NRC FORM 366 (4-95) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMD NO. 3150-0104
EXPIRES: 04/30/98
ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), 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.

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Oconee Nuclear Station, Unit One	05000 269	1 OF 7

TITLE (4)
Reactor Building Cooling Units Technically Inoperable Due To Design Deficiency

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(S)
										Oconee, Unit Two	05000 270
01	24	97	97	- 02	- 01		07	31	97	Oconee, Unit Three	05000 287

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	20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)		
		20.405(a)(1)(i)	50.36(c)(1)	X 50.73(a)(2)(v) (D)	73.71(c)		
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	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)			
		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	
	AREA CODE	
R. T. Bond, Safety Review Manager	(864)	885-3043

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	

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 fifteen single-space typewritten lines) (16)

On 1/24/97, Units 1 and 2 were at Cold Shutdown and Unit 3 was in a refueling outage. Oconee Engineering had been evaluating NRC Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design Basis Accident Conditions". This included conservative thermal-hydraulic analyses to determine if the Low Pressure Service Water (LPSW) System piping which serves the Reactor Building Cooling Units (RBCU) may be susceptible to waterhammer. The analysis determined that, during certain design basis scenarios, waterhammers might occur in piping to the non-safety related auxiliary cooling units. This might prevent the safety related RBCUs from performing their intended function. At 1426 hours, the NRC was notified, per 10 CFR 50.72. On 2/20/97, a partial LER was submitted because more detailed analyses had not been completed. On 3/13/97, a letter was submitted to the NRC indicating that additional time was needed to complete the detailed analyses. The analyses to return LPSW to the original configuration have not been completed. The root cause is deficient Design Analysis, Unanticipated interaction of systems. Corrective actions include isolating and draining the affected piping and performing modifications as required. This event is considered to be of no significance with respect to the health and safety of the public.

Background

The Low Pressure Service Water (LPSW) System [EIIS:BI] is a raw water support system that takes suction from the Condenser Circulating Water (CCW) [EIIS:BS] Crossover and supplies cooling water to safety and non-safety related loads in the Turbine Building [EIIS:NM], Auxiliary Building [EIIS:NF], and Reactor Building (RB) [EIIS:NH].

Safety Related Cooling Loads include the following:

- Low Pressure Injection (LPI) [EIIS:BP] Coolers
- Reactor Building Cooling [EIIS:BK] Units (RBCUs)
- High Pressure Injection [EIIS:BG] Pump Motor Bearing Coolers
- Motor Driven Emergency Feedwater [EIIS:BA] Pump Motors
- Turbine Driven Emergency Feedwater Pump Bearing Jacket Cooler

The LPI coolers and the RBCUs are supplied by separate LPSW supply lines. The return lines from the LPI coolers and the RBCUs maintain separation to a point beyond a remote-operated isolation valve.

Three (per unit) RBCUs ("A," "B," and "C") are supplied by individual lines from separate LPSW supply headers. Each inlet and discharge line is provided with a motor operated shutoff valve located outside the RB. This allows each RBCU to be isolated individually. During normal operation, the "A" and "C" RBCUs receive throttled flow. Inside the RB the "B" RBCU supply flow is isolated by valve LPSW-566 and diverted through valve LPSW-565 to the four Reactor Building Auxiliary Cooling Units (ACU) to assist normal RB cooling. The ACUs were installed by modification in 1980 to 1982. Flow to the ACUs is automatically isolated (LPSW-565 closes) by an Engineered Safeguards (ES) [EIIS:JE] signal returning full flow to the "B" RBCU (LPSW-566 opens). An ES actuation opens the outlet valves on the three RBCUs to assure emergency flow. During normal operation, the fan motors associated with RBCU "A" and "C" operate in HIGH and the fan motor associated with the "B" RBCU is off. Upon ES actuation, the fan motors associated with the RBCUs operating at high speed (A and C) change to low speed, and the idle unit (B) is energized at low speed.

Description of Event

On September 30, 1996, the NRC issued Generic Letter (GL) 96-06, "Assurance of Equipment Operability and Containment Integrity during Design-Basis Accident Conditions". A portion of this GL identified a concern that cooling water systems serving containment air coolers could potentially experience waterhammer during certain design basis accidents.

Engineering began conservative thermal-hydraulic analyses to determine if any portions of the Low Pressure Service Water (LPSW) System piping which serves the Reactor Building Cooling Units (RBCU) and Reactor Building Auxiliary Cooling Units (ACU) could be susceptible to waterhammer.

On January 24, 1997, Units 1 and 2 were at Cold Shutdown and Unit 3 was in a refueling outage. Engineering determined that condensation induced waterhammer could occur and possibly cause a pipe break in the LPSW supply to the ACUs. The LPSW flow would be diverted from the RBCUs to the pipe break location and could result in inadequate flow to the RBCUs. In addition, flow from the LPSW piping break would result in boron dilution of the Reactor Building Emergency Sump water. This condition was conservatively reported to the NRC per 10 CFR 50.72, based on the preliminary results from the GL 96-06 review.

As a temporary compensatory action, the ACUs for each Oconee unit were isolated and drained, making the Reactor Building Cooling system operable. The effect of operation without the ACUs was evaluated, prior to restarting each Reactor. Isolation of the ACUs eliminated the potential for condensation induced waterhammer, while further analyses continued. Engineering began more detailed analyses to determine whether the postulated waterhammer could have impacted the integrity of the LPSW piping.

On March 13, 1997, the NRC was notified that engineering analyses were still in progress and would not be completed before the expected date of March 20, 1997. At that time, it was anticipated

that the analyses would be completed and a supplemental LER would be submitted on July 31, 1997. On June 26, 1997, Engineering completed additional thermal hydraulic analyses evaluating the LPSW system two phase phenomena. These analyses further quantified waterhammer loads with the ACUs valved out. These analyses indicate that condensation induced waterhammers might occur in RBCUs under the current configuration. The conclusions of these additional analyses continued to support operability of the RBCUs with the ACUs valved out.

However, the current mode of operation is not considered a permanent solution to this issue, due to the impact on Reactor Building normal operating temperature. Therefore, Engineering is currently working on more detailed analyses with the system in the previous configuration with LPSW aligned to the ACUs but, for the ACU most susceptible to waterhammer, with the fan off. Additional analyses will be performed to determine what modifications would be required to return all ACUs to service. The results of these analyses will be used to determine the most appropriate long term solution to this issue.

Conclusion

The root cause of this event is determined to be Deficient Design Analysis, unanticipated interaction of systems. During the initial design of the Reactor Building Cooling Units in the early 1970s and the design of the modifications which added the Reactor Building Auxiliary Cooling Units (1979-1982), the waterhammer condition was not addressed. The analytical methods available at the time did not permit analysis of waterhammer in the detail necessary to reveal this problem. The current technology can better address piping system thermal hydraulics and design for the prevention of waterhammer conditions.

This event is considered to be non-recurring. No corrective action can be taken to assure that industry operating experience, improving technology, testing methods, and/or analytical models do not reveal previously unknown unanticipated system interactions.

Duke Power's Operating Experience Program is intended to assure evaluation of existing systems for the potential impact of industry experience on the current systems.

This event did not involve equipment failure and is not NPRDS reportable. There were no radiological overexposures, radioactive releases, or personnel injuries associated with this event.

CORRECTIVE ACTION:

Immediate:

1. The affected piping of the Reactor Building Auxiliary Cooling Units (ACU) was isolated and drained on all three Oconee units.

Subsequent:

None

Planned:

1. As an interim measure, perform analyses and, if appropriate, implement actions necessary to permit operation of one or more ACUs for improved Reactor Building temperature control.

2. Complete analyses and implement modifications, if required, to return the Reactor Building Cooling System (RBCUs and ACUs) to service.

Planned corrective action number 2 is considered to be an NRC Commitment Item. This is the only NRC Commitment item contained in this LER.

SAFETY ANALYSIS:

NRC Generic Letter 96-06 identified that cooling water systems serving the containment air coolers may be exposed to the hydrodynamic effects of waterhammer during either a Loss Of Coolant Accident (LOCA) or a Main Steam Line Break (MSLB).

The Engineering analysis for Oconee indicated that the only scenarios leading to waterhammer in Reactor Building (RB) Cooling Units (RBCUs) require a high energy line break accident (LOCA or MSLB) with a concurrent Loss of Offsite Power (LOOP). The scenario where a high energy line break accident occurs concurrently with a Loss of Offsite Power (LOOP) has a very low probability accident sequence.

If such an unlikely event were to occur, the Low Pressure Service Water (LPSW) pumps, the RBCU fans, and RB Auxiliary Cooling Unit (ACU) fans will temporarily lose power (an expected condition). The coast down time of the fans is longer than the coast down time of the pumps. The high temperature RB atmosphere will be forced across the RBCU and ACU cooling coils for a period of time with no forced LPSW flow through the coolers. The stagnant service water in the cooling coils may boil and create a substantial steam volume in the LPSW piping. As the LPSW pumps automatically restart, the pumped liquid may rapidly condense this steam volume and produce a waterhammer. The hydrodynamic loads introduced by such a waterhammer event could challenge the integrity and function of the LPSW system (especially the LPSW supply to, and return from, the B RBCU piping where the ACUs connect). The calculations to date indicate that it is less probable that damage would occur to either A or C RBCUs or associated piping. The analysis is still in progress to determine if the piping could have ruptured or if it would have deflected and remained intact.

If the waterhammer ruptured the LPSW piping, the concern would include loss of RB Containment Integrity, deboration of the RB Emergency Sump due to LPSW flow out the break, and decreased cooling capacity of the affected coolers. There are non-safety

related flow instruments in the control room and an alarm if outlet flow is significantly lower than inlet flow. However, these instruments may not be available after a LOCA/LOOP. Therefore it could be difficult for operators to detect a pipe rupture. If the rupture is detected by operators, flow could be isolated using motor operated valves on the inlet and outlet piping of each RBCU located outside containment in the Penetration room to minimize the effects of the break on containment and the sump.

With the operator action to isolate the failed flowpath, the effect on RB cooling would be similar to a single failure of an RBCU. The Reactor Building Spray System (RBS) [EIIS:BE] also provides post accident containment cooling. One RBS train with two RBCUs can provide adequate containment heat removal. However, certain single failure modes exist that could prevent the combined systems from performing their required function in this scenario.

The RBCUs are currently operable with the Reactor Building Auxiliary Cooling Units drained and isolated. When the analysis and any required modifications are completed, the original configuration will be returned to service.

The health and safety of the public were not affected and there were no releases of radioactive material involved with this event.