AEOD TECHNICAL REVIEW REPORT

UNIT: Susquehanna 2
DOCKET NO.: 50-388
LICENSEE: Pennsylvania Power & Light Company
NSSS/AE: General Electric/Bechtel

TR REPORT NO.: AEOD/T922
DATE: November 2, 1989
EVALUATOR/CONTACT: C. Hsu

SUBJECT: FAILURE OF HPCI TURBINE DUE TO HIGH MOISTURE IN LUBE OIL

EVENT DATE: January 27, 1988 (LER 88-001-00)

SUMMARY

On January 27, 1988 with the plant at full power, the high pressure coolant injection (HPCI) system was declared inoperable because of high moisture in the lube oil. The high moisture content was determined based on the analysis of a quarterly lube oil sampling. The water in the lube oil was found to be caused by steam leakage past the steam supply valve of the turbine. Since the turbine shaft seal was not designed to seal completely during standby conditions, the steam leaked through the seal and impinged on an adjacent bearing housing. Then the condensing steam intruded into the lube oil through the bearing.

Since the stop valve of HPCI turbine, located downstream of the supply valve, is normally closed during standby mode, the leak in the supply valve alone would not allow steam to enter the HPCI turbine. The possibility of combined leakage of the both valves is very low. Furthermore, the steam leakage past the shaft seals can be easily detected by the routine visual inspection of the HPCI pump room which is conducted once a plant shift. This being the case, the moisture accumulation in the lube oil would most likely be stopped before it exceeds the permissible level. Therefore, the problem would be corrected before it could cause the HPCI turbine to become inoperable.

One similar event was identified in a search of the LER data base. Based on our review of these events and the discussion with the licensees, we believe that the safety implication of such events are minor and the possibility of occurrence of such events are infrequent. Additional AEOD action does not appear to be needed.

DISCUSSION

LER 88-001 for Susquehanna 2 reported that on January 27, 1988 with the plant at full power, the HPCI system was declared inoperable because of high moisture in the lube oil; a condition which alone could have prevented HPCI from performing its safety function. The high moisture content was determined by a quarterly sampling of lube oil.

The lube oil was replaced and the HPCI was returned to operable status on the following day. In order to find the cause of high moisture in the lube oil, the licensee initiated an accelerated sampling program. The results of an oil sample taken on February 1, 1988, indicated that water continued to be introduced into the lube oil. A subsequent oil sample taken on February 3, 1988 indicated moisture content was high enough to affect system operability. Thus, the HPCI was again declared inoperable. An inspection of the HPCI turbine by the licensee revealed steam to be blowing out from around the turbine seal area onto an adjacent outboard bearing cover. The licensee indicated a possible leak in the steam supply valve of the HPCI turbine; steam leaking past the valve pressurized the turbine seal area. Since the turbine shaft seal was not designed to seal completely during static conditions, steam penetrated through the seal and reached an adjacent bearing house. The condensing steam intruded water into the lube oil through the bearing.

Seating surfaces of the valve body and disk were reworked to obtain proper seating. Lube oil was replaced and the system returned to operable status. Subsequent oil samples taken confirm resolution of the problem. Seating surface erosion was due to normal wear.

The steam supply valve of the HPCI turbine is located upstream of the stop valve. Both these valves are normally closed during the standby mode of the HPCI turbine. Discussion with the licensee confirmed that steam cannot enter the turbine without the combined leakage of the supply valve and the stop valve. The possibility of such combined leaks is very low. Besides, the combined leaks will not necessarily cause water contamination of the lube oil, but would depend on the magnitude of the steam leakage. If steam leaking increases to a flow which could spin the turbine, the shaft seal pressure could be built up at the same time and prevent leaking steam from penetrating the seals. Since the indication of turbine spinning are provided in the control room, the operators will be aware of the spinning once it occurs.

Although the small steam leakage past the valves could penetrate the turbine seals and result in water contamination of the lube oil, the event indicated that the accumulation of water in the lube oil is very slow. It took several days for the water content to exceed the permissible level. Since the HPCI pump room is subjected to visual inspection once per plant shift, the steam leakage would most likely be detected by the operator during the inspection and the problem would be corrected before the oil contamination can impair the operation of the HPCI system. However, the event at Susquehanna points out the need for the operators to be made aware of the significance of such steam leakage.

There are two water to oil interfaces in the HPCI system which are potential leakage areas. These two interfaces are at the lube oil cooler and at the turbine and pump shaft seals. If the cooler were to leak, the leak would directly contaminate the lube oil. In comparison, the build up of oil contamination as a result of steam leakage past the valves would be much less.

A search of the Sequence Coding and Searching System (SCSS) LER data base was conducted for moisture or water in HPCI lube oil. The search, which covered the period from 1980 to the present, identified only one event involving high moisture in the HPCI lube oil. This event occurred at Hatch 1 in 1984 and was reported in LER 50-321/84-011. The high moisture content in the lube oil was determined during regular oil sampling. The oil contamination was found to be caused by steam cuts in the seat of a HPCI turbine steam supply valve, combined with the the stop valve leak. Similar to the event that occurred at Susquehanna 2, the steam cuts allowed steam to enter the HPCI turbine wheel case and exit the turbine shaft seals. The steam condensed to water and flowed down to the lube oil. The licensee of Hatch also considered this to be a non-repetitive event as the steam leaking through turbine shaft seals can be detected by the operator during a shift visual inspection. Following the indication of steam leakage, ample time will still be available for the operator to prevent the moisture accumulation in the lube oil from reaching the intolerable level. However, as was the case at Susquehanna the operator were apparently not aware of the significance of such small leakages.

FINDINGS

Contamination of lube oil by steam leakage is an infrequent event readily detectable by visual inspection and lube oil sampling. The two events discussed above were detectable and could have been prevented by alert operators.

CONCLUSION

The safety implications for the identified lube oil contamination events are minor and as such require no further review or actions at this time. However, although the steam leaking can be detected by the operator during visual inspection of the HPCI pump room such that the moisture accumulation can be stopped before it reaches the intolerable level, two plants have ignored steam leaking around the HPCI turbine and the moisture contamination in lube oil was not detected until the quarterly sampling of lube oil. This illustrates the lack of explicit instructions and training of operators regarding the implication of small leakage of steam around the turbine shaft.