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W3B5-91-0114

A4.05

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April 17, 1991

U.S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, D.C. 20555

SUBJECT: Waterford 3 SES
Docket No. 50-382
License No. NPF-38
Reporting of Special Report

Gentlemen:

Attached is Special Report Number SR-91-002-00 for Waterford Steam Electric Station Unit 3. This Special Report is submitted per 10CFR50.36(c)(2) and Technical Specifications 4.8.1.1.3 and 6.9.2.

Very truly yours,

J.R. McGaha
General Manager Plant Operations

JRM/DDW:jrr
Attachment

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Special Report 91-002-00

Valid failure of Emergency Diesel Generator 'A' due to overpressurization of the crankcase.

INTRODUCTION

On March 18, 1991, Waterford Steam Electric Station Unit 3 was in cold shutdown when Emergency Diesel Generator (EDG) 'A' experienced a crankcase overpressurization. The EDG was being run in accordance with the prerequisites of the 18 month Emergency Diesel Engine Inspection procedure, MM-003-015, when the overpressurization occurred. The operator observing the EDG run, depressed the emergency stop button and pulled the overspeed trip. This event has been classified as a valid diesel failure and is being reported in accordance with Technical Specification 4.8.1.1.3.

The root cause of this event is still under investigation. A possible root cause, based on vendor bulletin information, is an improper temperature differential between jacket cooling water and lube oil temperatures. A related possible contributing cause is an omission of relevant information in that the vendor did not provide a service news bulletin which specifically identified the possible adverse consequences of the previously-mentioned temperature differential. The piston and piston liner have been replaced and the improper temperature differential will be corrected. A revision to this special report will be submitted if a more positive root cause determination is made.

NARRATIVE

At 0457 hours on March 18, 1991, Waterford Steam Electric Station Unit 3 was in cold shutdown when Emergency Diesel Generator (EDG) (EIIS Identifier EK-ENG) 'A' experienced a crankcase (EIIS Identifier BLK) overpressurization. Personnel operating the EDG depressed the emergency stop push button and pulled the overspeed trip after the overpressure condition occurred. This event has been classified as a valid diesel failure and is reported in accordance with Technical Specification 4.8.1.1.3.

EDG 'A' was started at 0221 to commence the prerequisite 4 hour continuous run of the 18 Month Emergency Diesel Engine Inspection procedure, MM-003-015. The purpose of the run was a pre-maintenance heatup and engine analysis prior to placing the unit out of service for the EDG 'A' refueling outage inspection. EDG 'A' was loaded to 4400 kilowatts when the crankcase overpressurization occurred. All 10 cylinder relief assemblies lifted, filling the room with oil vapor. The room was exited and there were no personnel injuries. After the vapor cleared, the room was entered and a crankcase oil sample was drawn. This oil sample was found to be within specifications. An on site fuel dilution test also yielded satisfactory results.

An inspection of the EDG cylinders, pistons, rods (EIIS Identifier ROD), and bearings was commenced as required by MM-003-015. The inspection revealed that the 5 left (5L) cylinder liner (EIIS Identifier LNR) exhibited intermittent 1 1/2 by 3 inch longitudinal rough spots or scuff marks perpendicular to the piston pin. Vertical scratch marks were noted throughout the length of the cylinder. Additionally, the metal on the underside of the piston had been discolored by heat. A borescope inspection of the other pistons indicated satisfactory results. Disassembly and inspection of four

other pistons, 5R, 1L, 1R and 8L, revealed normal wear.

Of particular interest was a missing piece of chrome from the 5L piston cylinder liner. The missing chrome flake is approximately 1/4 inch in diameter. The 5L cylinder liner was analyzed at the vendor's metallurgical lab to determine the cause and consequence of the missing chrome. The chrome flaking was determined to be a result of pre-crankcase overpressurization scuffing rather than a cause of the crankcase overpressurization.

Cooper-Bessemer Service News Bulletin number 688, dated June 26, 1985, addressed the possibility of "cylinder scuffing, piston seizure and...crankcase explosion" if jacket cooling water temperature was not maintained 5 degrees Fahrenheit higher than piston lube oil temperature. Waterford 3 had not received this bulletin from the vendor, but a consultant who was familiar with bulletin 688 noted that Waterford 3 EDG logs showed that jacket cooling water temperature was being maintained 4 degrees lower than piston lube oil temperature. Maintaining the recommended temperature differential would reportedly prevent a crankcase explosion caused by frictional heat resulting from scuffing of the cylinder in the piston skirt area. The piston is cast steel with a thin outer coating of tin. The piston cylinder wall is coated with chrome. Although the reasons are not known, there is empirical industry evidence that indicates that an improper temperature differential causes the cast steel in the piston skirt area to become exposed. This cast steel surface then scuffs the chrome cylinder wall, eventually generating enough frictional heat to cause a crankcase explosion. The fact that this temperature differential condition had existed at Waterford 3 on both EDGs for several years with no deleterious effects and the fact that none of the other EDG 'A' cylinders had scuff marks casts doubt that the improper temperature differential is the root cause. Consequently, this

temperature differential is being evaluated as only a possible root cause. A related possible contributing cause is an omission of relevant information in that Cooper-Bessemer Service News Bulletin Number 688 was not received at Waterford 3 from the vendor.

This failure is the second failure during a valid test of EDG 'A' at Waterford 3 since the operating license was issued. There has also been one failure during a valid test of EDG 'B'. The jacket water and lube oil thermostatic valve thermo-elements have been replaced and the resulting temperature differential is zero. Establishing a lube oil temperature which is lower than jacket water temperature will require utilizing a different lube oil thermo-element. A lower temperature lube oil thermo-element has been requested from the vendor and the vendor will provide these thermo-elements pending completion of their evaluation and procurement process. To address the second possible root cause, Waterford 3 will verify that Cooper-Bessemer Service News Bulletins are received in order by checking that the bulletin number is sequential. Additionally, the vendor now has a designated point of contact for all nuclear users who will be used to closely track the bulletins.

Reducing the lube oil temperature below the vendor's recommendation is being considered. A consultant will evaluate this failure and make a recommendation regarding the optimum jacket water to lube oil temperature differential. EDG 'B' cylinders will also be inspected for evidence of scuffing.

A review of industry experience revealed that crankcase overpressurizations at other plants have been attributed to metal cuttings in piston pin oil grooves, improper piston pin fit-up, piston bushing failure, lube oil pump bearing failure, a loose piston pin bolt, and water leaks. Additionally, four crankcase overpressurizations attributed to piston to liner

seizures have indeterminate root causes. All of these root causes have been systematically eliminated during the root cause investigation. Specifically, no metal cuttings were found in EDG 'A'. The vendor determined that although two piston bushings needed to be reconditioned, the piston bushings could have been used in their previous condition. An improper piston pin fit-up would have caused a piston seizure soon after the initial EDG start. The EDG lube oil pump functioned satisfactorily. No loose piston pin bolts were noted and the crankcase oil sample was within specification.

EDG 'A' was declared operable at 1930 on April 12, 1991. The following items were replaced during the refueling outage: 5L cylinder liner and piston assembly, 5R piston assembly, 1L piston assembly, and 5 and 1 rod bearings. The 1L and 5R pistons and bushings were reconditioned.

The current surveillance test interval is at least once per 31 days, which is in conformance with the schedule of Regulatory Position C.2.d. The crankcase relief assemblies functioned as designed and EDG 'B' remained operable throughout the time that EDG 'A' was out of service therefore, this event did not present a hazard to the health and safety of the general public.

Plant Contact

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