Progress Energy

U.S. Nuclear Regulatory Commission
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SHEARON HARRIS NUCLEAR POWER PLANT UNIT 1
DOCKET NO. 50-400/LICENSE NO. NPF-63
<u>LICENSEE EVENT REPORT 2004-006-00</u>

Ladies and Gentlemen:

The enclosed Licensee Event Report 2004-006-00 is submitted in accordance with 10 CFR 50.73. This initial report describes an event in which a motor driven auxiliary feedwater pump was manually started in response to lowering steam generator level. At the time of the event, the plant was in Mode 1 and reactor power was approximately 7%. Event Notification EN# 41179 previously reported this event in accordance with 10 CFR 50.72.

Please refer any questions regarding this submittal to Mr. Dave Corlett, Supervisor - Licensing/Regulatory Programs, at (919) 362-3137.

Sincerely,

(for)

B. C. Waldrep
Plant General Manager
Harris Nuclear Plant

BCW/bcm

Enclosure

c: Mr. R. A. Musser (HNP Senior NRC Resident)
Mr. C. P. Patel (NRC-NRR Project Manager)
Dr. W. D. Travers (NRC Regional Administrator, Region II)

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NRC FORM 366 (6-2004) U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB: NO. 3150-0104 EXPIRES: 06/30/2007
LICENSEE EVENT REPORT (LER) (See reverse for required number of digits/characters for each block)	Estimated burden per response to comply with this mandatory collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose 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.

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4. TITLE
Manual Actuation Of Auxiliary Feedwater Pump

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
									N/A	05000
11	07	2004	2004	- 006 -	00	01	06	2005	FACILITY NAME N/A	DOCKET NUMBER 05000

9. OPERATING MODE	11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: *(Check all that apply)*			
1	☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☐ 50.73(a)(2)(vii)
	☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
	☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
	☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
10. POWER LEVEL	☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☒ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
	☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
007	☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
	☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER
	☐ 20.2203(a)(2)(vi)	☒ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

FACILITY NAME	TELEPHONE NUMBER (Include Area Code)
Brian C. McCabe - Lead Licensing Engineer	(919) 362-2828

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

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
B	SJ	ISV	Flowserve	Y					

14. SUPPLEMENTAL REPORT EXPECTED		15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)*	☒ NO				

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

On November 7, 2004, with reactor power approximately 7%, the 'A' auxiliary feedwater pump was manually started in response to lowering 'C' steam generator level. The plant was subsequently cooled down and inspections conducted on the 'C' main feedwater isolation valve (MFIV) found that the stem was fractured at the backseat and the seat rings were damaged. Subsequent inspections of the 'A' and 'B' MFIVs found that these valves had damaged seat rings; however, no stem problems were identified.

The cause of the seat ring damage was a modification performed in 2000 that had insufficient margin in design, and insufficient controls over field implementation of the design, to prevent the valve discs from being fully retracted from the seat rings during the open stroke and impacting the seat rings during the close stroke. The cause of the 'C' MFIV stem failure was fatigue, due to a combination of a high stress concentrator at the stem backseat transition, cyclic loading of the actuator, and potential interaction with the damaged seat rings.

The damaged seat rings were replaced or repaired, the valve stems on all three MFIVs were replaced, and a pressure regulator on the 'C' MFIV was replaced. Several design changes were made to address the causes of the valve damage. Also, small pieces of foreign material were retrieved from the feedwater system.

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

I. DESCRIPTION OF EVENT

On November 7, 2004 at 1635, with the plant in Mode 1 and reactor power being increased to 7%, the 'A' motor driven auxiliary feedwater (AFW) [BA] pump was manually started in response to lowering steam generator [SG] level. At the time of the event, feedwater flow to the steam generators was being supplied by the main feedwater system [SJ] through the main feedwater regulating bypass valves [FCV] operating in automatic control. At 1633, control room operators observed a lowering trend in 'C' steam generator level and responded in accordance with plant procedures. Specifically, the following actions were taken: (1) the associated feedwater regulating bypass valve was taken to manual control in an effort to restore normal steam generator level, (2) the 'A' motor driven AFW pump was manually started to supply AFW to the steam generator, and (3) reactor power was lowered to reduce steam demand. These actions resulted in the restoration of 'C' steam generator level to its normal value. No automatic engineering safety feature actuations resulted from the lowering level or the actions performed to restore level. Normal operating steam generator level is 57% and the lowest level observed during the event was approximately 43%. This is well above the 25% steam generator level in which an automatic AFW actuation and a reactor trip are initiated.

Initial troubleshooting identified an air leak in the feedwater regulating bypass valve actuator. This leak was repaired. An attempt to restore main feedwater flow to the steam generators was made and again, the 'C' steam generator level began to drop. The operators once again took actions to restore level to its normal value. Further troubleshooting identified a significant pressure drop between the main feedwater check valve and the 'C' steam generator. The 'C' main feedwater isolation valve (MFIV) [ISV], 1FW-217, and the associated check valve [V], 1FW-216, are the only potential significant restrictive components in this section of piping. The plant was cooled down and inspections were conducted on both 1FW-216 and 1FW-217. The isolation valve, 1FW-217, was stroked from the main control board with a camera observing for disc movement. The disc did not move out of the flow stream when the actuator was opened, indicating a disc/stem separation.

The plant was placed in Mode 5 and 1FW-217 was disassembled. The valve stem was found fractured at the backseat. In addition to the broken stem, both valve seat rings were found damaged. The upstream seat ring was damaged significantly, with portions of the seat material missing. The downstream seat ring was deformed and exhibited some cracking. The damage to 1FW-217 prompted inspection of the 'A' (1FW-159) and 'B' (1FW-277) main feedwater isolation valves to determine extent of condition. Both of these valves were found to have significant damage to the seat rings. In contrast to 1FW-217, no problems were noted with the stems of either of these valves. Both stems were inspected using dye-penetrant testing and were found to have no evidence of cracks in the stems. (The MFIVs were manufactured by Flowserve)

Energy Industry Identification System (EIIS) codes are identified in the text within brackets [ ]. There are no commitments included in this report.

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

II. CAUSE OF EVENT

The seat ring damage is believed to have occurred just after a modification on the MFIVs was performed in RFO-09 (2000) or during the subsequent operating cycle (cycle 10). The cause of the damage was this modification had insufficient margin in design, and insufficient controls over field implementation of the design, to prevent the valve disc from being fully retracted from the seat rings during the full open stroke. The modified disc assembly has two discs that are mounted on a disc carrier, which attaches to the valve stem. The top of the disc assembly has a retaining bracket which holds the disc assembly together at the top. There is no such retaining bracket on the bottom of the disc carrier. The valve is designed so that the disc assembly should not be fully removed from the seat area. Insufficient margin in the design of the valve "stacking heights" and controls over field implementation of the stacking height design allowed the stem to travel an excessive amount compared to the seating surface outside diameter. From the observed damage to the seat rings, it is clear that the valve disc came all the way out of the seat rings and then contacted the seat rings on the next closing stroke. The parallel discs are spring loaded such that if they are allowed to come out of the seat ring, the spring would expand and decrease the clearance between the discs and the seat rings. Closing the valves in this condition caused damage to the seat rings as the discs pushed down and struck the top of the rings.

A review of MFIV operating performance data found that the 'C' MFIV stem failure occurred in RFO-12 (11/4/04) during a post-maintenance test associated with replacement of the valve's accumulator pressure regulator. The cause of the stem failure was fatigue, which resulted from inadequate stem design. The stem design included a sharp corner at the backseat transition and the valve's stress analysis used no stress intensification factor in evaluating stem stresses. The design did not adequately account for stress intensification at the backseat transition and thus did not provide for additional radius at this location to prevent low cycle fatigue failure. Other possible contributors to the 'C' MFIV stem failure were cyclic loading of the actuator and potential interaction with the damaged seat rings. With respect to the cyclic loading of the actuator, motive force for the MFIVs is provided by nitrogen stored in individual accumulators for each valve. Nitrogen pressure in each accumulator is regulated by a pressure regulator. During the previous operating cycle, the 'C' MFIV accumulator pressure regulator was not consistently maintaining accumulator pressure within its normal operating band, and the 'C' MFIV accumulator pressure was more erratic than that of the 'A' and 'B' MFIVs. Operation with the faulty pressure regulator caused cyclic stresses on the 'C' MFIV stem.

III. SAFETY SIGNIFICANCE

Actual Safety Consequences:

There were no safety significant consequences of this event. The Operations staff responded to a lowering trend in 'C' steam generator level in accordance with plant procedures and restored steam generator level to its normal value. No automatic engineering safety feature actuations resulted from the lowering level or the actions performed to restore level. Normal operating steam generator level is 57% and the lowest level observed during the event was approximately 43%. This is well above the 25% steam generator level in which an automatic AFW actuation and a reactor trip are initiated.

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

The MFIVs are designed to provide containment isolation for several analyzed accidents that generate a main feedwater isolation signal. These isolation valves are within the main feedwater system, which is a closed system. The integrity of this closed system was not affected by the MFIV problems. The main feedwater regulating valves and the main feedwater regulating bypass valves, which are in line with the MFIVs and automatically close upon receipt of a main feedwater isolation signal, were also not affected by the MFIV problems. At the time of the event on November 7, 2004, the three AFW trains were operable and remained operable as the plant was shutdown to effect repairs on the MFIVs.

None of the analyzed events which rely upon the design requirements of the MFIVs have occurred during the period in which the valves were inoperable.

Potential Safety Consequences:

As previously noted, the MFIVs provide containment isolation for several analyzed accidents that generate a main feedwater isolation signal. These isolation valves are within the main feedwater system, which is a closed system. The integrity of this closed system was not affected by the MFIV problems. The main feedwater regulating valves and the main feedwater regulating bypass valves, which are in line with the MFIVs and also automatically close upon receipt of a main feedwater isolation signal, were not affected by the MFIV problems.

The potential safety consequences under alternate conditions are bounded by conservative design and licensing basis analysis of record assumptions. The Harris plant performed a thorough evaluation of potential safety consequences resulting from the MFIV seat ring damage and 'C' MFIV stem damage. Included in this evaluation was a review of the effects of the MFIV degradation on FSAR Chapter 15 accident analysis events including steam generator tube rupture, main steam line break, feedwater line break, loss of normal feedwater flow, loss of non-emergency AC power, and loss of coolant accident (LOCA) events. The effects of the MFIV problems on event sequence, dose consequence, and containment response were evaluated. This evaluation concluded that the conservative modeling assumptions in the accident analyses bound the degraded as-found conditions of the MFIVs. No significant safety consequences were identified under these alternate scenarios which would place the plant in a condition beyond its design basis.

The potential safety significance associated with possibly having foreign material from the MFIVs remain in the feedwater system or steam generators was also thoroughly evaluated. As previously noted, the seat ring damage is believed to have occurred just after a modification on the MFIVs was performed in RFO-09 or during the subsequent operating cycle (cycle 10). The damaged seat ring surfaces did not have indication of recent major contact as the surfaces were covered with magnetite, which builds up due to iron transport in the secondary system during power operations. This indicates that little if any further damage occurred while stroking the MFIVs during RFO-12. The majority of the loose parts that were created during cycle 10, which preceded the steam generator replacement outage, would have been swept directly into the original steam generators. This is because of the high velocities of the water in the feedwater pipes, coupled with the design of the original steam generators which had openings in the feedwater nozzles that allowed pieces of foreign material as large as 3 inches in diameter to enter the steam generators.

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While the majority of loose parts were likely swept into the original steam generators, there is clear evidence that some loose material from the damaged main feedwater isolation valves either remained in the feedwater system or was transported into the new steam generators. In the Spring of 2004, the Harris plant experienced a steam generator tube leak in the 'C' steam generator due to foreign material fretting against the tubes. The foreign material that caused the tube leak consisted of carbon steel with Stellite 6 and appears to have been generated by the failure of the 'C' MFIV seat ring. Foreign Object Search and Retrieval (FOSAR) performed at that time also identified a small fragment of similar material in the 'A' steam generator. In addition, when the problems with the MFIVs were identified in November 2004, FOSAR of the feedwater lines downstream of the MFIVs was initiated. Several small pieces of foreign material were found and retrieved, with the largest piece being 0.9929 grams.

The existing steam generator feed ring nozzle spray nozzles prevent large pieces (> 3/8" diameter) of foreign material from entering the tube area of the generator. This design precludes foreign material from entering the steam generators which would be of sufficient size (weight) to cause a rapid loss of tube integrity on impact. While smaller, relatively light pieces can cause fretting damage and eventual tube leakage, this leakage is readily detected by secondary radiation monitors. In addition, Westinghouse experience indicates that small loose parts eventually migrate to a low flow region of the tube bundle and do not cause significant damage to tubes. This indicates that a straight foreign object that passes through a feed nozzle is not a safety concern when loose, since it would not threaten the tube structural integrity, and therefore a rapid failure of the tube is precluded. It is important to note that the Metal Impact Monitoring System (MIMS) provides for immediate detection of parts large or heavy enough to cause impact failure of the steam generator tubes.

In summary, while small loose foreign material associated with the damaged MFIV seat rings could potentially cause steam generator tube leaks due to fretting, these leaks would be detected at low levels as demonstrated in the Spring of 2004. The design of the feed ring nozzles precludes fragments that are of sufficient size to cause rapid loss of tube integrity from entering the steam generator. Therefore, no significant safety consequences related to the foreign material from the MFIVs exist under alternate scenarios that would place the plant in a condition beyond its design bases.

This report is submitted pursuant to 10 CFR 50.73(a)(2)(iv)(A) for the manual actuation of an auxiliary feedwater pump in response to lowering steam generator level, and pursuant to 10 CFR 50.73(a)(2)(i)(B) for operating with inoperable MFIVs, which are containment isolation valves specified in the Technical Specification Equipment List Program, plant procedure PLP-106.

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

IV. CORRECTIVE ACTIONS

The damaged MFIV seat rings were either replaced (4) or repaired (2), and the valve stems on all three MFIVs were replaced prior to plant startup. Also, the 'C' MFIV accumulator pressure regulator was replaced. Several changes were made to the MFIVs. The radius of the new valve stems was increased to 3/8 inch at the backseat transition to help eliminate the stress intensification at that stem location. Also, thicker spacer rings were incorporated in the pressure seal assembly, which position the backseat lower in the valve. This provides additional overlap between the bottom of the valve discs and the seat rings when the valve is in the fully open position. This additional overlap prevents the discs from being withdrawn out of their seats, and thus maintains proper clearance between the discs and the seat rings. Also, the new acceptance criteria for disc package to seat ring clearances were incorporated into valve design documentation and maintenance procedures.

Given the potential that the damaged seat rings introduced foreign material into the feedwater system and steam generators, Foreign Object Search and Retrieval of the feedwater lines leading from the MFIVs to the steam generators was performed. Pipe crawlers were used to examine the MFIVs and several small pieces of foreign material were found and retrieved. An evaluation of the effects that foreign material from the damaged seat rings could have on steam generator tube integrity was performed and no nuclear safety concerns were identified.

In addition to the normal monitoring provided by Metal Impact Monitoring System, the MIMS tapes will be analyzed at least twice during the current operating cycle to identify any small foreign material fragments that may be introduced into the steam generators. The first tape that was analyzed indicated the presence of a small loose part in the 'A' steam generator. The impacts of this part were small and infrequent, and the subsequent behavior of the part appears to be consistent with the previously discussed Westinghouse experience. There are no nuclear safety concerns associated with this loose part.

Inspections planned for the next refueling outage (RFO-13) include eddy current, FOSAR, and sludge lancing in all three steam generators as well as steam drum inspections in the 'B' and 'C' steam generators. The extent of MFIV inspections to be performed during the next refueling outage (RFO-13) and the need for additional feedwater system (i.e., feedring) inspections during that outage are currently being evaluated.

V. PREVIOUS SIMILAR EVENTS

HNP Corrective Action Program adverse condition reports CR 96-00792 and AR 18212

Two previous failures of MFIV stems have occurred at HNP. In March 1996, the 'B' MFIV (1FW-277) valve stem was found fractured. The cause of the stem failure was determined to be a manufacturing defect that allowed the disc to be pulled up into the bonnet when opened, which bound the disc to the stem causing unacceptable bending loads in the stem. In April 2000, during a refueling outage (RFO-09), the 'B' MFIV stem was found fractured. The cause of this failure was determined to be a fatigue failure at the stress riser created at the stem to backseat transition. Contributing to this failure was a misalignment between the disc and the internal disc guides, tolerances which allowed a bending moment to be applied to the stem from the weight of the disc, and the valve angle.

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During RFO-09, following the two stem failures described above and in response to a maintenance history of actuator problems and stem failures, the MFIVs were modified. This modification included design changes to the actuator and valve internals. The failures described in the subject LER (LER 2004-006) are the first MFIV failures since the installation of the valve modification in RFO-09.

While the two previous events also involved design deficiencies, the deficiencies were sufficiently different from those identified during this event that prior corrective actions would not have been expected to prevent the MFIV failures that are the subject of this LER.