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SOUTHERN COMPANY
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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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EDWIN I. HATCH NUCLEAR PLANT
Generic Letter 96-06
Response to Request for Additional Information

Ladies and Gentlemen:

By letter dated January 17, 2003, Southern Nuclear Operating Company (SNC) provided a comparison of the calculation methodology used for Plant Hatch with the Electric Power Research Institute (EPRI) methodology for waterhammer analysis, in lieu of responding to the individual RAI questions, as agreed to in an October 3, 2002, call with the NRC staff. In a subsequent telephone conversation on February 19, 2003, between the Hatch NRC Project Manager (PM), staff reviewers, Bechtel representatives and the SNC Hatch Licensing Manager, agreement was reached for SNC to respond to four additional questions based on questions discussed between NRC staff and Vogtle Electric Generating Plant personnel in a telephone conversation on February 7, 2003.

The enclosure to this letter provides the questions applicable to Plant Hatch and the SNC response to each question.

Should you have any questions in this regard, please contact this office.

Sincerely,

H. L. Sumner, Jr.

HLS/IL/dj

Enclosure: Edwin I. Hatch Nuclear Plant Generic Letter 96-06 Response to Request for Additional Information

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cc: <u>Southern Nuclear Operating Company</u>
Mr. J. D. Woodard, Executive Vice President
Mr. P. H. Wells, General Manager – Plant Hatch
Document Services RTYPE: CHA02.004

<u>U. S. Nuclear Regulatory Commission</u>
Mr. L. A. Reyes, Regional Administrator
Mr. S. D. Bloom, NRR Project Manager – Hatch
Mr. N. P. Garrett, Acting Senior Resident Inspector – Hatch

Enclosure

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1. NRC Request

Provide comparison of the HSTA calculated peak pressure with the pressure calculated using the Joukowski equation based on closing velocity.

Response

For E. I. HATCH Nuclear Plant Unit 1, the maximum calculated initial closure velocity is 10.67 ft/s (i.e. about 11 ft/s). This is given in Table 1 of Reference 1. Figure III.15 in Attachment III to Reference 1 gives the pressure head time history plot at a node near the void collapse location. From this plot, the peak pressure head is 847.7 ft of water. The pressure head calculated in HSTA is the hydraulic grade line i.e. it is the pressure head plus elevation. In order to calculate the pressure "increase" due to the void collapse (surge pressure), the vapor pressure plus the system elevation as modeled in HSTA (191.47 ft) is subtracted from the HSTA calculated peak pressure head before converting feet of water into psi units. Therefore, the surge pressure calculated by HSTA is 283 psi. Using a density of 62.05 lbm/ft^3 and a (pipe softened) sonic velocity of 4000 ft/sec, the Joukowski equation (equation 5-3 in the EPRI User's Manual – Reference 2) gives a surge pressure magnitude of about 286 psi for water on water impact. This value from Joukowski compares very well with the HSTA computed value.

In a separate calculation (documented in Reference 3), the example problem in Section 7.4 of the EPRI User's manual (Reference 2) was modeled using the HSTA computer code. This example problem is for an open loop system. The HSTA computed *uncushioned* "initial velocity" or "impact velocity" is 9.73 ft/sec. The EPRI calculated velocity as 9.8 ft/sec. Using this HSTA calculated uncushioned velocity, the surge pressure from Joukowski's equation is 278.3 psi for a liquid to liquid impact. HSTA computed this surge pressure internally as 278.5 psi. The ratio of the reflected to incident pressure pulse from the control valve, as calculated by EPRI matches exactly with the HSTA computed value (1.096). Also, the flow area attenuation and forcing functions calculations from HSTA matched very well with the EPRI calculated values as discussed in Reference 3.

2. NRC Request

What was used for the speed of sound?

Response

A value of 4000 ft/sec was used for the speed of sound in the HATCH analyses. This value was calculated per equation 5-2 of the EPRI User's Manual and accounts for the effects of thin walled pipe deformation on the speed of sound.

3. NRC Request

What adjustment was used for cushioning? What nomographs were used from the EPRI User's Manual?

Response

No credit was taken for air/steam cushioning during void collapse. Thus, the HATCH analysis has added conservatism due to ignoring the air/steam cushioning effects.

4. NRC Request

4a). *What were the maximum stresses in the critical components and the margin to failure?*

Piping (includes pipe, orifices, bends and containment penetrations)

Ratios of maximum load to failure: Includes piping, orifices, bends and the containment penetrations:

	Run 1 – All Supports Active		Run 2 – Failed/Uplifting Supports Removed	
	Max Stress	IR	Max Stress	IR
SW Supply Train A	9507	0.319	9779	0.338
SW Supply Train B	12299	0.413	12035	0.404
SW Return Train A	11760	0.395	12855	0.433
SW Return Train B	9809	0.330	9866	0.332

Notes:
1) Compared to 2.4SH (29760 psi)
2) Local pipe wall stresses at integral welded attachments (IWA's) are included with pipe support section below.

Pipe Supports

SW Supply Train A
- All support stiffnesses, anchor stiffnesses and nozzle stiffnesses modeled
- 21 supports, 8 anchors and 1 containment penetration in model
- 7 supports either failed to meet allowables or were downward only supports with uplift and were removed from later runs
- 8 supports bounded by existing loads, 3 anchors bounded by existing loads. The remainder were evaluated for load increases
- Maximum IR ==0.967 occurs on support SWH-148. Limiting attribute is local pipe wall stress

SW Supply Train B
- All support stiffnesses, anchor stiffnesses and nozzle stiffnesses modeled
- 22 supports and 4 anchors in model

- 6 supports either failed to meet allowables or were downward only supports with uplift and were removed later runs
- 2 supports bounded by existing loads. The remainder were evaluated for load increases
- Maximum IR ==0.98 occurs on support SWH-123. Limiting attribute is structural steel stress

<u>SW Return Train A</u>

- All support stiffnesses, anchor stiffnesses and nozzle stiffnesses modeled
- 22 supports, 3 anchors and 1 containment penetration in model
- 10 supports either failed to meet allowables or were downward only supports with uplift and were removed from later runs
- 1 support bounded by existing loads. The remainder were evaluated for load increases
- Maximum IR ==0.971 occurs on support SWH-156. Limiting attribute is local pipe wall stress

<u>SW Return Train B</u>

- All support stiffnesses, anchor stiffnesses and nozzle stiffnesses modeled
- 23 supports and 3 anchors in model
- 11 supports either failed to meet allowables or were downward only supports with uplift and were removed from later runs
- 2 supports bounded by existing loads. The remainders were evaluated for increases
- Maximum IR ==1.0 occurs on anchor SWH-259. Limiting attribute is local pipe wall stress (conservative evaluation)

4b). <u>*What are the combination of loads in the design basis (FSAR)?*</u>

The service water piping for the drywell coolers are classified as ANSI B31.7. Piping stresses were well under the $2.4S_h$ stress limit due to the combination of waterhammer loads, deadweight and the peak pressure seen during the water hammer transient. Due to the short duration of the Water Hammer event, it is not necessary to be considered with any other occasional loads, including seismic.

Pipe supports were evaluated using the rules for evaluation of service loadings with level D service limits as described in the ASME Code, Section III, Appendix F. Where pipe supports exceeded these limits, they were removed from the analysis. All remaining supports passed the acceptance criteria.

References

1. Edwin I. Hatch Nuclear Plant Unit 1 Calculation Number 058 (V999, B999), Revision 0, "PSW System Fan Coolers Waterhammer Analysis", 2001.

2. EPRI Report No. 1006456, Generic Letter 96-06 Waterhammer Issues Resolution, User's Manual – Proprietary, April 2002

3. Edwin I. Hatch Nuclear Plant Unit 1 Calculation Number 072 (V999, B999), Revision 0, "HSTA Verification of EPRI Sample Problem 7-4", 2002.