UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

January 21, 2004

NRC INFORMATION NOTICE 2004-01: AUXILIARY FEEDWATER PUMP RECIRCULATION LINE ORIFICE FOULING - POTENTIAL COMMON CAUSE FAILURE

Addressees:

All holders of operating licenses or construction permits for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.

Purpose:

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to inform addressees of the potential common cause failure of auxiliary feedwater pumps because of fouling of pump recirculation line flow orifices. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions in this information notice are not NRC requirements; therefore no specific action or written response is required.

Background:

Point Beach Nuclear Plant (PBNP) is a two unit site. Each unit has a turbine-driven AFW pump (pumps 1P29 and 2P29) which can supply water to both steam generators. Additionally, the plant has two motor-driven AFW pumps (pumps P38A and P38B) each of which can be aligned to a steam generator in each unit. Each pump has a recirculation line back to the condensate storage tanks (CSTs) to ensure minimum flow to prevent hydraulic instabilities and dissipate pump heat. The recirculation line contained a pressure reducing, flow restricting orifice. An arrow is pointing to the recirculation flow restricting orifice (RO) in the major flow path AFW diagram provided in Figure 1 and a picture of the RO is provided in Figure 2.

The RO used a multi-stage, anti-cavitation trim package installed in the body of a globe valve to limit flow. This style of orifice or flow restrictor was installed in the AFW recirculation lines at PBNP in the past few years to eliminate cavitation caused by the old orifices. This type of flow restrictor used very small channels and holes in each stage combined with a tortuous path to limit flow and prevent cavitation.

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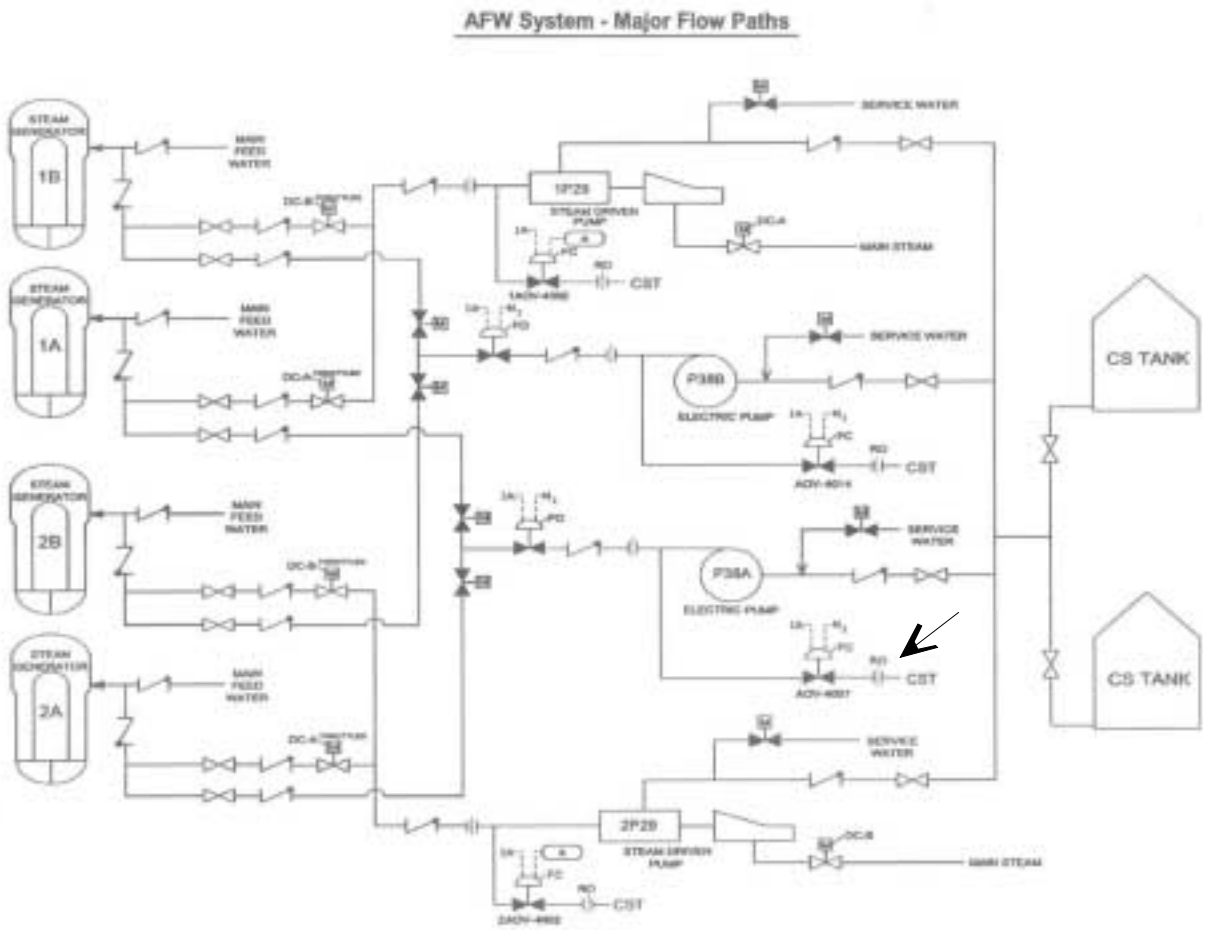

Figure 1. AFW System - Major Flow Paths

Figure 2. Recirculation Flow Restricting Orifice

Description of Circumstances:

On October 24, 2002, during post-maintenance surveillance testing of the P38A motor-driven AFW pump at PBNP, the licensee observed AFW recirculation line flow to be 64.5 gpm, which was less than the 70 gpm acceptance criterion. Normal flow through the recirculation line was 75 gpm. Suspecting instrument error, plant personnel vented and recalibrated the flow instrument. The P38A AFW pump was then started and tested again; however, the observed recirculation flow was essentially unchanged. Following that test run, the recirculation flow orifice was removed and inspected.

After removal of the orifice internals, partial blockage was observed in 24 of the 54 holes in the outermost sleeve. No particles were found on any of the inner sleeves. Samples of the particles removed from the orifice were retained for analysis. A boroscope inspection of the recirculation piping at the orifice location revealed no evidence of debris. Following cleaning and reassembly, the orifice was reinstalled and the P38A AFW pump was successfully retested. Testing was successfully completed on the other three AFW pumps to verify acceptable recirculation flow by October 25, 2002.

During the next several days, PBNP personnel evaluated the implications of the orifice plugging event. An apparent cause evaluation was initiated with specific directions to assess and evaluate the potential extent of condition. An action plan was developed to identify the source of the debris found in the orifice and to determine what other testing or flushing would be required to assure that future plugging did not occur.

As the investigations continued, questions developed concerning the operability of the AFW system while supplied by its safety-related water supply, the service water (SW) system. Although the service water supply was provided through a basket strainer, it was recognized that the strainer mesh was larger than the much finer RO channel holes and could allow debris to pass that could clog the RO. These concerns culminated in a meeting on October 29, 2002, at which PBNP personnel concluded that there was no longer a reasonable assurance that operation of the AFW system using its safety-related suction source of service water would not result in potential AFW recirculation line orifice clogging.

In a worst case scenario, Point Beach personnel determined that it may be possible, although unlikely, for each of the four flow control orifices, each associated with one of the four AFW pumps, to restrict the flow through the associated recirculation line. Under such conditions, it was hypothesized that if the discharge valves for the AFW pumps were throttled, adequate flow might be unavailable through the recirculation line and pump damage could occur due to overheating.

On October 29, 2002, all four AFW pumps were declared inoperable. Both units entered their technical specification action statements and required actions which directs immediate action to restore an AFW system to operable status. Immediate corrective actions consisted of briefing the on-shift crew of the potential consequences of restricted recirculation flow and initiating procedure changes. The operators were also directed to secure a running AFW pump if the pump discharge flows should be decreased to less than 50 gpm for the motor-driven pumps or 75 gpm for the turbine-driven pumps. These flow rates were substantially above the point at which pump damage could occur. Information tags were placed at the AFW pump flow indicators on the main control boards to convey that information. With these administrative controls in place, operations declared the AFW system operable, about four hours after the

pumps had been declared inoperable. An incident investigation was initiated to collect and confirm the facts of this event description beginning with the discovery of the P-38A AFW pump degraded recirculation flow during post-maintenance testing and concluding with the decision to declare the AFW system inoperable.

In accordance with 10 CFR 50.72(b)(3)(v), an eight-hour ENS notification (EN #39330) was made on October 29, 2002. The LER is available in ADAMS (Accession Number ML032890115).

A PBNP multi-discipline event resolution team was formed to identify and resolve the issues associated with the discovery of this condition. Activities included initiation of a root cause evaluation (RCE) to determine the root and contributing causes for the postulated common-mode failure that would render all AFW pump recirculation lines with restricted flow rates. The RCE concluded that this event had a direct root cause and an organizational root cause. The direct root cause was the failure by design engineering to properly evaluate the potential for orifice plugging within the design process. Instead of revisiting the design for adequacy and evaluating the potential for plugging of the proposed orifices within the rigor of the design process, the 10 CFR 50.59 safety evaluation was revised to justify the proposed design. The organizational root cause was less than adequate management oversight of the design modification process.

Also, in January and February 2003, a specially fabricated orifice was tested at a contractor laboratory in an effort to determine a plugging probability with service water. Definitive testing occurred on February 21 when a debris mixture of sand, silt, and zebra mussel shells, representative of what would exist in the Point Beach SW system, was injected into a closed loop configuration of piping, an orifice, and a centrifugal pump. The orifice plugged in much less than one minute after the mixture was injected into the loop. These results were contrary to those of a previously performed computational particle fouling model analysis that indicated that plugging was unlikely because of the particle size distribution of debris in SW and the shear forces in the holes and channels of the orifices developed with the minimum flow required through the orifice for pump cooling.

Discussion:

A special inspection was conducted by the NRC to evaluate the facts, circumstances, and licensee actions, and documented in NRC Inspection Report 50-266/02-15 and 50-301/02-15 (Accession Number ML030920128). This issue was determined to be of Yellow risk significance for Unit 1, an issue with substantial importance to safety, and Red risk significance for Unit 2, an issue of high importance to safety. The difference in significance between the Units was a result of the longer period of time that the AFW recirculation line pressure reduction orifices were installed in Unit 2. (See Final Determination Letter, dated December 11, 2003, Accession Number ML033490022).

This information notice requires no specific action or written response. If you have any questions regarding the information notice, please contact the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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Information Notice No.	Subject	Date of Issuance	Issued to
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2003-11, Sup 1	Leakage Found on Bottom-Mounted Instrumentation Nozzles	01/08/2004	All holders of operating licenses or construction permits for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.
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2003-21	High-Dose-Rate-Remote-Afterloader Equipment Failure	11/24/2003	All medical licensees.
2003-20	Derating Whiting Cranes Purchased Before 1980	10/22/2003	All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel; applicable decommissioning reactors, fuel facilities, and independent spent fuel storage installations.

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