



Omaha Public Power District
444 South 16th Street Mall
Omaha NE 68102-2247

June 3, 1996
LIC-96-0068

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

Reference: 1. Docket No. 50-285

Gentlemen:

Subject: Licensee Event Report 96-004 Revision 0 for the Fort Calhoun
Station

Please find attached Licensee Event Report 96-004 Revision 0 dated
June 3, 1996. This report is being submitted pursuant to
10 CFR 50.73(a)(2)(i)(B) and 10 CFR 50.73(a)(2)(v)(A). If you should have any
questions, please contact me.

Sincerely,

T. L. Patterson
Division Manager
Nuclear Operations

TLP/epm

Attachment

c: Winston and Strawn
L. J. Callan, NRC Regional Administrator, Region IV
L. R. Wharton, NRC Project Manager
W. C. Walker, NRC Senior Resident Inspector
INPO Records Center

9606070051 960603
PDR ADOCK 05000285
S PDR

IK22
11

LICENSEE EVENT REPORT (LER)

(See reverse for required number of

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO THE INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)

Fort Calhoun Station Unit No. 1

DOCKET NUMBER (2)

05000285

PAGE (3)

1 OF 7

TITLE (4)

Inadequate Shutdown Margin During Testing Due to an Incorrect Procedure

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 NAME	DOCKET NUMBER
05	02	96	96	-- 004 --	00	06	03	96	FACILITY NAME	DOCKET NUMBER
										05000
										05000
OPERATING MODE (9)		1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§ (Check one or more) (11)							
POWER LEVEL (10)		100	20.2201(b)			20.2203(a)(2)(v)		X	50.73(a)(2)(i)	50.73(a)(2)(viii)
			20.2203(a)(1)			20.2203(a)(3)(i)			50.73(a)(2)(ii)	50.73(a)(2)(x)
			20.2203(a)(2)(i)			20.2203(a)(3)(ii)			50.73(a)(2)(iii)	73.71
			20.2203(a)(2)(ii)			20.2203(a)(4)			50.73(a)(2)(iv)	OTHER
			20.2203(a)(2)(iii)			50.36(c)(1)		X	50.73(a)(2)(v)	Specify in Abstract below or in NRC Form 366A
			20.2203(a)(2)(iv)			50.36(c)(2)			50.73(a)(2)(vii)	

LICENSEE CONTACT FOR THIS LER (12)

NAME

Carl P. Stafford, Principal Reactor Engineer

TELEPHONE NUMBER (Include Area Code)

(402)-533-6670

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)

YES

(If yes, complete EXPECTED SUBMISSION DATE)

X

NO

MONTH

DAY

YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

During a review of the procedure for calculating shutdown margin, it was determined that errors in the shutdown margin calculation procedure resulted in the reactor having a shutdown margin that was less than required by the plant's Technical Specifications during a previous operating cycle. Specifically, during control rod testing on August 25, 1992, in operating cycle 14, the procedural error resulted in the plant unknowingly having violated the Technical Specification shutdown margin requirement of 4 percent shutdown margin. Revised calculations of the shutdown margin show that the shutdown margin during the control rod testing was at least 3.35 percent.

The error was introduced during a procedure change made in operating cycle 12. The procedural error was caused by an inadequate technical review by the plant personnel involved in reviewing the procedure change. Contributing to the problem is that the personnel using the procedure and reviewing the results did not recognize the error in the calculational methodology.

Corrective actions include correcting the procedure, strengthening the review process, and training appropriate personnel on this incident, its causes and the revised shutdown margin procedure.

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1)	DOCKET	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Fort Calhoun Station Unit No. 1	05000285	96	- 004 -	00	2 OF 7

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

BACKGROUND

The Fort Calhoun Nuclear Station (FCS) is required by Technical Specifications (TS) to maintain an adequate shutdown margin for all modes of plant operation. The requirement for shutdown margin when the reactor is in power operation, a hot standby condition, or hot shutdown condition (Modes 1, 2 or 3), is a shutdown margin of ≥ 4.0 percent reactivity. Whenever the reactor is in a cold shutdown condition (Mode 4), the shutdown margin shall be ≥ 3.0 percent reactivity. Finally, whenever the reactor is in a refueling shutdown condition (Mode 5), the shutdown margin shall be ≥ 5.0 percent reactivity. A sufficient shutdown margin ensures that (1) the reactor can be made subcritical from all operating conditions, (2) the reactivity transients associated with postulated accident conditions are controllable within the acceptable limits, and (3) the reactor will be maintained sufficiently subcritical to preclude inadvertent criticality while in a shutdown condition.

Design basis shutdown margin requirements vary throughout core life as a function of the fuel depletion, reactor coolant boron concentration, and reactor coolant average temperature. The most restrictive condition for shutdown margin occurs at the end of a cycle, with the average reactor coolant temperature at the no load operating temperature of 532 degrees Fahrenheit, and is associated with a postulated main steam line break accident. In the analysis of this accident, an initial shutdown margin of 4.0 percent reactivity is adequate to control the reactivity transient. Accordingly, the 4.0 percent shutdown margin requirement is based upon this limiting condition.

Procedure OP-ST-RX-0002, "Shutdown Margin Verification During Hot Shutdown, Cold Shutdown or Refueling" directs the use of the "Shutdown Margin Worksheet" (TDB-V.9) contained in the plant Technical Data Book (TDB). Shutdown margin is calculated by completing the appropriate worksheet in TDB-V.9. TDB-V.9 is divided into four parts.

Part I is completed just prior to or immediately following a reactor trip to determine the instantaneous shutdown margin. Allowances are made in this calculation for determining the reduction in shutdown margin due to control rod(s) which may not have fully inserted.

Part II is completed when the plant is in a hot shutdown condition (average reactor coolant temperature is ≥ 515 degrees Fahrenheit) and no control rod movements are planned. Part II assumes that all trippable control rods are inserted, no xenon exists and equilibrium samarium conditions exist.

Part III is completed when the average reactor coolant temperature is < 515 degrees Fahrenheit with the same assumptions that were made in part II.

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1)	DOCKET	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Fort Calhoun Station Unit No. 1	05000285	96	- 004 -	00	3 OF 7

TEXT (If more space is required, use additional copies of NRC Form 365A) (17)

Part IV is used for any shutdown condition where the possibility of rod movement exists, or control rod(s) are not fully inserted in the core, or a transient xenon condition exists.

EVENT DESCRIPTION

On March 15, 1996, FCS was in cold shutdown (Mode 4) for a scheduled maintenance outage. Part of the maintenance activities included replacement of selected control rod seal packages. Since this work required exercising individual control rods after the repairs, procedure OP-ST-RX-0002 was consulted to ensure adequate shutdown margin existed. The newly appointed Reactor Engineer (RE), while reviewing the results of the worksheet (TDB-V.9, Part IV), noted that the calculated required boron concentration appeared to be low, when compared to the value derived from the TDB-V.9, Part III, for an all rods in condition, and adjusting for a stuck rod.

Analysis by Design Engineering Nuclear (DEN) determined that the shutdown margin worksheet did not adequately address reactivity addition due to temperature changes as the plant cooled down to temperatures below 532 degrees Fahrenheit. As a result of this finding, a Condition Report was generated and the shutdown margin worksheet, TDB-V.9, Part IV, was revised to allow for a case-specific shutdown margin calculation to be provided to the RE by DEN. A revision of the procedure to address this issue was completed prior to its usage for rod testing during the mini-outage. Investigation of prior usage of TDB-V.9 for cycles 16 and 15 did not reveal any violations of the TS required shutdown margin.

After the outage (completed March 25, 1996), the RE resumed investigating the inadequacies in TDB-V.9, Part IV to fully resolve the issue. During the investigation into previous use of TDB-V.9, it was discovered that adequate shutdown margin was not maintained greater than 4.0 percent Technical Specification limit during cycle 14 for a period of 3.5 hours while testing the control rods. It has been determined that a change to the shutdown margin worksheet in cycle 12 (May 1989) resulted in the improper calculation of shutdown margin. This error is independent of the cooldown reactivity insertion issue first identified. Shutdown margin available during the 14 performance of OP-ST-CEA-0005 "Control Element Assemblies CEA Drive System Checks Check," was conservatively calculated as at least 3.35 percent.

in TDB-V.9, Part IV, was due to the method used for accounting for changes in reactivity due to Reactor Coolant System (RCS) boron concentration changes from the power reactivity condition (Boron Worth). This portion of the worksheet is being planned, such as would occur during the performance of the shutdown margin worksheets, TDB-V.9, Part II and Part III, which

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1)	DOCKET	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Fort Calhoun Station Unit No. 1	05000285	96	-- 004 --	00	3 OF 7

TEXT (if more space is required, use additional copies of NRC Form 368A) (17)

Part IV is used for any shutdown condition where the possibility of rod movement exists, or control rod(s) are not fully inserted in the core, or a transient xenon condition exists.

EVENT DESCRIPTION

On March 15, 1996, FCS was in cold shutdown (Mode 4) for a scheduled maintenance outage. Part of the maintenance activities included replacement of selected control rod seal packages. Since this work required exercising individual control rods after the repairs, procedure OP-ST-RX-0002 was consulted to ensure adequate shutdown margin existed. The newly appointed Reactor Engineer (RE), while reviewing the results of the worksheet (TDB-V.9, Part IV), noted that the calculated required boron concentration appeared to be low, when compared to the value derived from the TDB-V.9, Part III, for an all rods in condition, and adjusting for a stuck rod.

Analysis by Design Engineering Nuclear (DEN) determined that the shutdown margin worksheet did not adequately address reactivity addition due to temperature changes as the plant cooled down to temperatures below 532 degrees Fahrenheit. As a result of this finding, a Condition Report was generated and the shutdown margin worksheet, TDB-V.9, Part IV, was revised to allow for a case-specific shutdown margin calculation to be provided to the RE by DEN. A revision of the procedure to address this issue was completed prior to its usage for rod testing during the mini-outage. Investigation of prior usage of TDB-V.9 for cycles 16 and 15 did not reveal any violations of the TS required shutdown margin.

After the outage (completed March 25, 1996), the RE resumed investigating the inadequacies in TDB-V.9, Part IV to fully resolve the issue. During the investigation into previous use of TDB-V.9, it was discovered that adequate shutdown margin was not maintained greater than 4.0 percent Technical Specification limit during cycle 14 for a period of 3.5 hours while testing the control rods. It has been determined that a change to the shutdown margin worksheet in cycle 12 (May 1989) resulted in the improper calculation of shutdown margin. This error is independent of the cooldown reactivity insertion issue first identified. Shutdown margin available during the cycle 14 performance of OP-ST-CEA-0005 "Control Element Assemblies CEA Drive System Interlocks Check," was conservatively calculated as at least 3.35 percent.

The error in TDB-V.9, Part IV, was due to the method used for accounting for changes in reactivity due to Reactor Coolant System (RCS) boron concentration changes from the previous at power reactivity condition (Boron Worth). This portion of the worksheet is used if rod motion is being planned, such as would occur during the performance of OP-ST-CEA-0005. The shutdown margin worksheets, TDB-V.9, Part II and Part III, which

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1)	DOCKET	LER NUMBER (6)			PAGE (3)
Fort Calhoun Station Unit No. 1	05000285	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	4 OF 7
		96	- 004 -	00	

TEXT (if more space is required, use additional copies of NRC Form 365A) (17)

reference the appropriate TDB curves were correct, since these sections assumed no rod motion. TDB-V.9, Part I, addresses instantaneous shutdown margin and is not in error.

Normally, OP-ST-CEA-0005 is performed near the end of a refueling outage. During that time, the RCS boron concentration is at or very nearly at refueling concentrations. The shutdown margin under these conditions is readily verifiable as being adequate. OP-ST-CEA-0005 has a 90 day performance requirement. This means that if 90 days has elapsed since this test was last performed and an opportunity to perform the test arises (i.e. from a reactor trip or shutdown), OP-ST-CEA-0005 must be performed prior to a reactor restart.

The investigation into the inadequate shutdown margin revealed that a revision to account for boron worth was made in operational cycle 12. The introduction of the non-trippable Control Element Assemblies (CEA) in cycle 12 allowed FCS to reduce the amount of boron added to the RCS after a shutdown. Prior to cycle 12, the practice had been to borate to a RCS boron concentration of 4 percent shutdown margin for a 210 degree Fahrenheit RCS temperature, which would ensure adequate shutdown margin.

During a shutdown in cycle 14 (August 25, 1992), OP-ST-CEA-0005 was performed. Using TDB-V.9, Part IV, FCS calculated that adequate shutdown margin (4.16 percent reactivity) existed with a 909 ppm RCS boron concentration. The RE conducting this investigation determined that to maintain the required 4 percent shutdown margin would require a RCS boron concentration of 920 ppm without accounting for the worth of the highest worth rod stuck out. Preliminary calculations indicated that when accounting for the worth of a stuck control rod, boron concentration should have been closer to 1048 ppm in order to ensure the Technical Specification required shutdown margin would be maintained. Since this particular surveillance test was run at nearly 532 degrees Fahrenheit, the RE realized that there was an error within the shutdown margin worksheet, other than the temperature issue he was investigating at that time.

A detailed review of the worksheet revealed two factors in addition to the temperature cooldown effect which were responsible for the inadequate shutdown margin calculation on August 25, 1992.

The first factor is that the formula used to account for the change in boron worth was inaccurate. TDB-V.9, Part IV calculated the change in boron worth by evaluating the reactivity worth of the boron concentration prior to the shutdown, using the Hot Full Power (HFP) Inverse Boron Worth (IBW) and subtracting it from the boron activity worth under the current shutdown conditions, using the Hot Zero Power (HZIP) IBW.

The correct method to calculate the worth of the net difference in the boron concentration is by taking the difference in boron concentrations and dividing this

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1)	DOCKET	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Fort Calhoun Station Unit No. 1	05000285	96	-- 004 --	00	5 OF 7

TEXT (if more space is required, use additional copies of NRC Form 365A) (17)

difference by the HZP IBW:

$$(\text{CURRENT BORON CONCENTRATION} - \text{PREVIOUS BORON CONCENTRATION}) / (\text{HZP IBW})$$

The error introduced into the calculation by this mistake is small (0.4 percent reactivity). The calculation for shutdown margin for the rod testing in cycle 14 would have been 3.76 percent reactivity had this mistake in the calculation been eliminated.

The second factor is that this worksheet also failed to reference the TDB figures for required shutdown margin. These figures contain additional shutdown margin which was not included in the worksheet for TDB-V.9, Part IV.

The sum of the two factors and the temperature cooldown effect resulted in a non-conservative shutdown margin calculation in August of 1992. The only part of TDB-V.9 that was affected by any of these three errors is part IV.

Once the determination was made that there had been an inadequate shutdown margin the FCS Plant Review Committee (PRC) was convened, on May 2, 1996, to be briefed on the findings of the investigation. At 1610 Central Daylight Time (CDT) the PRC concluded that a condition had existed that could have prevented maintaining the reactor in a safe shutdown condition. At 1635 CDT, a four-hour non-emergency notification was made to the Nuclear Regulatory Commission pursuant to 10 CFR 50.72(b)(2)(iii)(A). This report is being submitted pursuant to 10 CFR 50.73(a)(2)(i)(B) and 10 CFR 50.73(a)(2)(v)(A).

SAFETY ASSESSMENT

Analysis by OPPD demonstrates that adequate shutdown margin existed during the time that the control rod testing was performed in 1992. This meets the design basis accident for the plant conditions that existed during the testing. The requirement of a 4 percent shutdown margin stems from the Main Steam Line Break (MSLB) accident at the end of a cycle. The assumed Moderator Temperature Coefficient (MTC) at end of cycle is the Technical Specification stipulated value of -0.0003 reactivity change ($\Delta \rho$) / degree Fahrenheit. Based on the MTC at the time in question, analysis shows that the of reactivity insertion by the RCS cooldown at this time in the cycle would have been 3.62 percent less than the reactivity inserted by the cooldown at the end of cycle 14. Therefore, the shutdown margin of 3.35 percent, a change from the Technical Specification required value of only 0.65 percent, was more than sufficient for any accident that might have occurred at that time (during the control rod testing on August 25, 1992) in cycle 14.

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1)	DOCKET	LER NUMBER (6)			PAGE (2)
Fort Calhoun Station Unit No. 1	05000285	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	6 OF 7
		96	- 004 -	00	

TEXT (if more space is required, use additional copies of NRC Form 366A) (17)

The safety concern is that the possibility existed that if a MSLB transient had occurred at end of cycle 14 under similar conditions, the plant could have been operated outside of its design basis.

CONCLUSIONS

The failure to detect the three procedural errors during initial review and during the following seven years of use and reviews was caused by several factors.

- 1) Personnel error was responsible for initiating the procedure revision with the incorrect method to account for the change in boron worth.
- 2) Personnel error was responsible for failing to discover the error during the 10 CFR 50.59 screening and approval process.
- 3) OP-ST-RX-0002 requires a review of the shutdown margin calculation by the Shift Supervisor. However, this review is intended only to verify to accuracy of the calculations on the worksheet and does not provide verification of the result.
- 4) Training was only provided on the completion of Shutdown Margin Worksheet. Training should have been provided on the basis for each portion of section IV of the calculation. Training is viewed as being inadequate for completion of this activity.

CORRECTIVE ACTIONS

TDB V.9, Part IV, has been revised to correct the three inconsistencies in the calculation of shutdown margin. In addition the following corrective actions will be implemented:

1. OPPD's design engineering group (DEN) will perform an independent review of all four parts of the "Shutdown Margin Worksheet", TDB-V.9 to verify that it is fully accurate. This review will be completed by June 30, 1996.
2. Training will incorporate the lessons learned from this event into initial and biennial retraining of Qualified Reviewers and 10 CFR 50.59 preparers and reviewers, as appropriate. The initial training lessons will be updated by September 30, 1996. Personnel will be trained by February 28, 1997.

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

FACILITY NAME (1)	DOCKET	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Fort Calhoun Station Unit No. 1	05000285	96	- 004 -	00	7 OF 7

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

3. Training will incorporate the lessons learned from this event into initial and continuing training for PRC members. The initial training lessons will be updated by July 31, 1996. Continuing training will be conducted for PRC members by September 30, 1996.
4. Training will be provided to the Shift Supervisors, Licensed Operators and Shift Technical Advisors on this event and on the revisions to the "Shutdown Margin Worksheet," TDB-V.9, Part IV. This training will be completed by September 15, 1996. The initial training lessons will be updated as appropriate by August 15, 1996.
5. OP-ST-RX-0002 will be revised to add a review and sign-off by the RE. This will provide a method to verify the accuracy of the shutdown margin calculation and identify any problems personnel may have with the worksheet. This procedure will be revised by July 31, 1996.

PREVIOUS SIMILAR EVENTS

No similar events have been identified.