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U.S. Nuclear Regulatory Commission
Washington D.C. 20555

Subject: Interim Report on the Preliminary Safety Concern (PSC 2-00) Related to Core Flood Line Break with 2-Minute Operator Action Time

Reference: FTI Letter FTI-00-2433, J. Kelly to the USNRC Document Control Desk, dated September 26, 2000

Gentlemen:

The purpose of this letter is to advise you that the final report regarding the consequences of a potential core flood tank (CFT) line break with offsite power available will not be complete on 12/20/00 as reported in the Reference letter. The delay is primarily because more extensive plant-specific sensitivity studies than originally planned were needed for both the CFT line break and cold leg pump discharge (CLPD) break analyses. This additional analysis work, coupled with limited resources within FTI and emergent plant operational issues, has delayed the formal completion of the material that will be the basis of the final evaluation report. To date, all analyses have been completed and they are in different stages of the quality assurance (QA) process. The analysis files should be completed by mid-January and a draft report prepared for the B&W utilities to review by mid February. The final report will be sent to the NRC by April 1.

The preliminary analysis results (which are preliminary because the QA has not completed) are summarized in the attached discussion. The analyses were performed with the approved ECCS Evaluation Model described in BAW-10192PA with a conservative lower bound "M3" LBLOCA two-phase pump head degradation multiplier. The analyses were also performed using the new RELAP5/MOD2 void-dependent cross-flow model that is currently under NRC review.

The information provided shows that no safety concern exists for the CFT line or CLPD break with offsite power available. This determination is based on use of a conservative pump degradation curve and a two-minute reactor coolant pump (RCP) trip for Oconee 1, Oconee 2, Oconee 3, ANO-1, and DB-1 and a one-minute trip for CR-3 and TMI-1.

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If you have any questions concerning this matter, please contact the undersigned at 804-832-3635, or you may contact Mr. Robert Schomaker at 804-832-2917.

Sincerely,

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Status of PSC 2-00 Analyses and Evaluations

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 of a postulated core flood tank (CFT) line break for the B&W-designed plants could be worse if offsite power was 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) coincident with 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 results 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 with LOOP cases, to adequately cool the core. The minimum core mixture level generally remains near or above the top of the core with typical peak cladding temperatures (PCTs) less than 800 F for this break with 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 past analyses credited 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 and unacceptable cladding temperature excursions for a CFT line break in the lowered-loop plants. If additional pumped ECCS (a second HPI pump or LPI via LPI line cross connect) is available by ten minutes, acceptable cladding temperatures are obtained. A RCP trip at one minute results in no core uncovering, even if only one CFT and one HPI are available. A two-minute RCP trip with one CFT and one HPI pump is also acceptable for the raised-loop plant CFT line break because of the higher flow from the low head HPI pump. Analyses have also shown that CLPD SBLOCA breaks of 0.5-ft^2 and larger will have higher PCTs if the RCPs run for two minutes after break opening. Analyses and evaluations have shown that CLPD break sizes of 0.3 ft^2 and smaller have higher PCTs when LOOP occurs coincident with reactor trip.

The CFT line break results are highly dependent upon the RCP performance, plant ECCS configuration, and pumped injection capacities. The CFT line break analyses with a RCP trip at two minutes have shown the potential for two separate and distinct core uncovering periods. The RCP two phase degradation model strongly influences the first core uncovering period. The evaluation model prescribed use of the RELAP5 semiscale (R5)

degradation model for SBLOCA, but this selection was made based on LOOP cases. This model was not, and cannot be shown to be conservative for the CFT line break application. The LBLOCA lower bound "M3" degradation model has been reviewed and it is conservative for this application. When this model is used, the first core uncovering period occurs between the RCP trip time and the time that the intact CFT begins to discharge (generally between 2.5 and 4 minutes). The maximum cladding temperature increase during this initial heatup is limited because the CFT refill limits the duration of the core-uncovering period. The second heatup can begin as early as 7 or 8 minutes and last past 20 minutes in some cases. When unacceptable PCTs were calculated, they occurred during the second heatup period. The first uncovering period is dominated by the RCP performance and CFT fill pressures and volumes. A minimum CFT pressure and maximum level will generally produce the highest cladding temperature during the first heatup period. The second period is dominated by the pumped ECCS injection flow rates, but the CFT liquid volume is also important. The highest clad temperature for the second uncovering period is generally produced with the minimum CFT level and pressure.

The multiple core uncovering periods for the CFT line break result in significantly more sensitivity studies to demonstrate that the worst combination of CFT inputs have been considered. These additional studies have increased the analytical burden and been one source of delay for completing the analyses necessary to evaluate this PSC. The key analyses that have been completed, but not formally QAed at this time, are given on a plant specific basis. Tables 1 through 4 are for the B&W lowered-loop plants and Table 5 is for the DB raised-loop plant.

TMI-1

Table 1 gives the preliminary analysis results for TMI-1. Acceptable PCT results were obtained for the CFT line break from the licensed power level of 2568 MWt using the NRC-approved R5 two-phase pump degradation model. Unacceptable PCT results were obtained for this scenario when the lower bound "M3" head degradation model was used with a two-minute RCP trip. A one-minute trip had no core uncovering during either period, even with one HPI pump and one CFT. The CFT line break is also acceptable if flow from a second HPI pump can be initiated within ten minutes. The 0.5- and 0.75-ft^2 CLPD breaks from an uprated power level of 2772 MWt had PCTs of 1017 F and 866 F for the two-minute RCP trip cases. These PCTs were 172 and 6 F higher, respectively, than the PCTs produced by the same break size with LOOP. The CLPD breaks have only one period of uncovering because these breaks have the added benefit of having flow from both CFTs and one LPI pump.

Although the PCTs increase significantly for some of these no LOOP cases, the limiting SBLOCA PCT for TMI-1 remains at 1412 F for the 0.05 ft^2 CLPD break. The only key change in the analysis assumptions for TMI-1 is the one-minute RCP trip operator action time used in the CFT line break at a power level of 2568 MWt. All of the PCT changes will be reported to Exelon for inclusion in the licensee 10 CFR 50.46 annual reporting letter.

CR-3

The preliminary CR-3 results are shown in Table 2. Unacceptable PCT results were obtained for the CFT line break when the lower bound "M3" head degradation model was used with a two-minute RCP trip. A one-minute trip had no core uncovering even with one HPI pump and one CFT. The 0.5- and 0.75-ft^2 CLPD breaks had PCTs of 1038 F and 965 F for the two-minute RCP trip cases. These PCTs were 236 and 104 F higher, respectively, than the PCTs produced by the same break size with LOOP. The 0.5-ft^2 CLPD break was also run for CR-3 without RCP trip. The ECCS flow from both CFTs and one LPI pump condensed the steam flowing through the RCPs and effectively negated the RCP operation by approximately three minutes. The PCT for this case was 1000 F.

Although the PCTs increase significantly for some of these no LOOP cases, the limiting SBLOCA PCT for CR-3 remains at 1415 F for the 0.07-ft^2 CLPD Line break. The only key change in licensing status for CR-3 is the one-minute RCP trip operator action time used in the CFT line break. The PCT changes will be reported to FPC for inclusion in the licensee 10 CFR 50.46 annual reporting letter.

Oconee 1, 2, and 3

When the Oconee plants are operating at full power, they are required to have three HPI pumps available. The 2568 MWt SBLOCA analyses use flow from one HPI pump initially, with credit for operator actions to assure flow from a second HPI pump at 10 minutes after ESAS. The limiting PCT for the CFT line break for these three units was 1346 F during the second core uncovering period with a two-minute RCP trip for Oconee 1. Oconee 1 has Westinghouse pumps and units 2 and 3 have Bingham pumps. The limiting CFT line break PCT for the units with Bingham pumps was 1127 F.

The 0.5- and 0.75-ft^2 CLPD breaks were only run with the limiting (Westinghouse) RCP type. These cases had PCTs of 1038 F and 965 F, respectively, when there was a two-minute RCP trip. The PCTs were 216 and 9 F higher, respectively, than the PCTs produced by the same break size with LOOP.

Although the PCTs increase significantly for some of these no LOOP cases, the limiting SBLOCA PCT for the Oconee units remains at 1369 F for the 0.15 ft^2 CLPD break for the 100 percent power analyses with two-HPI pumps available. The PCT changes will be reported to Duke Power for inclusion in the licensee 10 CFR 50.46 annual reporting letter.

ANO-1

This unit has cavitating venturis in the LPI lines and it has an open LPI crosstie line that passively balances the flow to both CFT nozzles. This configuration provides additional ECCS flow to augment the flow from one CFT and one HPI pump when the RCS pressure drops into the LPI discharge pressure range. The CFT line break performed from an initial core power of 2772 has a PCT of 1051 F during the first and only uncovering period with a two-minute RCP trip as shown in Table 4. The 0.5- and 0.75-ft^2 CLPD breaks had PCTs of 1068 F and 888 F for the two-minute RCP trip case at 2772 MWt. These PCTs were 223 and 28 F higher, respectively, than the PCTs produced by the same break size with LOOP.

Although the PCTs increase significantly for some of these no LOOP cases, the limiting SBLOCA PCT for ANO-1 remains at 1311 F for the 0.15 ft^2 CLPD break at 2568 MWt. The only key change in licensing status for the RELAP5/MOD2 ANO-1 analyses is credit for the LPI cross-tie and LPI flow during the CFT line break. The PCT changes will be reported to Entergy Operations for inclusion in the licensee 10 CFR 50.46 annual reporting letter.

Davis Besse 1

This plant has high volume, low head HPI pumps, each of which are nearly equivalent to two of the lowered-loop HPI pumps at lower pressures. For DB, the flow from one HPI pump will limit the core uncovering to only the first period. The maximum PCT for the CFT line break for DB was 962 F as shown in Table 5. The 0.5- and 0.75-ft^2 CLPD breaks had PCTs of 1039 F and 945 F for the two-minute RCP trip case analyzed at 2966 MWt. These PCTs were 324 and 230 F higher, respectively, than the PCTs produced by the same break size with LOOP.

Although the PCTs increase significantly for some of these no LOOP cases, the limiting SBLOCA PCT for DB-1 remains at 1408 F for the 0.02463 ft^2 HPI line break. The PCT changes will be reported to First Energy Operating Company for inclusion in the licensee 10 CFR 50.46 annual reporting letter.

Summary

This summary letter is not the final report that was scheduled for completion by December 20, 2000. It is a short progress report describing the status of current SBLOCA analyses performed for all the B&W-designed plants with the delayed RCP trip. The analyses needed to show that adequate core cooling occurs for the one-minute operator action time for the CFT line breaks for TMI-1 and CR-3 have been completed. The revised CLPD analyses, with new PCT consequences for the two-minute RCP trip, have also been completed for these two plants. Revised CFT line break and large CLPD SBLOCA cases with two-minute RCP trips have also been completed for the remainder of the B&W-designed plants. When these analyses are formally quality assured, a summary report will

be prepared, reviewed by the utilities, and sent to the NRC as notification that PSC 2-00 is been closed.

TABLE 1. PSC 2-00 Analyses Performed for TMI-1. (Preliminary)

Potential New Licensing Case from PSC 2-00 if marked with an *	RCP Trip Time after LSCM (min)	Break Area (ft^2)/ Break Type	HPI Flow fraction from 1 HPI pump into the RCS If two entries: < 10 min/ >10 min	LPI flow fraction From 1 LPI pump into the RCS	RCP Two-Phase Pump Degradation Model Used in the Analysis	Power Level (MWt) (2568 MWt is the current plant power)	Peak Clad Temp. (F)	Notes
	2.0	0.44/CFT	1.0	0.0	R5	2772	>2200	Non-limiting 2ϕ head mult
	2.0	0.44/CFT	1.0	0.0	R5	2568	1874	Non-limiting 2ϕ head mult
	2.0	0.44/CFT	1.0	0.0	M3	2568	>2200	Initial Source of PSC
	2.0	0.44/CFT	1.0 / 1.5	0.0	M3	2568	1582	CFT Min P, Min V, contingency
	2.0	0.44/CFT	1.0 / 1.5	0.0	M3	2568	1576	CFT Max P, Min V, contingency
	2.0	0.44/CFT	1.0 / 1.5	0.0	M3	2568	1454	CFT Min P, Max V, contingency
	2.0	0.44/CFT	1.0 / 1.5	0.0	M3	2568	1424	CFT Max P, Max V, contingency
*	1.0	0.44/CFT	1.0	0.0	M3	2568	717	CFT Min P, Min V
	2.0	0.3/CLPD	0.7	1.0	M3	2772	719	No heatup, LOOP is limiting
*	2.0	0.5/CLPD	0.7	1.0	M3	2772	1017	+172 F PCT over LOOP case
*	2.0	0.75/CLPD	0.7	1.0	M3	2772	866	+6 F PCT over LOOP case

TABLE 2. PSC 2-00 Analyses Performed with the Byron Jackson Pumps for CR-3. (Preliminary)

New Licensing Case from PSC 2-00 if marked with an *	RCP Trip Time after LSCM (min)	Break Area (ft^2)/ Break Type	HPI Flow fraction from 1 HPI pump into the RCS If two entries: < 10 min/ >10 min	LPI flow fraction From 1 LPI pump into the RCS	RCP Two-Phase Pump Degradation Model Used in the Analysis	Power Level (MWt) (2568 MWt is the current plant power)	Peak Clad Temp. (F)	Notes
	2.0	0.44/CFT	1.0	0.0	R5	2568	1391	Non-limiting 2ϕ head mult
	2.0	0.44/CFT	1.0	0.0	M3	2568	>2200	Initial Source of PSC
*	1.0	0.44/CFT	1.0	0.0	M3	2568	718	CFT Min P, Min V, no heatup
*	1.0	0.44/CFT	1.0	0.0	M3	2568	718	CFT Max P, Min V, no heatup
*	1.0	0.44/CFT	1.0	0.0	M3	2568	718	CFT Min P, Max V, no heatup
*	1.0	0.44/CFT	1.0	0.0	M3	2568	718	CFT Max P, Max V, no heatup
	2.0	0.3/CLPD	0.7	1.0	M3	2568	719	No heatup, LOOP is limiting
*	2.0	0.5/CLPD	0.7	1.0	M3	2568	1038	+236 F PCT over LOOP case
*	2.0	0.75/CLPD	0.7	1.0	M3	2568	965	+104 F PCT over LOOP case
	Never	0.5/CLPD	0.7	1.0	M3	2568	1000	Pump ineffective after 3 minutes

TABLE 3. PSC 2-00 Analyses Performed for the Oconee 1, 2, and 3 (Westinghouse and Bingham Pumps) (Preliminary)

New Licensing Case from PSC 2-00 if marked with an *	RCP Type / RCP Trip Time after LSCM (min)	Break Area (ft^2)/ Break Type	HPI Flow fraction from 1 HPI pump into the RCS If two entries: < 10 min/ >10 min	LPI flow fraction From 1 LPI pump into the RCS	RCP Two-Phase Pump Degradation Model Used in the Analysis	Power Level (MWt) (2568 MWt is the current plant power)	Peak Clad Temp. (F)	Notes
	B / 2.0	0.44/CFT	1.0 / 1.9	0.0	M3	2568	1105	CFT Min P, Max V
	B / 2.0	0.44/CFT	1.0 / 1.9	0.0	M3	2568	1127	CFT Min P, Min V
*	W / 2.0	0.44/CFT	1.0 / 1.9	0.0	M3	2568	1346	CFT Min P, Min V
	W / 2.0	0.44/CFT	1.0 / 1.9	0.0	M3	2568	1280	CFT Max P, Min V
	W / 2.0	0.44/CFT	1.0 / 1.9	0.0	M3	2568	1093	CFT Min P, Max V
	W / 2.0	0.3/CLPD	0.4 / 1.3	1.0	M3	2568	715	No heatup, LOOP is limiting
*	W / 2.0	0.5/CLPD	0.4 / 1.3	1.0	M3	2568	1147	+216 F PCT over LOOP case
*	W / 2.0	0.75/CLPD	0.4 / 1.3	1.0	M3	2568	994	+9 F PCT over LOOP case

TABLE 4. PSC 2-00 Analyses Performed with Byron Jackson Pumps for ANO-1. (Preliminary)

New Licensing Case from PSC 2-00 if marked with an *	RCP Trip Time after LSCM (min)	Break Area (ft^2)/ Break Type	HPI Flow fraction from 1 HPI pump into the RCS If two entries: < 10 min/ >10 min	LPI flow fraction From 1 LPI pump into the RCS	RCP Two-Phase Pump Degradation Model Used in the Analysis	Power Level (MWt) (2568 MWt is the current plant power)	Peak Clad Temp. (F)	Notes
*	2	0.44 CFT	1	P Depend: 0.0 to 0.5	M3	2772	1051	CFT Min V, Min P
	2	0.30 CLPD	0.7	1	M3	2772	715	No heatup, LOOP is limiting
*	2	0.50 CLPD	0.7	1	M3	2772	1068	+223 F PCT over LOOP case
*	2	0.75 CLPD	0.7	1	M3	2772	888	+28 F PCT over LOOP case

TABLE 5. PSC 2-00 Analyses Performed with Byron Jackson Pumps for DB-1. (Preliminary)

New Licensing Case from PSC 2-00 if marked with an *	RCP Trip Time after LSCM (min)	Break Area (ft^2)/ Break Type	HPI Flow fraction from 1 HPI pump into the RCS If two entries: < 10 min/ >10 min	LPI flow fraction From 1 LPI pump into the RCS	RCP Two-Phase Pump Degradation Model Used in the Analysis	Power Level (MWt) (2772 MWt is the current plant power)	Peak Clad Temp. (F)	Notes
	2	0.44 CFT	1	0	M3	2966	864	CFT Min V/Min P
	2	0.44 CFT	1	0	M3	2966	811	CFT Min V/Max P
*	2	0.44 CFT	1	0	M3	2966	962	CFT Max V/Min P
	2	0.44 CFT	1	0	M3	2966	913	CFT Max V/Max P
*	2	0.30 CLPD	0.49	1	M3	2966	715	Similar to LOOP case, has little heatup
*	2	0.50 CLPD	0.49	1	M3	2966	1039	+324 F PCT over LOOP case
*	2	0.75 CLPD	0.49	1	M3	2966	945	+230 F PCT over LOOP case