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December 10, 1999

U.S. Nuclear Regulatory Commission
Mail Stop P1-37
Washington, D.C. 20555

Attention: Document Control Desk

SUBJECT: Grand Gulf Nuclear Station
Docket No. 50-416
License No. NPF-29
HPCS System Declared Inoperable
Because of a Generator Shaft Bearing Failure
LER 1999-004-01

GNRO-99/00093

Gentlemen:

Attached is Licensee Event Report (LER) 1999-004-01 which is a final report.

Yours truly,

for J Venable

WAE/CDH
attachment
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NRC FORM 366 (6-1998) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Grand Gulf Nuclear Station, Unit 1	05000-416	1 of 9

TITLE (4)
HPCS System Declared Inoperable Because of a Generator Shaft Bearing Failure

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
									N/A	05000
09	09	1999	1999	-- 004 --	01	12	10	1999	FACILITY NAME N/A	DOCKET NUMBER 05000

OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR § (Check one or more) (11)							
POWER LEVEL (10)	100		20.2201(b)		20.2203(a)(2)(v)	X	50.73(a)(2)(i)		50.73(a)(2)(viii)
			20.2203(a)(1)		20.2203(a)(3)(i)		50.73(a)(2)(ii)		50.73(a)(2)(x)
			20.2203(a)(2)(i)		20.2203(a)(3)(ii)		50.73(a)(2)(iii)		73.71
			20.2203(a)(2)(ii)		20.2203(a)(4)		50.73(a)(2)(iv)		OTHER
			20.2203(a)(2)(iii)		50.36(c)(1)	X	50.73(a)(2)(v)		Specify in Abstract below or in NRC Form 366A
			20.2203(a)(2)(iv)		50.36(c)(2)		50.73(a)(2)(vii)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Charles D. Holifield / Senior Licensing Engineer	601-437-6439

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
A	EK	DG	Electric Prod. Co.	Y					

SUPPLEMENTAL REPORT EXPECTED (14)				EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
	YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO				

ABSTRACT (Limit to 1400 spaces, i. e., approximately 15 single-spaced typewritten lines) (16)

On September 9, 1999, Emergency Diesel Generator (EDG) 13 was run for a 24-hour load surveillance test. Soon after load was raised to 110 percent as required, a noise was heard and a load dip was observed. The "Generator RTD TEMP HI" alarm and all 6 stator temperature indicators came in. All but one of the alarms cleared. Operators observed sparks coming from the east generator end. The EDG was tripped using the emergency stop pushbutton. Investigation revealed that the east end generator bearing failed. The cause of the generator bearing failure was inadequate lubrication as a result of lowering oil level. Concerns with bearing oil "frothing" drove the decision to lower the oil level. Immediate corrective actions were initiated to repair the generator and resolve any safety concerns. A Significant Event Response Team was formed to determine the root cause and establish corrective actions to prevent reoccurrence. The health and safety of the general public were not compromised as a result of this event. This event is being reported pursuant to 10CFR50.73(a)(2)(v) and 10CFR50.73(a)(2)(i)(B).

A. Reportable Occurrence

During the performance of a 24-hour load surveillance run on the Division III Emergency Diesel Generator (EDG 13) [EK], EDG 13 was emergency stopped and placed out of service due to failure of the "B" (east end) generator bearing. As a result of this condition, the High Pressure Core Spray System (HPCS) [BG] was declared inoperable due to its onsite AC power source being inoperable and an initial 4-hour non-emergency notification was made by phone in accordance with 10CFR50.72(b)(2)(iii)(D). This event is being reported pursuant to 10CFR50.73(a)(2)(v).

EDG 13 was conservatively assumed to be inoperable from July 9, 1999 to September 9, 1999 when the bearing failure occurred. Since this exceeds the 72 hour limit of Technical Specification Limiting Condition for Operation Action 3.8.1.A.2, this is reportable persuant to 10CFR50.73(a)(2)(i)(B). A review of the equipment that was removed from service during the assumed inoperability of the Division III EDG revealed that the Division I or Division II diesel generators (D/Gs) were removed from service and made non-functional for reasons other than D/G surveillances. On 2 occasions, the outage times were in excess of the 24 hours allowed for 2 D/G out of service for Technical Specification 3.8.1.E plus the 12 hour shutdown statement (36 hours total). This was reported in the interim Licensee Event Report pursuant to 10CFR50.73(a)(2)(i)(B). Further review determined that the simultaneous D/G outages exceeded the Technical Specification time limit administratively but were, per the Maintenance Rule, functional for portions of that time. Therefore, from a functional standpoint, the aforementioned 36 hour limit was not exceeded. This review is described in Section F of this report.

B. Initial Conditions

At the time of the event, the reactor was in OPERATIONAL CONDITION 1 with reactor power at approximately 100 percent. Reactor temperature, reactor pressure vessel (RPV) pressure and RPV water level were at approximately 540 degrees F, 1045 psig and 36 inches, respectively. The 24-hour load surveillance run was being performed on EDG 13. There were no inoperable structures, systems, or components at the start of the event that contributed to the event.

C. Description of Occurrence

On September 9, 1999, EDG 13 was run for a 24-hour load surveillance test. Pre-start checks were satisfactory and EDG 13 was started and reached 100 percent load (3300 kW) at 1105. At 1124, the load was raised to 110 percent (3650 kW) for a required period of 2 hours. However, at 1145, a noise was heard and a load dip was observed. Personnel in the room began investigating. The system engineer and Operator-1 went towards the east end of the engine to investigate while Operator-2 was at the local D/G panel P118 monitoring conditions. Operator-2 observed the "Generator RTD TEMP HI" alarm come in along with all 6 stator temperature indicators. The reset pushbutton was pressed and the alarm remained in. All of the stator temperature indicators cleared except either number 4 or number 5. When the alarm did not clear, Operator-2 obtained the Alarm Response Instruction (ARI), performed the first two steps and looked for the system engineer for assistance.

At about the same time, the system engineer observed sparks coming from the east generator end and motioned for Operator-2 to trip the D/G. The EDG was tripped with the emergency stop pushbutton at 1148. When the engine coasted down to 15-20 RPM, it stopped rolling "suddenly". An oil sample of the "B" bearing collected about 12 hours after the event indicated an elevation in particulate counts but the results were still in the acceptable range.

A deficiency document (CR 1999-1054) was issued and EDG 13 was tagged out. The diesel room was quarantined and a plan for recovering the diesel generator was developed. A team was established to determine root causes for the bearing failure.

D. Apparent Cause

The immediate cause of the failure of the "B" generator bearing was extended operation without sufficient lubrication. In 1998, a conflict was noted between the nameplate data and a vendor drawing for the amount of oil in the bearing. The vendor drawing specified the high level as being 5-9/16 inches from the shaft centerline. The nameplate called for 3.75 gallons of oil. The system engineer used the drawing to establish sightglass marks for the bearing. After the marks were established, 3.75 gallons were added. However, oil level failed to reach the desired band. Additional oil was added to raise level into the band. The discrepancy between the amount of oil needed to reach the established marks (vendor drawing) and nameplate oil amount was not documented on a deficiency document.

D. Apparent Cause (cont'd)

In the summer of 1999, the system engineer started evaluating oil "frothing" in the bearing. At a D/G owners group meeting, he was told of a bearing failure after "frothing" had occurred at another plant. EDG 13 was experiencing "frothing" in the bearing while operating the oil level at the vendor drawing established level. The system engineer decided to lower oil level in the bearing to the nameplate data volume. The bearing oil level was lowered via the bearing housing drain on July 9, 1999. The oil was drained from the bearing and 3.75 gallons of oil was added. The diesel was run six times between July 9 and September 9 for a total of 8 hours and seven minutes. On September 9, 1999 the bearing failed during testing as described above.

The immediate cause of the failure of the "B" generator bearing was extended operation without sufficient lubrication. This condition was the result of the following root causes:

1) Plant personnel exhibited insufficient awareness of the impact of actions on safety or reliability in that the System Engineer used a vendor drawing to place acceptable bands on the generator oil level sightglasses and later recognized that the nameplate oil amount conflicted with the oil level specifications on the vendor drawing. This was done without initiating a formal process to evaluate and resolve the conflict between the nameplate information and the vendor drawing. An opportunity was missed to collaborate with peers and supervisors to determine the conservative action when faced with the competing alternatives and substantive information was unavailable.

2) Problems noted during maintenance and testing were not corrected or resolved. 'Foaming', 'Frothing' or 'aeration' of the oil in the "B" bearing has occurred intermittently since plant construction. The recent increase in observed foaming, combined with questions from both the NRC resident and the Operations shift and a reported foaming-induced bearing failure directly drove the sequence of decisions to lower the oil level in an attempt to prevent 'foaming'. No formal evaluations, oil testing, or other analytical methods were used to understand the true nature of the observed phenomena, establish the true cause or determine appropriate corrective actions.

D. Apparent Cause (cont'd)

3) Engineering policy guidance and expectations were not well defined or understood. The System Engineer did not consider the change in oil level as a configuration change since a value was provided on the nameplate and felt the vendor drawing and the nameplate data were both correct. No programmatic control exists for the basis of equipment oil levels. No expectations have been developed for proper use of nameplate information. Additionally, Engineering supervision and the other plant organizations involved with the oil level change did not exhibit an adequate questioning attitude. In the absence of clear guidance, the System Engineer did not use conservative decision-making and made the oil level change without sufficient understanding of its impact.

E. Corrective Actions

Immediate corrective actions:

1) A deficiency document was issued and the diesel generator was tagged out.
2) The diesel room was quarantined and a plan for recovering the diesel generator was developed.
3) A team was established to determine root causes for the bearing failure.

Interim Corrective Actions:

1) The failed generator was shipped to a repair facility to have the bearing removed and the generator repaired. Members of the Significant Event Response Team (SERT) witnessed and recorded pertinent data. After the bearing was removed it was sent to a laboratory for failure analysis.
2) A walkdown of safety systems conducted by Operations between 9/11/99 and 9/13/99 revealed several sightglasses without oil level markings.
3) A Condition Report (CR) was initiated to perform a broader evaluation to determine whether there are other less than adequate configuration control practices that should be subject to formal design control and configuration management requirements.

E. Corrective Actions (cont'd)

4) A meeting was held with Engineering personnel prior to Refueling Outage Ten to discuss the lessons learned from the root cause analysis of this event.

Long Term Corrective Actions:

1) Guidance to utilize collaboration with peers and supervisors to determine the conservative action when faced with competing alternatives such as conflicting design inputs will be established.
2) This issue will be reviewed with all Engineering personnel in an Engineering standdown or training.
3) Review the root cause report in the Engineering Support Personnel, Operations, and Maintenance Training Review Groups.
4) Evaluate lessons learned from the root cause report for inclusion in a Grand Gulf all-hands meeting.
5) Evaluate oil aeration (frothing) in Diesel Generator 13 generator bearings to determine impact.
6) Engineering will establish guidance for reporting/evaluating oil foaming in the Oil Analysis program, the use of oil analysis to predict bearing failures and how abnormalities/anomalies in the field or oil analyses are documented and evaluated.
7) Evaluate the oil sampling task frequency for the EDG 13.
8) Perform a broader evaluation of configuration control practices to determine whether there are other practices that should be subject to formal design control and configuration management requirements.
9) Engineering has addressed proper oil level determination including markings and basis for oil levels for EDG 13.
10) Nameplate oil volume data will be erased from the installed EDG 13 and the spare EDG 13.
11) Establish programmatic controls over oil levels and volumes, similar to other design basis information such as pressures and flows. The programmatic controls will be evaluated for engineering training needs when they are established.

F. Safety Assessment

To conservatively bound the safety consequence of the EDG 13 bearing failure, it is assumed that EDG 13 is inoperable or potentially inoperable for the 60 days prior to the event followed by the 12 days after the event (July 9 to September 19). Additionally, Maintenance Rule system non-functional time data was reviewed to determine what other systems were non-functional during this period of time. The impact of simultaneous system outages was evaluated by inputting Maintenance Rule data into an Equipment Out Of Service (EOOS) Risk Monitor, which utilizes a Probabilistic Risk Assessment (PRA) model.

The Maintenance Rule data is the appropriate source since it is determined based on whether a system (including support systems) would actually be capable of performing their specific safety function, if needed. The PRA model realistically addresses a wide range of accident initiators, as well as incorporating realistic accident mitigation capability. The total calculated core damage probability for this period of time was determined to be approximately 1.02E-05. This compares to the EOOS base model cdf of 2.43E-06/yr with no maintenance or a no-maintenance probability of 4.79E-07 for an equivalent time period. The difference between the calculated core damage probability and the EOOS base model no-maintenance probability core damage probability is approximately 9.7E-06.

There are six distinct periods when there were additional equipment outages that resulted in significant increases in calculated cdf. These equipment outages involved the non-functionality of either HPCS, EDG 11 or EDG 12 systems while EDG 13 was assumed to be inoperable. The associated core damage probabilities for the periods of time with the multiple equipment outages are listed below:

Equipment Out of Service		CD Probability Probability	Delta CDP (over Base)	Total Time
EDG 13	HPCS System	1.88E-07	7.94E-08	16.3 hours
EDG 13	EDG 11	1.55E-06	1.34E-06	31.7 hours
EDG 13	EDG 12	1.02E-06	9.00E-07	17.3 hours

F. Safety Assessment (cont'd)

Overall, the periods of time when there was a non-functional system in addition to EDG 13 were relatively short in duration and the associated delta core damage probabilities (over the equivalent base CDP) were either less than or only slightly above 1.0E-06. EPRI's PSA Applications Guide defines a non-risk significant temporary change as one with a CDP of less than 1.0E-06. This would imply that the periods with simultaneous system outages were relatively non-significant primarily because of the short time frames associated with the multiple outages. However, the overall time frame that EDG 13 is assumed to have been inoperable (72 days) is significant in comparison.

As indicated above, the calculated delta CDP for the entire period was 9.72E-06. While this represents a substantial increase over the base line CDP for a similar period of time, there were multiple divisions of mitigation systems available during the entire duration except for those short periods indicated above. The mitigation capability typically would have included RCIC and ADS in combination with low pressure ECCS for high pressure scenarios and both low pressure ECCS trains for low pressure scenarios. HPCS would also have been available as long as there was not a loss of off-site power. The short periods with multiple non-functional systems primarily involved the HPCS pump train or one of the other standby power diesel generators. The worst initiating event for this configuration would have been a loss of offsite power. The remaining mitigating capability would then have been RCIC and ADS in combination with the one remaining low pressure ECCS division for high pressure scenarios and the one remaining low pressure ECCS division for low pressure scenarios.

G. Additional Information

Generator data:
Electric Products (EP) Co. (division of Portec Inc.)
No. 150 AC synchronous generator
Serial No. 17312216
3474 kW rating / 900 RPM / self-ventilating

G. Additional Information (cont'd)

Bearing data:
Timken Co.
9.0 inch bore thrust bearing
tapered roller bearing - two row assembly
part No. 96140CD

Previous events:
A previous failure of the HPCS Diesel Generator "A" bearing occurred on July 13, 1985 due to circulating currents. No evidence of circulating current damage has been found in the September 9, 1999 event. Therefore, this previous occurrence is not similar to the September 9, 1999 event.

Another event involving the HPCS Diesel Generator occurred on January 26, 1996 due to a lube oil strainer valve being left out of position. The cause of the failure was different than that of the September 9, 1999 event. However, the consequences were similar in that the EDG was left inoperable for almost 7 days.

As a result of this event, Condition Report GGCR 1999-1054-00 and Root Cause Analysis Report RCDL No. 99-30 were generated. Energy Industry Identification System (EIIS) codes are identified in the text within brackets [ ].