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RECIP. NAME RECIPIENT AFFILIATION

SUBJECT: LER 87-001-00: on 861029, unit experienced 5% re-ratio of feedwater flow to steam generators. Caused by failure of suction wear ring retaining bolts. Bolts replaced & debris removed from reactor vessel internals. W/870403 ltr.

DISTRIBUTION CODE: IE22D COPIES RECEIVED: LTR 1 ENCL 1 SIZE: 9
TITLE: 50.73 Licensee Event Report (LER), Incident Rpt, etc.

NOTES: AEOD/Ornstein: 1cy. 05000287

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NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/85

LICENSEE EVENT REPORT (LER)

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TITLE (4)
Loose Parts and Reduced Reactor Coolant Flow Dut to Suspected Equipment 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 NAMES	DOCKET NUMBER(S)
										0 5 0 0 0
1 0	2 9	8 6	8 7	— 0 0 1	— 0 0	0 4	0 3	8 7		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)	0 9 7	20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)	
		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)	
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	XXX 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)	VOLUNTARY	
		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
PHILIP J. NORTH, LICENSING	AREA CODE 7 0 4 3 7 3 - 7 4 5 6

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	
X	A B	P	B 2 6 0	YES							

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	XX NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

On October 29, 1986 Oconee Unit-3, operating at 96% full power, experienced a Feedwater re-ratio of Steam Generator levels, alarms from the Loose Parts Monitor (LPM), and a Reactor Coolant Pump (RCP) '3B1' vibration alarm. On October 30, power was reduced to shutdown RCP '3B1' due to the high vibration. A recording of the noise in the Reactor Coolant System was made using the LPM. Upon examination of the pump during the refueling outage it was discovered that the suction wear ring retaining bolts had broken.

The immediate corrective action was to reduce power and secure the RCP '3B1'.

On December 17, 1986, RCP '3B2' started to show high vibration. The decision was made to shut down Unit-3 and go into an early refueling outage. Upon disassembly of the pump, it was found the vibration was due to a problem with the pump bearing.

When fuel was removed from the core on January 13, 1987, it was discovered that debris from the damaged Reactor Coolant Pump '3B1' was scattered about the bottom of the reactor vessel and fuel assemblies. All debris that was visible was removed from the reactor vessel and the fuel assemblies. Debris was mainly between the bottom of the fuel assemblies and the first support plate.

There were no releases of radiation associated with this event, as such the health and safety of the public was not affected.

☆ U.S.GPO:1984-0-454-481/18759

BACKGROUND

Each Oconee unit is a 2568 thermal megawatt Pressurized Water Reactor with four Reactor Coolant Pumps, two Once Through Steam Generators, and one Pressurizer. The bolts that failed were on one of the four reactor coolant pumps. The pumps are Bingham, 28 x 28 x 41 RQV reactor recirculation pumps. As flow leaves the Steam Generator and proceeds to the suction of one of the Reactor Coolant Pumps it passes up through the lower part of the pump housing, which includes the pump suction piece adapter. The suction piece adapter directs the reactor coolant flow to the pump impeller and separates the pump discharge flow from the suction flow, thus causing a differential pressure across the suction piece adapter. Pump performance is monitored by several means: motor amps, motor voltage, shaft and frame vibration, and flow indications.

The Loose Parts Monitor (LPM) is an acoustical monitor system. It listens to a total of 22 points in the core and on other piping systems in the Reactor Building. The LPM alarms when the noise level is above a set threshold. A tape recording function is included to record the noise for future evaluation.

The Integrated Control System (ICS) is an automatic system designed to maintain an adequate heat transfer between the primary and secondary sides at any power level above 15% power. The ICS has the capability of controlling the Turbine Control Valves, Main Feedwater Pumps, Main Feedwater Control and Startup Valves, and Control Rod Positions. Any heat balance change (i.e., flow change) in the primary side will cause the secondary side to adjust accordingly.

Prior to the event, Unit-3 was increasing to 100% power after a mini-outage due to an oil level problem in Reactor Coolant Pump '3B1'.

DESCRIPTION OF INCIDENT

October 29, 1986, at 1006, Unit-3 was at 75% full power when the "Reactor Coolant Pump '3B1' Frame Vibration" alarm actuated. The frame vibration had spiked above 2.3 mils. Pump parameters were checked, and no out of normal characteristics were observed.

At 2327 hours, on October 29, 1986, Unit-3 was at 96% full power when the unit experienced a 5% re-ratio of feedwater flow to the Steam Generators. Operators also noticed a decrease in RCP '3B1' amps, a decrease in total RCS flow and received Loose Parts Monitor alarms on points 1, 2, 5 and 9 (Incore #1, Incore #34, Core Flood Tank '3B' and RCP '3B1' suction respectively). Points 5 and 9 were faintly heard on the Loose Parts Monitor, but were assumed to be from the same origin as points 1 and 2.

Surveillance of the Loose Parts Monitor was increased to once every 2 hours from once every 6 hours to assure that the loose part within the Reactor Coolant System was staying lodged and not causing damage to the fuel or any other of the RCS internals.

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

At 0443 hours, on October 30, 1986, high frame vibration alarms came in on RCP '3B1'. Power was reduced in order to remove RCP '3B1' from service. When Unit-3 was at 66% full power, the pump was shutdown. A Reactor Coolant sample was taken to check on Reactor Coolant System activity. The sample showed no increase in its isotopic analysis, indicating no fuel damage.

On October 30, 1986, personnel began to decipher the information gathered. Based on the fact that the loose part(s) have become lodged in the system and should remain lodged, and no adverse effects due to the loose part(s) or the damaged pump have been identified, the conclusion was reached that continued operation with the loose part(s) did not pose any safety concerns.

The unit ran in a steady state condition at the reduced power level until 1538 hours on November 5, 1986, at which time a severe Feedwater transient in the ICS occurred due to personnel error during testing. Unit-3 was brought under control and returned to a stable power level within a few minutes. An hour after this transient, the Loose Parts Monitor alarmed, but the noise subsided before it could be recorded. At 0553 hours, on November 6, 1986, the Loose Parts Monitor alarmed again. This time the noise, which lasted for approximately 13 seconds, was recorded. Another RCS sample was requested with results indicating "normal," (i.e. no fuel damage).

On November 7, 1986, Babcock & Wilcox and Duke personnel temporarily installed a very sensitive LPM Computer (LPMC) on the Loose Parts Monitor to record the noise. The noise was heard on the LPMC at a rate of approximately one impact per hour. The LPMC uses the non- filtered LPM acoustical signals. It can detect the frequency, energy, and duration of the sound when it is above its set threshold limit. Noise was recorded continuously on the LPM. On November 15, 1986, at 0030, the LPM and newly installed LPMC alarmed. This time, a noise was heard continuously on the sensitive LPMC at a rate of approximately one impact per minute, but was not heard on the Oconee LPM. There were indications of more than one loose part in the RCS. Unit-3 ran without any changes in Reactor Coolant chemistry analysis from November 6, 1986 to December 15, 1986.

On December 14, 1986, during the monthly check of Reactor Coolant Pump vibration and running frequency, a loud noise and alarm was noted on the Loose Parts Monitor. Shortly afterwards, there was a noticeable change observed in the running frequency on the Reactor Coolant Pump '3B2'. On December 15, 1986, the chemistry analysis indicated that Magnesium was present (the suspected element that indicates pump problems) and there was an increase in the Iodine 133/135 ratio (this is an indication of leaking fuel).

By December 17, 1986, chemistry results had returned to normal; however the Reactor Coolant Pump '3B2' vibration had increased since early in the morning. The vibration returned to normal by mid-afternoon with the characteristic of a steady cycle. Due to vibration data, Management decided to shut down the unit and go into an early refueling outage.

Reactor Coolant Pump '3B1' was removed from the Reactor Coolant System on January 1, 1987. As the pump was being pulled, it was discovered that there was severe damage to the pump impeller and to the pump wear ring. The suction piece adapter had come loose and had come in contact with the running pump. The wear ring was still firmly attached to the suction piece adapter, but was severely worn. The pump bearing was in good condition.

While fuel was being removed from the core on January 13, 1987, a piece of metal was found on top of a fuel assembly when the fuel bridge operators had trouble latching onto a fuel assembly. This metal block did not show up on the review of the original core scan video. It was concluded that this piece of metal had fallen off the bottom of an already removed fuel assembly. Further review of the removed fuel assemblies indicated debris on the lower sections. Debris was removed from the fuel assemblies over the next few weeks to prevent fuel fretting during the next cycle. On January 18, 1987, debris was found in the bottom of the reactor vessel. This debris was removed by remote grippers and a vacuum system.

On January 20, 1987, the bearing for Reactor Coolant Pump '3B2' was found to be loose. This condition was due to poor design of the bearing retaining bolts. Personnel were aware prior to the outage that a modification was necessary, and had a Preventative Maintenance program in place to make the repairs. These repairs were completed on the RCP '3B2'.

During this refueling outage when RCP's '3A1' and '3A2' were pulled, no problems were noted and the suction piece adapter bolts were replaced in all the RC pumps.

CAUSE OF OCCURRENCE

It was suspected from interpretation of data that the problem within RCP '3B1' was in the wear ring/volute area. Based on past experience, the parts were thought to be held impinged on the core internals by system flow. Until the problem deteriorated further or the loose part(s) became unlodged, the unit could remain in operation at reduced power until its expected refueling outage in Feb., 1987.

On December 17, 1986, the unit was shutdown to prevent further deterioration of the Reactor Coolant Pumps. When RCP '3B1' was first removed from the system, evidence of a failure was apparent. Upon a closer examination, it is concluded that the suction piece adapter bolts failed from fatigue. This caused the wear ring to come into contact with the rotating impeller. The failure of the suction piece adapter bolts is considered to be the root cause of this event. Upon examination of bolts from the other pumps this is considered to be an isolated event.

When RCP '3B2' was inspected, it was concluded that the high vibration was not due to failure of the suction piece adapter bolts, but was a loose pump bearing. The capscrews that hold in the pump bearing were found loose. This problem was identified on earlier outages and a program was already implemented to programmatically repair two Reactor Coolant Pumps per outage on Units 2&3. Unit 1 does not have this concern because it uses Westinghouse pumps. It is hypothesized that the premature failure of the pump bearing capscrews is due to the extended operation of Unit-3 in three-pump operation. Operation of the unit using only three RC pumps tended to force the pump in the loop with a single pump operating to run off-center. This placed extra load on the pump bearing, which could have caused the premature wear. This type of operation is not common on Oconee Unit 2 and 3.

Video observations indicated that no damage occurred to any of the Reactor Coolant System internals.

CORRECTIVE ACTIONS

The immediate corrective action was to reduce power and secure RCP '3B1'.

Supplemental corrective actions were to:

- o evaluate LPM noise
- o assess RCP 3B1 parameters
- o evaluate RCS flow and power distribution under 3 pump operation
- o monitor LPM more frequently
- o evaluate all noise on the LPM and LPM Computer
- o monitor RCS chemistry for any trend changes
- o continuously evaluate operation of Unit 3 by Management with respect to significant increases in loose parts noise and indications of fuel damage
- o disassemble and repair RCP '3B1' during the refueling outage
- o replace the suction piece adapter bolts in all four of Unit 3's reactor coolant pumps
- o perform the pump bearing upgrade on RCP '3B2'
- o remove debris from the Reactor Vessel internals

Planned corrective actions are to evaluate the need and extent to which Unit 2 Reactor Coolant Pumps will be worked on during the next outage. In addition, an evaluation will be performed regarding the amount of time a unit may run in a three pump configuration to minimize pump bearing wear.

ANALYSIS OF OCCURRENCE:

The noise in the Reactor Coolant System (RCS) represented a significant concern to the operation of Unit-3. Monitoring of the noise and continued chemistry analysis provided indication of any change in RCS parameters. Removing Reactor Coolant Pump (RCP) '3B1' from service prevented any further damage to the pump.

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

The noise level increased slightly while the unit continued operating. It can be determined from the very sensitive LPMC that there were at at least two specific loose parts in the RCS. The Abnormal Procedures instruct the operator to trip the reactor on excessive LPM noise.

The chemical analysis of the RCS would have indicated an increase in fission product poisons and suspended solids in the event of any fuel clad damage (failure) and/or extensive mechanical damage. Chapter 15 of the Oconee Final Safety Analysis Report considers the occurrence of fuel clad damage and bounds the events in this safety analysis. All appropriate operator action is covered in the Abnormal Procedures which is part of the emergency plan.

The only potential safety concern associated with the damaged reactor coolant pump is the potential that due to the damage, the hydraulic losses associated with the idle pump may differ from the losses in an undamaged idle pump. The hydraulic losses determine flowrates throughout the RCS and are an integral part of the transient analysis computer simulation model that was used to license 3-pump operation. Insights into the hydraulic losses in the damaged pump can be obtained by comparing the current RCS loop flowrates and flowsplits with the normal and expected values. Plant data confirmed that the flowrates and flowsplits, and therefore the hydraulic losses of the damaged pump, were unchanged from the typical values. Therefore the damaged pump did not constitute a safety concern.

Potential effects resulting from the loose part(s) were evaluated by consideration of the potential consequences of flow blockage. The concern is a potential reduction in inlet flow to one or more fuel assemblies, which could result in a departure from nucleate boiling and subsequent cladding failure. Four types of plant instrumentation were utilized to diagnose if any flow blockage has occurred.

1) Reduction in RCS flow: RCS flowrates and flowsplits with RCP '3B1' removed from service were typical of normal 3-pump operation. Thus confirming that no gross blockage of normal flowpaths within the RCS existed.

2) Excessive Core Exit Thermocouple Temperatures: Core exit thermocouple temperatures with RCP '3B1' removed service were typical of the expected values for 3-pump operation at 65% full power. Therefore no hot spots were identified as might be indicated if significant flow blockage existed. It must be recognized that less than 52 of the 177 fuel assemblies are instrumented, and therefore this sample is somewhat limited.

3) Incore Flux Detectors: Seven levels of selfpowered nuclear detectors (SPNDs) are used for incore flux mapping. Less than 52 strings are distributed similar to the thermocouples across the core. These indications have been evaluated to identify any anomalous indications that might be associated with local flux depressions due to undermoderation. Undermoderation would result from high coolant temperatures caused by flow blockage. No anomalous indications were identified.

4) Primary coolant activity levels: A primary coolant sample was evaluated to determine the occurrence of fresh cladding failures. No such indications existed.

Based on the above evaluations of plant parameters it is concluded that no cladding failures have resulted from the loose part(s). No indications of gross or local flow blockage have been identified.

Potential consequences of future operation with the loose part(s) was examined based on the current situation and potential changes in boundary conditions. It was concluded that the loose part(s) were lodged in the system since no indications of impacts could be detected by the LPMS. Provided that there were no significant perturbations in hydraulic conditions, there was reason to conclude that the parts would not become dislodged and relocate. Therefore, since the only significant perturbation would result from reactor coolant pump starting or stopping, and since such operations were not permitted until the unit was shut down for pump repair, a reasonable probability existed that the loose parts would not become dislodged. Since it was likely that the loose part(s) was generated by some interaction with the rotating pump components, and since the damaged pump remained idle for the remainder of the cycle, it was reasonable to conclude that no additional loose parts would be generated. Newly generated loose parts due to a random failure of the undamaged pumps were also considered to be of low probability.

Upon indication of degradation in RCP '3B2', management made the decision to shutdown Unit-3, thus ensuring the safety of the plant and the public.

There were no radiological releases, exposures, or injuries associated with this event, therefore the health and safety of the public were not affected by this incident.

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HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
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April 3, 1987

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

Subject: Oconee Nuclear Station, Unit 3
Docket No. 50-287
LER 287/87-01

Gentlemen:

Pursuant to 10CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report (LER) 287/87-01 concerning loose parts and reduced reactor coolant flow due to suspected equipment failure.

This report is submitted on a voluntary basis. This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

Hal B. Tucker

PJN/140/jgm

Attachments

IE22
1/1

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