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JAFP-90-0002

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

REFERENCE: DOCKET NO. 50-333
LICENSEE EVENT REPORT: 89-025-00

Dear Sir:

This Licensee Event Report is submitted in accordance with 10 CFR 50.73.

Questions concerning this report may be addressed to Mr. Hamilton Fish at (315) 349-6013.

Very truly yours,

WILLIAM FERNANDEZ

WF:HCF:lar

Enclosure

cc: USNRC, Region I
INPO Records Center
American Nuclear Insurers
NRC Resident Inspector

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NRC Form 366 (9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/88

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
JAMES A. FITZPATRICK NUCLEAR POWER PLANT	0 5 0 0 0 3 3 3	1 OF 0 7

TITLE (4) High Pressure Coolant Injection Turbine Inoperable Due to High Steam Flow Isolation from Overly Conservative Setpoint and Performance Limits

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)
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1 1	3 0	8 9	8 9	— 0 2 5	— 0 0	0 1	0 2	9 0		0 5 0 0 0

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	1 0 0	20.402(b)	20.405(c)	X 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 (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)	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
Hamilton C. Fish	AREA CODE 3 1 5 — 3 4 9 — 6 0 1 3

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)

EIIS Codes are in []

At 4:46 A.M. on 11/30/89 with the reactor at full power, the High Pressure Coolant Injection (HPCI) [BJ] system isolated on a high steam flow signal during a surveillance test initiating a 7-day Limiting Condition for Operation (LCO). An extensive testing program was initiated to identify the cause. HPCI was successfully tested and returned to service ending the LCO on 12/3/89 at 1:05 P.M. HPCI was removed from service for maintenance and further testing at 6:10 A.M. on 12/5/89, initiating a second 7-day LCO. It failed to meet operability testing criteria during surveillance testing at 10:00 P.M. by requiring more than 25 seconds to achieve full flow. Additional recording instruments were connected, vendor field engineers were obtained and extensive testing was performed through 12/11/89 when HPCI was declared operable at 7:31 P.M. The NRC granted a temporary waiver of the setpoint requirements for the high steam flow isolation prior to expiration of the 7-day LCO and subsequently approved a Technical Specification amendment increasing the high steam flow differential pressure setpoint. PORC approved increasing the FSAR design basis required actuation time for HPCI from 25 to 30 seconds. A 1981 vendor recommendation was implemented increasing the turbine start-up ramp time from 9 seconds to 15 seconds. Causes included an overly conservative Technical Specification limit for high steam flow isolation and FSAR basis for maximum actuation time and implementation of a more conservative test procedure. Related LERs: 89-002, 89-018, and 86-015.

EIIS Codes are in []

Description

On November 30, 1989, with the reactor operating at 100% power, the surveillance test ST-4B for "HPCI Pump and MOV Operability" was in progress. At 4:46 A.M. an isolation signal closed the outboard isolation valves 23MOV-16 and 23MOV-60 on the steam supply line to the High Pressure Coolant Injection (HPCI) [BJ] system rendering the HPCI inoperable and initiating a seven-day Limiting Condition for Operation (LCO). The annunciator for "HPCI Turbine Exhaust Discharge Pressure High" activated. However, although this is a turbine trip signal, it is not an isolation signal. The source of the isolation signal was not apparent. At 10:10 A.M. the B logic train for HPCI isolation logic was reset to facilitate testing. At 11:30 P.M. the surveillance test was satisfactory.

An additional six channels of strip chart recording instrumentation were connected to HPCI to obtain additional data to determine the cause of the isolation. Positioning the HPCI discharge test valve is a manual operation. The test is normally run by holding the control switch to the open position for five seconds. A range of 3 to 7 seconds was believed to bound the actual time during which an operator might have held the switch open. On December 1, 1989, the surveillance test was run three times between 11:30 A.M. and 12:45 P.M. For each test the valve position control switch for the HPCI test discharge valve (23MOV-21) to the Condensate Storage Tank (CST) was held open for a different time interval. For these tests, the switch was held open for intervals of 3, 5, or 7 seconds. Holding the discharge valve open for a shorter time interval results in higher discharge head pressure and requires increased steam flow demand to meet this pressure, potentially leading to a high steam flow isolation signal. An isolation signal was received during the 7 second test interval. The test was repeated at 5:00 P.M. and another isolation signal was received. At 11:10 P.M. the test was run at 5 seconds without an isolation.

It was subsequently noted that performing the three tests within the short time interval (less than one hour) did not simulate the cold start conditions for which the control system was designed. Accordingly, the tests were repeated on December 2, 1989 between 1:10 A.M. and 3:15 A.M. with approximately one hour allowed between each turbine start. All three tests were completed satisfactorily. The test was repeated at 11:40 P.M. following adjustment of the governor. After review of the data from the tests, it was determined that 5 seconds would continue to be used as the time interval to preposition the discharge test valve.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
JAMES A. FITZPATRICK NUCLEAR POWER PLANT	0 5 0 0 0 3 3 3	8 9	— 0 2 5	— 0 0	0 3 OF 0 7

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

Four more test runs of HPCI were made on December 3, 1989 between midnight and 6:00 A.M. At 11:50 A.M. Surveillance Test 4N, "HPCI Flow Rate and Inservice Test (IST)" was performed satisfactorily. At 1:05 P.M. Surveillance Test 4B was again performed satisfactorily and HPCI was declared to be operable, ending the seven-day LCO.

On December 5, HPCI was removed from service at 6:10 A.M. for planned maintenance, further testing, and adjustment. This again initiated a 7-day LCO. An electrical ground in the HPCI speed control circuit actuator developed and is reported separately as a supplement to LER-89-019. The ground was eliminated by replacing the actuator. The new actuator required adjustment of the actuator needle valve which is part of the turbine speed control hydraulic mechanism. ST-4N was run at 10:00 P.M. and did not meet the full flow requirement within the 25 seconds used as a basis in the Final Safety Analysis Report (FSAR).

The turbine acceleration time (ramp speed) was decreased from 14 to 12 seconds. Ramp speed adjustment controls the rate at which the turbine speed is increased from zero to rated RPM. This in turn effects the rate of steam flow. Shorter ramp speed results in increased steam flow. On December 6, ST-4B was run and the turbine tripped on high steam flow isolation at 1:22 P.M. Vendor field engineers arrived and for the next three days, December 7, 8, and 9, the turbine was operated multiple times using a temporary operating procedure, TOP-107, to collect data and evaluate the effect of adjustments to control circuits. The HPCI full flow test, ST-4N, was run on December 10 and was terminated at 9:32 A.M. by an outboard high steam flow isolation.

On December 11 the Plant Operations Review Committee (PORC) reviewed and recommended approval of an update of the HPCI system FSAR design basis for actuation time to be consistent with the current loss of coolant accident analysis. This increased the maximum permitted time from receipt of initiation signal to injection by HPCI at design flow from 25 seconds to 30 seconds. The increase in response time in turn allows lower steam flows and reduced probability of high steam flow isolation. The PORC also recommended approval of a proposed emergency change to the Technical Specifications for the differential pressure setpoint for the HPCI high steam flow isolation setpoint increasing it from 106 inches of water to 160 inches of water. This change in setpoint had the effect of permitting higher steam flows before an isolation signal would be generated. The changes to the test procedures permitting a 30 second response time were implemented. At 6:00 P.M. the HPCI full flow test, ST-4N was performed satisfactorily. At 6:18 P.M. the NRC granted a temporary waiver of the requirements of Item 13 in Table 3.2-2 of the Technical Specifications for the high steam flow isolation setpoint. This permitted continued operation of the plant. The change to the high steam flow setpoint was implemented. At 7:31 P.M. HPCI successfully completed ST-4B but was administratively considered to remain in an inoperable status pending completion of further testing and analysis.

On December 12, a complete retest of the HPCI and the high steam flow isolation setpoints was conducted and HPCI was declared to be operable at 3:00 A.M. ending the LCO. To demonstrate continued reliability, HPCI was tested again on December 13 and 19 with satisfactory results. On December 15, 1989 the NRC issued Amendment No. 147 to the Technical Specifications and related bases increasing the trip level setpoint for the HPCI steam line high flow isolation.

Cause

The immediate cause of the isolation signal and subsequent closing of the HPCI steam supply isolation valves was a flow of steam in excess of the setpoint for the high steam flow differential pressure sensors. The setpoint itself was overly conservative. The HPCI was able to be operated within this conservatism for 14 years until several changes were made within the HPCI system such as test methodology, new hydraulic actuator, and a rewiring of the turbine stop valve (see LER-89-002). These changes, combined with the unnecessarily conservative design basis for response time resulted in steam flows occasionally exceeding the existing isolation setpoint. There was also a failure to fully appreciate the integrated nature of the control system which led to a failure to thoroughly test and analyze HPCI transients following procedural changes and component replacement.

A summary of these five causes follows:

1. Overly conservative value for high steam flow isolation signal:

   Although the FSAR Section 7.4.3.2.7 uses an analytical limit for determination of a break in the HPCI steam line of 300% rated flow, tests have shown that the Technical Specification setpoint isolates at a differential pressure equivalent to only 200% of rated flow.

2. Change to make test procedure more conservative:

   For fourteen years HPCI had been tested by fully opening the discharge test valve (23MOV-21) to the CST prior to starting the turbine. In March 1989, acting on INPO guidance, the discharge test valve was manually prepositioned to simulate the discharge head against reactor pressure during the pump speed ramp up rather than first opening the valve and then closing down on it to obtain the required discharge pressure. In addition, a requirement to measure the HPCI response time against an acceptance criteria of 25 seconds was added to the procedure. The result of these changes was a demand for higher initial steam flow to provide the energy required for higher initial discharge pressures and to meet the response time criteria.

3. Overly conservative FSAR design basis for HPCI response time:

The FSAR actuation time for HPCI was defined as 25 seconds from receipt of reactor vessel low low water level or high drywell pressure signals to achievement of design basis flow. This requirement was in the original vendor design specification. More recent plant specific analysis (10CFR50.46, Appendix K) based on vendor SAFER/GESTR LOCA application methodology redefines HPCI response time parameters. The assumed value in the analysis is 30 seconds. The current fuel reload analysis also assumes this value. Other documentation clearly defines this as the time to achieve full flow and does not require that the discharge valve be in the full open position for HPCI to be considered to be fully actuated. The result of the 25 second requirement was a higher initial steam flow demand and resulting potential for system isolation.

4. Failure to appreciate the integrated nature of the HPCI control system led to the associated failure to test and analyze the test start-up transient stability in sufficient depth following changes to the test procedure, adjustment of component controls, and replacement of individual components in the control system. Adjustment to a single control requires readjustment of all other interfacing controls. It is not sufficient to simply replace a control and adjust it to its previous setpoint without using input signals and testing to readjust interfacing controls in the start-up and speed control system.

Analysis

The HPCI system is an engineered safety feature designed to inject a highly reliable source of water into the reactor at rated pressure and in sufficient volume to maintain core coverage through a broad spectrum of hypothetical accident conditions. The principal component is a turbine driven, high pressure, high volume multi-stage centrifugal pump. The steam supply to the turbine comes directly from the reactor vessel thus ensuring availability regardless of the condition of the AC electrical power supplies.

Because the HPCI system was inoperable due to an isolation signal, it qualifies as an event reportable under 10CFR50.73(a)(2)(v) as a condition that alone could have prevented the fulfillment of the safety function of a system needed to remove residual heat or mitigate the consequences of an accident. It is also reportable under 10CFR50.73(a)(2)(iv) as an activation of an engineered safety feature for automatic isolation.

Surveillance tests of back-up emergency core cooling systems were successfully completed. While HPCI was not available, core coverage was assured by the automatic depressurization system together with the low pressure emergency core cooling systems including the two core spray systems [BM] and two residual heat removal (low pressure coolant injection) systems [BO].

Corrective Action:

Immediate:

1. The operability testing of back-up core cooling systems was performed as required by Technical Specifications.

2. The HPCI turbine start-up speed control ramp speed was adjusted to 15 seconds.

3. The HPCI steam supply line high steam flow differential pressure instrumentation setpoint was changed to 148 inches of water.

4. Surveillance Test 4N, "HPCI Flow Rate and Inservice Test (IST)" and 4B, "HPCI pump and MOV Operability Test" were revised to reflect the 30 second limit on response time for HPCI and closer control of the pre-positioning opening time for HPCI discharge test valve (23MOV-21) to the CST.

5. The FSAR was revised to reflect a 30 second permitted response time for HPCI as the design basis.

6. Technical Specification Table 3.2-2, Item 13 was revised to reflect a maximum permitted high steam flow differential pressure setting of 160 inches of water.

Long-Term:

1. A detailed engineering review of the complete HPCI system and its operating history will be performed. It is anticipated that further corrective actions will be recommended by the task force assigned to this review.

2. Existing surveillance procedures will be revised or new procedures will be developed to monitor the HPCI start-up transient performance stability including peak flow measurements.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
JAMES A. FITZPATRICK NUCLEAR POWER PLANT	0 5 0 0 0 3 3 3	8 9	— 0 2 5	— 0 0	0 7 OF 0 7

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

Related Licensee Event Reports:

LER-86-015 RCIC isolated due to false high steam flow signal due to air in sensor transmitter.

LER-89-002 HPCI wiring error between steam stop valve and speed control ramp generator.

LER-89-018 HPCI isolated due to false high steam flow signal due to air in sensor transmitter. (LER-89-018 will be revised to change the then stated cause to reflect the true causes as reported in this LER.)