NRC FORM 366 (4-95) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104

EXPIRES 04/30/99

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.

LICENSEE EVENT REPORT (LER)

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

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Millstone Nuclear Power Station Unit 3	05000423	1 OF 3

TITLE (4)

Reactor Trip Due To Main Steam Isolation Valve Closure During Partial Stroke Testing Due To Solenoid Valve Failure

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
12	11	1998	1998	-- 045 --	00	01	11	1999	FACILITY NAME	DOCKET NUMBER

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)	☐ 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)	☐ 50.73(a)(2)(v)	Specify in Abstract below or in NRC Form
		☐ 20.2203(a)(2)(iv)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(vii)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
David A. Smith, Manager Unit 3 Regulatory Compliance	(860)437-5840

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 15 single-spaced typewritten lines) (16)

On December 11, 1998, at approximately 0840 hours, with the Unit in Mode 1 at 100 percent power, Main Steam Isolation Valve (MSIV) 3MSS*CTV27A fully closed while performing partial stroke testing resulting in an automatic reactor trip initiated by low water level in the #1 Steam Generator(SG). The closure of the MSIV was caused by the failure of solenoid valve 3MSS*SV27A1A to fully open during the partial stroke test. This event is reportable pursuant to 10 CFR 50.73(a)(2)(iv) as "...any event or condition that resulted in a manual or automatic actuation of any Engineered Safety Feature (ESF), including the Reactor Protection System (RPS) ...".

The closure of the MSIV was caused by the failure of solenoid valve 3MSS*SV27A1A to fully open during the partial stroke test. A circumferential through-wall crack in the solenoid valve main piston which reduced the ability to adequately vent the inside of the piston, combined with marginal actuator force, was the cause of the failure. Metallurgical examinations of the microstructure of the solenoid valve piston structure conclusively identified the cracking propagation as stress corrosion cracking.

The safety function of main steam isolation provided by MSIV 3MSS*CTV27A was not compromised by the failure of solenoid valve 3MSS*SV27A1A. There were no safety consequences associated with this event.
Inspection of the other solenoid valves indicated several had surface indications on their main pistons. Partial stroke testing performed indicated that these indications did not prevent these valves from functioning properly. Considering the common mode implications, the decision was made to replace the solenoid valves.

The solenoid valve actuators' material was replaced with material less susceptible to stress corrosion cracking. The solenoid valve actuators were upgraded to provide additional margin on actuator force.

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

I. Description of Event

On December 11, 1998, at approximately 0840 hours, with the Unit in Mode 1 at 100 percent power, Main Steam Isolation Valve (MSIV) 3MSS*CTV27A fully closed while performing partial stroke testing resulting in an automatic reactor trip initiated by low water level in the #1 Steam Generator(SG). The closure of the MSIV was caused by the failure of solenoid valve 3MSS*SV27A1A to fully open during the partial stroke test. The plant responded normally to the trip. This included Engineered Safety Feature (ESF) actuations of the Auxiliary Feedwater and Feedwater Isolation.

On December 11, 1998, at 08:57, a prompt notification of this reactor trip was made pursuant to the requirements of 10 CFR 50.72(b)(2)(ii). This event is reportable pursuant to 10 CFR 50.73(a)(2)(iv) as "...any event or condition that resulted in a manual or automatic actuation of any Engineered Safety Feature (ESF), including the Reactor Protection System (RPS) ...".

Each MSIV relies upon 8 solenoid valves (4 in two independent trains) to port and/or vent steam pressure from the upper and lower MSIV piston chambers to open, close, position for cooldown, or perform a partial stroke test. Solenoid valve 3MSS*SV27A1A failed to fully open during the partial stroke test. Because the solenoid valve did not fully open, the upper chamber of the MSIV was not depressurized and the MSIV closed.

The failure of solenoid valve 3MSS*SV27A1A to fully open was caused by a 270 degree through wall circumferential crack around the valve piston. On demand to open, flow through the crack precluded the requisite depressurization of the inside of the main piston. Actuator force was insufficient to reposition the main piston without adequate depressurization. Subsequent inspection of the MSIV solenoid valves indicated several other valves had surface indications on their main pistons. Additional testing demonstrated that these surface indications did not prevent the solenoid valves from functioning properly.

II. Cause of Event

The cause of this event is discussed at two levels; the cause of the plant trip and the cause of the indications/cracks in the 3MSS*SV27A1A solenoid valve main piston.

The closure of the MSIV was caused by the failure of solenoid valve 3MSS*SV27A1A to fully open and vent the MSIV upper chamber during the partial stroke test resulted in the plant trip initiated by low water level in the #1 SG. The solenoid valve stroked sufficiently to open the pilot port, but did not continue stroking to open the main port. Thus, the upper chamber was not depressurized as rapidly as the lower chamber, resulting in MSIV closure. A circumferential through-wall crack in the solenoid valve main piston which reduced the ability to adequately vent the inside of the piston, combined with marginal actuator force, was the cause of the failure.

Metallurgical examinations of the microstructure of the solenoid valve piston structure conclusively identified the cracking propagation as stress corrosion cracking (SCC). Further metallurgical studies are being performed to determine the cause of the SCC.

III. Analysis of Event

The four MSIVs are safety-related components which are required to automatically isolate on a Main Steam Isolation Signal. Eight solenoid valves (4 in train A and 4 in train B) for each MSIV port and/or vent steam pressure from the upper and lower MSIV piston chambers to open, close, position for cooldown, or perform a partial stroke test. The

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sets of train A and B solenoid valves perform redundant functions to meet single failure criteria. Each MSIV is provided with redundant solenoid valves, both in series and in parallel, to ensure the proper pressurization and venting of the MSIV's upper and lower chambers. The valve design ensures that a single failure of a solenoid valve does not prevent the MSIV from performing its safety function. The safety function of main steam isolation provided by MSIV 3MSS*CTV27A was not compromised by the failure of solenoid valve 3MSS*SV27A1A. The safety function would have been accomplished if required during the time period that solenoid valve 3MSS*SV27A1A was in this degraded condition. There were no safety consequences associated with this event.

Inspection of the MSIV solenoid valves indicated several other valves (other than 3MSS*SV27A1A) had surface indications on their main pistons. Partial stroke testing performed indicated that these surface indications did not prevent these solenoid valves from functioning properly. Metallurgical examinations of the microstructure of the solenoid valve piston structure conclusively identified the cracking propagation as SCC. Considering the common mode implications, the decision was made to replace the solenoid valves.

IV. Corrective Action

The following corrective actions have been completed:

1. The MSIV solenoid valve actuators' material was replaced with material less susceptible to stress corrosion cracking.

2. The MSIV solenoid valve actuators were upgraded to provide additional margin on actuator force.

Results of the metallurgical studies to determine the cause of the stress corrosion cracking of the solenoid valve pistons and updates to the Maintenance Rule Action Plan will be evaluated under the Milstone Corrective Action Program.

V. Additional Information

The MSIVs are manufactured by the Sulzer Company of Switzerland. There are no other Sulzer MSIVs installed in nuclear plants in the United States.

Similar Events

None

Manufacturer Data

EIIS Codes Systems:
Main/Reheat Steam System.....SB

EIIS Codes Components:

Valve, Isolation.....ISV
Valve, Solenoid, Pressure.....PSV