoupled branch line analysis.
W Status **Closed** - SSAR Revision 9 subsection 3.7.3.8.2.1 includes changes to address this issue

3.12.5.3-1 (OITS #832)

1. Clarify the classification of the relief/safety valve open system sustained load.
W Status **Closed** - SSAR Revision 9 Table 3.9-3 includes changes to address this issue

2. Address the note in Table 3.6-5 that timing and causal relation ships that exist between SSE and other dynamic loads are considered for determination of appropriate load combinations.
W Status **Closed** - SSAR Revision 9 Table 3.9-5 includes changes to address this issue

3. Include ASME Code Equation (9) load combination in Table 3.9-6
W Status **Closed** - SSAR Revision 9 Table 3.9-9 includes changes to address this issue

4. Include ASME Code Equation (9) load combination in Table 3.9-7
W Status **Closed** - SSAR Revision 9 Table 3.9-10 includes changes to address this issue

5. Provide piping functional capability requirements consistent with the restrictions in NUREG-1367
W Status Action W - Address NRC comments on operability limits

NRC Summary

Westinghouse provided a revised draft SSAR Table 3.9-11 on piping functional capability requirements which included some but not all of the NUREG-1367 Restrictions. It was revised as follows:
(a) Equation (9) Service Level D was included with a limit of $2.0S_y$ but not $3.0S_m$ or $3.0S_h$
(b) footnote (4) indicated that the Equation (9) stress limit is applicable to reversing dynamic loads
(c) dead weight stresses shall be limited to $0.25S_y$
(d) no restriction was given on analysis method.

When the audit team noted that this does not comply with all of the restrictions of NUREG-1367*, Westinghouse stated that is does not agree with the audits teams interpretation of the requirements. In order to resolve this issue, it was agreed that the audit team would consult with other NRC staff members and consultants, including the author of the NUREG for the appropriate interpretation of the restrictions, Based on these subsequent discussion, the audit team concluded that the Draft Table 3.9-11 is not acceptable and should be revised as follows:
(a) The Equation (9) stress limit is the lesser of $3.0S_m$ or $2.0S_y$ for Class 1 piping and the lesser of $3.0S_h$ or $2.0S_y$ for Class 2 and 3 piping.

(b) The Equation (9) stress limit is applicable to reversing dynamic loads including fluid hammer pressure loads but not to slug flow.
(c) Steady-state stresses shall be limited to $0.25S_y$.
(d) Dyramic moments must be calculated using an elastic response spectrum method with ±15 percent broadening and with not more than 5 percent damping.

* NUREG 1367- Functional Capability of Piping Systems, D. Terao, E. Rodabaugh, November 1992

Westinghouse Response

(a) See Table 3.9-11 revision 9. **This item Closed.**

(b) The NUREG-1367 position on functional capability of piping, as stated in section 7.1, paragraph 5, is that there is no basis for increasing the limit on Code Equation 9 for slug type water hammer loads. The NUREG position as stated in section 9.1, is that the current Code limits on Equation 9 are adequate for functional capability for reversing dynamic loads, not for slug type water hammer loads. The NUREG does not recommend an alternative limit on Equation 9 for these slug loads. If the Equation 9 limits are not used then there is no limit for these loads. The AP600 position is to use the current Code limits on Equation 9. This is consistent with the practice of Westinghouse operating plants.

This item **Action N** pending review.

(c) The NUREG-1367 position on functional capability of piping systems that are subject to reversing dynamic loads in combination with steady state loads is based on very limited test data and conservative engineering judgment in the absence of adequate test data. Section 8.1.7 of the NUREG states that with a limit of 0.25*Sy on the steady state stress, the limit on Code Equation 9 can be increase from to 4.0*Sy. This is based on a single component test (37/5) which resulted in collapse with very high Equation 9 stresses (5.5 times the current Code limits) and a steady state stress of 0.32*Sy. A similar component test (37/4) did not show collapse even when the Equation 9 stress was 2.8 times the current Code limits.

Section 9.1 states that the limit of 0.25*Sy is used in conjunction with the current Code limits. This is in conflict with section 8.1.7 which states that the limit of 0.25*Sy is used in conjunction with the 4.0*Sy limit, which is much higher than the current Code.

The Westinghouse position is that with the current ASME Code limits on Equation 9, functional capability is assured for any value of steady state stress. None of the test data in the NUREG contradicts this position. The test data supports functional capability for total stress greatly in excess of the Code limit of 2.0*Sy combined with steady state stresses up to 0.32*Sy. Since the stress limit for the AP600 is the Code limit of 2.0*Sy there is no reason to believe, for steady state stresses beyond 0.32*Sy, that collapse will occur because of the strain hardening that shifts the elastic response range from "0 to +Sy" to "+Sy to -Sy".

In the AP600, the application of the recommended 0.25*Sy limit to steady state stresses that are the result of loads that include steady-state thrust from relief valve actuation is particularly onerous for no apparent regulatory benefit. Since the focus of NUREG-1367 was whether the overall Equation 9 stress limit be increased past the Code limit of 2.0*Sy and the AP600 does not require such an increase, the AP600 position on steady state stress is as follows:

For steady state stress due to deadweight, use the limit of:

$$B2*M_{dwt}/Z = 0.25*S_y.$$

For steady state stress due to combined deadweight and safety valve discharge, the NUREG limit would have a substantial impact on the design. The ASME Code limits for these steady state stresses are:

$$B2*(M_{dwt} + M_{sv})/Z = 1.5*S_h - B_1*P*D/(2t) < 0.71*S_y$$

- For the main steam safety line fabricated of SA333 Gr 6 with an S_h = 15.0 ksi and S_y = 31.3 ksi ($1.5*S_h$ = 22.5 ksi = $0.71*S_y$)

and

$$B_2*(M_{dwt} + M_{sv})/Z = 1.8*S_y - B_1*P*D/(2t) < 1.8*S_y$$

- For the pressurizer safety line fabricated of SA312 type 316LN with an $S_m = 0.9*S_y$

In order to provide similar functional capability margins for carbon and stainless steel piping during the SSE event, Westinghouse proposes the following limit on the steady state stress due to combined deadweight and safety valve discharge:

$$B_2*(M_{dwt} + M_{sv})/Z = 1.0*S_y$$

The ASME Code limits for Equation 9 including the dynamic loads are also satisfied.

The proposed limit of 1.0*Sy for steady-state stress combined with the ASME Code limits for Equation 9 provides an appropriate control on steady-state loading during application of reversing dynamic loads.

This item **Action N** pending review.

(d) The NUREG-1367 position on functional capability of piping system, as stated in section 9.1, is that the current Code limits may be used when the piping analysis is performed by an elastic response spectrum analysis with not more than 5% damping. The NUREG does not state that the current Code limits are not applicable when a time history piping analysis is performed. If the

Equation 9 limits are not used then there is no limit for these loads. For example, no guidance is provided in the NUREG for functional capability for the elastic SSE time history analysis of the primary loop piping, and for the elastic time history analysis for water hammer loads. The Westinghouse position is that the current Code limits on Equation 9 assure the functional capability of the piping system when the damping values in Table 3.7-1 are used with elastic dynamic time history analysis. This is consistent with Westinghouse operating plants.

This item **Action N** pending review.

3.12.5.3-2 (OITS #833)

1. NRC position on use of composite modal damping is that for piping analysis 5% damping may be used for the piping but the damping in Regulatory Guide 1.61 must be used for equipment included in the model. Westinghouse practice is to use 5% in the entire model for piping analysis.

   W Status Action W - Address comments on composite modal damping

   The W position has been that the test data for piping damping includes equipment and valves as a part of the tested system. Therefore 5% damping can be used for piping, valves, and equipment in the analysis of piping. This approach has been used on previous Westinghouse plants that were approved by the NRC.

   The NRC position is that for response spectra analysis of coupled models of piping, valves, and equipment, composite modal damping should be used with the following damping values: piping - 5%, valve - 4%, equipment - 4%

Response

Westinghouse has reviewed the impact of using the NRC staff position. The impact appears to be minor. The SSAR will be revised to reflect the staff position.

The piping analyses that has been done to date and available for audit by the staff will not be revised. These analyses are presented to demonstrate the capability of the AP600 design to meet design and regulatory requirements. The small effect of the change in damping values on analysis results does not alter the conclusion that the AP600 design satisfies regulatory requirements.

Revise the first paragraph of subsection 3.7.3.15 as follows:

Damping values used in the seismic analyses of subsystems are presented in subsection 3.7.1.3. Safe shutdown earthquake damping values used for different types of analysis are provided in Table 3.7.1-1. For subsystems that are composed of different material types, the composite modal damping approach with either the weighted mass or stiffness method is used to determine the composite modal damping value. Alternately, the minimum damping value may be used for

these systems. Composite modal damping for coupled building and piping systems is used for piping systems that are coupled to the primary coolant loop system and the interior concrete building. **Composite modal damping is used for piping systems that are coupled to flexible equipment or flexible valves.** Piping systems analyzed by the uniform envelope response spectra method **with rigid valves**~~, including coupled equipment, and valves,~~ can be evaluated with 5 percent damping. Five percent damping is not used in piping systems that are susceptible to stress corrosion cracking.

Table 3.7.1-1 will be revised as follows:

SAFE SHUTDOWN EARTHQUAKE DAMPING VALUES

	Percent
Concrete filled steel plate structures	5
~~Primary coolant loop (for uniform envelope response spectra analysis)~~	~~5~~
Piping ~~systems~~ (for uniform envelope response spectra analysis)	5
Piping ~~systems~~ (alternative for time history analysis and independent support motion response spectra analysis)	
Less than or equal to 12-inch diameter	2
Greater than 12-inch diameter	3
Primary coolant loop	4

This item is Resolved pending formal SSAR revision.

2. Clarify the use of uniform envelop response spectrum analysis for the primary coolant loop.
   W Status Action W - Address comments on composite modal damping

Response

See the response for item 1 of DSER # 3.12.5.3-2 (OITS #833) above.

This item is Resolved pending formal SSAR revision.

3.a. Justify the use of 4 % damping for independent support motion analysis of the coupled reactor coolant loop system.
   W Status **Closed** - NRC Status Resolved

3.b NRC staff does not accept the use of 5% damping to coupled reactor coolant loop model.
   W Status Action W - Address comments on composite modal damping

Response

See the response for item 1 of DSER # 3.12.5.3-2 (OITS #833) above.

This item is Resolved pending formal SSAR revision.

3.12.5.9-1 (OITS #836)

NRC staff or consultant needs opportunity to review thermal stratification calculation.
W Status **Action W** - Set up opportunity for audit. NRC Status Action N

Response

Westinghouse will provide the evaluation during the piping audit scheduled for November 1996.

3.12.5.10-1 (OITS #837)

The staff and consultant need to review the thermal stratification methodology.
W Status **Closed** NRC Status Action N

3.12.5.12-1 (OITS #838)

Table 3.9-11 is not consistent with NUREG-1367
W Status Action W - See #832 (5. (Address NRC comments on operability limits)

Response

See the response above for item (5) (c) of 3.12.5.3-1 (OITS #832). The following line will be added to Table 3.9-11

DW + RVOS

$$\frac{B_2 * (M_{dwt} + M_{RVOS})}{Z} \leq 1.0\ S_Y$$

This item **Action N** pending review.

3.12.5.16-1 (OITS #839)

The use of composite modal damping should be limited to account for pipe size
W Status Action W - See #833 (Address comments on Table 3.9-11)

Response

See the response for item 1 of DSER # 3.12.5.3-2 (OITS #833) above.

This item is Closed.

3.12.5.19-2 (OITS #842)

Revise Table 3.9-11 to reflect staff guidance on ASME Code Equation (9) stress limits.
W Status **Closed** - SSAR Revision 9 Table 3.9-11 includes changes to address this issue

3.12.5.19-5 (OITS #845)

Include relief/safety valve, open system sustained load as a dynamic transient event.
W Status **Closed** - SSAR Revision 9 Table 3.9-3 includes changes to address this issue

3.12.5.19-7 (OITS #847)

Provide load definitions, load combinations, and stress limits consistent with the ASME Code, Section III, 1989 Edition , 1989 Addenda
W Status **Closed** NRC Status Action W pending resolution of #832

3.12.6-1 (OITS #848)

1.a. Delete the reference to SSE from two of the notes in Table 3.9-8
W Status **Closed** - SSAR Revision 9 Table 3.9-8 includes changes to address this issue

1.b. Incorporate description of GAPPIPE into the SSAR
W Status **Closed** - Included in Revision 7 of the SSAR NRC Status Resolved

1.c. Provide a specific commitment that large bore snubbers would be subject to dynamic qualification
W Status Action W - Resolve DSER item 3.9.3.3-1

Response

Section 3.9.3.4.3 will be revised. See the response to DSER item 3.9.3.3-1 (Letter NSD-NRC-96-4857, dated October 23, 1996)

This item is Closed.

2. Revise the coefficient of steel sliding on steel in 3.9.3.4
W Status **Closed** - SSAR subsection 3.9.3.4, Paragraph 9 includes the correct coefficient.

3. For Standard component supports manufacturers\'s functional limitations must be followed.
W Status **Closed** - Last paragraph of SSAR subsection 3.9.3.4 includes commitment to follow manufacture's limitations.

3.12.6.3-1 (OITS #850)

Delete the reference to SSE from two of the notes in Table 3.9-8
W Status **Closed** SSAR Revision 9 Table 3.9-8 includes changes to address this issue.

CN 3.12.3.6-1 (OITS #1812)

Resolve the conflict with the standard review plan for factors that may be used with the equivalent static load method.
W Status **Closed** SSAR Rev. 9 subsection 3.7.3.5.1 bullet 3 addressed this issue

CN 3.12.5.5-1 (OITS #1814)

Resolve the use of alternate methods for combining closely spaces modes.
W Status **Closed** SSAR Rev. 9 subsection 3.7.3.7.2, paragraph 1 addressed this issue