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DATE: March 30, 2000

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Subject: McGuire Nuclear Station, Unit 1 and 2
Docket No. 50-369
Licensee Event Report 369/00-03, Revision 0
Problem Investigation Process No.: PIP M-00-0844

Gentlemen:

Attached is a Licensee Event Report describing a pre-existing design condition associated with criticality calculations. The condition affects calculations used to generate Limiting Conditions for Operation (LCO) for fuel storage requirements in the spent fuel pool. This event is being reported pursuant to 10 CFR 50.73 (a) (2) (ii) (B) "Operation Outside Design Basis of the Plant". This was previously reported under the parallel criteria of 10 CFR 50.72 in Event Number 36748 on March 2, 2000.

The design basis criteria at issue in this report is the required Keff associated with a spent fuel pool filled with water at zero boric acid concentration. The actual boron acid concentration of the spent fuel pools is maintained in excess of 2500 ppm and monitored on a routine basis as required by technical specifications. These factors mitigate this event to the extent that the condition did not adversely impact plant safety. These actual conditions allow for adequate time to detect and mitigate any dilution of the fuel pool before violating the Keff design basis acceptance criteria.

A Regulatory Commitment is listed as a planned corrective action.

Very truly yours,

H. B. Barron, Jr.
McGuire Nuclear Station, Vice President
Duke Energy Corporation

IE22

Attachment

cc: L. A. Reyes
U.S. Nuclear Regulatory Commission
Region II

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NRC FORM 366 U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

APPROVED BY OMB NO. 3150-0104
EXPIRES 04/30/98

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 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)	DOCKET NUMBER (2)	PAGE (3)
McGuire Nuclear Station, Unit 1	05000 369	1 of 5

TITLE (4) Non Conservatism In Spent Fuel Pool Criticality Calculation

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(S)
03	02	00	00	- 03 -	0	03	30	00	McGuire Nuclear Station, Unit 2	05000 370

OPERATING MODE (9):

POWER LEVEL (10):

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR (*Check one or more of the following*) (11)

20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
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)	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)	
20.405(a)(1)(iv)	XX 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	
	AREA CODE	
M. T. Cash	(704)	875-4117

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*)	NO				

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

Unit Status: Both Unit 1 and Unit 2 were in Mode 1 (Power Operation) at 100 percent power at the time of discovery.

Event Description: Modeling methods used to perform spent fuel pool criticality analysis have been determined to be non-conservative. Specifically, certain assumptions may result in Keff in excess of 0.95 for postulated off-normal conditions with 0 ppm boron concentration in the fuel pool. The design basis of the plant requires that fuel stored in the fuel pool remain ≤ 0.95 Keff when fully flooded with unborated water.

Event Cause: This event is the result of an original design condition.

Corrective Action: Technical Specifications will be revised to include additional conservatism to account for uncertainties associated with modeling assumptions.

NRC FORM 366 *NPRDS no longer exists, equipment failures will be reported through EPIX

BACKGROUND:

Each unit has an independent fuel storage pool that contains fuel storage racks [EIIS: RK] in a 2 region design. Region 1 uses a high density flux trap design for storage of nuclear fuel. Region 2 uses a high density "egg-crate" design for storage of nuclear fuel. The spent fuel pool storage racks provide for safe storage of nuclear fuel assemblies. This includes maintaining a coolable geometry, preventing criticality, and protecting the fuel assemblies from excess mechanical or thermal loading. The rack design provides for fuel storage in a array such that the Neutron Multiplication Factor (Keff) will remain equal to or less than 0.95 assuming unborated water filled the pool. Keff values less than 1.0 indicates a sub-critical condition.

The water in the spent fuel pool contains boric acid dissolved in solution to act as a neutron absorber. The large neutron absorption characteristics of boron in combination with the rack design results in an actual Keff far below 0.95. Technical Specification (TS) 3.7.14, Spent Fuel Pool Boron Concentration, requires that the spent fuel pool boron concentration be within the limits specified in the Core Operating Limits Report (COLR). Current COLR limits require boron concentration > 2675 ppm. TS Surveillance 3.7.14.1, Spent Fuel Pool Boron Concentration Surveillance, requires fuel pool boron verification every 7 days.

TS 3.7.15, Spent Fuel Assembly Storage, also specify acceptable storage configurations for fuel assemblies in the fuel pool. These limits are indexed against the initial enrichment and burnup of individual fuel assemblies. Based on these parameters fuel assemblies are grouped into one of three classes, Filler Assemblies, Unrestricted Storage, and Restricted Storage. This same TS specifies patterns for locating the fuel assemblies based on class. The classification of fuel assemblies and the associated patterns have been determined using nuclear physics models. These models consist of sophisticated neutronic computer codes. The computer codes simulate the geometry, materials, and physical behavior of the nuclear fuel and surrounding materials in the fuel pool. These models have included an assumption that fuel assembly axial burnup distribution is uniform and that axial neutron leakage will be zero. These assumptions along with geometric models have approximated fuel pools as two dimensional systems. The underlying assumption has been that the conservative assumption of zero axial neutron leakage would result in conservative values of Keff. These models have not taken any credit for soluble boron in the spent fuel pools or for other poisons in the form of fuel assembly inserts. The models have taken credit for the boraflex panels [EIIS: PL] in the region 1 racks.

EVALUATION:

Description of Event

On March 2, 2000, Nuclear Fuel Group engineers in Duke Energy's Corporate Office notified station personnel of a potential non-conservatism in the criticality calculations for the fuel pool storage configurations. Both Unit 1 and Unit 2 were in Mode 1 (Power Operation) at 100 percent power at the time of this notification. Fuel movement was not underway in either units fuel pools at the time of the discovery.

The Nuclear Fuels Group had been performing fuel pool criticality calculations using new models that used 3-dimensional geometry and non uniform fuel assembly axial burnup distributions. These calculations were being performed in support of a proposed TS amendment associated with Boraflex degradation in the spent fuel pools. Results from these analyses caused the Nuclear Fuels Group to suspect previous assumptions regarding the conservatism of 2-dimensional calculations. In the past, it was thought that the range of burnups and enrichments where 2-dimensional calculations were conservative easily bounded fuel assemblies in spent fuel pools. The 3-dimensional calculations estimated that 2-dimensional calculations might become non-conservative at lower burnups and enrichments.

The range at which these non-conservatisms could exist includes burnups and enrichments used to generate the TS limits discussed in the text above. Given the actual fuel assembly burnups and the existing limits, the potential existed that Keff would exceed 0.95 under the postulated unborated condition.

Conclusion

This event did not result in any uncontrolled releases of radioactive material, personnel injuries, or radiation overexposures. This event is not Equipment Performance Information Exchange (EPIX) reportable.

This event is the result of an original design condition.

CORRECTIVE ACTION:

Immediate

Verified that the fuel pools were operable with credit for soluble boron concentration maintained at concentrations as required by TS.

Subsequent

An Operating Experience Release was issued for industry awareness of this issue.

Planned

1. Technical Specification limits will be revised to include additional conservatism to account for uncertainties in the 2-dimensional calculations when compared to the 3-dimensional calculations.

2. Upon NRC approval of the TS revision, the Updated Final Safety Analysis Report will be revised to specify storage requirements using Boron credit methodology.

SAFETY ANALYSIS:

Based on this analysis, this event is not considered to be significant. At no time were the safety or health of the public or plant personnel affected as a result of the event.

The design of the spent fuel storage racks assumes the use of unborated water, which maintains each region in a subcritical condition during normal operation with the spent fuel pool fully loaded. The double contingency principle discussed in ANSI N-16.1-1975 allows credit for soluble boron under other abnormal or accident conditions, since only a single accident need be considered at one time. For example, the most severe accident scenario is associated with the movement of fuel from Region 1 to Region 2, and accidental misloading of a fuel assembly in Region 1 or Region 2. This could potentially increase the reactivity of the spent fuel pool. To mitigate these postulated criticality related accidents, boron is dissolved in the pool water. Safe operation of the two region poison fuel storage rack with no movement of assemblies may therefore be achieved by controlling the location of each assembly in accordance with the accompanying LCO.

Criticality analysis of the McGuire spent fuel pools demonstrate that approximately 460 ppm of boron for Region 1 and 550 ppm for Region 2 are required to off-set the axial burnup profile uncertainty. This uncertainty was identified as being non-conservative when the 2-dimensional calculation was compared to the 3-dimensional calculation. A boron dilution evaluation for McGuire has documented that for any credible dilution event the minimum soluble boron level in the spent fuel pools would be greater than 937 ppm. This dilution event is based on a minimum boron concentration of 2475 ppm as the initiating point for the event. The results also show that the dilution process requires many hours to significantly reduce pool boron concentration even under the most limiting conditions and provides sufficient time for operator actions to terminate the event. Because of level alarms [EIIS: LA] and operator rounds it is not credible for a dilution of the fuel pool to go undetected for a significant period of time.

Therefore, under conservative assumptions, the fuel pool would be diluted to a boron concentration approximately 400 ppm greater than that needed to maintain the fuel pool below 0.95 Keff. A condition of 0.95 Keff is approximately 5000 pcm subcritical. This is a substantial subcritical margin worth approximately 600 ppm boron concentration assuming a differential boron worth of 8.33 pcm per PPM. As such there is no credible scenario which could have resulted in an inadvertent criticality in the fuel pool under normal or off normal conditions. There are no safety consequences of this event beyond the potential for an inadvertent criticality.

In addition, there have not been any improper loadings of fuel assemblies in the fuel pool in recent operating history that would require consideration of a simultaneous misloading and boron dilution event. This condition had no adverse impact on public health and safety.