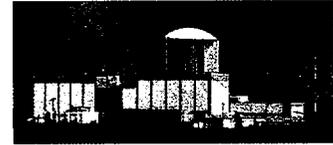




Kewaunee Nuclear Power Plant  
 N490, State Highway 42  
 Kewaunee, WI 54216-9511  
 920-388-2560



Operated by  
 Nuclear Management Company, LLC

September 20, 2000

10 CFR 50.73

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

Ladies/Gentlemen:

Docket 50-305  
 Operating License DPR-43  
 Kewaunee Nuclear Power Plant  
Reportable Occurrence 2000-014-00

In accordance with the requirements of 10 CFR 50.73, "Licensee Event Report System," the attached Licensee Event Report (LER) for reportable occurrence 2000-014-00 is being submitted. This report contains the following commitments:

1. Finalize the analysis of the as-found condition.
2. Submit a supplement after the analysis is completed.
3. The strainers were removed on August 20 and 21. Additional analysis will be performed to determine if this is the preferred long-term solution or if new strainers with larger holes should be re-installed.
4. This event was caused by inaccurate information, as opposed to a lack of information. However the event pointed out the need for better and more easily retrievable design basis information. To that end, the Nuclear Management Company (NMC) is reviewing the need for additional design basis reconstitution for the Kewaunee Plant.
5. The analysis of Information Notice 85-96 will be reviewed and revised as necessary.

Sincerely,

Kenneth H. Weinbauer  
 General Manager-Kewaunee

TJW

Attach.

cc - INPO Records Center  
 US NRC Senior Resident Inspector  
 US NRC, Region III

IE22

**LICENSEE EVENT REPORT (LER)**

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

Estimated burden per response to comply with this mandatory information collection request: 50 hrs. Reported lessons learned are incorporated into the licensing process and fed back to industry. Forward comments regarding burden estimate to the Records Management Branch (T-6 F33), 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. If an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

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TITLE (4)  
All Three Auxiliary Feedwater Pumps Declared Inoperable Due to the Potential to Plug Their Suction Strainers.

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	21	2000	2000	-- 014	-- 00	09	20	2000	N/A	05000
THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)										
OPERATING MODE (9)		N		20.2201(b)		20.2203(a)(2)(v)		50.73(a)(2)(i)		50.73(a)(2)(viii)
POWER LEVEL (10)		96%		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)
Tom Webb - Nuclear Licensing	(920)388-8537

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)

<input checked="" type="checkbox"/> YES (If yes, complete EXPECTED SUBMISSION DATE).	<input type="checkbox"/> NO	EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
			11	21	2000

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

At 1415 hours on August 21, 2000, with the plant at 96 percent power, all three auxiliary feedwater (AFW) pumps were declared inoperable. The pumps were declared inoperable when it was determined that the strainers in the suction of each pump had smaller diameter holes (1/16 inch versus 1/8 inch) than previously believed. As a result, there was no analysis of record that could conclusively demonstrate the strainers would not become blocked during a design basis accident. Upon declaring the AFW pumps inoperable, actions were taken as required by Technical Specification (TS) 3.4.b.4. The TS states to initiate immediate action to return at least one train to service and suspend all limiting conditions of operation (LCO) requiring mode changes until one AFW pump is returned to operable status.

The pumps were subsequently returned to operable status at 2047 hours on August 21, 2249 hours on August 21 and 1209 hours on August 22 after the strainers were removed from the suction of each pump. Additional analyses using both probabilistic and deterministic methods were performed. Both analyses determined that the event had a minor impact on safety.

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**DESCRIPTION OF EVENT**

Summary

At 1415 hours on August 21, 2000, with the plant at 96 percent power, all three auxiliary feedwater (AFW)[BA] pumps [P] were declared inoperable. The pumps were declared inoperable when it was determined that the strainers [STR] in the suction of each pump had smaller diameter holes (1/16 inch versus 1/8 inch) than previously believed. As a result, there was no analysis of record that could conclusively demonstrate the strainers would not become blocked during a design basis accident. Upon declaring the AFW pumps inoperable, actions were taken as required by Technical Specification (TS) 3.4.b.4. The TS states to initiate immediate action to return at least one train to service and suspend all limiting conditions of operation (LCO) requiring mode changes until one AFW pump is returned to operable status.

AFW pump A was subsequently returned to operable status at 2047 hours. AFW pump B and the turbine driven pump were returned to operable status on August 21, 2249 hours and at 1209 hours on August 22 respectively.

System Background Knowledge

There are three AFW pumps at the Kewaunee plant, two motor [MO] driven pumps and one turbine [TRB] driven pump, refer to Attachment 1 for a simplified diagram of the AFW system. Any one of the three pumps supplies adequate flow to remove the decay heat following a design basis event. As can be seen from Attachment 1, there are two sources of water to the AFW pumps, condensate [KA] and service water[BI]. No matter which system is used to supply the AFW pumps the flow must pass through the pump's strainer. Each of these sources is described in the following paragraphs.

Condensate is the normal supply and is the preferred source since it is filtered, demineralized, and chemically controlled. However, the condensate system is not safety related nor is it seismically qualified.

Service water is the emergency supply and is filtered by rotating strainers on the discharge of the service water pumps. The strainers filter out particles greater than 1/8 inch. The service water pumps take suction from Lake Michigan. Because introduction of lake water into the secondary system would have a negative impact on steam generator chemistry, the AFW pumps have never been flow tested with service water aligned as the suction source.

If the condensate supply to the AFW pumps was lost for any reason, the AFW pumps would automatically trip on low discharge pressure. Service water would then be manually aligned to the suction of the AFW pumps by opening service water supply valves [20] (SW-601A, SW-601B, or SW-502) from the control room [NA].

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Detailed Event Description

On July 17, 2000 maintenance work requests were written to inspect the strainers on the suction of the AFW pumps. The work requests were written in response to questions raised about the strainers by a Nuclear Regulatory Commission Inspector. The Inspector was a member of the inspection team performing a safety system design inspection of the service water system. The inspector had several concerns that included:

- The general lack of design basis information about the strainers
- The lack of inspection of the strainers since 1986
- The potential to plug the strainers if service water were ever needed as a supply.

Information on plant drawings and confirmed by vendor documents identified that the holes in the strainers should be 1/8 inch in diameter. Based on this information an operability determination was developed when questions were raised during the inspection. The crux of the determination was that since the holes in service water pump discharge rotating strainers were also 1/8 inch in diameter, the strainers in the suction of the AFW pumps would not plug prior to the AFW pumps completing their design basis function. Furthermore, during normal operation, there has been no noted indication of a pressure drop across the strainers on the suction of the AFW pumps.

To provide assurance that the strainers were clean and to confirm the diameter of the holes, the maintenance work requests were written to inspect and clean the strainers. Since there were no indications that there was an operability concern, the work requests were scheduled for the next time the pumps were to be taken out of service for normal surveillance. At 1000 hours on August 21, 2000 the AFW pump A was removed from service to perform routine surveillance procedures and inspect the suction strainers.

At approximately 1100 hours the mechanical maintenance group informed the Shift Supervisor (SS) that the holes in the strainer for AFW pump A were 1/16 inch in diameter rather than the expected 1/8 inch. They also informed the SS that although a small amount of debris was found in the strainers it was generally clean. The engineering and licensing departments were contacted to support the analysis of the as found condition. Based on the previous analysis (that the holes in AFW suction strainers were the same size as the holes in the service water pump strainers) and the lack of testing to demonstrate how the strainers would behave if service water were to be used, the pumps were declared inoperable at 1415.

At 1745 hours a temporary change request (TCR) was presented to the Plant Operation Review Committee (PORC) requesting the strainers be removed. The request was approved.

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With the TCR approved, the suction strainers were removed and the pumps were returned to operable status as follows.

<u>Pump</u>	<u>Time</u>	<u>Date</u>
A	2047	August 21
B	2249	August 21
C (Turbine Driven)	1209	August 22

Observations of the remaining two strainers also found them in good condition, very clean, and with only a small amount of debris.

It should be noted, all the while the strainers were being removed 2 AFW pumps were always available to remove decay heat.

**CAUSE OF THE EVENT**

The root cause determination of this event has not been completed. An initial review of the event identified the following causes and contributing factors.

There was inaccurate design basis information. A vendor document and a plant drawing of the system both indicated the strainer had 1/8 inch diameter holes. The cause of these errors has not been determined. It is known the errors have existed since at least 1975. Although there were errors in plant documents, there were previous opportunities to identify these errors.

NRC Information Notice 85-96 "Temporary Strainers Left Installed in Pump Suction Piping," notified licensees of potential problems with suction strainers for safety related pumps. As part of Kewaunee's response to the Information Notice, the suction strainers for the AFW pumps were removed and cleaned in March 1986. Approximately one tablespoon of "rust chips" was reported. However, the maintenance work request did not instruct the mechanics to verify the size of the holes. There was nothing on the work request that indicated the correct hole size. Therefore the mechanics could not reasonably be expected to identify a discrepancy.

Reportable Occurrence 75-20 described an event at the Kewaunee plant when all three AFW suction strainers were plugged. The event occurred when resin from a leaking mixed bed demineralizer clogged the AFW suction strainers. At the time, it was discovered that a #40 mesh screen had been left inside each of the strainer since construction. The #40 mesh was removed, but the size of the holes in the strainer left installed was not verified.

Due to the lapse in time since past inspections, the reason why the past inspections did not identify this problem can not be determined.

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**ANALYSIS OF THE EVENT**

This event is being reported in accordance with 10CFR50.73(a)(2)(ii)(B), as a condition that was outside the design basis of the plant. Contrary to the design basis of the plant all three AFW pumps were inoperable as a result of finding smaller holes in the suction strainers for the AFW pumps than previously analyzed. This event was also reported to the NRC in accordance with 10CFR50.72(b)(2)(i) at 1452 on August 20, 2000.

**Risk Assessment**

KNPP's probabilistic risk assessment (PRA) was reviewed to determine the risk associated with this finding. The failure was conservatively modeled by assuming the service water supply to the AFW pumps was lost immediately upon initiation of the accident. The failure of the service water supply to auxiliary feedwater causes core damage frequency from internal events to go from  $3.61 \times 10^{-5}/\text{yr}$  to  $3.63 \times 10^{-5}/\text{yr}$  (a 0.6% increase). This increase is small because of the low failure probability of the condensate storage tank and its associated piping.

The same failure causes seismic core damage frequency to go from  $1.06 \times 10^{-5}/\text{yr}$  to  $1.21 \times 10^{-5}/\text{yr}$  (a 14% increase). This increase, though larger than the internal events increase, is still small, because large-magnitude small-frequency earthquakes, which result in catastrophic failures of plant structures, dominate the seismic PRA.

These results are very conservative because they assume all three AFW pumps lose service water supply simultaneously at the start of the accident. In an actual event, the pumps would run for some period of time on service water. The preliminary results of the analysis to determine how long the pumps would run are provided in the following paragraphs. Please note, these results are preliminary and when they are finalized, a supplement LER will be submitted. We expect the final results will be available in approximately 30 days. A supplement will be submitted to the NRC approximately 30 days after that.

**Deterministic Analysis**

In order to understand the conservatism in the PRA, Kewaunee personnel performed an analysis of how the strainers would have performed if service water had been aligned as the supply source to AFW. This analysis established what material would have been retained in the strainers and the impact of that material on AFW pump operability. The analysis included:

1. The event(s) that would require the operators to align call SW to AFW,
2. The flow, total, that would be required to complete the "mission" of the AFW system in the events,
3. The deposition rate and nature of material that would have been deposited in the strainer to find the total debris load in a strainer,
4. The head loss resulting from this amount of material in the strainer, and

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5. The margin available for the postulated events to accommodate natural variation of the debris intake of the plant.

The Postulated Event and Total SW Flow

As noted earlier, the AFW pumps at KNPP are normally fed from the condensate storage tanks (CSTs). There is no known debris issue with the pumps taking suction from the CSTs. The previous problem of resin in the strainers was corrected by installing strainers on the discharge of resin beds. Only a small amount of debris was found in the AFW strainers when they were removed from the system. The strainers are not cleaned periodically because condensate is the normal suction source. It is assumed that the condensate supply source fails due to an earthquake and there is a coincident loss of off site power. Under these circumstances, service water is aligned to the AFW Pumps. Our estimate, based on KNPP's simulator, that less than 20,000 gallons per SG (100gpm for 120 minutes) will be required to stabilize the SG levels over the first two hour period of the event with flow rates of 100 gpm per SG. The cooldown would proceed and total duration prior to using RHR is assumed to be 24 hours at 50 gpm per SG for a total mission time of 26 hours. To calculate the flow through the strainers, 40 gpm is added to each of these flow rates to account for AFW pump recirculation flow. For debris deposition, we conservatively assumed 150,000 gallons per SG and for required flow we assumed 240 gpm to evaluate available head for the AFW Pump.

Debris Deposition

To establish the expected fouling of the AFW strainers a similar strainer in the service water (SW) system was identified and studied. The strainer used as a surrogate was the administration building air conditioning condenser strainer. Flow rates are variable but are in the same range at 40 gpm. Although the strainer size based on surface area is smaller, the debris loading has been normalized (increased) to account for the differences. The strainer hole size is 3/64" on the admin AC strainer versus 1/16" for the AFW strainer. The system was studied for one week.

Strainer Comparison

<u>Characteristic</u>	<u>Admin AC</u>	<u>AFW</u>
Flow source	20" SW header to TB	16" SW header to AB
Pipe Size	2 in	3 in
Tap Location	Top of pipe	Top or Upper 45 degrees on pipe
Flow	approx. 20-50 gpm	80-240 gpm*
Surface Area	35 in <sup>2</sup>	61 in <sup>2</sup>
Hole size	3/64 in	1/16 in

\* 89% of the flow is at 90 gpm or less

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The Admin building AC strainer, due to its smaller hole size will accumulate debris faster and will pass less debris than the AFW strainer would have. This surrogate strainer will conservatively estimate the amount of debris that would have accumulated in the AFW strainer.

The Administration strainer AC unit was emptied a number of times during the time period September 1 through September 8 and the corresponding total flow through the strainer was used to calculate a deposition rate. The highest measured deposition rate was 22.5ml of solid material accumulated from a total service water flow of 77,000 gallons. During this time period the lake was close to its warmest of the season, approximately 70 degrees F, and at least one storm front passed through the area raising suspended solids in the service water. Due to the combination of these conditions, the organic debris load carried in by service water in this time period should be greater than during most of the rest of the year.

Initial screen loading from the dead leg of the service water line to the AFW pumps is not considered to be significant. Kewaunee has addressed the potential for dead leg fouling through inspection, chemical treatment, design changes, and flushing. The result is that we know system dead legs will be available when called upon to flow. Furthermore, quarterly testing of the Auxiliary Feedwater pumps in accordance with KNPP Surveillance Procedures (SP-05B-104 & SP-05B-105) flush portions of the AFW pump suction lines. Therefore it is reasonable to expect the amount of debris existing in the AFW suction lines at the onset of Service Water-supplied AFW operation will not be significant and within the parametric analysis.

The radiography program confirms this conclusion. Currently there are numerous points (approx. 250) identified for radiography and each point is filmed at least once every ten years. The summary of the radiography shows only rare indications of "sand" accumulation anywhere in the system. Our radiography program demonstrates the low accumulation of material in these dead legs.

Head Loss due to Debris in the strainer

Kewaunee personnel retained ITS Corp of Albuquerque, NM to calculate a head loss curve for the AFW strainers given different flows and debris loading. The results are provided in their letter report dated September 15, 2000. ITS used NUREG/CR 6224 methodology to obtain the head loss. The material captured in the surrogate strainer was forwarded to them for examination and characterization. This data was then utilized to determine constants for the NUREG 6224 calculation. The head losses are low relative to the available head.

For 45ml of material and 240 gpm flow rate, the calculated head loss is less than twenty feet. Based on the manufacture's certified pump curve, each AFW pump has an net positive suction head (NPSH) requirement of 14 feet (absolute) at a flow rate of 240 gpm. Service water at this point in the system will have 90 psig of available pressure or well over 200 ft of head upstream of the strainer.

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Parametric Variation

Assuming the debris loading is double that presented above, the head loss will be approximately 25 feet at 240 gpm. Assuming the debris loading is four times the original value, the head loss would be approximately 50 ft. Both of these conditions will sustain pump operation.

Conclusion

Based on these preliminary results, it appears that the as found condition (the strainers installed) did not render the pumps inoperable. The pumps would have been capable of delivering the required flows resulting from an event that would have required SW to supply AFW pump suction.

CORRECTIVE ACTIONS

1. The strainers were removed on August 20 and 21. Additional analysis will be performed to determine if this is the preferred long term solution or if new strainers with larger holes should be re-installed.
2. This event was caused by inaccurate information, as opposed to a lack of information. However, the event pointed out the need for better and more easily retrievable design basis information. To that end, the Nuclear Management Company (NMC) is reviewing the need for additional design basis reconstitution for the Kewaunee Plant.
3. The analysis of Information Notice 85-96 will be reviewed and revised as necessary.

ADDITIONAL INFORMATION

Equipment Failures: None

Other Information: The strainers were manufactured by Mack Iron Works of Sandusky Ohio.  
Model: PB-4

SIMILAR EVENTS

Reportable Occurrence 75-20, "All Three Auxiliary Feedwater Pumps suction Strainers Plugged"

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ATTACHMENT 1

AUXILIARY FEEDWATER (AFW) SYSTEM

