SIEMENS

Proj 702

November 17, 2000
NRC:00:048

Document Control Desk
ATTN: Chief, Planning, Program and Management Support Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Simulation of the Low Head Safety Injection (LHSI) in Siemens Power Corporation's LOCA Evaluation Model (SEM/PWR-98)

A concern regarding the simulation of the low head safety injection (LHSI) in SPC's LOCA evaluation model (SEM/PWR-98) was identified in June 2000. We initially concluded that the model was in error and communicated this information to affected utilities.

SPC subsequently investigated the LHSI modeling in SEM/PWR-98 in more detail as part of its development of a modified evaluation model. As a result of this investigation, SPC concluded that the original modeling provided a reasonable and acceptable simulation of the large break LOCA. SPC plans to continue its use of the original LHSI modeling as part of the SEM/PWR-98 Appendix K evaluation model. The affected utilities will be informed that the previous information is being retracted.

The following discussion describes the concern that led to the investigation of model adequacy and a summary of the basis for the SPC conclusion that no error exists and that the original model fully meets the intent of 10CFR50.46 and Appendix K.

The issue that led to this investigation was whether the modeling of the interaction between the termination of accumulator water flow and the initiation of LHSI flow adequately reflected expected behavior. More specifically, the matter involved the timing of the initiation of LHSI flow into the reactor vessel relative to the termination of the flow of water from the accumulator.

Because of code limitations, it is assumed in SEM/PWR-98 that the accumulator flow is terminated just prior to the flow of the nitrogen gas into the accumulator lines. Recognizing that the accumulator flow will not stop at this time, the model extends the accumulator flow to inject the water remaining in the accumulator, accumulator lines, and part of the cold legs into the reactor vessel. For plants where the LHSI injects into the accumulator line, the model also calculates LHSI flow into the accumulator line and adds this flow to the reactor vessel without any delay. The model calculates LHSI flow into the accumulator lines based on the back pressure in the line at the injection point. For plants where the LHSI injects into the accumulator line, the flow of LHSI is calculated to start at the time the accumulator flow is assumed to have stopped.

The following discussion explains the basis for concluding that the original modeling of LHSI injection is acceptable. The conclusion is based on two items. First, SPC has shown that the injection of ECC as modeled in SEM/PWR-98 is a reasonable representation of expected behavior. Second, the overall conservatism of the evaluation model is large relative to any uncertainty in the LHSI flow.

Siemens Power Corporation

2101 Horn Rapids Road
Richland, WA 99352

Tel: (509) 375-8100
Fax: (509) 375-8402

D056

SPC's conclusion regarding the adequacy of the LHSI modeling is based on a comparison between the evaluation model and our realistic LBLOCA model. This comparison was made for a plant design that is known to be sensitive to this part of the modeling. The comparison shows that the original LHSI injection model provides a reasonable approximation of LHSI injection behavior. In making the comparison between the two models, the time at which the accumulator empties was made identical. This alignment most accurately addresses the central issue of the effects of the clearing of the accumulator lines and the initiation of LHSI flow into the reactor vessel. The results of the comparison show that the total amount of LHSI water is a few percent higher in the realistic model calculation for the first 25 seconds after the accumulators empty and a few percent lower for the remainder of the event. A key difference between the two models is that isothermal expansion is assumed in SEM/PWR-98, which keeps the pressure in the accumulator lines high enough to prevent LHSI injection until the accumulators have emptied, whereas the realistic model assumes that the accumulator expansion is not isothermal, and therefore it predicts that the pressure in the accumulator lines drops to the LHSI injection pressure prior to the time at which the accumulators empty. Specifically, the realistic model predicts that approximately 1,400 lbm of LHSI injection occurs prior to the time at which the accumulators empty.

The SEM/PWR-98 model is conservative in its calculation of the end of bypass. Specifically, the modeling in SEM/PWR-98 delays the end of bypass substantially beyond the time it would be expected to occur. This delay causes the loss of additional ECCS water when the Appendix K requirement is imposed to discard water injected prior to the end of bypass.

The SEM/PWR-98 Appendix K evaluation model contains inherent limitations associated with the homogeneous equilibrium model and the one-dimensional downcomer model. These features of the model result in a calculation in which the boundary flow of ECCS in the downcomer is unrealistically delayed. This delay in the initiation of sustained down flow, which signals the end of bypass, results in a very conservative calculation. The extent of this conservatism can be demonstrated by using the realistic LOCA model. Performing this calculation with the evaluation model and the realistic model for the same large break LOCA shows that about 13,600 lbm of accumulator water is arbitrarily lost due to the delayed end of bypass coupled with the requirement to discard water injected prior to the end of bypass.

SPC concludes that the original LHSI model provides a reasonable representation of the LHSI injection behavior. Any uncertainty associated with the exact timing of LHSI flow into the reactor vessel is insignificant compared to the conservative predictions of total ECCS injection using the SEM/PWR-98 Appendix K evaluation model.

Very truly yours,

Jerold S Holm for

James F. Mallay, Director
Regulatory Affairs

/arn

cc: R. Caruso
N. Kalyanam
Project No. 702