FRAMATOME
TECHNOLOGIES

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

Subject: Report of Preliminary Safety Concern Related to Core Flood Line Break with 2-Minute Operator Action Time

Gentlemen:

The purpose of this letter is to advise you of a potential safety concern regarding the consequences of a potential core flood tank (CFT) line break that could be worse if offsite power were available. With offsite power available, the operators are required (per the emergency operating procedures) to trip the reactor coolant pumps (RCPs) immediately following the loss of loss of subcooling margin (LSCM). The RCP trips have historically been credited within two minutes following the LSCM

Historically, the CFT line break has been analyzed for the B&W-designed plant with a loss-of-offsite power (LOOP) at the time of reactor trip. However, if offsite power is available, the operators are instructed by the emergency operating procedures to manually trip the RCPs immediately following a loss of subcooling margin.

Preliminary analyses performed with the approved ECCS Evaluation Model predicted significant peak cladding temperature (PCT) increases for several of the B&W designed plants when the RCPs pumps are powered for the first two minutes following the LSCM. FTI has evaluated the SBLOCA EM pump degradation model and concluded that it cannot be considered conservative for this two-minute RCP trip analysis. Use of a lower bound "M3" LBLOCA degradation curve is conservative. When this degradation curve is used, the PCT for CFT line break with a two-minute RCP trip at TMI-1 and CR-3 exceed the acceptance criteria. When this lower bound curve is used with a one minute RCP trip there is little to no core uncovering with PCTs less than 750 F for these two plants.

Attached is a more detailed description of the concern including justification for use of a lower bound pump degradation curve. The information provided is adequate to show that no safety concern exists for the CFT line break with offsite power available. This determination is based on use of a conservative pump degradation curve and a two-minute RCP trip for Oconee 1, Oconee 2, Oconee 3, ANO-1, and DB-1 and a one-minute trip for

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CR-3 and TMI-1. Based upon this information, this matter is not reportable under 10CFR 21.

A plan for final resolution of this concern is being discussed with the B&W operating plant owners for their approval. FTI believes that it is prudent to inform the NRC at this time on the nature of this concern. The evaluation analyses will be completed and a final report submitted to the NRC by December 20, 2000.

If you have any questions concerning this matter, please contact the undersigned at 804-832-2964, or you may contact Mr. Robert Schomaker at 804-832-2917.

Sincerely,

for JJ Kelly

Mr. Joseph Kelly
Manager,
B&W Owners Group Services

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Status and Preliminary Evaluation of PSC 2-00

CFT Line Break with 2-Minute RCP Trip

Preliminary Safety Concern (PSC) 2-00 was initiated by Framatome Technologies on July 28, 2000. It identified that the calculated consequences for a postulated core flood tank (CFT) line break for the B&W-designed plants could be worse if offsite power were available, and credit for operators tripping the reactor coolant pumps (RCPs) was performed at two minutes after loss of subcooling margin (LSCM).

The CFT line break has historically been analyzed for the B&W-designed plants with a loss-of-offsite power (LOOP) at the time of reactor trip. The worst single failure following LOOP is generally a loss of an emergency diesel generator, such that a single HPI and LPI pump are initially unpowered. The single operating LPI pump and valve arrangement result in all the LPI flowing to only one CFT line, which is assumed to be the broken line. Therefore, the event is mitigated in the short term by the flow from one HPI pump and one intact CFT. This ECCS flow is sufficient, with the residual reactor vessel inventory from early RCP trip, to adequately cool the core. The minimum core mixture level generally remains near or above the top of the core with typical PCTs less than 800 F for this break with an immediate loss-of-offsite power.

If offsite power is available, the operators are instructed by the emergency operating procedures (EOPs) to manually trip the RCPs as an immediate action following LSCM. The analyzed event credits RCP trip at two minutes following LSCM. When the RCP's trip at two minutes, the continued forced circulation in the RCS causes more RCS liquid to flow out the break, thereby decreasing the liquid inventory that remains in the reactor vessel. This reduced vessel inventory, with the ECCS flow from a single CFT and one HPI pump results in additional core uncovering with higher cladding temperature excursions. Where the previous analysis assumed the single failure of an EDG, this condition would require a different single failure which for some of the B&WOG plants would require the passive failure of the vital buss.

Preliminary analyses performed with RELAP5/MOD2 using the NRC-approved evaluation model (EM) reported in BAW-10192PA predicted significant PCT increases for several of the 177-FA lowered-loop plants when the reactor coolant pumps are powered for the first two minutes following the loss of adequate subcooling margin. More significantly, sensitivity studies showed that the calculated consequences are highly dependent upon the modeling of RCP performance under two-phase flow conditions. The severity of the predicted cladding temperature excursions is directly tied to the extent that pump head performance is degraded during two-phase flow. Increased degradation reduces the amount of liquid inventory lost through the break. Conversely, less degradation will increase inventory loss, with a significant adverse impact upon predicted PCT.

The NRC-approved SBLOCA EM calculates two-phase RCP performance curves using the RELAP5 head difference and degradation multipliers that were derived from the Semiscale pump tests. Examination of the Semiscale pump degradation curves, which are based upon tests run at relatively low pressures, indicates that they will overpredict the amount of head degradation during the early portion of a CFT line break transient. Predicted RCS pressures during the first two minutes are significantly higher than those from which the curves were derived. Comparison of the EM curves to more representative data, specifically the CE 1/5-scale steam-water tests (which were run at higher pressures) confirms that the EM pump model overpredicts pump head degradation during two-phase flow early in the event. Since less pump degradation results in additional core uncovering and higher PCTs, the approved EM model cannot be judged to be conservative for this application. When a bounding pump performance curve (the lower bound "M3" curve used in the approved large break LOCA model) is modeled the predicted consequences are much more severe. In certain cases, the predicted PCTs do not meet the 10 CFR 50.46 acceptance criteria.

The following summarizes results of preliminary analyses done for this evaluation:

CR-3

Analysis using Appendix K assumptions with the RELAP5 head multiplier and difference curves has a PCT of 1395 F with a manual RCP trip at two minutes after LSCM. Acceptable results are not obtained using a lower bound head degradation model (Earlier RCP trip or additional ECCS would be required to produce acceptable results). Preliminary analyses performed with the bounding M3 degradation curve and a manual RCP trip at one minute after LSCM predict no core uncovering. The maximum PCT is less than 750 F.

TMI-1

Analysis using Appendix K assumptions with the approved Evaluation Model RELAP5 head multiplier and difference curves at the current licensed power level of 2568 MWt produces an acceptable PCT of 1650 F with a two-minute RCP trip. Unacceptable PCT results are obtained at a conservative power level of 2772 MWt assuming the two-minute operator action of tripping the reactor coolant pumps. Acceptable results are not obtained using two-minute RCP trip and a lower bound head degradation model (earlier pump trip or additional ECCS would be required). Preliminary analyses at 2568 MWt have been performed with the bounding M3 degradation curve and a one-minute RCP trip. They predict little to no core uncovering with a maximum PCT less than 750 F.

Oconee 1, 2, and 3

The Oconee plants, when operating at full power, are required to have three HPI pumps available. The limiting SBLOCA analysis uses flow from one HPI pump initially, with credit for flow from a second HPI pump at 10 minutes after ESAS. The PCT for the CFT line break is the same as the initial cladding temperature when the RELAP5 default pump modeling is used. Use of the lower bound M3 head multiplier is acceptable because there is additional flow from the second HPI pump at 10 minutes that limits the extent of the core uncovering. PCTs in the range 1200 F - 1300 F are obtained when manual RCP trip is credited at two minutes. Therefore, there are no unacceptable results for the Oconee units for any LOCA with a RCP trip within the first two minutes after LSCM.

ANO-1

The unit has a continuously cross-tied LPI system with cavitating venturis to balance the flow to both CFT nozzles. This configuration provides additional ECCS flow to the core when the LPI pressure is reached. The additional ECCS results in significantly better PCT behavior (PCT<800 F) even if a lower bound head degradation curve is applied with a manual two-minute RCP trip. Therefore, there are no unacceptable results for ANO-1 for any LOCA with a RCP trip within the first two minutes after LSCM.

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This plant has high volume, low head HPI pumps, each of which is nearly equivalent to two HPI pumps for the lowered-loop plants. For DB, the flow from one HPI pump will limit or preclude core uncovering (PCT < 900 F) with a manual two-minute RCP trip. Therefore, there are no unacceptable results for DB-1for any LOCA with a RCP trip within the first two minutes after LSCM.

Summary

The preliminary CFT line break analyses performed as a result of PSC 2-00 have indicated that TMI-1 and CR-3 are most affected when an operator must manually trip the RCPs because they have the lowest available ECCS flow rates. TMI-1 has the added complication that the plant licensing analyses were performed at a conservative power level of 2772 MWt. Analysis of this CFT line break scenario, with two minute RCP trip will not meet the acceptance criteria at the uprated power level. Analysis of TMI-1 at the current licensed power level of 2568 MWt using the EM predicts a PCT of 1650 F with a two-minute RCP trip. The preliminary CR-3 PCT with the approved model is 1395 F for that same pump trip time. When the bounding degradation curve is applied, manual RCP

trip at one minute or additional ECCS flow credited within ten minutes will produce acceptable PCT's.

It is worth noting that this event is analyzed with a different single failure assumption than previously considered in the EM, because offsite power is available. Plant reviews of the single failure assumptions and requirements were somewhat inconclusive, although electrical buss failures were considered that resulted in the loss of one HPI and one LPI pump.

The NRC was informed of these findings by phone on September 12, 2000. This letter summarizes the information discussed during that phone call and other analyses performed since that time. FTI is reanalyzing those plant-specific SBLOCA break sizes or locations whose PCTs can be increased by the delayed RCP trip. The new analyses will use the lower bound M3 pump degradation head multiplier and the void dependent core cross-flow model that is currently under NRC review. New analyses for TMI-1 and CR-3 will model a one-minute RCP trip. For DB, Oconee-1, Oconee-2, Oconee-3, and ANO-1 manual RCP trip at two minutes will continue to be modeled. Sensitivity studies will be used to determine the most limiting initial CFT liquid inventory and pressure.

Preliminary results obtained to date indicate that the PCTs for the two-minute CFT line break cases and possibly some of the larger (0.3- to 0.75-ft^2) CLPD break cases may increase, but they will not become the limiting small break transient. The analyses performed with a one-minute RCP trip will have lower PCTs than those predicted for a two-minute trip. The one-minute trip results will be similar to the immediate RCP trip on LOOP. When all of the analyses are completed, a summary report describing the results and providing an evaluation of the reportability of the concern under Part 21 will be prepared and sent to the utilities operating B&W designed plants and the NRC by December 20, 2000.