



October 2, 1991

1CAN109106

U. S. Nuclear Regulatory Commission  
Document Control Desk  
Mail Station P1-137  
Washington, DC 20555

SUBJECT: Arkansas Nuclear One - Unit 1  
Docket No. 50-313  
License No. DPR-51  
10CFR50.46 Report - Significant  
Change in Peak Cladding Temperature

Gentlemen:

Pursuant to 10CFR50.46 (a) (3) (ii), the following information is provided concerning changes to the Arkansas Nuclear One, Unit 1 (ANO-1) Emergency Core Cooling System (ECCS) analysis. The changes in the ECCS analysis resulted in an increase in the estimated peak cladding temperature (PCT) of greater than 50 degrees Fahrenheit from the previous temperature calculated for the limiting plant transient. These changes are discussed below.

In letter 1CAN089006, dated August 8, 1990, ANO-1 submitted the Cycle 10 Reload Report. As part of the analyses supporting this report, it was demonstrated that the PCT for the 4-foot core elevation was 2160°F for an assumed linear heat rate (LHR) of 16.1 kw/ft. In December 1990, the 4-foot elevation LHR was reanalyzed using revised inputs from the NRC approved TACO3 code. A reduced PCT of 1786°F was calculated for a 16.1 kw/ft LHR. [This reduction in PCT was reported to the NRC in letter from Mr. M. S. Tuckman (Duke Power Company) dated January 14, 1991.] Subsequent to the ANO-1 cycle 10 reload report, the revised B&W analysis for 177-fuel assembly (FA) lowered loop (LL) plants became applicable to ANO-1. In April 1991, a minor input error was corrected in the 4-foot analysis that yielded a revised PCT of 1793°F.

In July 1991, while performing linear heat rate calculations to support the Mark-B9 fuel design for the 177-FA LL plants, Babcock & Wilcox (B&W) discovered an error in the application of the B&W ECCS evaluation model. The core crossflow paths had been modeled incorrectly for the 2-, 4-, 8-, and 10-foot core elevation analyses that define the current beginning-of-life LHR limits for the 177-FA LL plants. The 6-foot core elevation analyses had been modeled correctly.

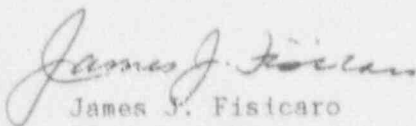
AD2 1/1

A re-analysis at the 4-foot core elevation for the 177-FA LL operating plants, produced a revised PCT of 1878°F. This PCT is within the acceptance criteria of 2200°F as defined in 10CFR50.46; therefore the existing LHR limit remains acceptable for continued plant operation. This revised PCT, however, results in a change of greater than 50°F from the previously calculated value of 1793°. Even though not specifically analyzed by B&W, increased PCT values were also estimated for the 2, 8 and 10 foot core elevations.

Additional details of the background of this issue and the latest re-analysis was provided to the NRC in letter from J. H. Taylor, B&W to Dr. T. E. Murley, USNRC (JHT/91-142), dated September 3, 1991. A copy of this letter is attached.

Should you have any questions regarding this submittal, please contact me.

Very truly yours,

  
James J. Fisicaro  
Director, Licensing

JJF/SAB/sjf  
Attachment

cc: Mr. Robert Martin  
U. S. Nuclear Regulatory Commission  
Region IV  
611 Ryan Plaza Drive, Suite 1000  
Arlington, TX 76011

NRC Senior Resident Inspector  
Arkansas Nuclear One - ANO-1 & 2  
Number 1, Nuclear Plant Road  
Russellville, AR 72801

Mr. Thomas W. Alexion  
NRR Project Manager, Region IV/ANO-1  
U. S. Nuclear Regulatory Commission  
NRR Mail Stop 11-D-23  
One White Flint North  
11555 Rockville Pike  
Rockville, MD 20852

Ms. Sheri Peterson  
NRR Project Manager, Region IV/ANO-2  
U. S. Nuclear Regulatory Commission  
NRR Mail Stop 11-D-23  
One White Flint North  
11555 Rockville Pike  
Rockville, MD 20852



B&W NUCLEAR TECHNOLOGIES

JHT/91-142  
September 3, 1991

3315 Old Forest Road  
P.O. Box 10935  
Lynchburg, VA 24506-0935  
Telephone: 804-385-2000  
Telecopy: 804-385-3663

Dr. Thomas E. Murley, Director  
Office of Nuclear Reactor Regulations  
U. S. Nuclear Regulatory Commission  
Washington, D.C. 20006

Subject: LOCA LHR Limits for 177-FA Lowered-Loop and Raised-Loop  
Operating Plants

- References:
- 1) Letter from J.H. Taylor to T.E. Murley (JHT/90-43), dated March 19, 1990.
  - 2) TACO3-Fuel Pin Thermal Analysis Computer Code, BAW-10162P, November, 1989.
  - 3) Letter from J.H. Taylor to T.E. Murley, dated July 12, 1990.
  - 4) Letter from T.E. Murley to J.H. Taylor, dated August 2, 1990.
  - 5) Letter from M.S. Tuckman (DPCo) to NRC Document Control Desk, dated January 14, 1991.
  - 6) DB-1 Cycle 8 Reload Report, BAW-2137, June 1991.

Dear Dr. Murley:

In compliance with 10CFR50.46, this letter is to advise the Nuclear Regulatory Commission (NRC) of recent findings regarding loss-of-coolant accident (LOCA) limits for the B&W designed 177-fuel assembly (FA), lowered-loop (LL), and raised-loop (RL) operating plants.

#### Introduction and Background

BWNS regularly reviews the linear heat rate (LHR) limits associated with the postulated design basis LOCA for the 177-FA operating plants. Those reviews occur in conjunction with fuel cycle operation analyses, fuel design changes, and changes in regulatory requirements.

In Reference 1, the NRC was notified of the 177-FA LL LHR limit established for the 4-ft core elevation. The results of that analysis, using the BWC critical heat flux (CHF) correlation with TACO2 fuel data input, demonstrated a peak clad temperature (PCT) of 2160°F for an assumed LHR of 16.1 kW/ft.

910926009  
6/11

In December, 1990, the 4-ft core elevation LHR limit was re-analyzed using the revised fuel pin performance code, TACO3. The TACO3 code was approved for use by the NRC in Reference 2 and has been approved to provide fuel input to the Emergency Core Cooling System (ECCS) Evaluation Model (EM) via References 3 and 4. A reduced PCT of 1786°F for a LHR limit of 16.1 kW/ft was calculated. This calculation was reported to the NRC in Reference 5 and provides the 4-ft elevation LOCA analysis and LHR limit for the 177-FA LL operating plants at beginning-of-life (BOL) conditions. In April, 1991, a minor THETA1-B input error was corrected in the 4-ft analysis that yielded a revised PCT of 1793°F.

An assessment of the impact of using TACO3 fuel data input at all core elevations is illustrated in Tables 1 and 2 for the LL and RL plant designs, respectively. All estimates are based on the results of the 4-ft elevation analysis and the TACO3 versus TACO2 initial stored energy difference.

#### Problem Discovery

In July, 1991, while performing LHR calculations to support the Mark-B9 fuel design for the 177-FA LL plants, an error was discovered in the application of the B&W ECCS EM. The core crossflow paths, used in the ECCS EM code CRAFT2, had been modeled incorrectly for the 2-, 4-, 8-, and 10-ft core elevation analyses that define the current BOL LHR limits for the 177-FA LL and RL plants. The 6-ft core elevation analyses had been modeled correctly for both plant types, RL and LL.

#### Problem Resolution

A re-analysis at the 4-ft elevation for the 177-FA LL operating plants, using TACO3 fuel data input with the correct crossflow path modeling, has produced a revised PCT of 1878°F. This PCT is within the acceptance criteria of 2200°F, therefore, the existing LHR of 16.1 kW/ft remains acceptable for continued plant operation. This revised PCT, however, results in a change of greater than 50°F from the previously calculated value of 1793°F. In compliance with 10CFR50.46, the NRC is being notified of this change in PCT.

#### Impact at BOL for all Core Elevations

After reviewing the 2-, 8-, and 10-ft BOL cases for the lowered-loop design, as well as the 2-, 4-, 8-, and 10-ft BOL cases for the raised-loop design, it was determined that the previously accepted LHRs remain conservative despite the crossflow path modeling error.

This is based on the temperature difference calculated with fuel data input from TACO2 versus TACO3. Currently, all BOL calculations, except the 4-ft core elevation for the lowered-loop plants, have been performed with TACO2-supplied initial steady-state average fuel temperatures. Any new analyses would be performed using TACO3 fuel data input. The decrease in PCT associated with the lower TACO3 initial stored energy input would more than compensate for the expected cladding temperature increase due to the crossflow path modeling error. As previously stated, the 6-ft elevation analyses for both RL and LL plant types do not contain the crossflow modeling error. Tables 1 and 2 tabulate the estimated changes in BOL PCTs at all elevations for the 177-FA LL and RL plants, respectively.

Implementing the correct crossflow model at the 2-ft elevation is expected to yield a 90°F increase in the PCT for both plant types. The impact at the 4-ft elevation for the 177-FA RL plant would be similar to that calculated for the LL plants. The potential impact of the crossflow modeling error at the upper core elevations, 8- and 10-ft for both plant types, is judged to be minimal (50°F will be estimated for conservatism).

#### Impact at Time-in-Life for all Core Elevations

It has been determined by analysis that end-of-life (EOL is defined as the burnup corresponding to an internal pin pressure equal to 2200 psia) LHRs are bounded by the PCTs established at BOL; therefore, the LHRs determined to be valid at BOL are acceptable to EOL. For various reasons, plant operational limits included, the BOL LHR can be held constant at most elevations without any impact on plant operation or safety. However, certain elevation LHRs do become restrictive and analyses/evaluations are performed to allow LHR increases as a function of burnup. The 177-FA RL plant maintains constant LHRs at the 2-, 4-, 8-, and 10-ft elevations. An evaluation performed at the 6-ft elevation for the RL plant allows an LHR increase from 16.5 kW/ft to 18.0 kW/ft at 40,000 MWd/mtU (Reference 6). The 177-FA LL plants maintain constant LHRs at the 6-, 8-, and 10-ft elevations. Analyses have been performed for the LL plants to justify increasing the LHRs at the 2- and 4-ft elevations at 1000 MWd/mtU. See Tables 3 and 4 for the tabulated time-in-life LHR limits and the estimated/calculated PCTs for the lowered-loop and raised-loop plants, respectively.

Dr. T. E. Murley  
JHT/91-142  
September 3, 1991  
Page 4

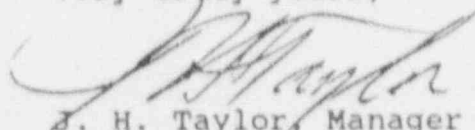
-----

Summary

In compliance with 10CFR50.46, (a)(3)(i) and (ii), the NRC is being notified of a reportable change in the application of the EM. An analysis has been performed that results in an increase to the previous PCT of greater than 50°F. In addition, calculations supporting the 177-FA LL 2-ft and 4-ft time-in-life LHR limits are also being reported. In no case is the PCT calculated or evaluated to be greater than the 2200°F acceptance criteria.

Should you or a member of your Staff wish to discuss this further, please call me at 804/385-2817.

Very truly yours,

  
J. H. Taylor, Manager  
Licensing Services

JHT/bcc

cc: T. N. Wampler  
C. F. McPhatter  
R. B. Borsum  
E. R. Kane

bcc: J. Link/GPUN  
J. E. Burchfield/DPC  
T. Lang/TE  
J. N. Miller/Entergy  
E. H. Davidson/FPC  
C. M. Callihan/FPC  
J. R. Paljug  
K. L. Short  
J. C. Seals  
K. L. Sanford  
J. J. Cudlin  
G. A. Meyer  
B. J. Delano

Table 1. 177-FA Lowered-Loop BOL PCTs

Elevation (ft)	Fuel Performance Code	X-flow Error	LHR (kW/ft)	PCT (*F)
2	TAC02	yes	14.5	2028*
	TAC03	yes	14.5	1778
	TAC03	corrected	14.5	1868
4**	TAC02	yes	16.1	2160*
	TAC03	yes	16.1	1793*
	TAC03	corrected	16.1	1878*
6	TAC02	NA	16.1	2073*
	TAC03	NA	16.1	1823
8	TAC02	yes	17.0	1959*
	TAC03	yes	17.0	1709
	TAC03	corrected	17.0	1739
10	TAC02	yes	16.0	1757*
	TAC03	yes	16.0	1507
	TAC03	corrected	16.0	1557

\* The PCTs for these cases are calculated values, all other PCTs are estimated.

\*\* The PCTs specified at the 4-ft elevation are supported by analyses and are used as the basis for all estimates.

NA Not Applicable

Table 2. 177-FA Raised-Loop BOL Results

Elevation (ft)	Fuel Performance Code	X-flow Error	LHR (kW/ft)	PCT (°F)
2	TAC02	yes	16.0	2152*
	TAC03	yes	16.0	1902
	TAC03	corrected	16.0	1992
4	TAC02	yes	15.75	2049*
	TAC03	yes	15.75	1699
	TAC03	corrected	15.75	1784
6	TAC02	NA	16.5	2176*
	TAC03	NA	16.5	1926
8	TAC02	yes	17.25	2142*
	TAC03	yes	17.25	1892
	TAC03	corrected	17.25	1942
10	TAC02	yes	17.0	1850*
	TAC03	yes	17.0	1600
	TAC03	corrected	17.0	1650

\* The PCTs for these cases are calculated values, all other PCTs are estimated based on the results of the 177-FA LL 4-ft elevation analysis (See Table 1).

NA Not Applicable

Table 3. 177-FA Lowered-Loop Time-in-Life PCTs

Elevation (ft)	Time-in-Life (MWd/mtU)	Fuel Performance Code	X-flow Error	LHR (kW/ft)	PCT (*F)
2	1000	TACO3	yes	15.5	1828*
2	1000	TACO3	corrected	15.5	1918
2	EOL	TACO3	yes	15.5	1638*
2	EOL	TACO3	corrected	15.5	1728
4	Composite**	TACO3	yes	16.6	1978*
4	Composite	TACO3	corrected	16.6	2063

NOTE: The 6-, 8-, and, 10-ft elevation LHRs and PCTs are the same as BOL throughout the fuel cycle. The 2- and 4-ft LHRs and PCTs are also the same as BOL up to 1000 MWd/mtU.

\* The PCTs for these cases are calculated values, all other PCTs are estimated based on the results of the 177-FA LL 4-ft BOL elevation analysis (See Table 1).

\*\* A composite case was performed at the 4-ft elevation using BOL fuel temperatures and EOL pin pressures. These conditions provided the most limiting case from 1000 MWd/mtU to EOL.

Table 4. 177-FA Raised-Loop Time-in-Life PCTs

Elevation (ft)	Time-in-Life (MWd/mtU)	Fuel Performance Code	X-flow Error	LHR (kW/ft)	PCT (*F)
6	40000	TACO2	NA	18.0	2000
6	40000	TACO3	NA	18.0	1750

NOTE: The 2-, 4-, 8-, and 10-ft elevation LHRs and PCTs are the same as BOL throughout the fuel cycle. The 6-ft elevation LHR and PCTs are also the same as BOL up to 40000 MWd/mtU. The PCTs in Table 4 are estimated.

NA Not Applicable