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H. B. Barron
Vice President

May 31, 2002

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

Subject: McGuire Nuclear Station, Unit 2
Docket Nos. 50-370
Licensee Event Report 370/02-01, Revision 0
Problem Investigation Process No.: M-02-1877

Pursuant to 10 CFR 50.73, Sections (a)(1) and (d), attached is Licensee Event Report (LER) 370/02-01, Revision 0.

On April 5, 2002, with Unit 2 at 100% power and a Unit 2 Residual Heat Removal (ND) system flushing evolution in progress, the discharge check valve for the 2A ND Pump became stuck open. During an event requiring residual heat removal, this condition could have diverted sufficient 2B ND Pump flow from the reactor core to prevent the 2B ND train from performing its safety function. There were no immediate indications to plant operators that the discharge check valve for the 2A ND Pump was stuck open. Procedurally directed actions to render the 2A ND train inoperable were implemented later during the ND system flushing evolution. These actions resulted in both trains of the Unit 2 ND System being inoperable for less than two hours.

Probabilistic risk assessment has determined this event to be of no significance to the health and safety of the public. This LER is being submitted as per the requirements of 10 CFR 50.73 (a)(2)(i)(B), 10 CFR 50.73 (a)(2)(v)(B), and 10 CFR 50.73 (a)(2)(v)(D). There are no regulatory commitments contained in this LER.

H. B. Barron

Attachment

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U. S. Nuclear Regulatory Commission
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FACILITY NAME (1)
McGuire Nuclear Station, Unit 2

DOCKET NUMBER (2)
05000 370

PAGE (3)
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TITLE (4)
Residual heat removal system inoperable due to stuck open check valve.

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
04	05	2002	2002	001	00	05	31	2002	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	POWER LEVEL (10)	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply) (11)			
1	100	20.2201(b)	20.2203(a)(3)(ii)	50.73(a)(2)(ii)(B)	50.73(a)(2)(ix)(A)
		20.2201(d)	20.2203(a)(4)	50.73(a)(2)(iii)	50.73(a)(2)(x)
		20.2203(a)(1)	50.36(c)(1)(i)(A)	50.73(a)(2)(iv)(A)	73.71(a)(4)
		20.2203(a)(2)(i)	50.36(c)(1)(ii)(A)	50.73(a)(2)(v)(A)	73.71(a)(5)
		20.2203(a)(2)(ii)	50.36(c)(2)	<input checked="" type="checkbox"/> 50.73(a)(2)(v)(B)	OTHER
		20.2203(a)(2)(iii)	50.46(a)(3)(ii)	50.73(a)(2)(v)(C)	Specify in Abstract below or in NRC Form 366A
		20.2203(a)(2)(iv)	50.73(a)(2)(i)(A)	<input checked="" type="checkbox"/> 50.73(a)(2)(v)(D)	
		20.2203(a)(2)(v)	<input checked="" type="checkbox"/> 50.73(a)(2)(i)(B)	50.73(a)(2)(vii)	
		20.2203(a)(2)(vi)	50.73(a)(2)(i)(C)	50.73(a)(2)(viii)(A)	
		20.2203(a)(3)(i)	50.73(a)(2)(ii)(A)	50.73(a)(2)(viii)(B)	

LICENSEE CONTACT FOR THIS LER (12)

NAME: J. W. Bryant, Licensing Engineer
TELEPHONE NUMBER (Include Area Code): (704) 875-4162

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

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
B1a	BP	V	B350	Yes					

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE). NO

EXPECTED SUBMISSION DATE (15)

MONTH: DAY: YEAR:

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

Unit Status: At the time of the event, Unit 1 and 2 were in MODE 1 (Power Operation) at 100 percent power.

Event Description: During a Residual Heat Removal (ND) system flushing evolution, the 2A ND Pump discharge check valve (2ND-23) became stuck open. During an event requiring residual heat removal, this condition could have diverted sufficient 2B ND Pump flow from the reactor core to prevent the 2B ND train from performing its safety function. There were no immediate indications to plant operators that 2ND-23 was stuck open. Procedurally directed actions to render the 2A ND train inoperable were implemented later during the ND system flushing evolution. The combination of these conditions resulted in both trains of the Unit 2 ND System being inoperable. Upon identifying this condition, plant operators responded quickly to restore operability of the 2B ND train. The total time that both ND trains were simultaneously inoperable was approximately 1 hour and 54 minutes. A probabilistic risk assessment determined this event to be of no significance to the health and safety of the public.

Event Cause: Design deficiency - previous redesign of 2ND-23 in 1999, to preclude the valve from sticking open, was inadequate.

Corrective Action: 2ND-23 was modified to preclude sticking open. A review determined that other applications of this valve model at McGuire are not susceptible to sticking open.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

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.

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BACKGROUND

The following information is provided to assist readers in understanding the event described in this LER. Applicable Energy Industry Identification (EIIS) system and component codes are enclosed within brackets. McGuire system and component identifiers are contained within parentheses.

Residual Heat Removal (ND) [BP] System:

The Unit 2 ND system is a sub-system of the Unit 2 Emergency Core Cooling System (ECCS). Its ECCS safety function is to transfer heat from the core following a loss of cooling accident (LOCA) at a rate such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts. The ND system consists of two redundant trains (2A and 2B) with each train capable of providing 100% of the required ECCS flow. Each train contains a pump, heat exchanger, and attendant piping, valves, and instrumentation. The two ND trains are normally cross-connected to ensure that either train is capable of providing flow to all four reactor coolant (NC) [AB] system loops during the ECCS injection phase of a LOCA.

McGuire Technical Specification (TS) 3.5.2 - ECCS Operating:

TS 3.5.2 requires that two ECCS trains be operable in MODES 1 through 3. With one ND train inoperable and 100% of the ECCS required flow available to the other operable train, TS 3.5.2 requires that the inoperable train be restored to operable status within 72 hours. Since TS 3.5.2 does not provide actions for two ND trains inoperable, the provisions of TS 3.0.3 are applicable for that condition. In such a case, TS 3.0.3 requires that actions be initiated within 1 hour to place the unit in a MODE or other specified condition in which the relevant TS is not applicable.

EVENT DESCRIPTION

On April 5, 2002, McGuire Nuclear Station Unit 2 was in Mode 1 (Power Operation) at 100% power. Initially, both Unit 2 ND trains were operable with the ND trains in a normal cross-connected alignment. Each ND train was capable of providing 100% of the required ECCS flow. As part of a planned flush of the Unit 2 ND system, the following relevant sequence of events occurred on April 5, 2002 (times approximate):

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08:52 2B ND train was declared inoperable due to flush related valve alignments and removal of the 2B ND Pump's control power fuse.

10:28 2A ND Pump was started to commence flushing of the ND system.

11:07 2A ND Pump was stopped.

12:36 Upon realignment of applicable valves and reinstallation of the 2B ND pump's control power fuse, the 2B ND train was declared operable.

13:29 2A ND train was declared inoperable due to flush related valve alignments and removal of the 2A ND Pump's control power fuse.

15:06 2B ND Pump was started to commence flushing of the ND system. Abnormal ND system flowrates were immediately observed. Commenced evaluation of flow anomalies.

15:10 Evaluation of abnormal flows determined that the 2A ND Pump discharge check valve (2ND-23) was stuck open and that 2B ND train flow was being diverted via reverse flow through 2ND-23. Entered TS 3.0.3 for Unit 2.

15:17 The 2B ND Pump was stopped. Prior to stopping the pump, operators observed that the 2A ND Pump was rotating in the reverse direction.

15:23 The 2A ND Pump discharge valve (2ND-24) was closed which isolated the flow diversion path. This restored operability of the 2B ND train. Exited TS 3.0.3 for Unit 2.

INVESTIGATION

Subsequent evaluation determined that 2ND-23 most likely became stuck open upon starting of the 2A ND Pump at 10:28. This start resulted in a sudden un-throttled flow through 2ND-23 which wedged its disc against the valve's body. Upon stopping the 2A ND Pump at 11:07, the disc remained stuck open. The following evidence supports this conclusion:

- Observed reverse rotation of the 2A ND Pump just prior to stopping the 2B ND Pump at 15:17. The design of the ND system is such that any 2B ND train flow causing reverse rotation of the 2A ND Pump

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would have to flow through 2ND-23 in the reverse direction. Reverse flow through 2ND-23 is only possible with the valve not fully closed.

- During disassembly of 2ND-23 following the event, the valve disc was heard falling onto the valve seat during removal of the bonnet bolts.
- Inspection of the 2ND-23 internals following the event revealed strike marks on the valve's disc and body.

With 2ND-23 stuck open, approximately 1000 gallons per minute of 2B ND Pump discharge flow was passing through the valve in the reverse direction. For an event requiring residual heat removal, this condition would have diverted some 2B ND Pump flow from the reactor core. Initial analysis did not provide conclusive evidence that this diversion flow would have prevented the 2B ND train from providing sufficient core cooling to perform its safety function under limiting design conditions. However, absent a more detailed confirmatory analysis, McGuire is conservatively assuming the diversion flow rendered the 2B ND train inoperable. There were no immediate indications to plant operators that 2ND-23 was stuck open. Procedurally directed actions to render the 2A ND train inoperable were implemented at 13:29. Therefore, based upon the above sequence of events, both ND trains were simultaneously inoperable for approximately 1 hour and 54 minutes (from 13:29 until 15:23).

CAUSAL FACTORS

Valve 2ND-23 is a Borg-Warner 8" swing check with a bonnet hung design, meaning the disc hanger assembly is hung from the valve cover. The valve is designed to be used in horizontal piping configurations and relies on gravity to close the disc. Since 2ND-23 is installed in a vertical section of pipe, gravity provides less closing force than would be present in a horizontal section of pipe.

Upon disassembly of 2ND-23 following the event, a ridge was observed on the backside of the disc. In addition, there was a lip present on the valve body at the location where contact between the disc ridge and the valve body had occurred when 2ND-23 experienced sudden un-throttled flow conditions upon start of the 2A ND Pump during the ND system flush evolution. It was determined that this lip provided a point where the disc caught on the valve body and became stuck in the open position. Since gravity provides less closing force with the valve mounted vertical, the disc was unable to break loose and close.

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The potential for 2ND-23 to stick open had been previously identified during evaluation of a similar event in April of 1999. As part of the corrective actions associated with that event, the internal backstop for 2ND-23 was extended to prevent the valve disc from striking the valve body. Review of that work has identified that, for vertical applications, the length of the backstop extension for 2ND-23 was insufficient to accomplish this goal.

Based upon the above, the root cause for the event described in this LER is inadequate redesign of 2ND-23 in 1999 for vertical applications which, upon the sudden un-throttled start of the 2A ND Pump, allowed the disc for 2ND-23 to strike the valve body and stick open.

REPORTABILITY

This event is reportable for the following reasons:

- The LOCA safety analyses in Chapter 15 of the McGuire Updated Final Safety Analysis Report (UFSAR) credit the Unit 2 ECCS system in removing residual heat and mitigating the consequences of a LOCA event. McGuire is conservatively assuming that, between 13:29 and 15:23, the Unit 2 ND system was not capable of performing this safety function if needed. Consequently, this represents a condition that could have prevented the fulfillment of a safety function needed to remove residual heat and mitigate the consequences of an accident. This is reportable under the requirements of 10 CFR 50.73 (a)(2)(v)(B) and 10 CFR 50.73 (a)(2)(v)(D).
- Since TS 3.5.2 does not provide any actions associated with two inoperable ND trains, the provisions of TS 3.0.3 were applicable for Unit 2 during this event. Since McGuire was unaware of this situation, Unit 2 was in this condition for longer than the one hour allowed by TS 3.0.3 (from 13:29 until 15:23). As per NUREG-1022, Event Reporting Guidelines, this represents a condition reportable as a TS prohibited operation pursuant to 10 CFR 50.73 (a)(2)(i)(B). Note that at 15:10, upon recognizing that the provisions of TS 3.0.3 were applicable, plant operators entered TS 3.0.3. The conditions requiring entry were then corrected within the required one hour.

This LER is being submitted as per the requirements of 10 CFR 50.73 (a)(2)(iv)(A) for the reasons stated above. Note that, when this event was initially reported on April 5, 2002, it was classified as an unanalyzed condition significantly degrading plant safety, pursuant to 10 CFR 50.72 (b)(3)(ii)(B). However, due to the short period of time

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that Unit 2 was in this condition and the low probability of an event requiring residual heat removal, a probabilistic risk assessment (PRA) determined this event to be of no significance to the health and safety of the public (reference the Safety Analysis section of this LER). Consequently, McGuire is retracting that portion of the initial event report related to the requirements of 10 CFR 50.72 (b) (3) (ii) (B).

CORRECTIVE ACTIONS

- Immediate:
- 1) A modification was implemented which rounded off a corner on the back of the 2ND-23 valve disc to preclude contact with the valve's body during large and sudden flow conditions. In addition, this modification smoothed the internal surface of the valve body in the area where the valve disc was contacting the body. These modifications were also performed on the 2B ND Pump discharge check valve (2ND-8). These actions provide reasonable assurance that 2ND-23 and 2ND-8 will not stick open. Note that the equivalent Unit 1 valves (1ND-23 and 1ND-8) are of a different manufacturer and design which precludes a failure similar to that experienced on 2ND-23.
 - 2) A review was performed to identify any other plant applications using valves of the same design as 2ND-23. This review did not identify any valves in other systems that were susceptible to sticking open.
- Subsequent:
- 1) An evaluation of the effect of reverse rotation on the 2A ND Pump determined there is reasonable assurance the pump was not damaged by the reverse flow experienced during the April 5, 2002 event.

SAFETY ANALYSIS

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

The ND system provides mitigation capability for various initiating events. This mitigation capability is provided as part of the ECCS high pressure recirculation mode of operation or as part of the ECCS

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low pressure injection and ECCS low pressure recirculation mode of operation.

The failure of 2ND-23 to close is not explicitly modeled in the McGuire PRA. However, the worse case change in core damage frequency (CDF) and conditional core damage probability (CCDP) associated with this event has been estimated to be 4.5E-06/yr and 1.1E-9 respectively.

The major contributors to Large Early Release Frequency (LERF), according to the McGuire PRA, are the containment bypass sequences. This event does not contribute significantly to the containment bypass plant damage state. As a result, the impact on LERF is very small.

Given the above, this event did not have a significant impact on CDF, CCDP, or LERF. Consequently, it is considered to be of no significance with respect to the health and safety of the public.