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JAFP-94-0498

United States Nuclear Regulatory Commission
Document Control Desk
Mail Station P1-137
Washington, D.C. 20555

SUBJECT: DOCKET NO. 50-333
LICENSEE EVENT REPORT: LER-93-021-01:

Motor Operator Valve Failure Due to Inadequate Brake Design

Dear Sir:

This report is submitted in accordance with 10 CFR 50.73(a)(2)(v)(B).

The supplement is provided to update the status of a planned modification to preclude motor operator valve failures due to motor cyclin The modification will be installed during the 1994 Refuel utage.

Questions concerning this report may be addressed to Mr. Donald Simpson at (315) 349-6361.

Very truly yours,

HARRY P. SALMON, JR.

HPS:DES:tlc
Enclosure

cc: USNRC, Region I
USNRC Resident Inspector
INPO Records Center
RMS (JAF)

cert # P284-860022

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NRC FORM 366 (5-92) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 5/31/95

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LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

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TITLE (4)
Motor Operator Valve Failure Due to Inadequate Brake Design Test

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
										05000
07	22	93	93	021	01	10	17	94	FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)							
POWER LEVEL (10)	100		20.402(b)		20.405(c)		50.73(a)(2)(iv)		73.71(b)
			20.405(a)(1)(i)		50.36(c)(1)	X	50.73(a)(2)(v)		73.71(c)
			20.405(a)(1)(ii)		50.36(c)(2)		50.73(a)(2)(vii)		OTHER
			20.405(a)(1)(iii)		50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		(Specify in Abstract below and in Text, NRC Form 366A)
			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 (Include Area Code)
Mr. Donald Simpson, Senior Licensing Engineer	(315) 349-6361

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
B	BO	MO	R165	Y						

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 15 single-spaced typewritten lines) (16)

The plant was operating at 100 percent power in the Run mode. During the performance of testing on 7/22/93, the motor for 10MOV-25A, Residual Heat Removal A Side Low Pressure Coolant Injection Inboard Isolation Valve, failed due to repeated starts in the closed direction after the valve was closed. Failure appeared to be due to overheating caused by repetitive in-rush starting current. The cause was an apparent design deficiency in the selection of motor brake which was determined to be inadequately sized to prevent actuator spring pack energy release after operator torque-out and motor cut-off. This condition is reportable because with the plant in shutdown cooling operation the potential exists for common mode failure of the redundant subsystem actuator. In Shutdown cooling operation, if an isolation signal is received, a continuous, sealed in, close signal is sent to both 10MOV-25A and B, which could lead to this postulated failure and neither valve could be remotely opened for residual heat removal or vessel inventory control. Plant operators were made aware of the potential failure scenario and an operability determination was performed. A modification to the motor thermal overloads was implemented to minimize failure potential. The Authority intends to replace the motor operators during the 1995 refuel outage.

EIIS Codes are in []

Description

While operating at 100 percent power in the Run mode on July 22, 1993, technicians were performing a test that demonstrates operability of the Primary Containment Isolation System [JM] (PCIS) logic systems which automatically initiate upon low reactor water level or high drywell pressure. The motor operator for Residual Heat Removal/Low Pressure Coolant Injection (RHR/LPCI) [BO], Inboard Injection Valve, 10MOV-25A, failed due to repeated motor starts in the closed direction when tested. Maintenance engineers determined that the repeated motor starts were due to an incorrectly sized motor brake. This brake allowed the non-locking gear train to release the energy stored in the spring pack and the torque switch to reclose. As soon as the torque switch closed, the seal in circuit sent a close signal to the valve again. This repeating cycle continued for approximately one hour, leading to overheating and motor failure. The failed motor was replaced and the operator restored to service on August 5, 1993.

Following this event, the failed motor and brake were removed from the valve operator in order to perform an equipment failure evaluation. Initially, prior to testing and inspection of the motor brake, the evaluation postulated that the motor failed due to a failure of the motor brake from improper adjustment or wear-out. Following discussion with the brake manufacturer and Limitorque Corporation, additional testing was performed on the motor brake and calculations were performed to verify the minimum brake torque requirements. MOV (Motor Operated Valve) Engineering concluded that the motor brake was inadequately sized for this application.

It was determined that the redundant subsystem motor operated valve, 10MOV-25B, could fail in a similar manner. A review of other motor operated valves found none with the potential failure mechanism either because of design differences such as gear ratio ranges or control schemes that preclude similar failure.

The inboard RHR/LPCI valves (10MOV-25A&B) are normally closed as an isolation for the Reactor Coolant System Pressure Boundary. The valves have a safety related function to automatically open upon receipt of either Low-Low-Low reactor water level or high Primary Containment [NH] drywell pressure to provide a LPCI flow path during accident conditions. The valves also have a safety related function to close for primary containment isolation (PCIS) purposes.

In the shutdown cooling (SDC) mode of the RHR/LPCI System, one of these valves is normally open to permit the cooled reactor water to return to the reactor vessel. In this mode, these valves have a protective feature to automatically close upon receiving either a low reactor vessel water level signal or a high drywell pressure signal isolating a potential reactor drain path. This is referred to as the Shutdown Cooling PCIS Isolation. The automatic closure circuitry has a seal-in and operator action (pushbutton reset from the Control Room [NA]) is required to reset the isolation logic to ensure that the LPCI initiation circuitry does not automatically re-open 10MOV-25A & B and re-establish a potential reactor drain path.

The automatic sealed-in closure of 10MOV-25A & B will occur when all of the following conditions exist:

- Reactor Pressure is less than 75 PSIG

and

- Outboard Shutdown Cooling Suction Valve (10MOV-17) is not on its closed seat

and

- Inboard Shutdown Cooling Suction Valve (10MOV-18) is not on its closed seat

and

- Low Reactor Water Level or High Drywell Pressure

An operability review determined that the valve actuators were operable in the Run mode of reactor operation. The operability review concluded that failure of these valves to operate would be a concern only in the shutdown cooling mode of operation. With the plant in the shutdown cooling mode of operation, Low Pressure Emergency Core Cooling System requirements may be met by either or both of the Core Spray [BM] subsystems in the event both RHR/LPCI subsystems were declared inoperable due to inoperability of 10MOV-25A & B.

Following completion of the operability assessment and review of the 10MOV-25A & B actuator design, event notification was made on September 28, 1993, in accordance with 10CFR50.72(b)(2)(iii)(B) due to potential reduced RHR/LPCI capability when in the shutdown cooling mode of operation.

Event Cause

This event is the first failure of this type experienced even though the test had been performed every six months as required by Technical Specifications. A review of testing methodology determined that prior to December, 1992, the test did not include automatic operation of 10MOV-25A or B from simulated high drywell pressure or low reactor water level signals. Therefore, there was no challenge to motor brake performance. This is because 10MOV-25A and B did not receive the sealed-in close signals that they now have with the revised test procedure.

The test was performed on December 26, 1992, with the sealed-in close signal and no motor failure was experienced. The plant was in a cold shutdown condition during conduct of this test. It is possible that the lower ambient and equipment temperatures associated with cold weather and plant shutdown conditions lowered the operator gear train efficiency, which reduced the backdriving torque to below the motor brake torque thereby preventing spring pack relaxation and subsequent reclosure of the actuator torque switch.

Calculations were performed to determine the locking torque required from the motor brake to reliably prevent the spring pack energy from "backdriving" the motor and allowing the torque switch contacts to close. These calculations supported the observation that the currently installed 35 ft-lb motor brake may not provide sufficient locking torque under all conditions to prevent the torque switch from reclosing. Calculations concluded that a 75 ft-lb brake would provide the best assurance that the torque switch contacts would not reclose due to backdriving torque.

Based upon calculations performed and equipment failure evaluation, the cause of the motor failure is a design deficiency in the sizing of the motor brake for this Limitorque operator. The motor brake appears to have been sized to minimize inertial run load torque effects after motor cut-off and not seating load actuator torque-out and motor cut-off. Purchase specifications for the motor operator did not specify any unique brake requirements therefore, brake torque requirements were left to the manufacturers determination. The failure to develop adequate design specifications for this motor operator was due to insufficient knowledge regarding motor operated valve design and operation. The requirements to prevent gear train relaxation were not considered.

Analysis

The failure mechanism for 10MOV-25A and 10MOV-25B as described in this event is only possible under specific plant conditions. That is, the plant is shutdown and cooled down with the RHR system aligned in the shutdown cooling mode of operation. Reactor pressure is less than 75 PSIG under these conditions. Although only one train of the RHR system would be aligned in the shutdown cooling flowpath, the failure mode has the potential to affect both RHR/LPCI subsystems, a common mode failure which could prevent the automatic realignment (opening) of valves 10MOV-25A & B in the LPCI mode in the event of a loss of reactor water inventory.

The common failure could occur upon receipt of a Shutdown Cooling (SDC) Isolation Signal. In this case, the 10MOV-25A & B valves would automatically close then potentially fail in that position.

10MOV-25A & B operability is required for LPCI mode initiation signal during all modes of plant operation as defined in the Technical Specifications. During power operation, operability of the 10MOV-25A & B valves in the LPCI mode of RHR is assured because the potential failure scenario is only present when RHR/LPCI is in the Shutdown Cooling lineup.

One of the functions of the RHR system is to remove residual heat in the shutdown cooling mode following an accident or other conditions which require shutdown and maintenance of coolant temperature less than 212 F degrees. Since the presence of a shutdown cooling isolation signal to 10MOV-25A & B cannot be precluded when RHR is in service in the shutdown cooling mode, the potential common failure of both valves in this mode of operation create a condition which is reportable under 10CFR50.73 (a)(2)(v)(B). That is, a condition that could have prevented the fulfillment of a safety system function needed to remove residual heat.

If a motor failure occurred during a Shutdown Cooling Isolation and a LPCI signal was subsequently received, 10MOV-25A & B would not automatically open once operators reset the isolation signal. Likewise, neither valve could be remotely opened for residual heat removal or reactor vessel inventory control. This condition does not challenge the design bases Low Pressure Coolant Injection function because the design bases assumes the plant is in normal power operation Likewise, the design basis is not challenged for reactor pressures below the SDC cut-in permissive pressure such as during the Shutdown Cooling Mode of operation because automatic Low

Pressure Coolant Injection (LPCI) actuation is not required. The purpose of the isolation seal in logic on the 10MOV-25A & B valves is specifically to isolate a possible reactor drain path which could have been created during the Shutdown Cooling Mode of operation. Therefore, manual operation of the valves is permissible provided plant pressure is below the shutdown cooling permissive setpoint (75 PSIG).

The safety significance of the failure described herein is low because of the specific plant conditions under which the failure is possible. That is, the plant is operating in the shutdown cooling mode at low pressures and with only decay heat levels. Should a shutdown cooling isolation occur under these conditions which results in 10MOV-25A and B failure, the LPCI mode of RHR is available because 10MOV-25A and B may be manually opened if needed. In addition, one or both of the Core Spray [BM] subsystems is available as required by the Technical Specifications.

The RHR design basis document describes the requirements for RHR/LPCI subsystem availability in the shutdown cooling mode of operation in terms of the shutdown cooling isolation logic. The design basis document states that the automatic LPCI actuation is not required during the SDC mode or when reactor pressure is below 135 PSIG. Since the SDC logic is initiated only when the RHR system is in the SDC mode and the SDC mode is not initiated when the LPCI initiation is postulated to be needed, the initiation of this logic does not prevent an automatic LPCI mode of operation when it is required.

Failure of the 10MOV-25A and B valves as a result of a SDC isolation is further bounded by the loss of coolant accident safety analysis which demonstrated cooling effectiveness using one core spray subsystem. With the plant in the SDC mode of operation there is reasonable assurance that at least one of the core spray subsystems would be available for removal of residual heat or reactor vessel inventory control based upon the application of shutdown risk analysis at FitzPatrick.

Corrective Actions

1. Modification M1-90-174 was completed on the motor actuators for 10MOV-25A & B. This modification replaced existing 300 percent valve motor overloads with properly sized overloads to reduce the potential of motor failure in the event of a SDC isolation signal.

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

2. An operability review was performed. The Limiting Condition for Operation (LCO) is being tracked to ensure LPCI is declared inoperable when the plant is in the Shutdown Cooling Mode of operation.

3. An on-site MOV group was established in support of the Generic Letter 89-10 program. The development of this group has resolved the lack of MOV knowledge problem and has improved the overall reliability of motor operated valves at FitzPatrick through improved maintenance, testing and diagnosis.

4. The Operational Review Group has alerted the industry of this motor actuator failure scenario over the Nuclear Network.

5. A modification is being developed to replace the existing motor actuators for 10MOV-25A & B. This modification is planned for the 1995 refuel outage and will use design features such as a locking gear train that will preclude failure as identified herein. Status: In the development of this modification, the lead time of parts precluded installation as planned. A modification to the existing motor actuator control circuit logic will be installed during the 1994 Refueling Outage, refer to Corrective Action #6. The 10MOV-25A and B motor actuators will not be replaced.

6. Engineering will evaluate possible logic changes to prevent 10MOV-25A & B motor cycling problem. Status: A motor actuator control circuit logic modification will be installed on the 10MOV-25A and B actuators during the 1994 Refueling Outage. This modification is designed to prevent motor actuator cycling on receipt of a close signal through the installation of a limit switch contact in the close circuit.

Additional Information

Failed Component: Valve Operator (Motor)
Manufacturer: Reliance
Torque Rating: 150 ft-lb
3 phase
575 VAC
3600 RPM
Operator Size: SMB-4

Previous Similar Events:

LER-92-002-01 describes other motor operated valve deficiencies which were, in part, due to design inadequacies associated with required attributes of the particular valve actuator.