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10CFR50.46(a)(3)(ii)

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May 29, 2003

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Subject: Arkansas Nuclear One - Units 1 and 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6
Errors or Changes in the Emergency Core Cooling System Evaluation Model; Annual Report for 2002

Dear Sir or Madam:

10CFR50.46(a)(3)(ii) requires licensees to report annually each change to or error discovered in an acceptable evaluation model (EM) or in the application of such model for the emergency core cooling system (ECCS) that affects the peak cladding temperature (PCT). Included in the submittal is the estimated effect these changes or errors have on the limiting ECCS analysis. The purpose of this submittal is to provide that required information for Arkansas Nuclear One (ANO) for the reporting period January 1, 2002, through December 31, 2002.

ANO-1: The ANO-1 licensing basis for the year 2002 was the CRAFT2-based EM for the first part of the year. During 2002, the ANO-1 licensing basis was changed to the RELAP5/MOD2-based EM. Other than the change to the RELAP5/MOD2-based EM, there were no errors in or changes to the EMs or the application of these models that resulted in a change in the PCT or non-conformance to additional criteria set forth in 10CFR50.46(b). However, one EM change and two new applications using the RELAP5/MOD2-based EM have been evaluated which resulted in no change to the PCT. Also, during 2002, there were no input errors detected that changed the results of completed loss-of-coolant accident (LOCA) analyses. In addition, for information only, Attachment 1 provides a description of the analyses and evaluations that have been completed during the reporting period for ANO-1.

ANO-2: For ANO-2, there were two errors in the ABB-CE ECCS large-break LOCA (LBLOCA) EM which are discussed in Attachment 2 that resulted in an increase in the PCT of less than 1°F. There were no other errors in or changes to the LBLOCA or small-break LOCA (SBLOCA) EMs or the application of these models that resulted in a change in the PCT or non-conformance to additional criteria set forth in 10CFR50.46(b).

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This submittal contains no commitments. Should you have any questions regarding this submittal, please contact me.

Sincerely,

Sherrie R. Cotton

Sherrie R. Cotton
Director, Nuclear Safety Assurance

SRC/nbm
Attachments

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Attachment 1
ANO-1 Annual 10CFR50.46 Information for 2002

1.0 2002 Generic LOCA EM Error Corrections or Changes

This section describes the generic EM error corrections or changes for submittal pursuant to 10CFR50.46.

1.1 CRAFT2 Evaluation Model Error Corrections or Changes

No errors or changes were reported in the CRAFT2-based B&W ECCS EM, BAW-10104P-A, Revision 5 for LBLOCA (Reference 1) and BAW-10154-A, Revision 0 for SBLOCA (Reference 2), during 2002.

1.2 BWNT LOCA Evaluation Model Error Correction or Changes

This model is applicable to B&W-designed pressurized water reactors (PWRs) for LBLOCA and SBLOCA analyses. The NRC approved topical report for this evaluation model is BAW-10192PA Revision 0 (Reference 3).

The LBLOCA Evaluation Model consists of four computer codes: (1) BAW-10164P-A, RELAP5/MOD2-B&W to compute the system, core, and hot rod response during blowdown (Reference 4), (2) BAW-10171P-A, REFLOD3B to calculate the time for refill of the lower plenum and core reflood rate (Reference 5), (3) BAW-10095-A, CONTEMPT to compute the containment pressure response (Reference 7), and (4) BAW-10166P-A, BEACH (RELAP5/MOD2-B&W reflood heat transfer package) to determine the hot pin thermal response during refill and reflood phases (Reference 6). The SBLOCA Evaluation Model consists of two codes: (1) BAW-10164P-A, RELAP5/MOD2-B&W to compute the system, core, and hot rod response during the transient and (2) BAW-10095-A, CONTEMPT to compute the containment pressure response, if needed. An NRC-approved fuel code (currently BAW-10162P-A, TACO3 (Reference 9) or BAW-10184P-A, GDTACO (Reference 10)) is used to supply the fuel rod steady-state conditions at the beginning of the SBLOCA or LBLOCA. These codes are approved for use with M5™ cladding via the safety evaluation report on BAW-10227P-A (Reference 8).

Two EM changes were reported in the RELAP5/MOD2-B&W-based BWNT LOCA EM, BAW-10192P-A Revision 0 during 2002. The first item is associated with the power uncertainty factor applicable to Appendix K power uprates. The second item discusses the recent approval of Revision 4 of the RELAP5/MOD2-B&W topical report.

1.2.1 Power Measurement Uncertainty

The NRC has modified Appendix K to 10CFR50 to allow two options for defining the reactor power level for LOCA applications. It allows the power to be modeled as: (1) at least 1.02 times the licensed power level (to allow for instrumentation error), or (2) an alternate power level (not less than the licensed power level), provided the proposed alternative value has been demonstrated to account for uncertainties due to power level instrumentation error. The Framatome ANP (FANP) LOCA evaluation models were written prior to this modification and specified the use of a power level at least 1.02 times the rated power level. The EM change reported herein simply acknowledges the change in the regulations and allows current or future EM analyses to be performed with either of the Appendix K prescribed options. This is considered an EM Change.

1.2.2 Approval of RELAP/MOD2-B&W Topical Report Revision

The NRC, by letter dated April 9, 2002, approved Revision 4 of the RELAP5/MOD2-B&W topical report, BAW-10164, and its use with the once-through steam generator LBLOCA and SBLOCA evaluation models, BAW-10192P-A. The RELAP5 revision for large break analyses allows: (i) modeling of the hot fuel assembly as a hot pin and a hot bundle, each with their own heat structure, (ii) improvements to the TACO3-based, steady state, fuel temperature uncertainties, and (iii) automation of the BEACH (BAW-10166P-A) blockage limitation. The RELAP5 revision for the small break analyses allows an automation of the void-dependent cross-flow model. Material was also added to the RELAP5 topical report revision reflecting prior approvals for M5™ cladding (BAW-10227P-A) applications with the once-through steam generator evaluation model. This is considered an EM Change.

1.3 Babcock and Wilcox Nuclear Technology (BWNT) LOCA Evaluation Model Generic Analyses

Two generic LOCA 50.46-related B&W evaluations were completed in 2002. These evaluations are not considered EM changes.

1.3.1 Best-Estimate 10-Min Reactor Coolant Pump (RCP) Trip

An evaluation was performed that considered the generic emergency operating guidelines (GEOG) for RCP trip following the loss of subcooling margin (LSCM) (Reference 11). In the event that the RCPs are not tripped within the initial one to two minutes following LSCM, the GEOG instructs the operator to keep the RCPs in operation (preferably with one in each loop) until SCM is restored or LPI flow to the core is established. A limited set of SBLOCA analyses were run and the effects of tripping two of the four RCPs at times between 15 and 25 minutes following LSCM were evaluated. It was concluded that immediate RCP trip within one or two minutes after LSCM remains the best guidance. In the event that the operator misses the RCP trip, the analyses showed that it is preferable to leave all of the RCPs in operation. No 10CFR50.46 calculations were performed.

1.3.2 BEACH Benchmark Comparisons

Benchmark comparisons were provided in Reference 12 to support the NRC requests for information (RAIs) regarding Topical Report BAW-10166P Revision 5 (Reference 13). No 10CFR50.46 calculations were performed.

2.0 2002 Arkansas Nuclear One – Unit 1 Specific LOCA EM Error Corrections and Changes

During 2002 limiting ECCS analyses were tracked for the Mark-B9 fuel rod design for both the CRAFT2-based and RELAP5-based EMs. In the beginning of Cycle 18, the ANO-1 licensing basis switched to the RELAP5-based EM (References 14 and 15). Therefore, 2002 will be the last report that discusses the CRAFT2-based licensing calculations. Each activity and the effect on the limiting ECCS analysis is summarized in Table 1 and Table 2.

2.1 CRAFT2-Based EMs

The Cycle 17 licensing basis for the ANO-1 unit was based on the CRAFT2 EM described in References 1 and 2. The CRAFT2 analyses applicable to ANO-1 are described in References 16 and 17. No new LOCA analyses have been performed in 2002 based on this EM.

2.2 RELAP5-Based EM

The ANO-1 licensing basis for Cycle 18 is based on the BWNT LOCA EM (Reference 3), which uses the RELAP5-MOD2 B&W and associated computer codes. Information relating to the RELAP5-based analyses has been reported in previous year's ECCS reports when they were performed.

2.2.1 Approval of RELAP5/MOD2-B&W Topical Report Revision

Of the newly approved models in BAW-10164P-A Revision 4, the automation of the BEACH blockage limitation and the void-dependent cross-flow model are applied to the ANO-1 licensing analyses. This constitutes the initial use of the RELAP5/MOD2-B&W-based EM for ANO-1.

The automation of the BEACH blockage limitation for LBLOCA analyses has no affect on the temperature calculation.

The SBLOCA spectrum at 2568 MWt was performed entirely with the void-dependent cross-flow model (see section 1.2.2). This spectrum considered the current ANO-1 Technical Specifications on the core flood tank (CFT) inventory and pressure, and also the consequences from the resolution of potential safety concern 2-00. The limiting PCT for the SBLOCA spectrum at 2568 MWt is 1068°F for the 0.5 ft^2 cold leg pump discharge break case with a two-minute RCP trip (Reference 15).

The LBLOCA PCT change is (0°F) for the automation of the BEACH blockage limitation.

2.2.2 Fuel Surface Roughness Change

A new common product specification for UO_2 pellets was developed to streamline the Framatome manufacturing practices. This new specification is being applied to all new batches of Mark-B9 fuel starting with ANO-1 Batch 20. The new specification results in a smaller fuel surface roughness. This change was evaluated and the applicability of the Mark-B9 LOCA analyses was justified (Reference 18). This evaluation is a new application – fuel design change. The current Mark-B9 LOCA analyses were found to be applicable to the new fuel pellet design. The PCT change for LBLOCA and SBLOCA is (0°F).

2.2.3 ANO-1 Cycle 18 Reload Documentation

The ANO-1 Cycle 18 Reload Report (Reference 19) documents the LOCA limits used for Cycle 18 core design. The Reload Report addresses a fuel cycle redesign that includes 15 stainless steel rods and adds reference to BAW-10164P-A Revision 4 to the COLR section. Documentation of the Cycle 18 LOCA Reload Report inputs did not require additional LOCA evaluations or calculations. The cycle 18 evaluations are a new application – fuel design change (fuel surface roughness). The PCT change is (0°F).

3.0 References

1. FANP Topical Report BAW-10104P-A, Rev. 5, "B&W's ECCS Evaluation Model," November 1988.

2 FANP Topical Report BAW-10154-A, Rev. 0, "B&W's Small-Break LOCA ECCS Evaluation Model," July 1985.

3. FANP Topical Report BAW-10192P-A, Rev. 0, "BWNT LOCA – BWNT Loss-of-Coolant Accident Evaluation Model for Once-Through Steam Generator Plants," June 1998.

4. FANP Topical Report BAW-10164P-A, Rev. 4, "RELAP5/MOD2-B&W – An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis", November 2002.

5. FANP Topical Report BAW-10171P-A, Rev. 3, "REFLOD3B – Model for Multinode Core Reflooding Analysis", December 1995.

6. FANP Topical BAW-10166P-A, Rev. 4, "BEACH – A Computer Program for Reflood Heat Transfer During LOCA" February 1996.

7. FANP Topical Report BAW-10095-A, "CONTEMPT – Computer Program for Predicting Containment Pressure-Temperature Response to a LOCA", January 1995.

8. FANP Topical Report BAW-10227P-A, "Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel", February 2000.

9. FANP Topical Report BAW-10162P-A, "TACO3 Fuel Pin Thermal Analysis Code" October 1989.

10. FANP Topical Report BAW-10184P-A, "GDTACO – Gadolinia Fuel Rod Thermal Analysis Code", February 1995.

11. FANP Proprietary Document 32-5011221-01, "BE 10-MIN RCP Trip SBLOCA at 2568 MWt", 1/25/02.

12. FANP Proprietary Document 32-5019288-00, "BEACH Benchmark Comparisons to Support Responses to NRC RAI on BEACH Topical", 7/12/02.

13. FANP Topical BAW-10166P, Rev. 5, "BEACH – A Computer Program for Reflood Heat Transfer During LOCA", December 2001.

14. FANP Document 86-5017127-00, "ANO-1 RELAP5/MOD2 LOCA Summary Report", 7/10/02.

15. FANP Document 86-5017127-01, "ANO-1 RELAP5/MOD2 LOCA Summary Report", 8/13/02.

16. FANP Proprietary Document 32-1202149-04, "Mk-B9 LL Spectrum LOCA Study", 3/29/95.

17. FANP Document 86-1244489-00, "SBLOCA ECCS Evaluation for CR-3", 5/31/96.

18. FANP Document 51-5017537-01, "ANO-1 CY18 LOCA LHR Limits ", 7/29/02.

19. BAW-2334, Rev. 1, "Arkansas Nuclear One Unit-1 Cycle 18 Reload Report".

Table 1: 2002 CRAFT2-Based LOCA Licensing Activity for ANO Unit 1

Plant Name:	Arkansas Nuclear One – Unit 1	**LOCA Spectrum**	
Utility Name:	Entergy	CRAFT2 Mark-B9 LBLOCA	CRAFT2 Mark-B9 SBLOCA
Previous CRAFT2-based Licensing Basis		2089 F	< 1859 F estimated
2002 Licensing Activity: None			

Table 2: 2002 RELAP5-Based LOCA Licensing Activity for ANO Unit 1

Plant Name:	Arkansas Nuclear One – Unit 1	**LOCA Spectrum**	
Utility Name:	Entergy	RELAP5 Mark-B9 LBLOCA	RELAP5 Mark-B9 SBLOCA
Previous RELAP5-based Licensing Basis (current CFT tech specs)		**2032 F**	**1068 F**
2002 Licensing Activity			
Item #	**Reporting Category**	**Description**	**PCT or (PCT Change)**	
1	EM Change	Approval of RELAP5/MOD2-B&W Topical Report Revision BEACH blockage limitation automation and void-dependent cross-flow	(0 F)	1068 F
2	New Application	Fuel Surface Roughness Change	(0 F)	(0 F)
3	New Application	ANO-1 Cycle 18 Reload Documentation Includes evaluation of fuel surface roughness change	(0 F)	(0 F)
Revised RELAP5-based Licensing Basis			**2032 F**	**1068 F**

Attachment 2
ANO-2 Annual 10CFR50.46 Information for 2002

1.0 COMBUSTION ENGINEERING ECCS EVALUATION MODELS AND CODES

Five EMs for ECCS performance analysis of PWRs developed by Combustion Engineering are described in topical reports, are licensed by the NRC, and are covered by the provisions of 10CFR50.46. The evaluation models for LBLOCA are the June 1985 EM and the 1999 EM. There are two evaluation models for SBLOCA: the SBLOCA Evaluation Model (S1M) and the S2M SBLOCA EM. Post-LOCA long-term cooling (LTC) analyses are performed with the LTC evaluation model.

Several digital computer codes are used to do ECCS performance analyses of PWRs for the evaluation models described above that are covered by the provisions of 10CFR50.46. Those for LBLOCA calculations are CEFLASH-4A, COMPERC-II, HCROSS, PARCH, STRIKIN-II, and COMZIRC. CEFLASH-4AS is used in conjunction with COMPERC-II, STRIKIN-II, and PARCH for SBLOCA calculations. The codes for post-LOCA LTC analyses are BORON, CEPAC, NATFLOW, and CELDA.

2.0 EVALUATION MODEL CHANGES AND ERROR CORRECTIONS

Discussed below are all the error corrections and model changes to the ECCS performance evaluation models for PWRs described above in calendar year 2002 that may affect the calculated PCT.

2.1 STRIKIN-II Code Errors

Errors in the implementation of the time step algorithm and the Coffman plastic strain model were identified and corrected in 2002.

2.1.1 Time Step Algorithm

The algorithms used in the automatic time step selection method for STRIKIN-II are described in Appendix C of "STRIKIN-II – A Cylindrical Geometry Fuel Rod Heat Transfer Program," CENPD-135-P, Supplement 5, dated April 1977. They are designed to automatically adjust the time step length such that STRIKIN-II calculates an appropriate solution for the fuel, cladding and coolant temperature and the heat flux to the coolant by limiting the Courant number. They are designed to ensure that the Courant number, R_j, defined for Equation II.2-6 in "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program," CENPD-135P, dated August 1974, never exceeds 1.0 which ensures conservation of energy. That is,

$$R_j \equiv G_j \bullet \Delta t / (\rho_j \bullet \Delta z) \leq 1.0$$

where

G_j = Mass flux at axial node j (lbm/ft^2-sec)
Δt = Time step interval (sec)
ρ_j = Coolant density at axial node j (lbm/ft^3)
Δz = Axial node length (ft).

While the numerical limit for the Courant number is 1.0, the time step algorithm in STRIKIN-II further limits it to a value of 0.5. An error in the implementation of the algorithm bypassed this test which could allow the Courant number to exceed the normal limit. This error was corrected.

An additional problem that could produce a Courant number greater than 1.0 was found with the implementation of a user input for the minimum time step length. When the user input for the minimum time step is less than the value calculated by the automatic time step algorithm, the minimum time step length is used. An error test was added to stop the code with an error message if the minimum time step specified by the user would allow the Courant number to exceed 0.99.

2.1.2 Coffman Plastic Strain Model for Cladding

A problem with the implementation of the Coffman plastic strain model for fuel cladding in STRIKIN-II was discovered. The model is only used when the heating rate and the cladding temperature are within bounds set for application of the model. The calculated plastic strain is continuous except when the cladding conditions are outside these bounds and later return within the bounds at a higher cladding temperature. In order to address the resulting discontinuity, a ramp function is used to introduce the strain over several time steps. The problem occurred when the heating rate fell below the lower bound for the model within the time duration of the ramp. This was corrected by terminating the ramp when the conditions for the use of the model described above are not satisfied.

2.1.3 Effect of Correcting STRIKIN-II Errors

Analyses of several plants with the 1985 EM for Zircaloy-4 cladding shows that the effect on PCT is less than $|0.2°F|$. Analyses of plants with the 1999 EM for Zircaloy-4 and ZIRLO™ cladding show that the effect on cladding PCT is less than $|1.2°F|$.

CONCLUSIONS

There were two errors in the ECCS evaluation models for PWRs in calendar year 2002. Both of the errors were in STRIKIN-II code models that affect the results of LBLOCA analyses using either the 1985 or 1999 EM. The sum of the absolute magnitude of the changes in PCT calculated using the June 1985 EM for LBLOCA, including those from previous annual 10CFR50.46 reports remains less than 1°F. The total 1985 EM LBLOCA impact on PCT for ANO-2 remains <1°F. The maximum impact on PCT with the 1999 EM is less than 1.2°F. ANO-2 specific LBLOCA considerations are discussed in Appendix A.

There are no errors for SBLOCA in calendar year 2002. Previous plant specific PCT effects for both the S1M and S2M SBLOCA evaluation models are discussed in previous annual 10CFR50.46 reports. In addition, there is a generic effect on maximum cladding temperature for the SBLOCA S1M (due to the change in application of the SBLOCA S1M described in the 1997 annual 10CFR50.46 report) that is less than 3°F. There is no previous accumulated change in cladding temperature for the S2M.

There is no PCT effect for the post-LOCA long term cooling evaluation model.

APPENDIX A
Plant Specific Considerations for Arkansas Nuclear One Unit 2

The total effect on PCT due to the STRIKIN-II errors described in Section 2 is less than 1°F for all LBLOCA analyses of Arkansas Nuclear One Unit 2 to date that were done with the 1985 EM including the analysis for Cycle 15 with replacement steam generators (RSGs). The plant-specific effect for LBLOCA analysis of power uprate at Cycle 16 operating conditions with the 1999 EM is less than 1°F for ANO-2.

The plant specific effect for analyses done with the S2M SBLOCA methodology is stated in calendar year 2001 CENPD-279, Supplement 13, Revision 1, April 2002 to be that "... the total effect is +21°F for the RSG analysis and +24°F for the power uprate analysis." The SBLOCA analysis for RSG is done for Cycle 15 operating conditions and the power uprate analysis is done for Cycle 16 operating conditions.