NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/85

LICENSEE EVENT REPORT (LER)

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D. C. Cook Plant - Unit 1	0 5 0 0 0 3 1 5	1 OF 0 7

TITLE (4)
Discovery of Error in Detector Code

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 5	2 8	8 4	8 4	— 0 0 7	— 0 1	0 8	1 0	8 4		0 5 0 0 0
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OPERATING MODE (9)	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
1	20.402(b)	20.406(c)	50.73(a)(2)(iv)	73.71(b)
POWER LEVEL (10) 1 0 0	20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
	20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	X OTHER (Specify in Abstract below and in Text, NRC Form 366A)
	20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	Voluntary
	20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
	20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
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COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

This is a revision to Voluntary LER 84-007 previously submitted to the USNRC. The purpose of this revision is to clarify the previous LER, address questions raised by the NRC Inspector, discuss additional recommendations from our consultant, and to also discuss the steps AEPSC has taken and will take as a result of these items and further evaluation by our staff. The Voluntary LER and our conclusions are as follows.

During the process of modifying the DETECTOR code, which analyzes raw flux map data to determine compliance with Power Distribution Technical Specifications, a coding error was discovered which under certain circumstances will affect one of the output edits of DETECTOR.

To prevent recurrence, procedural changes are being made which will require:

1) An independent line by line review of coding changes be performed, and
2) Standardized Benchmark input models be set up and utilized to verify new versions of DETECTOR.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

This is an updated report of a Voluntary LER. Previous Report Date 6/21/84

BACKGROUND

In August of 1983, modifications were made to the DETECTOR code to allow comparison to Technical Specification parameters which varied with fuel type. These modifications were made by Shanstrom Nuclear Associates, the original author of the code.

The modified code was tested by making runs with old data sets and put into production for Unit 1 Cycle 8. The changes to DETECTOR were carried out in accordance with IMFM Procedure No. 7, Changes to the DETECTOR Code.

DISCOVERY OF ERROR

An effort was begun in May of 1984 to modify the DETECTOR code in house to incorporate the ability to monitor a modified $F^N_{\Delta H}$ Technical Specification required for Unit 2 Cycle 5. The modification involved incorporating into the code two $F^N_{\Delta H}$ limits, one related to DNB (the current $F^N_{\Delta H}$ limit), and a new, LOCA related $F^N_{\Delta H}$ limit. During this process, it was determined that one of the edits describing the $F^N_{\Delta H}$ limit under certain circumstances would produce incorrect results. The error was present in the August 1983 version of DETECTOR and thus was present in the analysis of the first 47 flux maps taken for Unit 1 Cycle 8.

NATURE OF ERROR

The DETECTOR Code requires that the input data include Technical Specification limits for each fuel type. With the August 1983 modification to the DETECTOR code (version 23), it was intended that the relative power of each fuel pin (assemblage) be compared to the limit appropriate to its fuel type. However, an error was made in the coding such that the relative power of each pin was always compared to the limits of the last fuel type in the input data set. Therefore, the DETECTOR output would not indicate the correct margin between $F^N_{\Delta H}$ and its Technical Specification limit for the first fuel type.

It should be noted that the error affected only one page in the DETECTOR output. Review of other pages of output from DETECTOR could potentially have led to our identifying any discrepancies in the output data. The specific error was that a transfer was made to the wrong line of code.

Impact on Unit 1 Cycle 8

The coding error in DETECTOR did not cause a Technical Specification violation during Unit 1 Cycle 8 operation. To justify this statement, one must look at the input going into DETECTOR for Unit 1 Cycle 8 flux map analysis.

There were two sets of Technical Specifications which were applicable for Unit 1 Cycle 8. Technical Specification set 1 was applicable to Exxon Nuclear Company (ENC) fabricated fuel, which applied to once and twice burned fuel assemblies present in the core. Technical Specification set 2 was applicable to Westinghouse fuel which was fresh at the start of Unit 1 Cycle 8. The corresponding Technical Specifications limits for $F^N_{\Delta H}$ input into DETECTOR were:

Technical Specification Set 1: $F^N_{\Delta H}(1) \leq 1.45\ [1+0.2\ (1-P)]$

Technical Specification Set 2: $F^N_{\Delta H}(2) \leq 1.49\ [1+0.3\ (1-P)]$

where F is the ratio of actual thermal power to related thermal power (RTP).

In all cases DETECTOR compared $F^N_{\Delta H}$ to the Technical Specification limit for Technical Specification set 2 (Westinghouse) regardless of whether the $F^N_{\Delta H}$ was associated with an ENC (Technical Specification set 1) or a Westinghouse (Technical Specification Set 2) fuel assembly. The error was in the coding such that the relative power of each pin was always compared to the limits of the last fuel type in the input data set. Thus, if an $F^N_{\Delta H}$ greater than 1.45 [1+0.2 (1-P)] occurred in an ENC fuel assembly it might not have been indicated as a violation of the Technical Specification limit by DETECTOR.

To verify that this did not occur, Flux Maps 1-47 for Unit 1 Cycle 8 were analyzed to determine whether any $F^N_{\Delta H}$ for ENC fuel was greater than 1.45 (the most limiting $F^N_{\Delta H}$ for ENC fuel with P = 1.0). No maps were identified where $F^N_{\Delta H}$ (ENC) was greater than the Technical Specification $F^N_{\Delta H}$ limit for ENC fuel and therefore there were no Technical Specification Violations.

Once satisfied that no Technical Specification violations had occurred, the possibility that the most limiting Technical Specification margin edit did not contain completely accurate information was investigated. Specifically, the possibility existed that an ENC $F^N_{\Delta H}$ was closer to its Technical Specification limit than the most limiting Technical Specification margins printed out for the Westinghouse fuel. Since the $F^N_{\Delta H}$ for ENC fuel

would be compared to the Westinghouse limit, which is higher than the ENC limit, this ENC fuel assembly (or pin) might not be included in the most limiting Technical Specification margins edit.

This in fact did occur on two flux maps, 108-04 and 108-05. However, these maps were taken at BOC, < 50% RTP, with the Technical Specification margin for the most limiting pins approximately equal to 0.20. Therefore, the fact that ENC fuel assemblages were not listed on the most limiting $F^N_{\Delta H}$ edits does not appear on the basis of engineering judgment to be significant.

One should note also that from a core analysis of the Unit 1 Cycle 8 core, the hot spots $F^N_{\Delta H}$ and F_Q (Z.1) will occur in fresh fuel assemblies once equilibrium HFP core conditions are reached. This was confirmed by the analysis of all Unit 1 Cycle 8 flux maps.

Possible Impact on Unit 2 Cycle 5

It is difficult to postulate whether the error would have been discovered if the Unit 2 Cycle 5 Technical Specifications had not required modification to include the addition of LOCA based $F^N_{\Delta H}$ limitations. If we assume that the error would not have been discovered, we can look at the two cases and see the potential outcome. In either case the applicable $F^N_{\Delta H}$ Technical Specification limits for the two different fuel types are:

Exxon Fuel: $F^N_{\Delta H} \leq 1.49\ [1.0+0.2\ (1-P)]$

Westinghouse Fuel: $F^N_{\Delta H} \leq 1.48\ [1.0+0.2\ (1-P)]$

Case 1

In this case Exxon Fuel would be assigned to Technical Specification set 1 and Westinghouse Fuel to Technical Specification set 2. One should note that the Unit 2 Cycle 5 core consists of one region (twice burned) of Westinghouse fuel and 2 regions (once burned and fresh) of ENC fuel. In this case, the peak $F^N_{\Delta H}$, occurring in the ENC fuel, would have been compared to the Technical Specification limit for Westinghouse fuel. However, the $F^N_{\Delta H}$ Technical Specification limit for Westinghouse is more conservative than the $F^N_{\Delta H}$ Technical Specification limit for ENC, therefore this would not have been a problem. Furthermore, it is believed that this problem would have been identified upon analysis of the most limiting pins on the $F^N_{\Delta H}$ lowest Technical Specification margin edit.

Case 2

In this case Westinghouse fuel would be assigned to Technical Specification set 1 and ENC fuel to Technical Specification set 2. This case is similar to what actually occurred in Unit 1 Cycle 8 in that the fresh fuel Technical Specifications were input as the second Technical Specification set. The fresh fuel Technical Specification limit would be applied to all fuel. This is a non-conservative comparison for the Westinghouse fuel. However, since the Westinghouse fuel is twice burned and consequently operates at low power, it is highly unlikely that this fuel would reach an $F^N_{\Delta H}$ as high as its own limit or the marginally higher ENC limit.

SHANSTROM RECOMMENDATIONS

In a letter dated May 24, 1984, from Dr. Raymond T. Shanstrom to the USNRC regarding notification of a potential 10CFR21 item (i.e., the DETECTOR coding error discussed in this LER), Dr. Shanstrom recommends two items for additional surveillance of DETECTOR performance and results. These recommendations are:

(1) Increase the size of the edits for $F^N_{\Delta H}$ and F^N_Q technical specification edits (eg from 20 to the maximum code allowance of 100). This would have clearly identified this particular bug since the "TECH SP. FSUBH" for TS Set 1 would have incorrectly been listed as the "CONST. MULT" for TS Set 2.

(2) For each change in DETECTOR versions and for any change in input values for calculational options, the user should verify, via hand calculations, that the DETECTOR results for limiting technical specification are valid for <u>each fuel type</u>. (The SHA verification and the DETECTOR training include hand-calculation verification of results for all <u>expected</u> options).

Shanstrom's first recommendation was examined and tested by increasing the size of the $F^N_{\Delta H}$ and F^N_Q edits and rerunning Unit 1 Cycle 8 maps 108-04 and 108-05 with both the old and corrected versions of DETECTOR. After analyzing the results, it was concluded that there would have been no clear or immediate indication that DETECTOR was not performing as expected. We therefore saw no benefit in adopting Dr. Shanstrom's first recommendation.

Shanstrom's second recommendation was evaluated and we feel that our current proposed strategy, which is identified below, will encompass his recommendation along with other improvements.

1) For each new DETECTOR version, the code will be checked by running a standardized input model benchmark test matrix with emphasis on testing the areas of the code that were modified.

2) A post processing code will be developed to read the output from DETECTOR and summarize critical information pertaining to a particular flux map. Included in this summary will be DETECTOR results for limiting technical specifications for each fuel type.

It is felt that by upgrading the methodology by which changes are made to DETECTOR, coupled with a more thorough automated method of monitoring DETECTOR results, errors that may occur will be easier to detect should they occur.

CORRECTIVE ACTION

The coding error was corrected in conjunction with the other DETECTOR modifications being made for Unit 2 Cycle 5.

The two flux maps that indicated the incorrect most limiting pins on $F^N_{\Delta H}$ for Unit 1 Cycle 8 maps 108-04 and 108-05, were rerun with the corrected DETECTOR version.

AEPSC has changed their source library disk file management system on the corporation computer system from SOURCE to LIBRARIAN. LIBRARIAN offers a much more thorough method of maintaining an accurate audit trail of changes made to a program than previously existed with SOURCE. It is believed that this software enhancement will reduce the possibility of future code modifications being in error.

NMFM Procedure No. 7, Changes to the DETECTOR Code, will be revised to assure that not only are test cases run, but that an independent line-by-line review of the coding changes is performed. If changes are made to DETECTOR between now and when the revision to NMFM Procedure No. 7 is completed, then a complete line-by-line review of all coding modifications made to DETECTOR at that time will be performed, as well as running test cases to test the modifications that were made. This procedure will be revised by December 31, 1984.

A detailed analysis of all DETECTOR changes from August, 1983 to the present will be performed. We currently anticipate that this analysis will be completed by October 31, 1984.

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A standardized input model will be set up to provide a common benchmark for all future versions of DETECTOR. This model will be used to verify the chang s made to DETECTOR since August, 1983. We will also perform comparisons with past benchmarks performed during Unit 1 Cycle 1 between DETECTOR and Westinghouse's INCORE code. We currently anticipate that this analysis will be completed by April 30, 1985.

A DETECTOR post-processing code will be developed to more closely and efficiently monitor DETECTOR performance and results. We currently anticipate that this code will be developed, tested, debugged and documented by June 30, 1985.

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August 10, 1984

United States Nuclear Regulatory Commission
Document Control Desk
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Docket No. 50-315

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RO 84-007-1

Sincerely,

W. G. Smith, Jr.
Plant Manager

/cbm

Attachment

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