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INDIANA
MICHIGAN
POWER

February 01, 2001

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

Operating Licenses DPR-58 and DPR-74
Docket Nos. 50-315 and 50-316

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:

LER 315/1998-047-01 "Reactor Coolant Pump Silicon Nitride Seals"

This revision replaces LER 315/1998-047.

There were no commitments associated with this submittal.

Should you have any questions regarding this correspondence, please contact Mr. Scot Greenlee, Director Design Engineering/Regulatory Affairs, at 616/697-5728.

Sincerely,

Joseph E. Pollock
Plant Manager

/drb
Attachment

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IE22

NRC Form 366 (6-1998) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

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TITLE (4)

Reactor Coolant Pump Silicon Nitride Seals

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
11	17	1998	1998	-- 047 --	01	02	01	2001	DC Cook Plant Unit 2	05000-316
									FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	5	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)							
			20.2201 (b)		20.2203(a)(2)(v)		50.73(a)(2)(i)		50.73(a)(2)(viii)
POWER LEVEL (10)	0		20.2203(a)(1)		20.2203(a)(3)(i)	X	50.73(a)(2)(ii)		50.73(a)(2)(x)
			20.2203(a)(2)(i)		20.2203(a)(3)(ii)		50.73(a)(2)(iii)		73.71
			20.2203(a)(2)(ii)		20.2203(a)(4)		50.73(a)(2)(iv)		OTHER
			20.2203(a)(2)(iii)		50.36(c)(1)		50.73(a)(2)(v)		Specify in Abstract below or in NRC Form 366A
			20.2203(a)(2)(iv)		50.36(c)(2)		50.73(a)(2)(vii)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
D. R. Bronicki, Regulatory Affairs/OE	616 / 465-5901, x1668

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX

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 15 single-spaced typewritten lines) (16)

This LER is revised in its entirety to include information from the completed root cause evaluation.

On September 11, 1997, during an investigation of component cooling water flow rates, it was determined that during a loss of seal injection (LOSI), the reactor coolant pump (RCP) thermal barrier heat exchanger may not be able to maintain the number one seal leak-off temperature below 235 degrees Fahrenheit (F). Based on the vendor design for the RCPs, it was previously believed to be within the design capability of the RCP thermal barrier heat exchanger to permit sustained (essentially indefinite) pump operation without seal injection over the full range of vendor-recommended seal leak-off flow rates. The higher temperatures of the reactor coolant taking the place of normal reactor coolant pump seal injection combined with the reduced leak-off flow through the number one seal could have resulted in the water transforming to steam. Seal performance cannot be predicted with two-phase flow in the downstream piping, and therefore, two-phase flow must be precluded. This LER is submitted in accordance with 10 CFR 50.73(a)(2)(ii)(B), for a condition that was outside the design basis of the plant. The root cause of this event was personnel failing to adequately review vendor information and the associated design change for implementation of the silicon nitride pump seals. When the low seal leak-off problem was identified, Cook Nuclear Plant (CNP) contacted the vendor to help evaluate the impact on operation. The vendor subsequently issued Nuclear Safety Advisory Letter (NSAL) 99-005, "Reactor Coolant Pump operation during Loss of Seal Injection." Seals identified as having reduced flow rates (RCPs 14 and 24) have been changed out and station procedures have been revised to address the seal leak-off flow issues raised. A change request to the Updated Final Safety Analysis Report (UFSAR) has been submitted to align it with current design basis information.

The analysis documents that the use of RCP number one seals having low leak-off rates does not result in a significant increase in risk.

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

Conditions Prior to Event

Unit 1 was in mode 5, cold shutdown
Unit 2 was in mode 5, cold shutdown

Description of Event

On September 11, 1997, during an investigation of component cooling water (EIIS:CC) flow rates, it was determined that during a loss of seal injection (LOSI), the reactor coolant pump (RCP) (EIIS:P) thermal barrier heat exchanger (EIIS:HX) may not be able to maintain the number one seal (EIIS:SEAL) leak-off temperature below 235 degrees Fahrenheit (F). It was originally calculated in the design of the RCPs that a pump could operate indefinitely without seal injection flow.

The RCPs in use at CNP are vertical shaft pumps employing a controlled leakage seal assembly to restrict reactor coolant system (RCS) (EIIS:AB) leakage (seal leak-off) along the pump shaft. The controlled leakage seal is called the number one seal. Seal leak-off cools and lubricates the number one seal. Insufficient seal leak-off, therefore, results in less than adequate cooling and lubrication to the number one seal.

During normal operation, cooled and filtered high pressure charging water (seal injection) is admitted to an annular region in the pump casing around the pump shaft. At the top of this annular region is the number one seal. At the bottom of the annular region, above the pump impellor, is a thermal barrier heat exchanger (TBHX) and labyrinth seal. Seal injection water pressurizes the annular region to slightly above RCS pressure. A portion of the seal injection water goes through the pump's lower radial bearing, up the pump shaft to the number one seal, leaks across the faces of the seal and is directed back to the charging system through the seal leak-off return line. The leak-off effectively cools and lubricates the radial bearing and the number one seal. The rest of the seal injection water goes down the pump shaft, through the TBHX and into the RCS through the labyrinth seal.

During a LOSI, the annular region cannot be maintained at a higher pressure than the RCS. As a result, hot, unfiltered RCS water (primary coolant) flows into the annular region through the labyrinth seal and is then cooled by component cooling water (CCW) as it passes through the TBHX. The cooled primary coolant then flows up the pump shaft, cooling and lubricating the radial bearing and number one seal in the same manner as previously described for seal injection water.

In the late 1980's, CNP, with the support of the pump vendor, started replacing the number one seal packages on all RCPs from an aluminum oxide design to a silicon nitride version. During plant operation, the aluminum oxide seal material would wear, resulting in gradually increasing seal leak-off flowrates. Conversely, after installation of the new silicon nitride seals, it was common for seal leak-off flowrates to gradually decrease over several operating cycles.

When a LOSI event is postulated with less than nominal flowrates through the silicon nitride seals, calculations show that seal leak-off temperatures would exceed 235 degrees F. With less than adequate seal leak-off flow, the reactor coolant flowing upward along the pump shaft has more time to absorb pump heat after it has been cooled by the TBHX. The excessive temperature could cause a two-phase flow condition on the low pressure side of the seal face. Seal performance cannot be predicted with two-phase flow in the downstream piping, and therefore, two-phase flow must be precluded.

Before the installation of the silicon nitride seals, the phenomenon of gradually decreasing RCP seal leak-off flow rates was unknown to the vendor or the other affected power plants. NSAL 99-005 "Reactor Coolant Pump operation during Loss of Seal Injection" was issued after CNP contacted the RCP vendor.

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

The postulated LOSI condition was determined to place the plant outside its design basis. This LER is being submitted in accordance with 10CFR50.73(a)(2)(ii)(B), for a condition that was outside the design basis of the plant. This LER is revised in its entirety to include information from the completed root cause evaluation.

Cause of Event

The root cause of this event was personnel failing to adequately review vendor information and the associated design change documentation before installation of the silicon nitride pump seals.

This issue is a symptom of the larger generic issue of inadequate design and licensing basis control that had been previously identified and confirmed during the Expanded System Readiness Reviews (ESRR). The ESRR was performed during CNP's extended shutdown.

Analysis of Event

A prolonged failure of seal injection is a low frequency event. Even if this occurs on RCPs with low leakage number one seals, the transient is on the order of one to two hours providing operators time to respond.

The issue of a LOSI occurring in an RCP with a low-leaking number one seal only applies to model 93A, 93A- 1 and 100 pumps that have number one seals with an initial leakrate less than 2.5 gpm. Given the operating history of Westinghouse plants, an uncontrolled loss of seal injection event for an extended time has occurred infrequently. While there have been cases of charging pump malfunctions that have temporarily stopped seal injection, one of the redundant charging pumps is usually started and seal injection promptly restored. Also, the postulated scenario would include a gradual rise in bearing temperature and the number one seal leak-off temperature. The operator will have sufficient time to either restore seal injection or secure the pump. Even with continuing temperature increases, the number one seal is expected to function so the leakage from the RCS will be controlled such that the charging system can provide makeup fluid.

If a LOSI event occurs and the seal/bearing temperature rises to the temperature required for two-phase flow in the leak-off line, the possibility of a water hammer event exists due to the potential mixing of steam and water. Westinghouse has not performed a detailed evaluation of the effects of two-phase flow or of a water hammer event in the number one seal leak-off line. However, based on engineering judgement, the postulated two-phase flow for this scenario is low quality steam, containing gases originally dissolved in the reactor coolant. This steam and gas mixture will attenuate the magnitude of water hammer forces. The leak-off line configuration, i.e. pipe bends and diameter changes, also would help to attenuate a water hammer. The seal leak-off line is a seismic class 2 line made of ductile stainless steel and is expected to survive minor water hammer events.

Assuming a line break occurs, the leak-off line would be expected to fracture at the small bore, low pressure piping instead of at the larger bore piping comprising the leak-off line containment penetration. Also, the containment penetration is far removed from the RCPs so that water hammer forces will be attenuated to levels that would not be expected to challenge containment isolation.

Finally, if a number one seal failure occurs in conjunction with piping failure, the event would not impair the performance of CNP's safety systems. This event, if it proceeds to a LOCA due to a number one seal failure, is bounded by CNP's LOCA analysis.

Based on the above, it is concluded that the use of RCP number one seals having low leak-off rates does not result in a significant increase in risk.