GE Nuclear Energy

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March 5, 1993

Docket No. STN 52-001

Chet Poslusny, Senior Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of the Nuclear Reactor Regulation

Subject: **Submittal Supporting Accelerated ABWR Review Schedule - Justification Supporting Decoupling of AP and SSE**

Dear Chet:

My January 28, 1993 letter transmitted markups of the ABWR SSAR, Section 3.6 and 3.9 for OBE elimination and elimination of the AP + SSE load combination. However, this letter did not provide the basis and justification for decoupling AP & SSE. My February 4, 1993 letter transmitted a comparison of SSAR and industry initiatives on pipe design and analysis. One of the pages transmitted in this second letter included a short summary of the justification for eliminating the AP + SSE load combination.

Enclosed is a more detailed presentation of the justification and benefits for eliminating Annulus Pressurization + SSE as a design load combination for ABWR.

Please provide a copy of this transmittal to Dave Terao.

Sincerely,

Jack N. Fox

Jack Fox
Advanced Reactor Programs

cc: Norman Fletcher (DOE)
Maryann Herzog (GE)
Ed Swain (GE)

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## JUSTIFICATION SUPPORTING DECOUPLING OF AP AND SSE

GE believes that the short term dynamic loads associated with Annulus Pressurization (AP) and the Safe Shutdown Earthquake (SSE) should not be a design load combination for the ABWR for the reasons provided in the paragraphs below.

1. LOCA Definition:

The LOCA event for the ABWR is defined as three different types:

(1) Small Break LOCA (SBL), which does not result in rapid reactor depressurization;

(2) Intermediate Break LOCA (IBL), which requires operation of ECCS, results in reactor depressurization, and is characterized by an effective break area of 0.1 $ft^2$ break located below the reactor vessel water level;

(3) Large Break LOCA (LBL), which is associated with the rupture of a main steam line, or any pipe severance of equivalent mass flow area. The consequences and effects of any LOCA may be classified as either Short-term or Long-term. Short-term LOCA effects are the loads acting during the period of $10^{-1}$ year after the LOCA. These loads include the dynamic effects of condensation oscillation, chugging, pool swell, jet impingement, and annulus pressurization. Long-term LOCA effects are the pressure, temperature and environmental conditions that continue after a period of $10^{-1}$ year following the LOCA.

2. Probability of Large Pipe Break and SSE: The probability of occurrence of any LBL event is generally characterized as $10^{-4}$ to $10^{-5}$ per reactor year. The loads from events with this low probability are categorized "faulted" and assigned ASME Section III Service Level D stress limits, per Paragraph 3.9.3.1.1.5 of the SSAR.

The SSE is characterized as having a probability of occurance of $< 10^{-4}$ per reactor year. The SSE loads are also categorized "faulted" and assigned ASME Section III Service Level D stress limits, per Paragraph 3.9.3.1.1.5 of the SSAR. Since ABWR is designed for an envelope SSE, the encounter probability is actually $<< 10^{-4}$ per reactor year.

The values above show the probability of LBL and SSE occurring in the same reactor year is $(10^{-4}/\text{year})(10^{-4}/\text{year}) = \sim 10^{-8}/\text{year}$. If LBL and SSE did occur in the same reactor year, the probability of overlap of the LBL and SSE loads would be very much lower than $10^{-8}$, the probability of the two events occurring in the same year.

The NRC and the nuclear industry are in reasonable agreement that events and event combinations which have a probability of occurance of $< 10^{-7}$/plant year are "incredible" and need not be considered in the design basis. SRP 2.2.3 uses the term, "approximately $10^{-7}$ per year. However, the ABWR SSAR requires consideration of LOCA + SSE as a design basis event. This is a marked departure from the generally accepted definition of event combinations that must be considered for design, but this combination does introduce reasonable "margin" into the ABWR design.

Although ABWR is committed to consider LOCA + SSE as a design basis load, it is reasonable and justified to exclude the AP + SSE load combination, which is a much lower probability subset of the LOCA + SSE events.

3. Probability of Simultaneous Large Pipe Break in RPV Annulus and SSE. The probability of an SSE event causing pipe break at a specific high stress joint, such as a pipe to RPV nozzle connection, is estimated to be $\sim 2\times10^{-10}$ per reactor year. This value is the result of combining the probability of LOCA at a specific pipe joint, while stressed by SSE, of $\sim 7\times10^{-6}$ and the probability of an SSE of $\sim 10^{-3}$. This gives $\sim 7 \times 10^{-9}$ per 40 year life or about $2 \times 10^{-10}$ per reactor year. There are 12 specific breaks that could cause Annulus Pressurization (4 main steam, 6 feedwater and 2 RHR). Thus the probability of simultaneous SSE and a pipe break that causes AP would be $12 \times 2 \times 10^{-10} = \sim 2.4 \times 10^{-9}$ per reactor year. This is almost two orders of magnitude less than $10^{-7}$ per year probability usually accepted as an incredible event. The probability of AP and SSE occurring simultaneously is thus much more remote than the probability of SSE and any LOCA occurring simultaneously.

4. Accounting for the Short Time Duration of AP and SSE Loads. Although the probability of the SSE and AP events occurring simultaneously is very low ($\sim 2.4 \times 10^{-9}$), the probability of the peak piping stress cycles resulting from the two events occurring simultaneously is much lower yet, when the short time duration of peak dynamic loads from each event is considered. The time duration of the peak cycles of the annulus pressurization load is less than 0.30 seconds. The duration of the SSE is taken as 30 seconds. Because of the short duration of each of these postulated events, the probability for the maximum response due to SSE to occur at the peak of annulus pressurization becomes even more remote.

5. AP + SSE is a Controlling Design Load Combination. Analysis of ASME III, Class 1 piping in ABWR shows that AP + SSE is the most limiting load combination that generally controls the number and size of seismic restraints, including snubbers, on the piping. Combining two separate, independent events, each having a short duration, and each having a very low probability of occurrence is so excessively conservative, it leads to unnecessary restraints that do not improve the safety and reliability of the piping.

6. Dynamic Loads From AP and SSE Will Not Cause Piping Failure. If AP and SSE did occur simultaneously, there would be no unacceptable consequences to the piping. It is now widely accepted that, for reversing dynamic loads, such as earthquake and LOCA building filtered loads , the piping failure mode is fatigue or fatigue ratcheting. Therefore, in the very remote chance that SSE and AP occurred simultaneously, the only possible failure mode would be fatigue or fatigue ratcheting. The number of peak cycles would be only two or three, which is far too few to cause a fatigue or fatigue ratcheting failure in the piping.

7. Pipe Mounted Equipment. The NRC has suggested that even though the AP + SSE load combination could not cause piping failure, there is still a concern about total deflections of the piping and loss of function of valves and equipment. The suggested approach to solving this problem is:

■ Show ASME Section III valves will remain functional for the AP + SSE load combination. For example, include AP + SSE in the RRS for valve design and equipment qualification.

■ Check seismic supports against "loss of function" criteria rather than Service Level "D" limits. For example, demonstrate snubbers can operate without "loss of function" at two times the rated load, instead of the 1.5 times rated load for Service Level D limits.

8. Inservice Inspection of Pipe to RPV Nozzle Welds. ASME Section XI requires that each circumferential weld of pipe to the RPV be given a surface and volumetric examination during each of the inspection periods. Each weld is thus inspected at least once every 10 years. The piping ISI program is thus at least equivalent to the ISI requirements for the welds in the RPV. An augmented ISI program for the pipe to RPV nozzle welds, and the additional radiation exposure to personnel that would result, is not desirable and is not necessary to justify the elimination of AP + SSE as a design load combination.

## COMPLIANCE WITH SRP 3.9.3

Appendix A, Table 1, SRP 3.9.3 identifies Sustained Loads + LOCA + SSE as a combination with a Service Level D stress limit. Also, the NRC staff interprets GDC-2 to require the effects of LOCA and SSE be combined. However, it is reasonable and justified to eliminate the special, extremely low probability load combination of SSE + AP, but maintain the load combinations of SSE combined with all other short-term and long-term loads resulting from any LOCA (SBL, IBL, and LBL). This would meet the requirements of SRP 3.9.3 and GDC-2 and eliminate the need to base design on an overly conservative assumed load combination that could result in the installation of needless and undesirable pipe supports for dynamic loads.

## BENEFITS OF DECOUPLING LOCA AND SSE

Analysis of ABWR Class 1 piping shows the combination of LOCA + SSE is the most frequent load combination that controls the number and size of supports on a piping system. This is particularly true for the combination AP + SSE. If the peak responses due to AP loads and the peak responses due to SSE are not combined, a major and unjustified conservatism is eliminated. This in turn allows elimination of unneeded dynamic restraints that do not contribute to the overall safety and reliability of the piping system.

NOTE:

The primary sources of the probability of occurance of events and event combinations used in the JUSTIFICATION SUPPORTING DECOUPLING OF AP AND SSE are listed below.

1. Standard Review Plan 2.2.3, EVALUATION OF POTENTIAL ACCIDENTS.

2. NEDE-21235, Class III, April 1976, LOADS TASK FORCE FINAL REPORT, Approved by DC Ditmore and FD Judge, GE COMPANY PROPRIETARY.

3. 385HA738, Rev. A, Issued December 7, 1976, LOADING COMBINATIONS AND ACCEPTANCE CRITERIA, by PW Marriot.

4. ANSI/ANS-52.1-1983, NUCLEAR SAFETY CRITERIA FOR THE DESIGN OF STATIONARY BOILING WATER REACTOR PLANTS.