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POWER BUILDING
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WILLIAM O. PARKER, JR.
VICE PRESIDENT
STEAM PRODUCTION

TELEPHONE: AREA 704
373-4083

November 26, 1980

Mr. James P. O'Reilly, Director
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, Suite 3100
Atlanta, Georgia 30303

Re: Oconee Nuclear Station
Docket No. 50-270

Dear Mr. O'Reilly:

Please find attached Reportable Occurrence Report RO-270/80-11. This report is submitted pursuant to Oconee Nuclear Station Technical Specification 6.6.2.1.b(2), which concerns operation in a degraded mode permitted by a limiting condition for operation, and describes an incident which is considered to be of no significance with respect to its effect on the health and safety of the public.

A letter report concerning this incident was submitted to your office on September 18, 1980. This report finalizes the HPI pump investigation.

Very truly yours,

William O. Parker, Jr.

JLJ:scs
Attachment

cc: Director
Office of Management & Program Analysis
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

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DUKE POWER COMPANY
OCONEE NUCLEAR STATION, UNIT 2

Report Number: RO-270/80-11

Report Date: November 26, 1980

Occurrence Date: July 26, 1980

Facility: Oconee Unit 2, Seneca, South Carolina

Identification of Occurrence: 2B HPI Pump Inoperable Due to High Upper Bearing Temperature on the Motor

Conditions Prior to Occurrence: Oconee 2 - 100% FP

Description of Occurrence:

At 1730 on July 26, 1980, the 2B HPI pump was declared inoperable due to high upper bearing temperature on the motor. Upon investigation, the upper thrust bearing of the motor had failed and the pump was determined to be inoperable due to limited axial pump lift.

On July 13, 1980, the Oconee Unit 2 "B" HPI pump was declared inoperable due to a high lower motor bearing temperature ($\sim 200^{o}F$). The lower bearing on the motor was replaced and the motor was test run and declared operable on July 18, 1980. This repair is discussed in RO-270/80-8. As indicated in that report, the probable cause for failure has not been definitively established.

On July 26, the 2B HPI pump was started after adding one quart of oil, and stopped approximately 6 minutes later when the upper motor bearing temperature was $199^{o}F$. The oil level was reverified at the mark on the upper bearing sight glass, and the motor cooling water was also verified correct. It was then decided to drain the oil from the upper motor bearing. The oil was drained from the upper bearing and replaced. The oil showed a caramel color discloration. The 2B HPI motor was started again, and stopped approximately 20 minutes later with the upper bearing temperature at $200^{o}F$. The pump was declared inoperable at 1730 hours.

On July 27, 1980, the upper guide bearing of the motor was determined to show wear in the upthrust direction. Since the normal operation of the HPI pump does not cause thrust in the upward direction, the HPI pump was suspected of operating abnormally. When the axial travel of 2B HPI pump was found to be .052", and the assembly limits were found to be .125 to .250 for axial travel, the pump was suspected of having internal damage and not being suitable for continued operation.

On July 28, 1980, a spare HPI pump was installed and the motor repaired and tested.

On July 29, 1980, the pump was started, and then stopped 44 seconds later when a high motor amp reading of approximately 72 amps was noticed (normal is 50 to 55 amps). The seal supply filter ΔP had increased to unacceptable limits. The 2B HPI pump was inspected and hence declared unserviceable. At this time personnel began rebuilding the pump which had been removed on July 27, 1980. The pump manufacturer was contacted for assistance in reassembling the pump.

On July 30, 1980, the reactor power on Unit 2 was decreased to below 60% as required by Technical Specification 3.3.1.C(2).

On August 10, 1980, the rebuilt HPI pump was installed in the 2B location. The motor amps appeared normal at first but then began to increase. The pump suction and discharge pressures remained normal throughout the total run time of approximately 50 seconds. The pump could not be rotated by hand and was therefore declared unserviceable. Personnel began removing the pump and rebuilding the one which had been removed on July 29, 1980.

On August 16, 1980, the rebuilt HPI pump was installed in the 2B location. The pump was again declared unserviceable after only two minutes of operation. Since no spare pump shafts were on site the rebuilding of the pump did not start until this pump had been disassembled.

On September 4, 1980, the rebuilt HPI pump was installed in the 2B location. The 2B HPI pump was finally declared operable after a successful performance test was complete.

Post maintenance, operation, and testing verified that the 2B HPI pump and motor are performing acceptably. The pump was declared operable and the unit was returned to 100% power.

Special shaft motion diagnostic equipment was installed on 2B HPI pump prior to the September 4, 1980 startup. This equipment verified that the alignment, balance and running shaft motion are well within acceptable tolerances.

Apparent Cause of Occurrence:

A possible cause of the high upper bearing temperature was the upward pressure of the motor rotor against the upper guide bearing. If for some reason the rotor should stay in an upthrust state, the guide bearing babbit lining would show the wear seen on July 27, 1980.

The 2B HPI pump declared inoperable on July 26, 1980 had run without any problems for approximately two years. When this pump was initially started during that time, the pump was stopped and started several times due to a high ampere reading on the motor. It was not known, at that time, that this high ampere reading indicated the pump was being damaged. When the pump and motor were being coupled after the repair of the motor's lower bearing which failed on July 13, 1980, the axial pump rotor travel was found to be 0.052". At this time, the coupling and uncoupling procedure did not state the limitations of the axial travel. When the upper motor guide bearing was found to have abnormal wear in an upthrust direction, the pump's axial rotor lift was checked and found to be 0.052" once again. Through further investigation, it was found that this rotor lift was unacceptable, and the pump was declared unserviceable. The pump was removed and disassembled. Damage

was limited to the first seven stages. Most of these impellers were locked in the volute housings and the stuffing box bushing was welded to the shaft sleeve. It is concluded that part of the damage to this pump occurred during its initial startup approximately two years ago, therefore, it was impossible to determine the exact cause of the problems observed on July 26, 1980. It was felt that since the damage was restricted to the upper stages, that it was likely that inadequate venting was the cause of the observed damage. The pump declared unserviceable on July 29, 1980 had a bent shaft in the area of the lower journal sleeve. The lower journal sleeve and lower bearing lining were found fused together. These pumps must be turned upside down to be disassembled. Also when transporting the pump to the HPI room, the pump must be in a horizontal position. Therefore, it is possible that this pump was supported by its lower bearing casing while being turned or transported to the HPI room. This could put too much stress at the end of the pump, therefore, causing misalignment in the lower guide bearing area.

While the repair effort was in progress, all ONS HPI procedures were reviewed, to identify any possible shortcomings. One deficiency, which was noted, was that the proper time to lock the mechanical seal, sleeve, to the pump shaft, during alignment was not defined by the alignment procedure. This could have created problems if the sleeve was locked to the shaft before the axial lift of the pump had been set. If this had occurred, the only possible problem that could have been created would have been excess axial loading of the seal faces during operation. This would have quickly overheated the seal faces and caused obvious damage. No evidence of this type of damage was found throughout the entire episode.

The 2B HPI pump declared unserviceable on August 10, 1980 had the top shaft sleeve and the stuffing box bushing fused together. Rubbing had occurred on the bottom of some impeller wear rings. The damage to the stuffing box bushing and shaft sleeve was felt to have resulted from the mechanical seal gland having been too small in the area of the fit into the nozzle head. The undersize fit of the seal gland to the pump head could have allowed the seal to have been installed off-center. It was felt that this was the case, since during the pump run heavy rubbing had occurred between seal sleeve and the seal gland. This was also felt to have been the reason for the damage to the upper guide bearing area, of the pump.

The 2B HPI pump declared unserviceable on August 16, 1980 had the stuffing box bushing and the top shaft sleeve fused together. Some impeller wear rings showed rubbing had occurred on the bottom. It was felt that the motor shaft in the coupling fit location had been hand smoothed, to allow the motor half coupling to easily fit onto the shaft. This caused the shaft to become tapered and uneven. This would allow the motor half coupling to tilt under the applied torque causing damage to the pump.

This tilt would result in a gross misalignment between the pump and motor. This would produce damage in the upper area of the pump.

Also during alignment of 2B HPI pump on September 2, 1980, the amount of radial movement in the upper motor bearing had a detrimental effect on the alignment effort.

Analysis of Occurrence:

Should a loss-of-coolant accident have occurred, during maintenance and testing, all that would have been required for emergency core cooling would have been two independent trains, each comprised of an operable HPI pump. HPI pumps 2A and 2C were operable and available during the course of the maintenance and testing. When reactor power is reduced below 60% FP only one HPI pump and train is required to function to mitigate the consequences of the accident. Since this was the case, this incident was of no significance with respect to safe operation, and the health and safety of the public were not affected.

Corrective Action:

The immediate corrective action was to stop 2B HPI pump and start the 2A HPI pump with the 2C HPI pump as a backup. A work request was written to repair the upper motor bearing.

The motor bearing was repaired. This consisted of replacing the upper thrust bearing and two guide bearing pads. A 30 minute test run was performed and the motor was determined to be operable.

After the failure of each pump, the immediate corrective action was to rebuild another pump, if a spare was not available. When these pumps were rebuilt, the damaged parts were replaced.

As a result of the failure of this series of HPI pumps, the following corrective actions have been implemented:

1) A cart was constructed to support the pump in several places while it was being transported. Also a device was constructed to be attached to the pump to secure the pump rotor from moving while turning and transporting the pump. The pump is turned appropriately and not by the bottom bearing casing only.

2) Two procedures are still under review to make the uncoupling and coupling process consistent to both procedures and to add other needed information, such as the limitation of the pump rotor axial travel.

3) The motor shaft to coupling fit has been defined as a required interference fit of .001" - .002".

4) The motor shaft centering jigs are required by procedure to ensure proper alignment.