FEB 15 1991

MEMORANDUM FOR: Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

FROM: Thomas M. Novak, Director
Division of Safety Programs
Office for Analysis and Evaluation
of Operational Data

SUBJECT: INCORRECT ROTATION OF PDP

Enclosed for your information is a copy of an AEOD Technical Review Report discussing a positive displacement pump (PDP) that was found rotating in the reverse direction at Brunswick Unit 2. A PDP rotating in the reverse direction may not receive adequate internal lubrication. The technical review report notes that PDPs are used in the standby liquid control system at all BWRs and in the charging system of PWRs. In the short term, performance of a PDP is unaffected by the direction of pump rotation, so their respective systems remain capable of completing their intended function.

Clearly though, reverse rotation is not desirable due to long term pump degradation from insufficient pump internal lubrication. We believe that licensees should be informed that pumps may be operating with incorrect rotation without noticeable degradation in pump performance. This may be prevented with appropriate procedural checks.

A PDP rotating in the reverse direction is not reportable by 50.73, so we would not expect to find similar events.

Original signed by

Thomas M. Novak, Director
Division of Safety Programs
Office for Analysis and Evaluation
of Operational Data

Enclosure: As stated

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AEOD TECHNICAL REVIEW REPORT

UNIT:	Brunswick Unit 2	TR REPORT NO.: AEOD/T91-02
DOCKET NO.:	50-324	DATE: February 15, 1991
LICENSEE:	Carolina Power & Light Co.	CONTACT: T. Cintula

SUBJECT: **INCORRECT ROTATION OF PDP**

SUMMARY

One positive displacement pump (PDP) at Brunswick Unit 2 was wired incorrectly. The pump rotated in the reverse direction (backwards) which could cause an internal lubrication problem. We concluded a PDP operating with reversed rotation would not affect plant safety at either boiling water reactors (BWRs) or pressurized water reactors (PWRs).

DISCUSSION

1. Event Description and Cause

After maintenance, the PDP was observed to be rotating in the reverse (backwards) direction. The PDP, with reverse rotation, was one of two PDPs in the safety-related standby liquid control (SLC) system at Brunswick Unit 2. Nothing in the maintenance procedure could have affected the rotational direction of the PDP motor. Subsequent investigation found two electrical power leads to the pump motor had been interchanged at the motor control center. After that, the three phase pump motor simply rotated in the reverse direction. Since the motor control center leads were not part of the PDP maintenance procedure, it was not possible to determine when reverse rotation occurred. Rotational checks of the SLC pumps are routinely conducted following maintenance at Brunswick. However, it is possible at some time in the past, this was not correctly performed.

2. Consequence of Reverse Rotation

The SLC pumps are positive displacement reciprocating piston pumps. Direction of rotation has no effect on their pumping ability. Therefore, periodic surveillance of pump operation, if only limited to pump output pressure or pump flow rate would not reveal reverse rotation of the pump.

However, reversed rotational operation does affect internal drive train pump lubrication. The pump lubrication system depends on the crankshaft throw to fill an elevated reservoir which then drains oil over the drive pistons, thus providing lubrication. The pump vendor, Union Pump, informed the licensee, that sufficient short term oiling of the drive pistons would occur

during reverse rotation at the relatively slow rotational speed of the SLC pumps at Brunswick. Higher RPM pumps would not receive sufficient lubrication from oil splash. Also, extended reverse operation could cause excessive wear at the pump seal. The wear would be detectable by oil leakage at the pump seals.

3. Observed Effect of Pump Reverse Rotation at Brunswick

Although the total duration of SLC pump operation with reverse rotation could not be determined, the licensee estimated the pump operates at a usage rate of 15 minutes per month. Vibration measurements indicated the effect of reverse rotation was negligible. Also, no wear was evident by oil leakage at the pump seals. The licensee concluded that the indefinite period of reverse operation did not render the pump inoperable. The NRC inspector (Ref. 1) determined that, if called upon to function in an actual event, the pump would have to operate two hours to inject the contents of the SLC storage tank given the single failure of the redundant SLC pump. The inspector concluded that, in its current state, pump failure within two hours did not seem likely.

4. Safety Concerns with PDPs

a. Boiling Water Reactors (BWRs)

The SLC system is designed to provide a redundant, independent, backup control mechanism capable of shutting down the reactor and maintaining it in a shutdown condition in the event that the control rod system is totally inoperable. The analyzed accident for the SLC system is an anticipated transient without scram (ATWS). The SLC system at Brunswick is designed to satisfy the ATWS rule by providing the capability of operating both PDPs simultaneously at a flow rate of 82 gpm which will inject highly borated solution from the SLC tank in 29 to 59 minutes. Injection with a single PDP would require 58 to 113 minutes of operation.

b. Pressurized Water Reactors (PWRs)

PDPs may also be used for injection as charging pumps in the chemical and volume control system (CVCS) at pressurized water reactors. Some Westinghouse designs have one PDP and two centrifugal pumps in their charging systems. In these designs, the PDP is always designated as a non-safety component and the two centrifugal charging pumps provide the needed plant safety functions.

Many Combustion Engineering plants use three PDPs as the only injecting force in the charging system. In this plant design, the PDPs are not part of the emergency core cooling system, but some plants take credit for injection flow from the PDPs in some accidents. For example, the long term cooling analysis for San Onofre Units 2 and 3 assumes that charging (from one of PDPs) is terminated between 1.5 and 2 hours after initiation of the LOCA.

PDPs are not used at Babcock & Wilcox Plants.

5. Search for Similar Events of Reversed Pump Rotation

The Nuclear Document System--Advanced Design (NUDOCS/AD) was used to search for other events involving reverse rotation of PDPs; none were found. The search was then expanded to find events of reverse rotation of any pump. There was no record of a pump operating with reverse rotation in the data base.

FINDINGS

PDPs are a safety-related component for all BWRs, as the injection source of the SLC system and some PWRs take credit for the PDP injecting in the small break LOCA analysis. Reverse pump rotation does not affect the pumping characteristics of a PDP, i.e., actual flow rate and pressure head, but may lead to pump lubrication problems with extended reversed rotation usage. The licensee concluded that the reverse rotating PDP at Brunswick could operate for two hours. The safety analyses for both BWRs and PWRs are satisfied with two hours of PDP operation, and, in either case, a redundant PDP is available. Reverse rotation of a PDP may be a rare occurrence, with the only documented event occurring at Brunswick-2.

CONCLUSIONS

Reported events of reversed PDP operation have not occurred. Should reverse operation occur, the PDP will fulfill its safety function in terms of pressure head, flow rate and duration of operation. Accordingly, plant safety should not be degraded if the PDP is wired to operate with reversed rotation.

OTHER CONSIDERATIONS

Apparently, reverse rotation of a PDP will occur whenever the electrical power leads are switched in the electrical supply to the PDP motor. Although safety consequences associated with this error are limited, reverse rotation is not desireable due to long term degradation of the PDP, and it would be appropriate to inform licensees of the potential for reversal of pump operation and consequences.

REFERENCE

1. NRC Inspection Report Numbers: 50-325/90-11 and 50-324/90-11, dated April 17, 1990.