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FACIL:50-315 Donald C. Cook Nuclear Power Plant, Unit 1, Indiana M 05000315
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SUBJECT: LER 97-001-01:on 970822,operation outside design bases for ECCS & CSP after switchover to recirculation sump suction was noted.Caused by lack of understanding of instruement design.Revised manuals.W/971114 ltr.

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TITLE: 50.73/50.9 Licensee Event Report (LER), Incident Rpt, etc.

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INDIANA MICHIGAN POWER

November 14, 1997

United States Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Operating Licenses DPR-58
Docket No. 50-315

Document Control Manager:

In accordance with the criteria established by 10 CFR 50.73 entitled Licensee Event Report System, the following report is being submitted:

97-011-01

Sincerely,

A. A. Blind
Site Vice President

/mbd

Attachment

c: A. B. Beach, Region III
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NRC FORM 366 (5-92)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 5/31/95

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 1 of 6
Donald C. Cook Nuclear Plant - Unit 1	50-315	

TITLE (4)
Operation Outside the Design Bases for the ECCS and Containment Spray Pumps after Switchover to Recirculation Sump Suction

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
08	22	97	97	-- 011 --	01	11	14	97	Cook, Unit 2	50-316
									FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	1
POWER LEVEL (10)	100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.2201(b)		20.2203(a)(3)(i)		50.73(a)(2)(iii)		73.71(b)
	20.2203(a)(1)		20.2203(a)(3)(ii)		50.73(a)(2)(iv)		73.71
	20.2203(a)(2)(i)		20.2203(a)(4)		50.73(a)(2)(v)		OTHER
	20.2203(a)(2)(ii)		50.36(c)(1)		50.73(a)(2)(vii)		(Specify in Abstract below and in Text, NRC Form 366A)
	20.2203(a)(2)(iii)		50.36(c)(2)		50.73(a)(2)(viii)(A)		
	20.2203(a)(2)(iv)		50.73(a)(2)(i)		50.73(a)(2)(viii)(B)		
	20.2203(a)(2)(v)	X	50.73(a)(2)(ii)		50.73(a)(2)(x)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Mr. Stan Farlow, I & C Engineering Manager	616/465-5901, x2858

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	NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

While evaluating a proposed procedure change that affected switchover from the Refueling Water Storage Tank (RWST) to the containment recirculation sump during a Loss of Coolant Accident (LOCA), it was determined that level indications used to determine when the switchover is required were not adequate to prevent vortexing in the containment recirculation sump or to ensure adequate water is transferred from the RWST for long term cooling of the core and containment. The indications involved were the RWST level instruments and the containment level instruments. The cause for the RWST level instrumentation inadequacy was lack of complete understanding of instrument design basis and failure to fully address velocity effects. The cause for the inadequate containment level to prevent vortexing was attributed to ineffective change management.

To correct this condition the RWST level taps were relocated, the Emergency Operation Procedure (EOP) for switchover, 01(02) OHP 4023.ES-1.3, Transfer to Cold Leg Recirculation was revised, and the Updated Final Sfety Analysis Report (UFSAR) will be revised to clearly indicate assumptions associated with minimum water level requirements during a LOCA. An evaluation of recent past operations was performed regarding the active containment sump water level following small and large LOCAs. The evaluation results show that, during recent operation of the Cook Nuclear Plant, there would have been sufficient water in the containment active sump following a LOCA to assure ECCS and CTS pump operability.

This event is being reported under 10 CFR 50.73(b)(1)(ii)(B) as any event or condition that resulted in a condition outside the design basis of the plant.

Condition Prior to Event
Unit 1 Mode 1, 100 percent Rated Thermal Power
Unit 2 Mode 1, 100 percent Rated Thermal Power

Description of Event
While evaluating a proposed procedure change that affected switchover from the Refueling Water Storage Tank (RWST) to the containment recirculation sump during a Loss of Coolant Accident (LOCA), it was determined that level indications used to determine when the switchover is required were not adequate to prevent vortexing in the containment recirculation sump or to ensure adequate water is transferred from the RWST for long term cooling of the core and containment. The indications involved were the RWST level instruments and the containment level instruments. It was determined that the RWST level indication may read lower than actual level due to transmitter location and flow induced bias. Additionally, the volume of water in containment based on containment level indicators used in 01(02) OHP 4023.ES-1.3, Transfer to Cold Leg Recirculation, to backup the RWST level was not sufficient to prevent vortexing in the containment recirculation sump. If vortexing occurs in the sump a potential exists for the loss of the Emergency Core Cooling System (ECCS) and the Containment Spray system (CTS).

The ECCS and CTS provide core cooling and reduce containment pressure under design basis accident conditions. Accident conditions require switchover of the suction source for the ECCS pumps and CTS pumps from the RWST to the containment recirculation sump. The determination of the time that switchover occurs is based on the inventory remaining in the RWST, as indicated on the RWST level instruments, and backed up by containment level indicators. The RWST instruments sensed pressure in the suction line from the RWST to the ECCS and CTS pumps, and use this sensed pressure to develop an indicated level in the RWST. It was postulated that the flow through this line could make the indicated level appear lower than the actual RWST level, with the effect that insufficient water might be in containment when the operators were executing the switchover procedure. Additionally, the containment level used as a confirming indication of the proper level in containment for switchover was inadequate to prevent vortexing in the containment recirculation sump. The containment level setpoint used as confirmation of sufficient water for switchover was less than the required level to prevent vortexing. The containment elevation level to prevent vortexing is 602 feet 10 inches. The value identified in 01(02) OHP 4023.ES-1.3 for switchover was based on a level equivalent to 599 feet 5 inches.

For the Cook plant the RWST level is determined using a differential pressure transmitter. This is a typical method used for measuring static level in a tank. However, given the original design of mounting the differential transmitter on the suction pipe, the level of the tank may not be static at the time of level measurement. A pressure drop is caused by one or more pumps taking suction from the bottom of the tank. The instrument process tap for the differential pressure transmitter was connected to the discharge pipe well downstream of the tank. The velocity of the fluid through the discharge pipe was significant due to the relatively small pipe diameter and large flow. Analysis of the flow induced Bernoulli effects on the RWST level instrumentation, performed during the 1997 NRC Architect Engineer Inspection, revealed that a potential bias of up to 22 percent of indicated level could be induced at peak ECCS flows during accident conditions. This bias could potentially cause the level indication to read lower than actual tank levels, which may have resulted in the operator prematurely starting the switchover to long term containment sump recirculation.

Description of Event (cont'd)

The above condition was determined to be reportable at 1856 hours EDT on August 22, 1997. An NRC notification was made at 1943 hours EDT on August 22, 1997 under reporting criteria 10 CFR 50.72(b)(1)(ii)(A) and 10 CFR 50.72(b)(1)(ii)(C) as any event or condition that resulted in the nuclear power plant being in an unanalyzed condition that significantly compromised plant safety and in a condition not covered by the plant's operating and emergency procedures, respectively.

Cause of Event

RWST Level

The cause for this condition was lack of complete understanding of instrument design basis and failure to fully address velocity effects.

- Lack of complete understanding of instrument design basis:
  The engineering control procedure (ECP) associated with the RWST level instrument indicated that the function of the RWST instrument was to protect pumps taking suction from the RWST from loss of Net Positive Suction Head (NPSH), that is to ensure that pumps taking suction from the RWST during the injection phase did not lose a suction source. It did not recognize that the instrument was also being used to assure adequate water is transferred from the RWST to containment for long term cooling of the core and containment. In 1993, during an NRC Systems Based Instrumentation and Control Inspection, it was recognized that a velocity term impacted the instrument due to the location and a violation was issued. A reanalysis was performed, however, not all velocity terms were included. The friction loss associated with entrance losses as water entered the pipe from the RWST and the dynamic head loss associated with the velocity in the pipe were not recognized. The friction error associated with water flow in pipes and elbows was recognized and accounted for in the calculation. The result was that the actual level was higher than indicated. Based on the understanding that the design basis was to provide adequate NPSH during injection, as opposed to ensuring adequate water level in containment, the new calculation resulted in a conservative change and no further actions were taken.
- Failure to fully address velocity effects:
  Based on supporting calculations, there was no recognition of the error introduced by flow velocity based on the instruments location. The supporting calculations were revisited in 1993 after the NRC inspection identified that not all velocity terms were recognized, as noted above.

Containment Level

- Failure to Incorporate Revised Design Calculation:
  Design calculations performed during Unit 2 pre-operational testing indicated that at elevation 602 feet 10 inches NPSH requirements would be met, and that vortexing would not be encountered while operating the RHR and CTS pumps. This design basis information did not get transferred to the Emergency Operating Procedures (EOPs). The EOPs retained an original containment level of containment level elevation of 599 feet 5 inches which is less than the required 602 feet 10 inches. In 1995 discussions relative to the required level were conducted and it was determined that the lower level was adequate as containment level was a backup indication beyond the design basis and that continued use of the value was appropriate.

Analysis of Event

This event was determined to be reportable under 10 CFR 50.73(b)(1)(ii)(B) as any event or condition that resulted in a condition outside the design basis of the plant.

The ECCS is required to provide adequate cooling to the reactor core in compliance with requirements of 10 CFR 50.46. The ECCS is considered an Engineered Safeguards System (ESF) required to meet general design criteria in effect in accordance with the plant license. This includes the single failure criteria which, for Cook Nuclear Plant, is the single active failure prior to recirculation, or the single active or passive failure (but not both) following recirculation.

The CTS is required to provide sufficient spray water so that, when operating in conjunction with the ECCS and ice condenser, 1) the containment long term pressure stays below its design value of 12 psig, and 2) sufficient radioactive material is removed from the containment atmosphere to assure radiation doses to the public remain below those specified in 10 CFR Part 100. The CTS is also considered an ESF required to meet general design criteria in effect in accordance with the plant license. This includes the single failure criteria as discussed above.

Following the transfer to cold leg recirculation, both the ECCS and CTS will draw water from the active containment sump. In order to prevent damage to the pumps, the water level in the active sump must remain above that required to prevent damage to the pumps which would make them inoperable. Pump damage can occur either due to vortexing or inadequate NPSH. The active containment sump level to prevent damage due to vortexing is 602 feet 10 inches. The level to assure adequate NPSH is several feet below that. Therefore the level of 602 feet 10 inches becomes the minimum level at which the ECCS/CTS pump suction operability can be assured under full flow conditions.

The RWST flow biases created the possibility that less water is transferred to the containment than assumed in the safety analysis. In addition, after the water gets into containment, it is not distributed in the manner that was assumed in the original FSAR safety analysis which assumed the water went to either the cavity or the active sump. The net effect is that less water transferred from the RWST to the containment then was assumed in the accident analysis and, of the RWST water transferred to the containment, not all of it goes to a location where it is immediately useful to support long term cooling needs (Refer to Cook Nuclear Plant LER #315/97-017 and LER #316/97-005 for additional detail on water transfer in containment).

Calculations have been completed for Unit 1, Cycle 16 and Unit 2, Cycle 11 to assess the safety significance of the ECCS performance described in the previous reports. This assessment evaluated the adequacy of the water level in the containment recirculation sump to support operation of the RHR and CTS pumps during the recirculation phase of a postulated loss of coolant accident. These calculations have considered a spectrum of break sizes ranging from a 0.5 inch diameter break to a double ended guillotine break, the usable water volume contained in the refueling water storage tank (RWST), the water available from ice that melts during the progression of the accident, the diversion of spray flow into the inactive sump, the break flow being directed into the active sump or the reactor cavity, as appropriate, and the impact of penetrations in the crane wall and biological shield which allow the sump to communicate with adjacent compartments. The estimate of the usable RWST water has considered errors in the instrumentation providing the indication of RWST water level, including the errors resulting from flow past the instrumentation tap. The ice mass present in the ice condenser was determined from ice surveillance records.

Analysis of Event (cont'd)

The limiting case has been determined to be a break of a 0.61 inch diameter instrument line inside the reactor cavity. Based on the assumption that there is no communication between the reactor cavity and the recirculation sump until water spills over the wall separating the two regions, the minimum water level in the recirculation sump would have been at the 602 feet 2.4 inch level. For this break, the LOCA analyses show that the required suction flow from the sump is never greater than 700 gpm, and the minimum required water level at this flow is well below 602 feet 2.4 inch . For the other breaks considered, the water level exceeds the minimum required level of 602 feet 10 inches based on runout operation of the pumps.

The analyses have demonstrated that for all break sizes and locations, there will be sufficient water in the sump to prevent vortex formation when the ECCS and CTS pumps are operated in the recirculation mode.

Analyses for other cycles is presently in progress. Results of other cycles is scheduled for completion by December 10, 1997. This LER will be updated as necessary to reflect findings of the other cycles analyses.

Corrective Actions

RWST Level

The following corrective actions are associated with incomplete understanding of the instrument design bases:

- The UFSAR will be revised during the next update to clearly indicate assumptions associated with minimum level required in containment. Specific assumptions associated with this condition are the delivery of 218,020 gallons of water to the containment prior to operation in the recirculation mode, and the requirement for a minimum containment elevation to provide adequate NPSH and prevent vortexing at the pump suction.
- ECP 1-2-O0-14, Emergency Operation Procedure Setpoints, was revised. The revision included the requirement of 20 percent RWST level as the footnote value where transition to cold leg recirculation may be initiated. Included in the revision was information to clearly identify the basis, which is the requirement to ensure adequate water level exists in containment to operate in the recirculation phase.
- 01(02)-OHP 4023.ES-1.3, Transfer to Cold Leg Recirculation, was revised and included steps to ensure sufficient water is delivered, based on RWST level indication, to support operation in the recirculation phase.

The following corrective actions are associated with the failure to fully address velocity effects:

- The RWST level taps have been relocated to a drain line off of the RWST. This work was completed on October 17, 1997. This eliminates the velocity effects from the suction location.
- A review of other level measurement systems that interface directly to the flowpath was performed; no further issues were identified.
- The engineering design standards are to be revised to ensure appropriate considerations of flow induced bias in level instrument installations or modifications. This revision is scheduled for completion by March 31, 1998.
- The instrument uncertainty engineering guide EG-IC-004, is to be revised to detail flow induced Bernoulli effects. This revision is scheduled for completion by December 15, 1997.

Corrective Actions (cont'd)

Containment Level

A change sheet was issued to 01(02) OHP.4023.ES-1.3 Revision 4 on August 22, 1997. This change sheet revised the required containment level. The required containment level is now 29 percent (37 percent adverse containment), which corresponds to elevation 602 feet 10inches plus instrument uncertainties. This level assures adequate level to prevent vortexing in the containment recirculation sump.

The following corrective actions will be implemented to identify the scope of previous ineffective communications associated with EOP footnote values, and make corrections where appropriate:

- A review of EOP footnote values will be performed to identify and validate all footnote values used in the EOPs. Purpose of the validation will be to identify the design basis for each value used and ensure the footnote value is consistent with the plant design basis. This review is scheduled for completion by July 1, 1998.
- The ECCS System Description, SD-12-ECCS-100, will be revised to address the requirement for containment elevation required to ensure NPSH and vortexing requirements. This revision is scheduled for completion by February 28, 1998.
- The engineering control procedure for the EOP setpoints, ECP 1-2-O0-14, was revised to document the minimum containment level for operation in the recirculation mode and the RWST level required for transition to cold leg recirculation.

As discussed in the NRC's Confirmatory Action Letter (CAL) to the Cook Nuclear Plant, dated September 19, 1997, we are assessing the problems identified during the recent AE Design Inspection to determine whether these types of engineering problems exist in other safety related systems and whether they affect system operation. In the longer term, we will evaluate our programs for improvements to assure these kinds of engineering problems are promptly identified, thoroughly evaluated and resolved. The results of our reviews and assessments, as well as necessary preventive actions will be communicated separately to the NRC.

Failed Component Identification

Not Applicable

Previous Similar Events

315/97-018-01
315/97-023-01