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License Number NPF-3

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United States Nuclear Regulatory Commission
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Subject: Annual Report of Changes to the Emergency Core Cooling System Evaluation
Model In Accordance With 10 CFR 50.46(a)(3)

Ladies and Gentlemen:

In accordance with 10 CFR 50.46(a)(3), the FirstEnergy Nuclear Operating Company (FENOC) herewith submits the attached annual report for changes and errors to the Emergency Core Cooling System (ECCS) Evaluation Model (EM) used at the Davis-Besse Nuclear Power Station (DBNPS). This report covers the period of January 1, 2002 to December 31, 2002.

If you have any questions or require additional information, please contact Mr. Kevin Ostrowski, Manager, Regulatory Affairs, at (419) 321-8450.

Very truly yours,



AWB/s

Attachments

cc: Region III Administrator
DB-1 NRC Senior Resident Inspector
DB-1 NRC Senior Project Manager
Utility Radiological Safety Board of Ohio

A001

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COMMITMENT LIST

The following list identifies those actions committed to by the Davis-Besse Nuclear Power Station in this document. Any other actions discussed in the submittal represent intended or planned actions by Davis-Besse. They are described only as information and are not regulatory commitments. Please notify the Manager – Regulatory Affairs (419-321-8450) at Davis-Besse of any questions regarding this document or associated regulatory commitments.

COMMITMENTS

DUE DATE

None

N/A

**Annual Report of Changes to the 10 CFR 50.46 Emergency Core Cooling System
Evaluation Model for the Davis-Besse Nuclear Power Station**

10 CFR 50.46 (a)(3) states that each holder of an operating license shall report to the Nuclear Regulatory Commission (NRC) at least annually each change or error in an acceptable Emergency Core Cooling System (ECCS) Evaluation Model (EM) or in the application of such a model that affects the Peak Cladding Temperature (PCT) calculation.

Summary

EM Changes or Errors

For the period January 1, 2002 through December 31, 2002, no significant changes or errors (which resulted in a PCT difference greater than 50 degrees Fahrenheit (F)) were identified in the RELAP5 based EM that was used for licensing analysis for the Davis-Besse Nuclear Power Station (DBNPS). EM changes or errors resulting in PCT difference less than 50 degrees F are being reported accordingly. These EM changes have been previously reported to the NRC by Framatome in Reference 1.

EM Application Changes or Errors

For the period January 1, 2002 through December 31, 2002, no significant changes or errors in the application of the EM that resulted in a PCT difference greater than 50 degrees F were identified in the RELAP5 based EM that was used for licensing analysis for the DBNPS. EM application changes or errors resulting in PCT difference less than 50 degrees F are being reported accordingly.

A more detailed application of the EM for very small break sizes using license basis assumptions determined a vulnerability of the High Pressure Injection (HPI) pumps minimum recirculation flow protection that resulted in Licensee Event Report (LER) 2003-003, "Potential Inadequate HPI Pump Minimum Recirculation Flow Following SBLOCA." This was not considered a change or error in the EM or application of the EM that resulted in a calculated PCT change of greater than 50 degrees F, but rather resulted in the determination that the HPI pumps would not perform their function for certain small size breaks using license basis assumptions. A concise summary of the LER is provided herein.

EM Description

This model is applicable to all Babcock & Wilcox (B&W) designed pressurized water reactors for large and small break LOCA analyses. The NRC approved topical report for this evaluation model was BAW-10192P-A (Reference 2).

The large break loss of coolant accident (LBLOCA) Evaluation Model consists of four computer codes: (1) BAW-10164P-A, RELAP5/MOD2-B&W to compute the system, core, and hot control rod response during blowdown (Reference 3), (2) BAW-10171P-A, REFLOD3B to calculate the time for refill of the lower plenum and core reflood rate (Reference 4), (3) BAW-10095-A, CONTEMPT to compute the containment pressure response (Reference 5), 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 small break loss of coolant accident (SBLOCA) Evaluation Model consists of two codes: (1) BAW-10164P-A, RELAP5/MOD2-B&W to compute the system, core, and hot control 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 7) or BAW-10184P-A, GDTACO (Reference 8)), is used to supply the fuel rod steady-state conditions at the beginning of the small or large break LOCA. These codes are approved for use with M5 cladding via the Safety Evaluation Report (SER) on BAW-10227P-A (Reference 9).

EM Changes or Errors

Power Measurement Uncertainty

- EM Change
- This change has a PCT change of 0 degrees F for the LBLOCA and SBLOCA spectrums.

The NRC has modified 10 CFR 50 Appendix K 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 LOCA EMs 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 analysis to be performed with either of the Appendix K prescribed options. This change is applicable to all of the Framatome ANP LOCA evaluation models.

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

- EM Change
- The LBLOCA PCT change is 0 degrees F for the automation of the BEACH blockage limitation.

The NRC, by letter dated April 9, 2002 to Framatome ANP, approved Revision 4 of the RELAP5/MOD2-B&W topical report, BAW-10164, and its use with the once-through steam generator large break and small break LOCA EMs, BAW-10192P-A. The RELAP5 revision for large break analyses allows (1) modeling of the hot fuel assembly as a hot pin and a hot bundle, each with their own heat structure, (2) improvements to the TACO3-based, steady state, fuel temperature uncertainties, and (3) automation of the BEACH (BAW-10166P-A) blockage limitation. The RELAP5 revision for 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.

EM Application Changes or Errors

Application of Power Measurement Uncertainty

- Application Change
- This change has a PCT change of 0 degrees F for the LBLOCA and SBLOCA spectrums.

Evaluations were performed in 2002 (Reference 12) to support a change in the power measurement uncertainty assumed in the DBNPS Cycle 14 licensing analyses. The reduction in the core power measurement uncertainty to 0.37 percent results from assumed implementation of CALDON flow meter equipment. The power level analyzed for the DBNPS Mk-B10A, Mk-B10K and Mk-B12 LOCA analyses was 3025 MWt. Since the LOCA analyses analyze the rated power level times the power uncertainty, the maximum rated power increases as the power uncertainty decreases. This results in no change in the power level considered in the LOCA analyses. Therefore, the results of the DBNPS LOCA analyses are directly applicable to a rated core power level of 3014 MWt with CALDON operable (0.37 percent uncertainty) or 2966 MWt without CALDON operable (2 percent uncertainty). The Linear Heat Rate (LHR) limits obtained at 3025 MWt (analyzed) are adjusted to 2827 MWt for use as input to the Cycle 14 licensing calculations, as summarized in the LOCA inputs to the Reload Report (Reference 13). This change required a request to amend the license. NRC approval is required prior to implementation of the CALDON power update (Serial 2692, dated October 12, 2001).

Application of RELAP5/MOD2-B&W Topical Report Revision

- EM Application Change
- The LBLOCA PCT change is 0 degrees F for the automation of the BEACH blockage limitation.

Of the newly approved models in BAW-10164P-A Revision 4, only the automation of the BEACH blockage limitation is applied to the DBNPS LBLOCA analyses. This change only automated a check and has no effect on the temperature calculation.

The void-dependent cross-flow model was applied to the analyses performed for the resolution of Preliminary Safety Concern (PSC) 2-00 (Reference 14), and the NRC was notified of the use of this model for those cases (Reference 15). However, the void-dependent cross-flow model was not utilized in the current limiting SBLOCA case. Therefore, this EM change has not yet been applied to the limiting DBNPS SBLOCA analysis.

Energy Deposition Factor (EDF) Utilized in Mk-B10K Gadolinia LOCA Analyses

- Application Error Correction – The EDF utilized in the Mk-B10K gadolinia analyses was conservative.
- The Mk-B10K LBLOCA PCT change is 0 degrees F.

The original Mk-B10K gadolinia analyses (Reference 16) conservatively utilized the transient EDF in the calculation of the initial core power distribution. An analysis in Reference 17 reviewed the results of the analyses based on using the steady-state EDF in the initial power calculation. The results of the analysis showed that use of the transient EDF is conservative, and the results of the Mk-B10K gadolinia LOCA analyses remain applicable. Since the results of the gadolinia analyses remain unchanged, the limiting PCT continued to be determined by the UO₂ fuel pin.

LOCA Analyses for Mk-B12 UO₂ and Gadolinia

- New Application Change for Mk-B12 fuel.
- The Mk-B12 LBLOCA PCT is 2099 degrees F. There was no increase in the maximum calculated PCT (0 degrees F)

New LOCA analyses were performed for the UO₂ fuel, 4 and 8 weight percent gadolinia pins contained in the Mk-B12 fuel assembly. The analyses determined a limiting PCT of 2099 degrees F for the UO₂ fuel rod at beginning of life. All other 10 CFR 50.46 criteria were within the allowable limits. The LOCA summary report was revised to include the results of the Mk-B12 LOCA analyses (Reference 18). The Mk-B12 PCT is non-limiting and, therefore, there was no increase in PCT.

Reporting of LHR Limit for Mk-B8A Assembly

- Application Change.
- No 50.46 analyses were performed because fuel is non-limiting.

The base LOCA LHR limits for the Mk-B8A assembly were developed using the CRAFT2 LOCA EM at 1.02 times 2772 MWt. With the change to a licensing basis centered around the BWNT LOCA EM that uses RELAP5, the CRAFT2-based LOCA LHR limits were previously adjusted to consider the differences between the EMs and any differences in the boundary conditions. However, the CRAFT2-based LOCA LHR limits are reported on a thermal source basis and the RELAP5-base LOCA LHR limits are reported on a nuclear source basis. To create a consistency in the reporting of the LOCA LHR limits for DBNPS Cycle 14, the Mk-B8A LHR limits were converted from a thermal source basis to a nuclear source basis (Reference 19). The nuclear source is related to the thermal source by the EDF. The PCT for this fuel assembly type is non-limiting, and therefore, it is not tracked.

DBNPS CY14 Reload Documentation

- New Application – RV head replacement and stainless steel rods
- The LBLOCA and SBLOCA PCT change is 0 degrees F.

The documentation that supports the information contained in Revision 0 of the DBNPS Cycle 14 Reload Report (BAW-2417) is discussed above in the section pertaining to Power Measurement Uncertainty. Revisions to the LOCA-related documentation were prepared to address the replacement reactor vessel head and the addition of 15 stainless steel rods. The revisions (References 20 and 21) determined that the originally reported LOCA LHR limits remained applicable and bounding.

Other EM or EM Application Activities or Analyses during the Reporting Period

The following items represent activities or analyses performed during the reporting period that related to the EM, but which are not characterized as changes or errors.

LER 2003-003 Potential Inadequate HPI Pump Minimum Recirculation Flow Following SBLOCA

- EM Application (New Analysis) Change to LOCA of less than the previous minimum analyzed size.
- This analysis provided input to a past operability assessment related to HPI pump operability on Containment Emergency Sump recirculation. The evaluation revealed an equipment deficiency that could potentially compromise long term core cooling.

Calculations were performed to evaluate the SBLOCA spectrum and determine whether HPI pump operability during post-LOCA sump recirculation (Reactor Coolant System (RCS) pressure < 1750 psia) could be assured for all break sizes and transient scenarios. Calculations and RELAP5/MOD2-B&W analyses (Reference 10) identified that there is a range of break sizes for which HPI pump operability cannot be guaranteed due to system repressurization. The range of break sizes is greater than the leak-to-LOCA transition area (0.00206 ft²) but less than 0.0045 ft² with an initial core power level of 1.02 times 2772 MWt. This break range is less than the area typically included in SBLOCA analysis spectrums (0.01 to 0.75 ft²). HPI minimum recirculation to the BWST (previously the sole recirculation path) is isolated when pump suction is transferred from the BWST to the Containment Emergency Sump. The BWST would be expended slowly due to the small break sizes of concern. The delay time until the transfer is required would be as little as 20 hours to over 120 hours depending on the break size and location. Three sets of actions were evaluated; (1) open Pilot Operated Relief Valve (PORV), (2) start/align a Makeup (MU) pump to the Borated Water Storage Tank (BWST) and (3) open all three high point vents. Opening the PORV or starting/aligning a MU pump to the BWST provides assurance that the RCS pressure could be maintained below the HPI pump shutoff head. During the current outage, MU Pump 1 motor was rewound to safety grade requirements. Both MU Pumps are supplied with Class 1E electrical power and are seismically qualified. The PORV was upgraded to install a rewound solenoid that meets safety-grade requirements. The PORV cut-in switch was replaced with a switch upgraded from commercial grade to safety grade, and its power cable, previously qualified to safety grade and EQ standards, was replaced. The calculations and summary report (Reference 11) did not attempt to address licensing basis compliance for future plant operation, however, an additional recirculation flowpath is being installed to eliminate the equipment deficiency.

As a consequence of the preceding discussion, Davis-Besse reported this condition to the NRC in LER 2003-003-00, "Potential Inadequate HPI Pump Minimum Recirculation Flow Following SBLOCA. The following is the extract from that LER:

"The High Pressure Injection (HPI) Pumps are components of the Emergency Core Cooling System (ECCS) which is required to maintain core cooling following postulated accidents. In September 2002, a question was raised regarding the minimum flow protection of the pumps when the recirculation valves are closed upon pump realignment to the containment emergency sump. The investigation of this issue identified a subset of very small break loss of coolant accidents (SBLOCA) that can result in cyclic repressurization of the Reactor Coolant System in excess of the shut-off head of the pumps which may result in pump damage. Considering the highly conservative ECCS analytical assumptions required by 10CFR50.46, this condition would render the ECCS inoperable. However, operation of other highly reliable but non-safety grade equipment in accordance with approved emergency operating procedures would easily mitigate the consequences of the very SBLOCA sequences. Evaluation of this issue continues. This condition of analytical results and postulated consequences is being reported as a change of ECCS performance as predicted by the 50.46 analysis per 50.46(a)(3)(ii), a condition resulting in an unanalyzed condition per 50.73(a)(2)(ii)(B), a loss of safety function per 50.73(a)(2)(v), and creation of a common mode failure per 50.73 (a) (2) (vii)."

During preparation of this annual report, it was determined that the 10CFR50.46 (a)(3)(ii) criteria of making a 30 day report for a significant change or error in the EM or application of the EM did not apply to the condition as reported in LER 2003-003-00. Other reporting criteria were met.

Confirmation of EDF Values used in Mk-B10K and Mk-B12 UO₂ LOCA Analyses

- Confirmation Activity
- The LBLOCA PCT change for the Mk-B10K and Mk-B12 is 0 degrees F. Reference 22 reviewed the steady-state EDF values that were used for all LOCA analyses performed between 35 GWd/mtU and 62 GWd/mtU. The results of the evaluation confirmed that the reported LOCA LHR limit and PCTs remained applicable.

Axial vs. Radial Peak Text Correction

- Administrative change

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- **No 50.46 analyses were performed.**
- Replacement pages were provided in Reference 23 and 24 to correct the discussion of the axial peaking check. The equations provided in the original reference were correct. This correction has no effect on the temperature calculation for any LOCA analyses.**

Non-Licensing Basis Applications of Evaluation Model

Other non-licensing basis applications of the EM were performed by Framatome for the DBNPS, but are not required to be reported as they are not credited as part of the licensing basis compliance to 10 CFR 50.46 (Reference 25).

References

1. Letter to USNRC, "2002 - Annual Reporting of Changes and Errors in ECCS Evaluation Models," Framatome ANP NRC:03:013, February 28, 2003.
2. FTI Topical Report BAW-10192P-A, Rev. 0 "BWNT LOCA - BWNT Loss-of-Coolant Accident Evaluation Model for Once-Through Steam Generator Plants," June 1998.
3. 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.
4. FANP Topical Report BAW-10171P-A, Rev 3, "REFLOD3B - Model for Multinode Core Reflooding Analysis," December 1995.
5. FANP Topical Report BAW 10095-A, "CONTEMPT - Computer Program for Predicting Containment Pressure-Temperature Response to a LOCA," January 1995.
6. FTI Topical Report BAW- 10166P-A, Rev 4, "BEACH - Best Estimate Analysis Core Heat Transfer; A Computer Program for Reflood Heat Transfer During LOCA," February 1996.
7. FANP Topical Report BAW-10162P-A, "TACO3 Fuel Pin Thermal Analysis Code," October 1989.
8. FANP Topical Report BAW-10184P-A, "GDTACO - Gadolinia Fuel Rod Thermal Analysis Code," February 1995.
9. FANP Topical Report BAW-10227P-A, Rev. 0, "Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel," February 2000.
10. FANP Proprietary Document 32-5021276-00, "DB SBLOCA - Past HPI Operability," 12/9/02
11. FANP Document 86-5022260-00, "DB SBLOCA - HPI Pump Minimum Flow Preservation During Sump Recirculation," 12/10/02.
12. FANP Document 51-5014342-00, "DB-1 CY14 LOCA LHR Limits," 2/11/02
13. FANP Document 51-5016831-00, "DB-1 CY 14 Task 4 Inputs to Reload Report," 3/6/02.
14. FRA-ANP Document 51-5009856-00, "Summary of PSC 2-00 Analyses," 4/13/01
15. Letter to USNRC, "Report of Preliminary Safety Concern Related to Core Flood Line Break with 2-Minute Operator Action Time," FTI-00-2433, September 26, 2000.
16. FANP Proprietary Document 32-5005804-00,-01, "Davis Besse 1 LBLOCA Mk-B12 Gad Analysis," 5/3/00
17. FANP Proprietary Document 32-5005804-02, "Davis Besse 1 LBLOCA Mk-B12 Gad Analysis," 2/7/02
18. FANP Document 86-5006232-01, "DB-1 LOCA Summary Report," 9/17/02.
19. FANP Document 51-5006658-01, "DB-1 Mk-B8A Evaluation," 2/11/02.
20. FANP Document 51-5014342-01, "DB-1 CY14 LOCA LHR Limits," 9/20/02

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21. FANP Document 51-5016831-01, "DB-1 CY 14 Task 4 Inputs to Reload Report," 9/20/02.
22. FANP Proprietary Document 32-5004708-03, "DB-1 Mk-B10K LBLOCA Linear Heat Rate Limits," 2/11/02
23. FANP Proprietary Document 32-5004285-02, "DB-1 Mk-B10K Radial vs Axial Peaking Study," 8/8/02
24. FANP Proprietary Document 51-5006591-06, "DB-1 CY13 ECCS Reload," 8/8/02
25. FANP Document 47-5026040-00, "2002 DRAFT Annual 50.46 Letter," 4/28/03