Progress Energy

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SHEARON HARRIS NUCLEAR POWER PLANT, UNIT NO. 1
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SUPPLEMENTAL INFORMATION TO THE REQUEST FOR ADDITIONAL INFORMATION REGARDING GENERIC LETTER 96-06, "ASSURANCE OF EQUIPMENT OPERABILITY AND CONTAINMENT INTEGRITY DURING DESIGN-BASIS ACCIDENT CONDITIONS"

Ladies and Gentlemen:

By letter dated October 29, 2002, Progress Energy Carolinas, Inc.'s Harris Nuclear Plant (HNP) provided a response to an NRC request for additional information regarding Generic Letter (GL) 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions."

In conference calls on November 22, 2002 and February 4, 2003, it was determined that supplemental information would facilitate the NRC's review of the HNP response to the request for additional information. Attachment 1 provides the requested supplemental information.

Please refer any questions regarding this submittal to Mr. John Caves at (919) 362-3137.

Sincerely,

James Scarola

JS/jpy

Attachment: 1. Supplemental Information to the Request for Additional Information Regarding Generic Letter (GL) 96-06

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A072

James Scarola, having been first duly sworn, did depose and say that the information contained herein is true and correct to the best of his information, knowledge and belief, and the sources of his information are employees, contractors, and agents of Progress Energy Carolinas, Inc.

Lisa M. Randall

LISA M. RANDALL NOTARY PUBLIC WAKE COUNTY, N.C.

Notary (Seal)
My commission expires:
6-7-2008

c: Mr. R. A. Musser, NRC Sr. Resident Inspector
Mr. C. P. Patel, NRC Project Manager
Mr. L. A. Reyes, NRC Regional Administrator

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SUPPLEMENTAL INFORMATION TO THE REQUEST FOR ADDITIONAL INFORMATION REGARDING GENERIC LETTER (GL) 96-06

Background

By letter dated October 29, 2002, Progress Energy Carolinas, Inc.'s Harris Nuclear Plant (HNP), provided a response to an NRC request for additional information regarding Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions." In conference calls between HNP and NRC personnel on November 22, 2002 and February 4, 2003, it was determined that supplemental information would facilitate NRC's review of the HNP response to the request for additional information. The following supplemental information is provided:

Requested Supplemental Information:

1. Describe the method used to determine pipe stress and support loads and discuss the results. Specifically discuss and justify the load combinations used.
2. Provide additional detail regarding the risk perspective and the specific values for the risk evaluation. Show that the methodology used was consistent with the Electric Power Research Institute (EPRI) methodology.
3. Discuss the procedures that were changed to make the waterhammer events less likely.
4. Discuss the model applied force studies, Pressure times Area, (PxA) that produced unrealistically high results. Include a discussion of the damage that was done to one support. Relate the acceptability of the analytical results with the observed field conditions. In addition, discuss any repairs or modifications to support SW-H-2036.
5. Describe the study results showing acceptability of the system with combined seismic loads. In addition, discuss the combination of events required to be analyzed by the HNP Final Safety Analysis Report (FSAR).

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SUPPLEMENTAL INFORMATION TO THE REQUEST FOR ADDITIONAL INFORMATION REGARDING GENERIC LETTER (GL) 96-06

Supplemental Information Request #1

Describe the method used to determine pipe stress and support loads and discuss the results. Specifically discuss and justify the load combinations used.

Response

Harris Nuclear Plant (HNP) tested the Emergency Service Water (ESW) system by simulating loss of offsite power (LOOP) conditions that produced waterhammers during a period from 1986 through 1989. Post-transient walkdowns of the system documented the maximum piping displacement of 1-¾". Damage to one support, SW-H-2036, was also observed. Since this support was in a long, straight piping run, bounding waterhammer loads are expected in this portion of the piping.

Piping stress and acceptability were determined analytically using the observed pipe displacement from the waterhammer events that occurred during simulated LOOP testing. An ADLPIPE stress model was loaded by imposing the observed displacement in both positive and negative directions at the location of the failed support, with the SW-H-2036 support removed. See response to question #5 for further explanation of the load combinations used. The pipe analysis combined stresses due to deadweight, pressure and waterhammer (i.e., LOOP displacement). The combined pipe stresses were found to be within ASME Code allowable stresses and ASME Code requirements for potential fatigue due to repeated waterhammer events even with the SW-H-2036 support removed.

HNP also determined the magnitude of the waterhammer produced by a concurrent LOOP and loss of coolant accident (LOCA) by analytical methods consistent with the EPRI methodology (i.e., EPRI Final Report 1006456, "Generic Letter 96-06 Waterhammer Issues Resolution," formerly TR-113594). This analysis confirmed that the effects of LOOP without LOCA bound the compounding effects of LOOP with a LOCA. The LOOP waterhammer pressure term from the analysis, 235 psi for the return piping, was conservatively applied as a static pressure in the displacement model. Additional models using forces derived from this analytical waterhammer pressure were also evaluated (see response to supplemental information request #4 below), but these models were found to be inconsistent with observed plant conditions. Therefore, they were not used to qualify the system.

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SUPPLEMENTAL INFORMATION TO THE REQUEST FOR ADDITIONAL INFORMATION REGARDING GENERIC LETTER (GL) 96-06

Supplemental Information Request #2

Provide additional detail regarding the risk perspective and the specific values for the risk evaluation. Show that the methodology used was consistent with the EPRI methodology.

Response

The risk evaluation used the Harris Probabilistic Safety Assessment (PSA) model of record in existence at that time, which included the following initiating event frequencies:

Event Frequency	Probability
Large-Break LOCA	2.4×10^{-5}/yr
Medium-Break LOCA	3.6×10^{-6}/yr
Main Steam Line Break (MSLB)*	3.2×10^{-4}/yr
LOOP alone **	3.0×10^{-2}/yr

* MSLB based on MS break on steam generator side of MSIV (2.31E-4) plus feedwater line break (8.62E-5).
** The LOOP alone occurring simultaneously with a LOCA or MSLB within a 24-hour period is a very low probability event and is bounded by the LOCA or MSLB with consequential LOOP.

The probability of a consequential LOOP caused by the LOCA or MSLB is estimated as follows:

Event Frequency	Probability
Consequential LOOP following LOCA or MSLB	1.4×10^{-2}/yr

Based on the above estimated event frequencies and the probability of a consequential LOOP following a LOCA or MSLB, a conservative combination of both events produces the probability estimate for both a combined LOCA and LOOP, and a combined MSLB and LOOP, as follows:

$$(2.4\text{x}10^{-5})(1.4\text{x}10^{-2}) + (3.6\text{x}10^{-6})(1.4\text{x}10^{-2}) + (3.2\text{x}10^{-4})(1.4\text{x}10^{-2}) = 4.87 \times 10^{-6}/\text{yr}$$

This result is less than the initiating event risk of 1×10^{-5}/yr provided in EPRI Report TR-113594.

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SUPPLEMENTAL INFORMATION TO THE REQUEST FOR ADDITIONAL INFORMATION REGARDING GENERIC LETTER (GL) 96-06

Supplemental Information Request #2 (Continued)

A negligible probability of pipe failure exists as a result of GL 96-06 transient conditions at HNP because the stresses produced by GL 96-06 transients are within ASME Code limits. Therefore, it is conservatively assumed that the probability would be no more than 1×10^{-4}/yr as described under "Item b" of the NRC Safety Evaluation Report (SER) for EPRI Report TR-113594.

The combined risk perspective, based on combining the waterhammer event frequency estimate and the pipe failure probability, results in the following estimated frequency for a waterhammer event which results in pipe failure:

(Initiating Event Risk) x (Pipe Failure Risk) = $(4.87 \times 10^{-6})(1 \times 10^{-4}) = 4.87 \times 10^{-10}$/yr

The Harris PSA model of record was recently updated to use the NUREG/CR-5750 LOCA and MSLB frequencies instead of the frequencies shown in the table. The major impact is on the MSLB frequency, which is 1.3E-2 per year in NUREG/CR-5750. Using the updated frequencies results in a frequency estimate for a waterhammer event resulting in pipe failure of 1.82E-8 per year.

Therefore, the HNP risk perspective is bounded by the EPRI risk perspective of 1×10^{-7}/yr.

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SUPPLEMENTAL INFORMATION TO THE REQUEST FOR ADDITIONAL INFORMATION REGARDING GENERIC LETTER (GL) 96-06

Supplemental Information Request #3

Discuss procedures that were changed to make the waterhammer events less likely.

Response

Procedures OST-1823 and OST-1824, for the "A" and "B" SW trains, respectively, provide steps for the performance of emergency diesel generator start-up, simulating station blackout or LOOP conditions. Previously, if the system was aligned to permit drainage, a loss of pump pressure could create voids in the piping to two of the four containment fan coolers. To prevent this condition from occurring, procedures OST-1823 and 1824 were modified to align non-essential service water to maintain system pressure when this test is performed. This maintains system pressure and prevents voiding and subsequent column closure waterhammers.

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Supplemental Information Request #4

Discuss the model applied force studies (PxA) that produced unrealistically high results. Include a discussion of the damage that was done to one support. Relate the acceptability of the analytical results with the observed field conditions. In addition, discuss any repairs or modifications to support SW-H-2036.

Response

In addition to the displaced piping model, the waterhammer pressure was determined analytically to be 235 psi. This pressure was multiplied by the pipe internal cross sectional area to determine positive and negative forces to be applied statically to the ADLPIPE stress models at changes in piping direction, referred to as PxA models. The PxA models were analyzed with both SW-H-2036 in place and with the support removed. The PxA models predicted damaging loads to several pipe supports, including SW-H-2036 when active in the model, and plastic deformation of the pipe.

These analytical results were inconsistent with observed piping and support movements of the LOOP waterhammers simulated during 1986 to 1989. Therefore, the PxA models were determined to be unrealistically conservative. In comparison, the applied displacement model predicted elastic range stresses and support loads that would challenge only support SW-H-2036. Since the applied displacement model matched the observed field conditions, this model was used as the basis for qualifying the piping system.

Support SW-H-2036 was repaired at the time of the observed damage, discussed in the response to supplemental information request #1 above. The damage to the support was a broken paddle at the pipe clamp. No modifications were performed on the support. The ADLPIPE stress model determined that pipe stresses were found to be within ASME code requirements for stress and potential fatigue due to repeated waterhammer events even with the SW-H-2036 support removed.

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SUPPLEMENTAL INFORMATION TO THE REQUEST FOR ADDITIONAL INFORMATION
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Supplemental Information Request #5

Describe the study results showing acceptability of the system with combined seismic loads. In addition, discuss the combination of events required to be analyzed by the HNP FSAR.

Response

Pipe stress load combinations are provided on page 3.9.3-17 of the HNP FSAR. Specific mathematical combinations are provided in HNP design specification CAR-SH-M-71 and the corporate procedure for pipe stress analysis. Waterhammer due to a LOOP event and a LOCA event are both faulted condition loads. A faulted condition is a postulated event with an extremely low probability of occurrence that may impair the integrity or operability of a system. The design specification CAR-SH-M-071 requires combining the effects of a waterhammer due to a LOOP with a LOCA, and combining the effects of a LOCA with a safe shutdown earthquake (SSE) event.

The HNP design considered a LOOP as a randomly occurring event, which is not expected to occur simultaneously with an SSE event. Even though the additional complications of LOOP are included in the system design to mitigate a LOCA, there is no requirement or precedent for "combining loads" resulting from a LOOP and an SSE event. Since there are no mechanistic links between these events in the Harris design basis, it is also not appropriate to add this feature to the design. Combining the effects of low probability events does not significantly improve plant safety. Therefore, HNP has not previously performed a formal analysis combining deadweight, pressure, seismic and a LOOP waterhammer.

HNP has performed a pipe analysis combining stresses due to deadweight, peak pressure and waterhammer (i.e., LOOP displacement). The combined pipe stresses were found to be within ASME Code allowable stresses and ASME Code requirements. Analysis results for a LOOP with a LOCA were not reported because the effects of a LOOP without a LOCA bound the compounding effects of LOOP with a LOCA.

Although not required, HNP performed an informal calculation, combining the waterhammer effect with the other loading conditions (i.e., deadweight, peak pressure and seismic). The stresses produced by the seismic event and the LOOP were combined by the square root sum of squares (SRSS) method. The combined stresses meet the ASME Code allowable stresses (2.4*Sh) with 21% margin. However, the combined stresses exceed the more conservative HNP design basis allowable stresses (1.8*Sh) for faulted conditions of essential piping by 5%. This pipe stress level is acceptable based on meeting ASME Code allowable stresses and the extremely low probability of maximum loads occurring simultaneously.