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SUBJECT: LER 88-006-00:on 880519,inadequate design analysis of high pressure injection in emergency core cooling sys sump.
W/8 ltr.

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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)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Oconee Nuclear Station, Unit 1	0 5 0 0 0 2 6 9	1 OF 0 7

TITLE (4) Inadequate Design Analysis of the High Pressure Injection System in the Emergency Core Cooling System Sump Recirculation Mode

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	1 9	8 8	8 8	— 0 0 6	— 0 0	0 8	0 1	8 8	Oconee Unit 2	0 5 0 0 0 2 7 0
									Oconee Unit 3	0 5 0 0 0 2 8 7

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)	1 0 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)	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
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	

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 May 19, 1988 with all three units at 100 percent full power upon completion of a design calculation two deficiencies in the design of the High Pressure Injection (HPI) and Low Pressure Injection (LPI) systems were discovered. The deficiencies relate to HPI and LPI operation in the Emergency Core Cooling System (ECCS) sump recirculation (piggyback) mode. Specifically, NPSH concerns in all operating scenarios were not adequately addressed in the original system design or operating procedures, and the electrical design of Units 2 and 3 did not satisfy single failure criteria.

The root cause of this incident was determined to be a design deficiency since the appropriate design analysis was not performed during the original design of the system.

The immediate corrective actions were to change valves 2LP-9 and 3LP-9 to a normally open position and to provide operational guidance to assure adequate NPSH to the HPI pumps. This corrected the identified deficiencies and assured complete operability of the ECCS. Subsequent corrective actions included procedure revisions.

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☆U.S.GPO:1984-0-454-481/18759

Background

The Emergency Core Cooling System (ECCS) sump recirculation mode is used during a Loss of Coolant Accident (LOCA) to provide core cooling capability after the Borated Water Storage Tank (BWST) has been depleted. The level in the Reactor Building (RB) emergency sump increases as the BWST is emptied. The Low Pressure Injection (LPI) system [EIIS:BP] and Reactor Building Spray (RBS) system [EIIS:BE] are capable of taking suction directly from this sump. The suction of the High Pressure Injection (HPI) pumps [EIIS:BQ] is not connected directly to the sump. If the Reactor Coolant System (RCS) [EIIS:AB] pressure is above the discharge capability of the LPI system, the LPI system is used to supply suction to the HPI pumps. This mode is referred to as the HPI "piggyback" mode.

The HPI piggyback mode circulates coolant from the RB emergency sump, through the LPI pumps, through the HPI pumps, to the RCS. Like HPI, the RBS pumps may also take suction from the LPI pump discharge downstream of the LPI coolers (Decay Heat Removal Coolers) (see Figure 1).

Sequence of Events

October 2, 1987 - A Duke Power Company calculation review identifies the absence of a design calculation on the HPI pump Net Positive Suction Head (NPSH) from the Reactor Building emergency sump.

May 19, 1988 - The HPI pump NPSH calculation from RB emergency sump - piggyback mode is completed. Results conclude that current system design and operating procedures do not provide sufficient precautions and limitations and do not meet single failure criteria.

May 19, 1988 - 0900 hrs. - A conference phone call is held between Design Engineering and Oconee Nuclear Station. The station is notified of the deficiencies.

May 19, 1988 - Problem Investigation Reports (PIR) are initiated.

May 19, 1988 - 1600 hrs. - Problem is determined to be reportable per 10 CFR 50.72.

May 19, 1988 - Operating procedure are revised to open valves 2LP-9 and 3LP-9 respectively.

May 19, 1988 - 1716 hrs. - Emergency Notification Report to NRC is completed by phone.

May 19, 1988 - 1900 hrs - Operation Guidance is provided to operators through a letter to Shift Engineers and Duty Engineers.

May 24, 1988 - Design Engineering (Electrical) completes the operability evaluation for the PIR concerning the effect of loss of offsite power simultaneously with a single failure to switchgear 2TD and 3TD.

May 25, 1988 - Design Engineering (Mechanical) completes the operability evaluation for the PIR concerning adequate NPSH to the HPI pumps in the piggyback mode.

June 6, 1988 - Oconee Nuclear Station Emergency Procedure Guidelines are revised.

June 7, 1988 - Oconee Nuclear Station operating procedures are revised.

June 8, 1988 - Station Problem Reports are initiated by Oconee Operations. These initiate evaluation of providing several motor control centers with an alternate power supply which will be available during a loss of offsite power.

Description of Incident

As an expanded self initiated followup to observations of the 1986 NRC Safety System Functional Inspection (SSFI) of the Oconee Emergency Feedwater [EIIS:BA] System, Design Engineering at Duke Power Company performed a technical review of all nuclear safety related mechanical calculations. On October 2, 1987 this review identified the absence of a design calculation on the HPI pump NPSH from the Reactor Building emergency sump. Design Engineering completed an HPI pump NPSH calculation from RB emergency sump-piggyback mode on May 19, 1988.

This calculation performed a detailed flow and pressure analysis of the HPI piggyback mode. A review of operating procedures and single failure modes was included in the calculation to determine worst case scenarios. The calculation identified two deficiencies in the current system design and operating procedures. At the completion of the calculation, all units at Oconee Nuclear Station were operating at 100 percent full power.

The first deficiency identified by the calculation was that current operating procedures did not provide adequate guidance to ensure that adequate NPSH would be provided to the HPI pumps [EIIS:P] operating in the HPI piggyback mode. The analysis of the calculation indicated that pressure drops through the subject piping and components could deprive the HPI pumps of their required NPSH during high flow scenarios. Calculated large pressure drops from the LPI pump discharge to the HPI pump suction were due to the long runs of 3 and 4 inch piping at high flow rates. The operating procedures allowed

the LPI and HPI systems to both be injecting simultaneously into the RCS with no flow limitations due to operating in the piggyback mode and no guidance on the use of RBS which could also be aligned to the piggyback line. A precaution was also needed to prevent the throttling of valves LP-12 and LP-14, since the HPI piggyback line is downstream of these valves.

The second deficiency was that the electrical design of Oconee Units 2 and 3 did not satisfy Oconee's FSAR Section 15.14.3.3.6. This section states that the LOCA analysis of Oconee's ECCS is based on loss of offsite power with a single failure. The calculation identified that a single failure of switchgear [EIIS:SWGR] TD on Units 2 or 3 during loss of offsite power would prevent the alignment of the HPI system in the piggyback mode. Valve LP-9 which is critical to this alignment has a backup power supply which may not be available during loss of offsite power because it is classified as a load shed power supply.

These deficiencies had the potential for rendering the HPI system inoperable in the piggyback mode. In compliance with 10 CFR 50.72, these deficiencies were reported to the NRC on May 19, 1988. This incident is reportable pursuant to 10 CFR 50.73(a)(2)(v).

Cause of Occurrence

The root cause of this incident was determined to be a design deficiency since the original design of the HPI piggyback mode was not analyzed adequately. This is now evident since the limitations of this mode of operation were not included in operation procedures and alignment of this system during single failure of switchgear TD was not considered. Investigation shows that no significant modifications of the piping and components which are unique to the HPI piggyback line have occurred since the original design.

The significance of this event is that the HPI system could have been prevented from fulfilling its safety function of emergency core cooling if the HPI piggyback mode had been required to function and the analyzed scenarios had occurred.

This incident is not a recurring event. The method of discovery (a review of nuclear safety related mechanical calculations) is a corrective action which should ensure that any other incident of a similar nature would have been detected.

This incident does not involve an actual component failure or malfunction and is therefore not reportable to NPRDS. There were no radioactive releases, radiation exposures, or personnel injuries.

Corrective Actions

The immediate corrective actions were to:

- Change Valves 2LP-9 and 3LP-9 to a normally open position so they would not be required to operate when aligning the HPI system in the piggyback mode. All other components requiring electrical power would be available after loss of offsite power and any single failure;

- Write and distribute operational guidance providing the operators with the additional precautions and limitations to maintain adequate NPSH to the HPI pumps if they should be required to operate in the piggyback mode.

Subsequent corrective actions were to:

- Revise the Oconee Nuclear Station Emergency Procedure Guidelines to incorporate the additional precautions and limitations;

- Revise the appropriate operating procedures to incorporate the additional precautions and limitations to maintain adequate NPSH to the HPI pumps operating in the piggyback mode.

Analysis of Occurrence

The ECCS, including the HPI system, is designed to meet criteria established in 10 CFR 50.46, Acceptance Criteria for Emergency Core Cooling Systems for Light Water Reactors. One criterion in this section requires the establishment of long term cooling. This criterion states, "After any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core." Although the FSAR Chapter 15 LOCA analyses demonstrate ECCS acceptability during the initial phase of the LOCA, it is implied that long term cooling can be established by virtue of the ECCS system design. Following a review of the deficiencies described in this report, it is apparent that the design of the HPI system did not sufficiently satisfy the long term cooling requirement of 10 CFR 50.46 prior to implementation of the corrective actions. The conditions for which this requirement was not met are outlined below.

Following a small break LOCA, the HPI piggyback mode is required to sustain injection flow when the BWST has been depleted and RCS pressure remains above the shutoff head of the LPI pumps. Since the HPI system is not directly connected to the emergency sump, fluid recirculation through the LPI system is necessary to maintain the HPI suction supply.

The occurrence of a small break LOCA alone does not necessarily imply reliance on the HPI piggyback mode of operation. Depending upon break size and location and equipment availability, the operator may be able to successfully cool and depressurize the RCS to LPI system operating conditions prior to depletion of the BWST. These scenarios do not rely upon the piggyback mode for successful transient mitigation. However, a certain small break "window" exists for which the piggyback mode of operation is necessary. RCS conditions will reside within this window provided the proper combination of break size and location, equipment availability, and operator actions exist. RCS pressure will remain greater than the LPI pump shutoff head when the BWST is depleted and thus HPI piggyback is required to ensure core cooling.

Although appropriate cautions and limitations did not exist in the Emergency Operating Procedure (EOP) to ensure adequate HPI pump NPSH during operation in the piggyback mode, failure of the HPI system was not certain. Inadequate HPI NPSH requirements would have resulted only if the appropriate combination of piggyback supply lines, RBS flow, and HPI flow existed. Conversely, assuming the single failure outlined in the Description of Incident Section, the HPI piggyback mode would not have operated as designed.

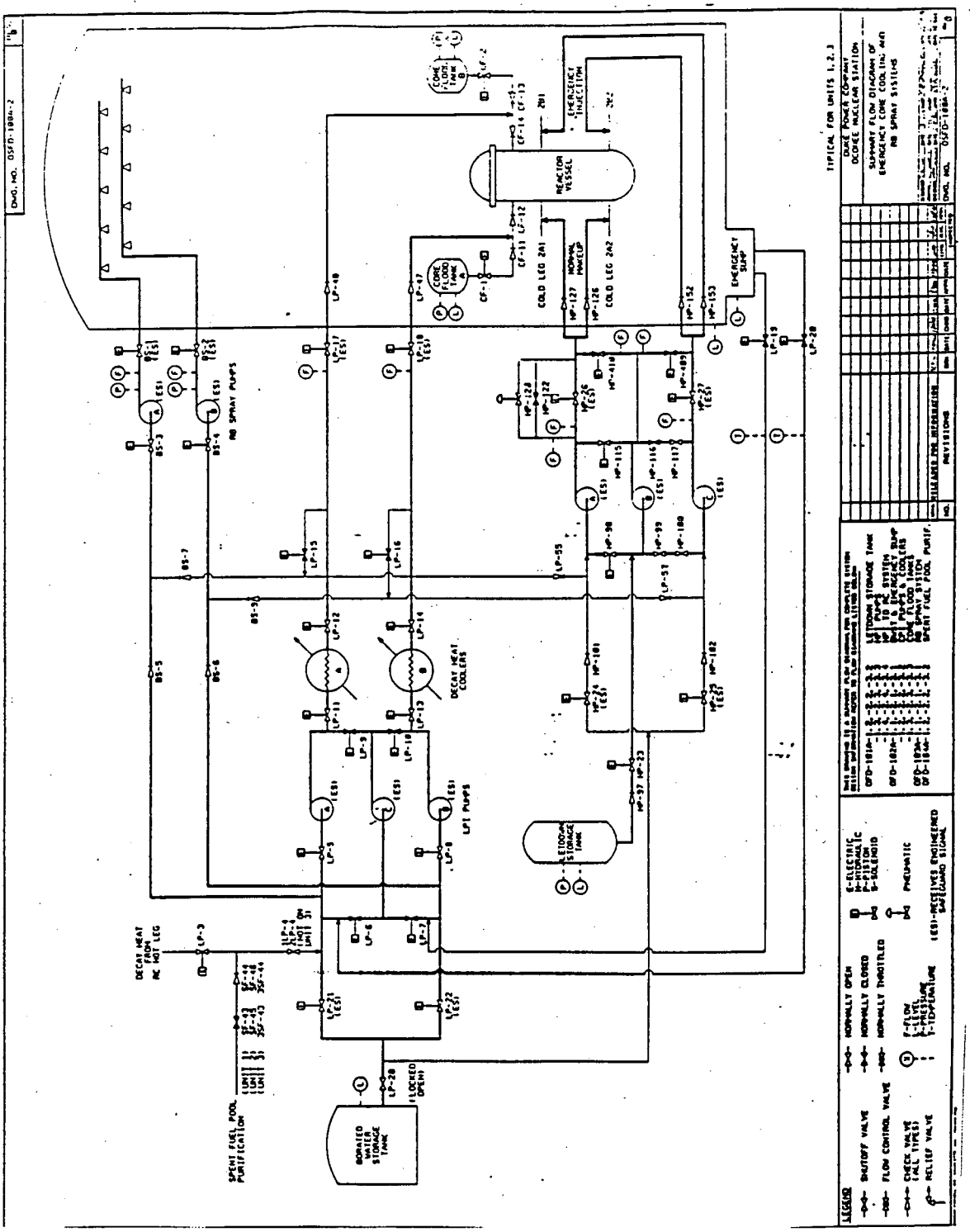
There are no redundant systems which would have performed the same function as the HPI system in the piggyback mode. However, the loop and reactor vessel high point vents and the PORV could have been opened in an attempt to depressurize the RCS to LPI operating pressures. Although this option exists in the EOP and may have resulted in RCS depressurization, the effectiveness of venting is not assured. It is not practical to demonstrate by analysis that successful RCS depressurization to LPI operating pressures would occur for all combinations of break sizes, equipment availability, and operator actions.

It is concluded that although the HPI piggyback mode of operation is not required for all small break LOCAs and that the HPI system would not have necessarily failed during piggyback operation, a potential for HPI system unavailability existed. The HPI system design therefore did not satisfy the 10 CFR 50.46 ECCS acceptance criteria for long term cooling under all circumstances. Corrective actions identified in this report ensure complete operability of the ECCS. There have been no incidents which called for use of the HPI system in the piggyback mode, nor were there any releases of radioactive materials, radiation exposures, or personal injuries, as such the health and safety of the public was not affected by this event.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Oconee Nuclear Station, Unit 1	0 5 0 0 0 2 6 9	8 8	— 0 0 6	— 0 0	0 7 OF 0 7

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

FIGURE 1
EMERGENCY CORE COOLING AND
REACTOR BUILDING SPRAY SYSTEMS



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August 1, 1988

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

Subject: Oconee Nuclear Station
Docket No. 50-269, -270, -287
LER 269/88-06

Gentlemen:

Pursuant to 10CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report (LER) 269/88-06 concerning the inadequate design analysis of the High Pressure Injection System in the ECCS sump recirculation mode.

This report is being submitted in accordance with 10CFR 50.73(a)(2)(v)(D). 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

Hal B. Tucker

PJN/363/bhp

Attachment

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