FPL

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L-2000-043
10 CFR § 50.73

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

Re: Turkey Point Unit 4
Docket No. 50-251
Reportable Event: 2000-001-00
Date of Event: January 24, 2000
Manual Reactor Trip due to Main Feedwater Flow Control Valve Cage Disengagement

The attached Licensee Event Report 2000-001 is being submitted pursuant to the requirements of 10 CFR § 50.73 to provide notification of the subject event.

If there are any questions, please contact us.

Very truly yours,

R. J. Hovey
Vice President
Turkey Point Nuclear Plant

RJH/SM
Attachment

cc: Regional Administrator, USNRC, Region II
Senior Resident Inspector, USNRC, Turkey Point Nuclear Plant

IE22

NRC FORM 366 (6-1998) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 06/30/2001

Estimated burden per response to comply with this mandatory information collection request: 50 hrs. Reported lessons learned are incorporated into the licensing process and fed back to industry. Forward comments regarding burden estimate to the 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. If an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

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

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Turkey Point Unit 4	05000251	Page 1 of 7

TITLE (4)

Manual Reactor Trip due to Main Feedwater Flow Control Valve Cage Disengagement

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
01	24	2000	2000	- 001	- 00	02	23	2000	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	1
POWER LEVEL (10)	95

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	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)	x	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 366A
	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)
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COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
D	SJ	FCV	C635	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)**

At approximately 7:30 AM on January 24, 2000, FPL's Turkey Point Unit 4 reduced power to 95% to investigate main feedwater flow instabilities caused by the "A" Steam Generator (SG) Feedwater Flow Control Valve, FCV-4-478. At approximately 11:14 AM feedwater flow appeared to increase causing a SG level deviation. The Operators placed FCV-4-478 in manual operation. A preliminary determination of valve internal problems versus control problems resulted in the decision to shut down the Unit by performing a fast load reduction. At approximately 11:42 AM, the Reactor Control Operator (RCO) manually tripped the reactor due to difficulty in controlling SG levels. All rods were fully inserted and all systems except Feedwater functioned as designed.

The immediate cause of the reactor trip was a manual action taken by the RCO in response to Main Feedwater flow instabilities. The underlying cause of the trip was a failure in FCV-4-478 valve internals. The valve cage had disengaged from the valve body web. The root cause of the failure of FCV-4-478 is inadequate change management in the 1980's when the practice of periodic replacement of the cage was stopped; specifically, FPL failed to require periodic re-torque of a re-used FCV cage.

FCV-4-478 was repaired. FPL established inspection controls to monitor for signs of valve degradation. Cage torque will be verified for all feedwater FCV at the next opportunity.

Event Description

On January 24, 2000, FPL's Turkey Point Unit 4 was operating at 100% power.

At approximately 6:00 AM, the Feedwater Flow Control Valve (FCV) [SJ:fcv] to the "A" Steam Generator (SG)[AB:sg], FCV-4-478, was at 100% demand with SG level decreasing. The Reactor Control Operator (RCO) reduced SG blowdown [WI] and started the third condensate pump [KA:p] to recover SG level. As a result of a conservative management decision to provide additional operating margin, the RCO commenced a load reduction to 95% power and an Event Response Team (ERT) was formed. The Unit reached 95% power successfully, and FCV-4-478 seemed to provide stable SG level control.

At approximately 11:14 AM, while the ERT was investigating the source of earlier flow instabilities, FCV-4-478 appeared to initiate another flow transient, causing flow instabilities in all SGs. The RCO placed FCV-4-478 in manual and stabilized levels in all SGs. However, FCV-4-478 indicated deteriorating flow control stability. A preliminary field determination of valve internal problems versus control loop problems resulted in the decision to reduce power by using Off Normal Operating Procedure 4-ONOP-100, Fast Load Reduction. At approximately 11:42 AM, the RCO manually tripped the reactor due to difficulty in controlling SG levels.

The manual reactor trip was initiated in Mode 1 at 95% power with automatic reactor coolant system (RCS) [AB] pressure control operational. All rods [AA:rod] were fully inserted and all systems other than Feedwater functioned as designed. The Main Turbine [TA] automatically tripped in response to the manual reactor trip. The SG "A" and "B" Feedwater flow control valves were taken to manual prior to the reactor trip in response to unstable level control. Following the reactor trip, a feedwater isolation signal was generated on reactor trip with low RCS average temperature of 554 degrees F, as expected. FCV-4-478 did not fully isolate for approximately 100 seconds, allowing approximately 10% of the nominal feedwater flow into the "A" SG. In accordance with 4-EOP-E-0, Reactor Trip or Safety Injection, the RCO closed the Feedwater Isolation Valve MOV-4-1407 [SJ:isv], and terminated the FCV leakage flow. All SG levels were restored to desired levels.

A walkdown was performed on the affected piping and components associated with valve FCV-4-478. A Feedwater Flow Transmitter [JB:ft] tube associated with the SG "B" loop was broken off at the interface of the 3/8 inch port connector [JB:ft,con] with a 3/4-inch x 3/8-inch adapter. The port connector failure likely occurred as a result of the nearby SG "A" piping deflections during FCV-4-478 flow instabilities. FPL found no further evidence of damage to any other major components (piping/supports). This was determined from the observation of no insulation damage, no bent or misaligned supports, and no evidence of excessive movement.

Background

The Turkey Point Unit 4 Main Feedwater System consists of two SG feedwater pumps [SJ:p], two high pressure feedwater heaters [SJ:hx], the Feedwater FCVs and the controls associated with these components. Feedwater leaving the high pressure feedwater heaters splits into three feedwater headers, which supply feedwater to the three SGs. The Feedwater FCV, one for each SG, controls flow to each SG. Upstream of each FCV is a motor operated valve, which is the feedwater isolation valve. Normally the FCV controller will be in "Auto" with power between 15-100%. During plant operations, the FCV maintains a programmed level of water in the steam generator by controlling feedwater flow to the SG depending upon the steam flow demand and actual level in the SG.

On December 25, 1999, Operations discovered that with Unit 4 at 100% power, the demand for FCV-4-478 was between 98% and 100%, while the demand for the FCVs on the other two SGs was about 90%. A condition report was initiated to document a high demand condition identified for FCV-4-478. Investigation was underway to determine the validity of the demand and to isolate the problem to either the control system or the valve. Review of maintenance and calibration records, field inspections, measurements of feedwater flow for all FCVs (for comparison purposes), and an examination of performance data had been completed without identifying any anomaly associated with FCV-4-478. Additional investigation was conducted for other potential flow restrictions, including feedwater isolation MOV and check valves, and for bypass flow paths or undocumented demand. No problem was identified. However, the investigation confirmed that FCV-4-478 continued to adequately maintain SG levels at full power conditions.

On January 16, 2000, blowdown was increased in all Unit 4 SGs to correct SG chemistry due to increased sodium concentrations. When blowdown was increased to 60,000 lbm/hr, a SG "A" level deviation alarm [SG:la] was received. Operations discovered that FCV-4-478 could not maintain level with blowdown at 60,000 lbm/hr. Although level was slowly decreasing, both Steam Flow and Feed Flow channels were matched and operating correctly. "A" SG level could be maintained at 50,000 lbm/hr. The investigation activities planned in response to the December 25, 1999 condition report were augmented based on this event. Feed pump performance was monitored and manual valve positions were verified. Preparation was underway for both a non-intrusive radiographic inspection of the valve internals and a performance test to evaluate FCV response to varying blowdown conditions.

On January 24, 2000 an instability in SG Feedwater flow occurred. FPL decided to conservatively reduce power to provide additional operating margin. An Event Response Team (ERT) was formed. The initial ERT activities were underway when feedwater flow control stability deteriorated without a corresponding valve position change (indicative of internal problems), and significant vibration of the feedwater piping occurred. At 11:42 AM, Turkey Point Unit 4 was manually tripped from 95% power. The stem position and the valve indicating lights indicated that FCV-4-478 did not fully close.

Failure Analysis

The problem originally identified for FCV-4-478 was one of high demand when compared with similar valves for the "B" and "C" SGs. Further examinations of the control functions and the actual valve position also validated the demand signal. A number of potential failure mechanisms were under investigation. However, prior to performing a non-intrusive internal examination, the valve began to exhibit extreme control instability, which then led to the Turkey Point Unit 4 manual reactor trip on January 24, 2000.

FCV-4-478 is a 12 inch Copes-Vulcan double web valve. The valve body has an upper and a lower set of threads. The valve cage threads into the web at these two locations. The valve plug rides in the cage. When the valve cage is threaded into the web (at installation), it is held in place by torque alone.

When FCV-4-478 was disassembled, the cage was found loose in the web. The upper set of threads on the valve body web were destroyed. The lower set of threads were damaged.

FPL believes that the cage could have come loose from the web only by relaxation of the torque over time. Until the 1980's FPL's practice was to replace the valve plug and valve cage at each refueling outage. The new cage was thus torqued into place approximately every 18 months. Because the cage rarely showed wear, FPL changed its maintenance practice sometime in the 1980's (the exact time is unknown), and began replacing only the plug, leaving the cage in place unless it showed signs of wear. FPL did not recognize that periodic re-torquing of the valve cage was necessary to correct torque relaxation. The last known torque of FCV-4-478 took place in 1986.

The root cause of the failure of FCV-4-478 is inadequate change management in the 1980's when the practice of periodic replacement of the cage was stopped.

The phenomenon of relaxation of a threaded fastener over time following application of an installation torque is not uncommon. In the case of flow control valve cages, the most probable cause for this relaxation is time in service and flow induced loading. For FCV-4-478, the condition of the lower threads may have aggravated this phenomenon. It was documented in 1986 that the cage thread engagement was degraded from original condition. Such degradation would reduce the stability of the cage, permitting greater influence from flow instability and perhaps accelerating the cage disengagement. An examination of the procedures and work packages documentation used to overhaul FCV-4-478 did not identify any requirement to verify the cage torque on a periodic basis. The most recent documented verification of the torque occurred in June 1986. It is likely that thirteen years of service, without re-torque of the cage and under constant hydraulic loading, is sufficient time for torque relaxation and cage disengagement.

Other evidence of relaxation of installation torque is available within the work history at Turkey Point. A work package and an Operating Experience Feedback report review identified two other recorded loose cages during routine valve inspection activities: FCV-3-478 in April 1992 and FCV-3-488 in February 1991. This phenomenon likely became applicable after changing the maintenance practices in the 1980s. Previously, the valve internals, including the cage and plug, were changed on a routine basis. The practice was changed since the cage seldom evidenced any degradation that would require replacement. The replacement of the cage was eliminated in the 1980s without changing the inspection requirements, since the potential for torque relaxation was not recognized.

Cause of the Event

The immediate cause of the reactor trip was a manual action taken by the RCO in response to Main Feedwater flow instabilities. The underlying cause of the trip was a failure in FCV-4-478 valve internals. The valve cage had disengaged from the valve body web. The root cause of the disengagement of the cage in FCV-4-478 was the failure to recognize that reuse of the FCV cage should have been accompanied by torque rechecks whenever plug replacements were scheduled. This resulted in specifying inadequate maintenance activities in the inspection/overhaul procedure for the feedwater FCVs. Procedure 0-PMM-074.10, Main Feedwater System Flow Control Valve Inspection, which is performed every 18 months on each FCV, permits a visual inspection of the cage to accept its condition. The visual inspection should have been augmented with verification that the cage remained properly torqued into the valve body web. Implementation of that change would have eliminated the potential for torque relaxation and the subsequent potential for flow instabilities to loosen the cage within the threaded body.

Safety Consequences and Safety Analysis Impact

Disengagement of the valve cage does not impact the function of the FCV until the loose cage becomes a restriction on flow. Such a condition can be identified by the external symptoms of high valve demand and valve position. The other two Unit 4 SG FCVs were monitored as part of the investigation of FCV-4-478. Normal stroke was verified for valves FCV-4-488 and FCV-4-498 during this reactor trip outage. The available data confirms no operability concern exists for the Unit 3 SG FCVs: FCV-3-478, FCV-3-488, FCV-3-498, or for the other two Unit 4 SG FCVs: FCV-4-488, and FCV-4-498. There are no other systems at Turkey Point which have double web Copes-Vulcan FCVs. Continued monitoring will ensure no operability concerns develop. Interim monitoring will ensure proper valve function until the next refueling outage when valve cage torque can be verified. Permanent monitoring will continue to track valve performance to detect any deteriorating trends in FCV performance.

The manual reactor trip resulted in an automatic turbine trip. The trends of nuclear power, pressurizer pressure, pressurizer water volume, RCS average temperature, RCS inlet temperature, and SG pressure for this trip compared very conservatively to the trends in the Updated Final Safety Analysis Report (UFSAR).

Following the reactor trip, a feedwater isolation signal was generated on reactor trip with RCS average temperature of 554 degrees F. FCV-4-478 did not fully isolate, allowing approximately 10% of the nominal feedwater flow into the "A" SG for approximately 100 seconds (normally the valve closes in 20 seconds). In case of failure of the FCV, termination of feedwater flow to the SG can be accomplished by closing the feedwater isolation MOV, or by tripping the Main Feedwater pump. For this case, and in accordance with EOP E-0, the RCO closed the feedwater isolation valve, which also terminated the leakage flow. The potential impact on the Safety Analyses of the additional feedwater flow to the SG has been evaluated. The two UFSAR safety analyses directly impacted by feedwater malfunction are the Feedwater Malfunction Event and the Main Steamline Break (MSLB) Event.

The Feedwater Malfunction Event is assumed to result in excessive feedwater reaching one SG. The excessive feedwater flow increases the heat removal capability of the secondary system thus resulting in a primary system cooldown. The cooldown of the primary system will cause a power increase due to negative reactivity feedback. The current analysis assumes one feedwater FCV malfunctions resulting in a step increase to 200% of the nominal feedwater flow to one SG. The assumptions and results of the analysis in the UFSAR bound the conditions of the actual event, i.e., the total amount of feedwater added to the SG in the safety analysis is significantly greater than the amount of feedwater added as a result of the FCV malfunction. Therefore, the RCS cooldown predicted in the Safety Analysis for this event envelops the cooldown caused by the FCV malfunction.

The Main Steamline Break analysis results in an RCS depressurization, cooldown and corresponding reactivity addition initiated from hot standby conditions. The analysis assumes that the positive reactivity resulting from the Steamline Break could exceed the minimum plant shutdown margin. The analysis assumes that the faulted SG is conservatively supplied with twice the nominal feedwater flow, with the intact SG receiving the nominal feedwater flow. The results of the analysis (factoring in the malfunction of the FCV occurring in either the faulted or intact SGs) conclude that fuel cladding damage is not likely to occur since the 95/95 Departure from Nucleate Boiling (DNB) ratio limit is satisfied. Therefore, because the assumptions and results of the analyses in the UFSAR bound the conditions of the actual event, this event did not compromise the health and safety of plant personnel or the general public.

Corrective Actions

1. The cage for the SG "A" Main Feedwater Flow Control Valve, FCV-4-478, was repaired and properly secured, ensuring acceptable operation by implementing a temporary design change and modification. FPL and the vendor are evaluating the acceptability of the temporary repair as a permanent modification of FCV-4-478.

2. FPL reviewed maintenance records for all six valves, which represents all of the valves of this design at Turkey Point Units 3 and 4. Records indicate that four of the valves had their valve cage torque inspected. No records of any inspection were found for the Unit 3 FCV-3-498. Interim monitoring of all (total of six) Turkey Point Units 3 and 4 Main Feedwater FCVs demand will be used to identify unusual trends in demand, indicative of potential cage disengagement. FPL will monitor and record the demand position for each Feedwater FCV once per shift until each unit's next refueling outage when cage torque will be verified.

3. Permanent monitoring of the loose cage symptom will be incorporated in the System Engineer trends for the Feedwater system by trending valve position on a monthly basis. Experience with FCV-4-478 indicates that both position and demand will yield an extended warning of potential valve cage movement.

4. Procedure 0-PMM-074.10, Main Feedwater System Flow Control Valve Inspection, will be revised to require verification of the cage installation torque during FCV inspections or overhauls. Incorporation of torque verification within the standard valve inspection/overhaul will prevent torque relaxation and eliminate the potential for flow instability to move the valve cage.

5. All of the Unit 4 feedwater flow transmitter port connectors have now been replaced with 0.065-inch thick 3/8-inch tubing. The Unit 3 port connectors will be replaced during the next Unit 3 refueling outage.

Additional Information

There has been one earlier event reported related to Feedwater FCV failure: LER 250/94-006-00. This failure was due to intermittent open circuit in the transducer.

The Institute of Nuclear Power Operations (INPO) LER data base has been searched and no other LERs were found which identify the cause of a reactor trip as the disengagement of the FCV cage from the valve body web.

EIIS Codes are shown in the format [EIIS SYSTEM:IEEE component function identifier, second component function identifier (if appropriate)]