UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

May 15, 2000

NRC INFORMATION NOTICE 2000-08: INADEQUATE ASSESSMENT OF THE EFFECT OF DIFFERENTIAL TEMPERATURES ON SAFETY-RELATED PUMPS

Addressees

All holders of operating licenses for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to inform addressees of the potential for differential temperature conditions to affect the operability of safety-related pumps. 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 contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

The following describes two events that appear to have been caused by inadequate engineering design assessment of the effect of differential temperatures on safety-related pumps.

Arkansas Nuclear One, Unit 1 (ANO-1)

In 1992, the licensee for ANO-1 implemented a design change to replace the cast iron inboard and outboard bearing housings on the low-pressure injection/decay heat removal (LPI/DHR) pumps with stainless steel for improved service water corrosion resistance. The LPI/DHR system is designed to remove decay heat from the core and sensible heat from the reactor coolant system (RCS) during the last stages of a plant cooldown. It also provides a means of automatically injecting borated water into the reactor vessel for cooling the core in the event of a loss-of-coolant accident during power operation. During the September 1999 refueling outage, the licensee implemented a design change to increase the viscosity of the lubricating oil for the LPI/DHR pump bearings in order to reduce wear.

On February 5, 2000, ANO-1 began cooling down the plant in preparation for entering a maintenance outage to install replacement parts on the “D” reactor coolant pump anti-rotation device. When the RCS temperature had been reduced to 280°F and the pressure had been reduced to 240 psig, the “A” LPI/DHR pump was placed in service for decay heat removal. After 52 minutes, the licensee was forced to secure the “A” LPI/DHR pump when the inboard bearing temperature reached approximately 160°F. The licensee then placed the “B” LPI/DHR

pump in service for DHR but stopped it after 16 minutes due to a high inboard bearing temperature. The licensee tested both pumps by recirculating water from the borated water storage tank and noted that the bearing temperatures remained stable at approximately 80°F. During this test the pumped fluid, the borated water, was at ambient temperature. Upon switching the "B" pump suction back to the RCS, the bearing temperature again rose to approximately 160°F. In this instance the pumped fluid, the RCS water, was at a temperature of approximately 250°F.

On February 6, 2000, the licensee changed the "A" LPI/DHR pump bearing oil back to the original (lower viscosity) specification. When the "A" LPI/DHR pump was placed back in the DHR mode of operation, the bearing temperature stabilized at 119°F. The licensee then declared the LPI/DHR pump operable for the DHR mode only and proceeded to cool down the plant. The licensee then changed the "B" LPI/DHR pump bearing oil back to original specification. But, unlike the "A" pump, the "B" pump again had to be shut down due to high bearing temperature. Inspection of the "B" pump following shutdown indicated that the inboard bearing had to be replaced due to abnormal wear. Further details were provided by the licensee in its Licensee Event Report (LER) 50-313/2000-002-00 dated March 6, 2000 (Accession No. ML003691450).

Beaver Valley Power Station, Unit 1

On February 8, 2000, the licensee for the Beaver Valley Power Station, Unit 1 (the licensee), was performing a routine surveillance on the "B" river water pump. The pump tripped on over current protection after approximately 3 seconds. A few hours later, startup of the "C" river water pump was attempted and it also tripped after 3 seconds because of over current protection.

The licensee determined that the over current trips were a result of pump binding. The cause of the binding was thermal expansion of the pump shaft as a result of a temperature differential between the river water (35 degrees F) and an elevated seal injection water temperature (70 degrees F). The river water pump seal water was being supplied by the non-safety related filtered water system. At the time of the event, the filtered water system was in an abnormal configuration that created the elevated water temperature. Further details on this event are available in LER 50-334/2000-002-00 dated March 8, 2000 (Accession No. ML003692855), LER 50-334/2000-002-01 dated April 27, 2000 (Accession No. ML003712023), and in NRC Inspection Reports 05000334/2000-01 dated March 17, 2000 (Accession No. ML003693247), and 05000334/2000-02 dated April 28, 2000 (Accession No. ML003709259).

Discussion

At ANO, the NRC performed a special inspection (report number 50-313/00-04; 50-368/00-04, Accession No. ML003708466) to follow up on the events which led to declaring both Unit 1 LPI/DHR pumps inoperable. The inspectors concluded that the failure to complete adequate engineering evaluations for the replacement of the cast iron bearing housing with a stainless steel housing and the change in lubricating oil viscosity resulted in the inoperability of both

LPI/DHR pumps. The changes in the bearing housing material and use of a higher viscosity oil, in combination with low cooling water temperatures (<42°F), resulted in both low pressure injection/decay heat removal pumps operating with high bearing temperatures, which required the pumps to be secured. From January 28 to February 5, 2000, when the cooling water temperature was 42°F or less, both low pressure injection/decay heat removal pumps were not operable as they could not perform their intended safety function. These design deficiencies were not identified by post modification or surveillance testing. Testing performed by recirculating water from the borated water storage tank did not duplicate actual operational conditions because the pumped fluid (from the borated water storage tank) was at a much lower temperature than the RCS.

Subsequent investigation by the ANO licensee identified other potentially susceptible equipment in both units and took appropriate corrective actions.

At the Beaver Valley Power Station, the licensee determined that when warmer seal water is provided to an idle pump during cold river water conditions, the warmer seal water travels down the pump shaft and increases the shaft temperature. The pump casing is not in direct contact with the seal water and, therefore, is not affected by the increase in seal water temperature. This temperature differential resulted in elongation of the pump shaft, impeller contact with the pump casing, and eventual pump binding. The same warmer seal water supplied to the pumps when they are idle is also supplied to them when they are operating. However, the effect of having warmer seal water supplied to an operating pump was negligible because of the extremely large volume of pumped fluid acting as a heat sink on the small volume of seal water passing through the pump inner column. The licensee also determined that the filtered water system could introduce a common-mode failure to all three safety-related river water pumps. The filtered water system was subsequently isolated as a supply source to the river water pumps and the pumps were operated from their safety related supply.

During this operation, the licensee identified an inadequacy in the design of the safety-related seal water supply strainers. Since original plant operation in 1976, the non-safety-related filtered water system had been the primary supply to the river water pump seals. However, during operation of the pumps on their safety-related supply, the safety-related in line strainers fouled during high silt conditions.

Safety-related pumps are expected to operate under a wide range of environmental conditions. These two events highlight the importance of assessing the effects of differential temperatures on safety-related pump operability. In addition, these events highlight the importance of having test programs that include suitable qualification testing under the most adverse design conditions (e.g., temperature and differential temperature), when the test program is used to verify the adequacy of a specific design feature (e.g. seal water supply).

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

/RA/

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