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AUTH. NAME AUTHOR AFFILIATION
TUCKER, H. B. Duke Power Co.
RECIP. NAME RECIPIENT AFFILIATION
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SUBJECT: Special rept: on 871207, condenser circulating water pumps w/ disconnected or broken vent tubes w/possibility of air inleakage through flange. Caused by design deficiency. Pump 2A isolated & repairs planned. W/880217 ltr.

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DUKE POWER COMPANY
P.O. BOX 33189
CHARLOTTE, N.C. 28242

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

February 17, 1988

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

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
Emergency Condenser Circulating Water System

Gentlemen:

Attached is a special report concerning the potential loss of the Emergency Condenser Circulating Water (ECCW) System due to the possibility of air inleakage at the condenser circulating water pumps caused by a design deficiency.

Previously, LER 269/86-11 was submitted concerning the inoperability of the ECCW system. This incident is not reportable per 10CFR 50.73 requirements and is thus submitted on a voluntary basis.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

PJN/289/jgc

Attachment

xc: Dr. J. Nelson Grace, Regional Administrator
U.S. Nuclear Regulatory Commission - Region II
101 Marietta Street, NW, Suite 2900
Atlanta, GA. 30323

Ms. Helen Pastis
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. P.H. Skinner
NRC Resident Inspector
Oconee Nuclear Station

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DUKE POWER COMPANY
OCONEE NUCLEAR STATION
POTENTIAL LOSS OF EMERGENCY CONDENSER CIRCULATING WATER SYSTEM DUE TO THE POSSIBILITY OF AIR INLEAKAGE AT THE CONDENSER CIRCULATING PUMPS CAUSED BY A DESIGN DEFICIENCY

Introduction

On December 7, 1987, an inspection of all three Unit's Condenser Circulating Water (CCW) pump flange modifications found three pumps with disconnected or broken vent tubes on Units 1 and 2. Unit 3's system was subject to the same failure. These tubes normally extend from the flange to a point below the surface of Lake Keowee to prevent air inleakage through the flange. In order to provide emergency cooling during a station blackout, the CCW system is designed to function as a siphon from Lake Keowee through the main condensers and then into Lake Hartwell. At the time of discovery, Unit 1 and Unit 3 were at 100% power, and Unit 2 was at 87% power.

The immediate corrective action was to isolate CCW Pump 2A, because its flange was above the lake surface and to maintain the lake level above the other two pumps' flanges until repairs could be made.

The root cause of this incident was determined to be a design deficiency due to the inadequate design of the vent tubes. Stresses due to pump vibration resulted in two broken tubes and in three tube couplings becoming unscrewed.

Background

The CCW System provides water to the condenser to condense steam from the main turbines. It also supplies suction to the Low Pressure Service Water (LPSW) and High Pressure Service Water (HPSW) Systems and serves as the ultimate heat sink for decay heat removal.

Each unit has four CCW pumps, each with a design flow of 177,000 gpm. In the event of a loss of station AC power, the CCW system is designed to function by gravity flow. When the CCW system functions as the Emergency Condenser Circulating Water (ECCW) System, it discharges into the tailrace below Keowee Dam rather than out the normal discharge structure back into Lake Keowee. The alternate discharge provides the necessary elevation difference so that gravity induced flow will occur.

A key point in the CCW design is that whenever lake levels are less than approximately 796 feet in elevation, a portion of the intake CCW system is above water. In order for water to flow by gravity, it must be siphoned up through the pumps into the piping. It is critical that air inleakage be prevented for the siphon to function. In October, 1986 as reported in LER 269/86-11 it first came to light that a design problem existed in that the pumps' flanges were not airtight and could result in failure of the ECCW system whenever lake levels were low enough to uncover them (approximately 791 feet). This current report concerns a design deficiency associated with a modification which was to prevent air inleakage at the flanges.

Discussion

On October 1, 1986 a load-shed test was begun on Unit 2 which was in a refueling outage. As a part of this test, power was removed from the Unit 2 CCW pumps. After approximately one hour, the LPSW Pumps began cavitating as they lost suction. The LPSW pumps pull suction from the CCW system and supply cooling water to the decay heat coolers, plus other loads. It was subsequently determined that the CCW system had failed to operate as a siphon when power was removed from the CCW pump. Further investigation determined that inleakage at flanges on the CCW pumps caused the loss of siphon flow. Units 1 and 3 were shut down so that their CCW pump flanges along with Unit 2's could be modified to prevent air inleakage.

The leaking flanges were not designed to be leakproof by their manufacturer, Baldwin Lima Hamilton Corporation. The lower portion of the pump is supported by this flange.

Exempt changes were installed on the twelve CCW pumps to prevent air inleakage. A rubber boot was installed around each pumps' flange and each was vented under the lake surface by 12 separate pipes. Venting the boot under water allowed the water leakage to drain off and prevented pressurization of the rubber. Since the vent tubes extended under the surface of the water, no air would be drawn into the system when siphon flow was required.

The vent tubes were connected to welded nipples at the rubber boot by quick-disconnect type couplings. Each tube consisted of two sections of two inch diameter aluminum conduit that were ten feet long, which were joined by a union. This total length of twenty feet would allow the lake level to drop to the lowest permitted operating level of 775 feet, with the piping still vented into water. The pipes were banded to the pump for stability.

The Mechanical Maintenance Engineer (MME) who was responsible for the CCW pumps and the exempt changes that modified the flanges, was aware that there was a potential problem with damage to the vent pipes as a result of vibration. He noted this in a Memo to File after the modifications were completed, and provided a copy of this memo to his management. The use of flexible hose was mentioned in the memo as a possible alternative.

One other problem was noted in that leakage through the flange was resulting in erosion. This was significant because the flange supports the weight of the lower portion of the pump. A design study has been completed which determined an alternate way to seal the flange.

The MME stated that he inspected the modification on each pump shortly after installation and found no problems. After this inspection, no further inspections were performed until December 7, 1987 because the lake level was over the flanges for most of that time which prevented inspection.

It is known that the tubes were intact after installation as all three units' siphon flow through the CCW System was tested successfully. As noted, an inspection by the MME found no problems either. Two additional gravity flow tests were performed successfully in 1987 during the Unit 1 and 3 refueling

outages. Unit 3 had no disconnected tubes. Although Unit 1 had two pumps with disconnected tubes, at the time of its test, the lake level was at 796 feet, approximately five feet over the flange. At this level, flange integrity is immaterial as no air could leak in.

On December 7, 1987 an inspection was performed on the modifications of the twelve CCW pumps. This was done in response to a query by management on the status of the modifications. That day three pumps were discovered to have broken or unscrewed tubes. CCW pump 1A had two tubes that were unscrewed at their quick disconnect couplings. CCW pump 1C had two tubes broken at the coupling and CCW pump 2A had one tube unscrewed at its coupling. Of the three, only 2A's flange was above lake level making it subject to air inleakage.

CCW pump 2A was isolated and tagged out of service which would have permitted the siphon flow if needed at that lake level. Lake Keowee's level was maintained at or above its current elevation, approximately 791 feet, while the nipples at the flange for the disconnected tubes were plugged. This would prevent air inleakage at any lake level in the allowed operating range. With its tubes plugged, CCW pump 2A pump was placed back in service. Plugging the tubes did not affect operability of the flange seals because there was still ample drainage present on each pump to prevent overpressurization.

Conclusions

The root cause of this incident was a design deficiency due to the failure of the modification's design to compensate for the vibrational stresses to the vent pipes. The facts that the vent pipe assemblies were rigid and that they extended twenty feet made them susceptible to breakage.

Further, the vibration of the pipes led to rotation of the quick disconnect couplings such that three of the vent pipes became unscrewed. This conclusion is based on the fact that during repair, there was no indication that the tubes were improperly installed. The successful tests performed in October, 1986 and the inspection performed after installation revealed no deficiencies with the modification. Finally, an inspection of the broken vent tubes quick disconnect fittings indicated that they had been installed properly.

The planned corrective action for this incident of installing flexible piping should correct the current design deficiency and therefore insure the integrity of the ECCW System. The planned inspection program will identify any further failures of the modification in a timely manner.

This event did not involve a component failure that was reportable to NPRDS. There were no releases of radioactive materials, radiation exposures or personnel injuries involved with this event.

Corrective Action:

The immediate corrective actions were to isolate and tag out of service Condenser Circulating Water Pump 2A until the vent tubes connections were capped. In addition, Lake Keowee's level was maintained at or above the current level until repairs were completed.

Subsequent corrective actions were to:

- Plug the vent tube connections on CCW pumps 1A, 1C and 2A;
- Conduct a Design Study to determine if an alternate, more efficient modification can be designed to assure siphon flow and possibly eliminate flange leakage;
- Write a procedure to periodically inspect the modification to the pump flanges to assure their integrity.

Planned corrective actions are to:

- Place and maintain equipment on the intake to facilitate quick repair of the modification. This will include an inflatable raft, tools, lights, safety equipment and a means of inflating the raft other than plant air;
- Replace the Unit 2 CCW pump vent pipes upper sections with non-collapsible, flexible hoses. If this is determined to be successful, the other units will be modified;
- Review changing emergency procedures to require inspecting the intake to assure proper siphon operability in event of a station blackout.

Safety Analysis

The ECCW System is designed to provide a heat sink for secondary side decay heat removal. It is the CCW system functioning as a siphon leading from Lake Keowee, through the main condenser and then discharging into the Keowee Hydro Station Tailrace. The impact of the inoperability of the ECCW system is discussed in LER 269/86-11.