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March 2, 1992

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

Subject: McGuire Nuclear Station Unit 1
Docket No. 50-369
Licensee Event Report 369/92-02

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a) (1) and (d), attached is Licensee Event Report 369/92-02 concerning a missed Technical Specification surveillance. This report is being submitted in accordance with 10 CFR 50.73 (a) (2) (i). This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

for

T.C. McMeekin

TLP/bcb

Attachment

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McGuire Nuclear Station

LICENSEE EVENT REPORT (LER)

FACILITY NAME(1)	DOCKET NUMBER(2)	PAGE(3)
McGuire Nuclear Station	05000 369	1 OF 9

TITLE(4) A Technical Specification Surveillance Requirement was Missed Due To A Non Conservative Calculation Of Nuclear Flux Hot Channel Factor Because Of A Design Deficiency

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)
										05000
01	17	92	92	02	0	03	02	92		05000

OPERATING MODE(9)	1	THIS REPORT IS SUBMITTED PURSUANT TO REQUIREMENTS OF 10CFR (Check one or more of the following)(11)								
			20.402(b)		20.405(c)		50.73(a)(2)(iv)		73.71(b)
POWER LEVEL(10)	100		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)
			20.405(a)(1)(iii)	X	50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		
			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	
	AREA CODE	
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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)

On January 17,1992, while Unit 1 was in Mode 2 (Startup) at 2 percent power and shutting down due to a Steam Generator tube leak, Nuclear Design personnel were performing a routine review of Reactor Core power distribution flux map data. During this analysis, an error was detected in the results from the computer program used to perform Unit 1 power distribution surveillance calculations. Previous use of the errant computer program by Performance personnel had resulted in incorrect calculation of Heat Flux Hot Channel Factor and Nuclear Enthalpy Rise Hot Channel Factor margins, as specified by Technical Specification (TS) 3/4.2.2 and 3/4.2.3, during performance of procedure TT/1/A/9200/289, MC18 Core Power Distribution, which was performed December 18, 1991. As a result, a TS surveillance requirement was not met and the action statement was not entered. This event is assigned a cause of Design Deficiency because the computer program was designed incorrectly. The computer program was subsequently corrected. The data collected during the latest run of procedure TT/1/A/9200/289, on January 16,1992, was reverified in February, 1992 using the revised computer program. This action verified that TS Axial Flux Difference and Heat Flux Hot Channel Factor limits were not violated during the time period in which the erroneous computer program was used for this latest flux map.

EVALUATION:

Background

Procedure TT/1/A/9200/289, MC18 Core Power Distribution, is used to verify compliance with Technical Specifications (TSs) 3/4.2.2 and 3/4.2.3 for nuclear power peaking factors. Compliance with the above TSs ensures that assumptions for accidents in the Final Safety Analysis Report (FSAR) that are affected by nuclear peaking factors are within limits. During performance of procedure TT/1/A/9200/289, Reactor Core Power Flux Maps (FCMs) are generated and analyzed to detect areas of high power peaking.

Reactor Core power distribution data for procedure TT/1/A/9200/289 is collected via the Incore Instrumentation (ENA) system [EIIS:IG]. The ENA system is used to collect input signals from the movable incore flux mapping system. The ENA system does not perform any nuclear safety related function and is not used during normal daily plant operations. Parameters obtained from the ENA system are: Heat Flux Hot Channel Factor (FQ), and Nuclear Enthalpy Hot Channel Factor (FDH). Certain data recordings within procedure TT/1/A/9200/289 are accomplished by using computer [EIIS:CPU] programs DUKE-MONITOR and DETECTOR. These programs were originally written by a vendor organization and were later certified for use on nuclear safety related systems by Duke Power personnel. That certification is documented as specified in the Design Engineering Quality Assurance Manual procedure PR-101, Engineering Calculation/Analysis. These computer codes are executed in series with the output of the DETECTOR program inputing to the DUKE-MONITOR program. The DETECTOR program is used to process measured data from the ENA system. Results from this computer code sequence are used to calculate the margin of the TS surveillance limit(s) for both FQ and FDH.

TS 4.2.2.2.b requires that FQ be measured according to the following schedule:

1. At least once per 31 effective full power days, or
2. Upon achieving equilibrium conditions after exceeding 10 percent or more of rated thermal power, the thermal power at which FQ was last determined, or
3. At each time the quadrant power tilt ratio indicated by the excore detectors is normalized using incore detector measurements.

If Heat Flux Hot Channel Factor, Measured (F_Q^M) is evaluated to exceed the limit, TS 4.2.2.2 requires that one of the following actions shall be taken:

1. Within 15 minutes, control the Axial Flux Difference (AFD) to within the new AFD limits determined by the mathematical relationship established in TS 4.2.2.2.c.2.a.1, or
2. Comply with the Limiting Condition for Operation (LCO) specified in TS 3.2.2.

Description of Event

On December 10,1991, initial power operation for Unit 1 Fuel Cycle 8 (MC18) commenced. This fuel cycle initiated revised TSs and computer programs for Unit 1 Nuclear Power Distribution Limits. The TS for MC18 are based on new methodologies for Duke Power Company (DPC). These changes were approved by the NRC on November 27, 1991 in Amendment No. 128 to Docket No. 50-369. A beginning of cycle (BOC) AFD graph was generated by Performance personnel using predicted axial offset data listed in the MC18 Startup and Operational Report. The BOC AFD graph was subsequently placed in the Control Room [EIIS:NA] for use by Licensed Operations personnel while operating the Unit 1 Reactor [EIIS:RCT].

On December 12, 1991, with Unit 1 holding at a power level of approximately 38 percent during power escalation testing, Performance personnel ran procedure TT/1/A/9200/289, using the computer programs DETECTOR and DUKE-MONITOR. As a result of this procedure run, core flux map FCM/1/8/001 was generated. The limits on the Control Room BOC AFD graph were not changed as a result of this run.

On December 14, 1991, with Unit 1 at a power level of approximately 78 percent, Performance personnel again ran procedure TT/1/A/9200/289. As a result of this procedure run, core flux map FCM/1/8/002 was generated. The limits on the Control Room AFD graph were not changed as a result of this run.

On December 18, 1991, with Unit 1 operating at a steady state power level of 100 percent, Performance personnel ran procedure TT/1/A/9200/289. Core flux map FCM/1/8/004 was generated during this procedure run. The limits on the Control Room AFD graph should have been adjusted slightly at this point, however, the graph was not adjusted since the results from the DETECTOR and DUKE-MONITOR computer program indicated no action was necessary. Station personnel who executed the program, at the time, were unaware that the computer program results were erroneous.

On January 16, 1992, with Unit 1 operating at a steady state power level of 100 percent, Performance personnel ran procedure TT/1/A/9200/289. Core flux map FCM/1/8/013 was generated during this procedure run. The results from this flux map indicated that no actions were required. However, reanalysis of this map showed that one of two actions should have been taken by station personnel. Either the AFD limits should have been reduced based on the results from TS 4.2.2.2.d.1, or the next flux map should be taken before the calculated burn up where zero operational margin is expected to occur. The calculated zero margin was determined to occur approximately 27 equivalent full power days (EFPD) from January 16, 1992. Since Unit 1 was shutdown on January 17, 1992, this action was not performed or required to be performed.

On January 17, 1992, a Nuclear Design Engineer was performing routine trending analysis of Unit 1 Reactor Core flux data generated during December 1991. He noticed that the margin for FDH for flux map FCM/1/8/004 was larger than expected. Subsequently, he initiated Problem Investigation Report (PIR) 1-M92-0012 to document and investigate the discrepancy. During investigation of the PIR, it was determined that the margin limit calculations performed by the computer program DUKE-MONITOR were being performed in a non-conservative manner. The software problem was corrected and the computer code re-certified in accordance with established procedures. Design Engineering personnel re-evaluated the MC18 flux maps using the revised computer program. It was determined that surveillance requirements were not met for map FCM/1/8/004, however, all LCO requirements were still satisfied for all MC18 flux maps generated during December 1991 and January 1992.

No additional corrective action was performed at that time because Unit 1 was shutdown, on January 17, 1992, for repair of an un-related Steam Generator [EIIS:SG] tube [EIIS:TBG] leak. This event will be documented in LER 369/92-01.

Conclusion

This event is assigned a cause of Design Deficiency due to the erroneous design of the computer codes for programs DUKE-MONITOR and DETECTOR. These computer codes are executed in series with the output of the DETECTOR program inputing to the DUKE-MONITOR program. The DETECTOR program processes measured reaction rates produced from the ENA system. The non-conservatism in the margin limit calculation was caused by differing forms of power distribution data passed from the DETECTOR program to the DUKE-MONITOR program. The DETECTOR program generates the power distribution data on a nuclear fuel assembly average basis. However, the surveillance limits that were supplied to the DUKE-MONITOR program were derived on a peak nuclear fuel rod basis. Therefore the DUKE-MONITOR program was expecting peak pin data, but in fact received nuclear fuel assembly averaged data. This resulted in the DUKE-MONITOR program calculating margins using inconsistent fuel pin and fuel assembly averaged data. This difference was not identified during initial development and verification of the programs by Nuclear Design Engineering Department personnel. This was not identified because of the interpretation by personnel developing the program of how the limits in the DUKE-MONITOR program and supporting analysis were derived.

During the certification and quality assurance phase of development of the DUKE-MONITOR program, it was thought by Nuclear Design Engineering staff personnel that the surveillance limits that were derived for the DUKE-MONITOR code were on an assembly average basis. It is possible to perform FDH and FQ surveillance on an assembly average basis or on a pin basis, and they thought that the methodology of the two programs were being applied in a consistant manner. They knew the power distribution data that was being passed from the DETECTOR program was on an assembly average basis, however, they did not know the inputs to the DUKE-

MONITOR program were derived on a pin basis. Therefore, the data inconsistancy between the integral computer package was not identified at this time.

It would have been possible to correct the Unit 1 flux map AFD limits early in the event on December 18, 1991. This would have released Unit 1 from constraints of TS. However, the problem was not discovered until January 17, 1992, when a Nuclear Design Engineer discovered inconsistencies on Unit 1 Reactor Core flux map data. The software problem was subsequently corrected and the computer code re-certified in accordance with established procedures. Since the surveillance calculations for Reactor Core power distribution were found to be non-conservative, all the previous McGuire Unit 1 Cycle 8 flux maps used for power distribution monitoring were re-evaluated with the following results:

Flux maps FCM/1/8/001 and FCM/1/8/002 were generated during initial Reactor power escalation testing following refueling. Unit 1 Reactor was not at steady state condition during this time, therefore the requirements of TS 3.2.2 and 3.2.3 were satisfied and, the surveillance requirements of TS 4.2.2 and 4.2.3 were not applicable.

Flux map FCM/1/8/004 was the first map taken after Unit 1 had been at a steady state power level for an extended time after refueling, and therefore, was the first map required to meet the TS surveillance requirements. The FQ margin was determined to have been slightly negative and in violation of TS 4.2.2.2. The required action was to reduce the AFD vs. power level limit graph. However, this action was not taken at the time, since the need was not recognized by appropriate Reactor Group personnel.

Flux map FCM/1/8/013 was the first map taken with Unit 1 at equilibrium conditions and therefore, was the first map to require extrapolation of the measured Reactor Core power distribution. The current margins were found to be positive, however, the extrapolated margin for FQ was negative. The TS requirement is to increase the current measured FQ by 2 percent, recalculate the margin and then reduce the AFD graph by the amount of the negative reanalyzed margin, or the next flux map must be taken before the date at which the margin is extrapolated to zero. The burn up to zero margin was calculated to be approximately 27 EFPDs from January 16, 1992, the day that map FCM/1/8/013 was taken. Since Unit 1 was reduced to Mode 5 (Cold Shutdown) on January 17, 1992, this was not done at the time, however the map will be taken after Unit 1 is returned to Mode 1.

Although surveillance requirements were not met for Reactor Core flux map FCM/1/8/004, all LCO requirements were satisfied for all MC18 flux maps. Analysis of the situation by the McGuire Nuclear Station Reactor Group and Nuclear Design Engineering showed that additional conservatism built into TS surveillance calculations includes sufficient margin which would have prevented Unit 1 from actually exceeding TS surveillance limits.

A review of the Operating Experience Program Data Base for the 24 months prior to this event revealed 4 events which involved a TS violation with a cause of Design Deficiency. The previous events are documented in LERs 369/90-10, 370/90-01, 369/91-03, and 369/91-17. However, these events involved different groups, different circumstances, and different equipment than this event. Additionally, the corrective actions in these events were unrelated and would not have prevented this event. Therefore, this event is not considered recurring.

This event is not Nuclear Plant Reliability Data System (NPRDS) reportable.

There were no personnel injuries, radiation overexposures, or uncontrolled releases of radioactive material as a result of this event.

CORRECTIVE ACTIONS:

Immediate: None

Subsequent: 1) The software problem was corrected and the computer code re-certified in accordance with established procedures.

2) Appropriate Performance personnel were notified and the MC18 flux maps were re-evaluated by Design Engineering personnel using the revised computer program.

Planned: 1) Appropriate Nuclear Design staff personnel will receive additional guidance on the DETECTOR, DUKE-MONITOR, and other associated computer programs to raise their knowledge and awareness levels on these subjects.

2) A revised AFD limit graph will be placed in the Control Room before 31 effective full power days on Unit 1.

3) The verification procedure for the DETECTOR and DUKE-MONITOR computer programs will be updated to require running a test case which demonstrates the correct function of the two codes as an integral package whenever the software is changed.

4) McGuire Safety Review Group (SRG) personnel will conduct a review of other computer programs related to quality operations or nuclear safety of the facility. The SRG will evaluate the validation process used on these programs and determine if enhanced verification techniques are appropriate.

SAFETY ANALYSIS:

The following TSs provide assurance that fuel integrity is maintained during Condition I and II transients as defined in the FSAR:

FQ - TS 3/4.2.2
FDH - TS 3/4.2.3
AFD - TS 3/4.2.1
Reactor Coolant (RC) system [TIIS:AB] flow rate -TS 3/4.2.5.

The FQ TS, in conjunction with the AFD TS, provides protection against Loss Of Coolant Accident (LOCA) and center-line fuel melt (CFM) related fuel failures. The FDH TS, in conjunction with the RC system [EIIS:AB] flow rate and AFD TSs provide assurance that the minimum Departure from Nucleate Boiling Ratio (DNBR) will not be exceeded during Condition I, or II transients.

Compliance with the FQ and FDH TSs is accomplished using the computer programs DETECTOR and DUKE-MONITOR. These codes are executed in series, with DETECTOR being executed first, followed by DUKE-MONITOR. DETECTOR processes the measured reaction rate data produced from the ENA system. At the completion of the DETECTOR run, data files containing the three-dimensional measured power distribution are written for use by the computer program DUKE-MONITOR. The DUKE-MONITOR program then processes this information to ensure that the surveillance requirements of TS 3/4.2.2 and TS 3/4.2.3 are satisfied.

TS 3/4.2.2 and 3/4.2.3 are two tiered specifications. Measured power distributions are first compared against an LCO limit and then against the surveillance limit. TS 3/4.2.3 was not violated during this event, however, TS 3/4.2.2 was violated.

If the measured power distribution is less than the LOCA limits at all Reactor Core

locations, the LCO portion of TS 3/4.2.2 is satisfied. Compliance with TS 3/4.2.2 is accomplished by comparing the measured power distribution against the LOCA limits specified in MCAI-0400-05, MICS Core Operating Limits Report. Prior to comparing the measured power distribution to the LOCA limits, an uncertainty is applied to the measured power distribution to account for manufacturing tolerance and measurement uncertainty.

The surveillance part of TS 3/4.2.2 is intended to provide assurance that the LOCA limit is not violated if the unit was operating at the extremes of the AFD envelope and a LOCA were to occur. That is, if Unit 1 was to experience a severe operational transient, but maintain AFD and rod insertions within the limits prescribed in TS 3/4.2.1 and TS 3.1.3.6, and a LOCA were to occur, core peaking would be within the limits assumed in the LOCA analysis. Surveillance is also performed to ensure that margin exists to the CFM limit.

The surveillance methodology employed in TS 3/4.2.2 is based on the Core Operating Limits Methodology described in DPC-NE-2011PA, Nuclear Design Methodology for Core Operating Limits of Westinghouse Reactors.

FQ surveillance is performed by comparing the measured power distribution against pre-calculated surveillance limits. Surveillance limits are calculated based on the methodology described in DPC-NE-2011PA. These limits are sometimes referred to as monitoring factors, and include allowances for manufacturing tolerances, measurement uncertainty, and a factor to account for allowable Reactor quadrant power tilt ratio.

Monitoring factors are generated to provide both LOCA, DNBR and Reactor Protection system (IPE) [EIIS:JC] protection. The monitoring factors which are generated to provide both LOCA and Reactor Core fuel melt protection are a three dimensional quantity which are functionalized against both Reactor power level, and fuel burn up. These factors represent the maximum power that can be measured at any given core location. If the measured power at this core location is greater than the monitoring factor, then the measured power distribution may be limiting with respect to LOCA or CFM. The peaking margin available to both the LOCA peaking limit (operational margin) and to the CFM limit (IPE margin) are calculated at each core location. This margin forms the basis for reducing the AFD limits in Section c.2 of TS 3/4.2.2, and for reducing the over temperature delta temperature (OTDT) trip setpoint in section c.3 of TS 3/4.2.2.

The monitoring factors which are generated to provide DNBR protection are a two dimensional quantity which are functionalized against Reactor power level and Core burn up. These factors represent the maximum radial power that can be measured at any core location. If the measured radial power at this core location is greater than the monitoring factor, then the measured power distribution may be limiting with respect to DNBR. The peaking margin available to both the operational DNBR limit and surveillance limit are calculated for each

core location. This margin forms the basis for actions required in TS 3/4.2.3.

The problem identified in the margin to limit calculations performed in the surveillance portion of TSs 3/4.2.2 and 3/4.2.3 caused a surveillance action item to be missed in TS 3/4.2.2. It should be noted that the FQ LCO limits and Core fuel melt limits of TS 3/4.2.2 were never challenged. In addition, positive margin to the LCO and surveillance limits for TS 3/4.2.3 were also satisfied. Negative FQ operational margin was calculated in flux maps FCM/1/8/004 used to satisfy the surveillance frequency of TS 3/4.2.2 and TS 3/4.2.3. The magnitude of the negative operational margin was -0.86 percent.

The monitoring factors that were generated for MC18 inherently included peaking margin which was not utilized in the surveillance monitoring calculations. This margin was present in the MC18 monitoring factors because of conservatism in the procedures used to calculate these factors. The analysis performed in MCC-1553.05-00-0116, Operability Evaluation for PIR-1-M92-0012, confirmed that positive FQ operational margin actually did exist in flux map FCM/1/8/004. The magnitude of this positive FQ operational margin was 1.14 percent. Therefore, it can be concluded that the initial condition peaking assumed in the LOCA accident analysis would not have been exceeded if Unit 1 were to go through a severe operational transient and then have a LOCA.

During the time period of December 10,1991 through January 17, 1992 Unit 1 was not operated near the extremes of the AFD envelope and did not experience any operational transients related to the Reactor Core. No additional anomalies were noted and all primary and secondary systems operated within specifications. No safety systems were challenged. Emergency core cooling and emergency electrical power were available but not required and not actuated. There were no radiological consequences as a result of this event.

Therefore, the health and safety of the public were not affected as a result of this event.