WOLF CREEK
NUCLEAR OPERATING CORPORATION

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Gentlemen:

The attached Special Report is being submitted pursuant to Technical Specifications 4.8.1.1.3 and 6.9.2. This report concerns failures of Emergency Diesel Generator "B" due to a failure of a temperature control valve and a generator synchronizing relay.

If you have any questions concerning this matter, please contact me or Mr. O. L. Maynard of my staff.

Very truly yours,

John A. Bailey

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JAB/aem

Attachment

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Special Report 89-003

**Failures of Emergency Diesel Generator 'B'
Due to Failure of a Temperature Control Valve
and a Generator Synchronizing Relay**

On December 9 and 10, 1989, several events occurred which resulted in one valid failure and two invalid failures of Emergency Diesel Generator 'B'. This Special Report is being submitted in accordance with the requirements of Technical Specifications 4.8.1.1.3 and 6.9.2.

DESCRIPTION OF EVENTS

On December 9, 1989, with Emergency Diesel Generator 'B' (D/G 'B') in standby, the Turbine Building watch reported to the Control Room that the normally warm D/G governor oil cooler was cold, indicating that no jacket water was flowing through the oil cooler. Normally while in standby, a small 'keep warm' pump circulates the D/G jacket water, which is heated with an electric heater, through the D/G jacket water lines to reduce engine wear and facilitate a quick startup of the D/G. Although the D/G governor does not need to be kept warm, the design of the jacket water system causes a small amount of the keep warm pump's flow to normally pass through the governor oil cooler (see Figure 1). With the governor oil cooler cold, it was decided at 0345 CST on December 9, 1989, to declare D/G 'B' inoperable to allow Maintenance personnel to investigate. No blockage of the governor oil cooler or the supply line was found. It is believed that the lack of flow was caused by an air bubble in the supply lines. Several days earlier, on December 5, 1989, the jacket water system was partially drained in order to clean the interior of the jacket water expansion tank. This tank is periodically cleaned in order to remove any loose corrosion that may have developed in the upper portion of the tank. The upper portion of the tank is exposed to humid air and does not receive protection from the corrosion inhibitor which is present in the jacket water. Following cleaning of the tank, the jacket water system was refilled. In the past, several maintenance activities have taken place while the jacket water expansion tank was being cleaned and an operability test was required before placing the D/G back in service. On December 5, 1989, however, no other maintenance activities were performed, and therefore, the D/G was not run after filling of the jacket water system. As a result, any air bubbles that may have existed in the jacket water lines did not get flushed out to the expansion tank. Most of the air bubbles were likely flushed out with the start of the keep warm pump, however, some accumulated in the governor lube oil cooler line which is a low flow area and a high point in the system. This prevented the jacket water from circulating through the cooler while in standby. As previously stated, the governor is not required to be kept warm while in standby and the main jacket water pump would have immediately flushed out the air bubble upon D/G start to cool the governor oil cooler. Therefore, this event had no affect on the operability of the D/G.

After running the D/G for a short period of time to allow the main jacket water pump to flush the jacket water lines, the D/G was started for an operability test to be performed in accordance with surveillance procedure STS KJ-005B. At 1510 CST on December 9, 1989, 13 minutes after the start of the D/G, operators were unable to parallel the D/G to bus NE02. The D/G was secured and Instrumentation and Control (I&C) personnel performed trouble-shooting on the D/G output breaker circuitry. The output breaker and all associated contacts and relays tested satisfactorily. In order to assist in troubleshooting, the D/G was started at 2217 CST on December 9, 1989. This time operators had no trouble in successfully paralleling the D/G to bus NE02 at 2230 CST. However, at 2239 CST on December 9, 1989, the D/G tripped on high jacket water temperature (195^{o}F). Troubleshooting revealed that the jacket water temperature control valve (KJ TCV 160) had failed. This valve regulates flow to the jacket water heat exchanger in order to maintain the proper jacket water temperature. Maintenance personnel disassembled the valve and removed what the valve manufacturer calls the "power pills". Three power pills are located inside the valve and provide control based on the temperature of the water passing through the valve. A test performed on the power pills after they were removed indicated they were not working properly. The three power pills were replaced and the valve reassembled.

Throughout the period of time work was being done on the temperature control valve, troubleshooting was continuing on the output breaker circuitry even though the D/G had been successfully paralleled to the bus. The switch in the Control Room for the D/G output breaker showed signs of oxidation on the contacts and was therefore replaced. At this time it was believed the D/G was ready for performance of the operability test and STS KJ-005B was commenced at 1530 CST on December 10, 1989. Again, operators were unable to parallel the D/G to bus NE02. The D/G was shutdown and troubleshooting began. To assist, the D/G was started again and an attempt was made to parallel it to the bus. The D/G could not be paralleled and I&C personnel found that the contacts for the generator synchronizing relay were not operating properly. The relay was replaced after which the circuitry tested satisfactory. An operability test was again performed in accordance with surveillance procedure STS KJ-005B at 1945 CST on December 10, 1989. This time the D/G was successfully paralled to the bus and ran fully loaded for one hour. Jacket water temperatures remained within normal operating ranges indicating the temperature control valve was functioning properly.

ROOT CAUSE AND CORRECTIVE ACTION

The root cause of the two failures associated with the generator synchronizing relay was dirty and/or out-of-calibration contacts. Due to the design of the relay, the contact gap has a very small tolerance which makes the relay very sensitive. This accounts for the relay operating successfully following an earlier failure on December 9, 1989, along with the difficulty in determining the failure mechanism. Immediate corrective actions were to temporarily replace the relay until the original relay could be cleaned and recalibrated. As a long term corrective action, the calibration frequency is being shortened from the current 18 month frequency to a 12 month frequency.

The root cause of the failure associated with the temperature control valve is believed to be associated with the power pills. The power pills are basically hydraulic units that act as a thermostat. They are sealed units that contain a small cup of wax covered by a rubber diaphragm. Sitting on the diaphragm is a rubber/metal plug assembly. Increasing the temperature within a specified range causes the wax to expand, raising the plug a short distance out of the power pill. Three power pills in series provide the force and travel distance necessary to position the valve. In order to test the three power pills removed from the valve following the event, they were placed in a water bath which was then heated. One of the power pills expanded near 175° F as expected. However, the other two didn't expand until approximately 195° F and then expanded only part of the normal distance. Discussions with the manufacturer and with other utilities indicates these results would be indicative of some of the wax having been forced out of the power pills. This typically takes place when the power pills are exposed to a temperature above their normal operating range. The power pills in the temperature control valve that failed normally begin to expand between 165°F and 170°F and are fully expanded between 180°F and 185°F. Heating beyond 185°F will cause the internal pressure of the power pill to increase since the power pill can no longer expand. The manufacturer of the power pills estimated that damage to the power pills (by having wax forced out of a crimped seam) would occur above 200°F for these particular power pills. The D/G has high jacket water temperature alarms at 185° and 190°F with a D/G trip at 195°F. The power pills present in the temperature control valve were installed during the second refueling outage (Fall of 1987) in accordance with the D/G vendor's recommended replacement frequency of every five years. Since that time the D/G has not experienced a trip on high jacket water temperature and has only had a few alarms for high jacket water temperature. Following this event, nothing could be found which would cause the high jacket water temperature other than failure of the power pills. Since the D/G was successfully tested and had normal jacket water temperatures following replacement of the power pills, it is concluded that the power pills caused the failure. Corrective actions are to increase the replacement frequency for the power pills from the vendor recommended five years to every refueling outage. The power pills will also be replaced after any trips of the D/G due to high jacket water temperature.

FAILURE CLASSIFICATION

The two failures which occurred during the performance of surveillance procedure STS KJ-005B were both caused by a failure of the generator synchronizing relay, which is equipment that is not operative during the emergency operating mode. Therefore, these two failures are invalid failures in accordance with Regulatory Position C.2.e(2) of Regulatory Guide 1.108. Although the failure associated with the temperature control valve occurred during troubleshooting while the D/G was out of service, and therefore, would appear to be an invalid failure in accordance with Regulatory Position C.2.e.(7) of Regulatory Guide 1.108, Wolf Creek Nuclear Operating Corporation has classified this event as a valid failure since it would have resulted in a failure during the performance of a valid test.

Through December 10, 1989, there have been a total of 90 successful valid tests, four valid failures, and seven invalid failures of D/G 'B'. From the time of the last valid failure on November 11, 1988, there have been 27 successful valid tests of D/G 'B'. Therefore, this event does not change the testing frequency of once every 31 days as required in Table 4.8-1 of Technical Specification 3.8.1.1. D/G 'B' was out of service for a total of 41 hours, 30 minutes during this event.

Figure 1 - Diesel Generator Jacket Water System (simplified)
"Keep Warm" Flow Path