TECHNICAL REVIEW REPORT [1/]

UNIT: Beaver Valley 1
DOCKET NO.: 50-334
LICENSEE: Duquesne Light Company
NSSS/AE: Westinghouse/Stone & Webster

EE REPORT NO: AEOD/T505
DATE: July 17, 1985
EVALUATOR/CONTACT: C. Hsu

SUBJECT: BEAVER VALLEY COMPONENT COOLING WATER PUMP DAMAGE

EVENT DATE: July 18, 1982 (LER 82-024/03L-0), July 7, 1982 (LER 82-022/03L-0), and December 5, 1981 (LER 81-103/03L-0)

SUMMARY

Licensee Event Report 82-024 for Beaver Valley 1 describes an event in which two of the three component cooling water (CCW) pumps became inoperable. The C pump had been previously shutdown for an extended period of time for repair, when a bearing of the B pump failed on July 18, 1982 during a plant startup operation. This left only the A pump operable. Since the plant technical specification requires that at least two component cooling water subsystems be operable, an action of limiting condition for operation was initiated.

This was the third recurrent event involving two inoperable CCW pumps (the B & C pumps). The cause of pump inoperability was bearing failure due to overheating. Bearing failures have been repetitive with the B and C pumps. The vendor was contacted and could not determine a specific cause for bearing overheating in his subsequent evaluations. However, the licensee attributed the cause to a misalignment between the pump and motor at the time of the initial LER report. The pumps are Model 3415 manufactured by Goulds.

Following the third occasion of simultaneous inoperability of two of the three CCW pumps, the licensee initiated a series of investigations and failure evaluations. These programs did not result in positive conclusions; however, it did not appear that a motor/pump misalignment was the cause. This problem remained unsolved until a thorough mechanical investigation of the pumps was conducted by the licensee. The mechanical investigation was described in the licensee's final failure report dated February 19, 1985. As described, a significant misalignment existed between the rotor and stator of the motors associated with the affected pumps. Such misalignment caused lateral tension on the pump shaft. The tension caused the bearing to cock and wear at an accelerated rate.

These events indicate that misalignment of the rotor and stator in a motor can cause pump bearing failure similar to that which is caused by pump/motor misalignment. Rotor/stator misalignment normally is not included in the plant

---

1/ This document supports ongoing AEOD and NRC activities and does not represent the position or requirements of the responsible NRC program office.

maintenance check list for pump bearing trouble and, thus, the licensee's identification of this problem remained unknown for a considerable period of time.

The misalignment appeared to be related to past activities associated with disassembly and reassembly of the motor rotors during motor rewinding. Since no other failure of this type was identified in a search of the LER data bases, and proper alignment can be achieved by carefully employing the manufacturer's recommendation and proper procedures, these events do not appear to indicate a generic problem. Therefore, additional AEOD action does not appear to be needed.

INTRODUCTION

On July 18, 1982 during a plant startup operation, a high temperature alarm from the B component cooling water (CCW) pump indicated an overheating bearing. Steam generator blowdown was terminated to decrease the load on the component cooling water system and the B pump was declared inoperable. This left only the A pump operable as the C pump had been shutdown for an extended period of time for repair. Since the plant technical specifications require that at least two component cooling water subsystems be operable, an action of limiting condition for operation was initiated. The B pump was restored to service 43 hours later. During this time, the A pump supplied sufficient flow for all safety related loads. The failure of the pump bearing was initially attributed to pump/motor misalignment. The pump is a Model 3415 manufactured by Goulds and had experienced similar problems in the past. This was a third similar event involving two inoperable component cooling water pumps. The pump vendor had been contacted to investigate this recurring problem, but could neither provide any information concerning similar failures at other plants nor determine a specific cause of failure.

DISCUSSION

This was a recurrent event. Two similar events had previously occurred to the pumps in the same system and were reported in LERs 82-022 and 81-103 in which two component cooling water pumps became inoperable.

The first event was described in LER 81-103. While the unit was at 90% power on December 5, 1981, one of the three (the C pump) component cooling water pumps had a motor bearing overheat, resulting in a fire and a trip of the breaker. The fire was immediately put out with no affect on other equipment, but the motor required major repairs. The B pump was also inoperable due to a prior motor bearing failure. Plant operation continued using only the A pump until repair of the B pump on December 8. The failed pump was removed for vendor repair. The specific cause of the failure was not determined.

The second event occurred on July 7, 1982, and was described in LER 82-022. During a plant startup, a high temperature alarm occurred for the C component cooling water pump bearing. Non-safety related loads on the system were shutdown and the C pump was isolated for trouble shooting. This left only the A pump operable as the B pump was shutdown for maintenance. The B pump was restored to service 16 hours later. During this time, the A pump supplied sufficient flow for all safety related loads. The pump bearing had turned, blocking oil flow to the bearing face. The cause of the failure was considered

to be pump/motor misalignment. The pump bearing was replaced while the A and B pumps maintained component cooling flow.

Based on the information provided by the licensee, the CCW pumps at Beaver Valley 1 have had a repeated history of bearing failures due to overheating. Specifically, in 1982, there was a high frequency of these failures. This type of bearing failure and subsequent bearing replacement had been a consistent problem. Most of these failures did not occur concurrently to more than one pump and, therefore, were not reportable events under the LER rule. Additionally, the failures were always on the B and C pumps. The A pump was not affected.

After the third event involving two inoperable pumps, the licensee conducted a series of investigations and failure evaluations to determine the root cause for the bearing failures. Since the bearing failures were considered attributable to pump/motor misalignment, vibration could be a significant mechanism to cause pump/motor misalignment. For this reason, in addition to the regular inservice inspection (ISI) program, various vibrational studies, both plant induced and flow induced, were performed. The actual cause of the bearing failures could not be determined during these evaluations. During these failure evaluations, the vendor was consulted, but could not provide any information concerning similar failures at other plants.

The problem of CCW pump failures remained unsolved for some time until a thorough mechanical investigation of the associated motors in which the actual cause of failures was identified. As described in the licensee evaluation report (Ref. 1) dated February 19, 1985, the cause of these bearing failures was discovered during a thorough mechanical investigation of the affected pumps and motors. The overheating of bearings was a result of significant misalignment between the rotor and stator of the motors on the B and C pumps. Such misalignment caused undesirable lateral tension in the pump shafts. The tension caused the pump bearings to cock and wear at an accelerated rate. This problem was corrected by re-aligning the motor shaft, thus bringing the rotor and stator into proper aligned condition. The licensee's review of its Incident Report and Maintenance history files have revealed no subsequent incidents of a similar nature after the correction. The problem is believed to be solved.

Events leading to the stator/rotor misalignment cannot be precisely determined; however, based on the information provided by the resident inspector, the operating and maintenance histories for the three CCW pumps showed that the motors for the B and C pumps had major bearing repairs and motor rewinding during the period of 1980-1981. It was likely that the disassembly and reassembly of the motor rotors during the motor rewinding caused the rotor/stator misalignment that ultimately led to the pump/motor bearing failures. This is consistent with the operating history which shows failures in the B & C pumps, but none in the A pump bearings.

In this review, a search of the LER data base files was conducted for failure of bearings on centrifugal pumps. This search did not result in the identification of any event involving pump bearing failure or degradation which was attributed to misalignment between the rotor and stator of a motor. The LER data searches included SCSS, RECON and NPRDS. Although this type of event does not appear to be generic, it demonstrates that misalignment of rotor and stator in a pump motor could cause excessive loads on the bearing similar to

that found from the result of pump/motor misalignment. Since rotor/stator misalignment normally is not included in the check list provided in the plant pump maintenance procedures for bearing trouble shooting, the licensee's resolution of this problem was prolonged for an extensive period of time. The cause was not identified until a series of special tests and analyses were undertaken.

FINDINGS AND CONCLUSIONS

Based on the information presented in the discussion above, the following findings and conclusions are provided:

1. The component cooling water pumps of Beaver Valley 1 have had a repeated history of bearing failures. In the past years, two of the three component cooling water pumps (the B and C pumps) have experienced a high frequency of these failures. (The A pump has had no bearing failures.) The bearing failures were a result of bearing overheating.

2. The affected pumps are Model 3415 manufactured by Goulds. The vendor was contacted to investigate this recurrent problem, but could not determine a specific cause for the failures, nor provide any information concerning similar failures at other plants. The licensee initially attributed the cause of failure to pump/motor misalignment.

3. Following this sequence of events, the licensee conducted a series of investigations and failure evaluations without positive conclusions. The investigations and evaluations included review of operating and maintenance histories, monitoring and trending motor bearing data, performing inspection items provided in the regular ISI program, and various vibration studies (both plant and flow induced vibrations). The licensee's resolution for corrective action remained unavailable for some time.

4. The problem remained unsolved until the licensee initiated a thorough mechanical investigation of the pumps. As described in the licensee's final failure report, dated February 19, 1985, this mechanical investigation discovered that a significant misalignment existed between the rotor and stator of the motors for the two affected CCW pumps. It was determined that such misalignment caused undesirable lateral tension on the pump shaft which, in turn, imposed an excessive load on the bearings, causing the pump bearings to overheat and wear at an accelerated rate.

5. Events leading to the rotor/stator misalignment could not be precisely determined; however, review of the operating and maintenance histories for the CCW pumps revealed that motors for the two affected pumps had major bearing repair and motor rewinding in the past. It appeared that the cause of the misalignment was related to the activity of disassembly and reassembly of the motors during motor rewinding.

6. The result of LER data base searches for additional similar reports was that no such additional reports were identified. The event does not appear to be generic.

7. The licensee's resolution of this problem seemed to lack a well defined engineering approach that attempted to identify and correct the source of the

problem. Instead, a series of isolated activities were performed until the problem was corrected.

It appears that the cause of the bearing failures was related to the activities that took place during motor rewinding, and since no other failure of this type was identified in a search of the LER data base, the event appears to be an isolated case. In addition, the manufacturer's recommendation and maintenance procedures for motor assembly provide guidance to prevent misalignment of the rotor and stator of a motor from occurring. The proper alignment can be achieved by appropriate implementation of procedures. Therefore, we believe that no further AEOD action on this item is necessary.

REFERENCE

1. Memorandum from W. S. Lacey, Duquesne Light Company, to K. D. Grada, "Closeout of URI 82-16-07," February 19, 1985.