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 DAVISON,W.S. Washington Public Power Supply System  
 POWERS,C.M. Washington Public Power Supply System  
 RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 90-012-00:on 900527,fire in div one diesel generator  
 caused by generator thrust bearing failure.

W/9 ltr.

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<u>REG FILE</u> 02	1 1	REGION 1	1 1
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WASHINGTON PUBLIC POWER SUPPLY SYSTEM

P.O. Box 968 • 3000 George Washington Way • Richland, Washington 99352

Docket No. 50-397

June 25, 1990

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

Subject: NUCLEAR PLANT NO. 2  
LICENSEE EVENT REPORT NO. 90-012

Dear Sir:

Transmitted herewith is Licensee Event Report No. 90-012 for the WNP-2 Plant. This report is submitted in response to the report requirements of 10CFR50.73 and discusses the items of reportability, corrective action taken, and action taken to preclude recurrence.

Very truly yours,



C. M. Powers (M/D 927M)  
WNP-2 Plant Manager

CMP:lr

Enclosure:  
Licensee Event Report No. 90-012

cc: Mr. John B. Martin, NRC - Region V  
Mr. C. J. Bosted, NRC Site (M/D 901A)  
INPO Records Center - Atlanta, GA  
Ms. Dottie Sherman, ANI  
Mr. D. L. Williams, BPA (M/D 399)

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## LICENSEE EVENT REPORT (LER)

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1) Washington Nuclear Plant - Unit 2										DOCKET NUMBER (2) 0 5 0 0 0 3 9 7				PAGE (3) 1 OF 0 7											
TITLE (4) Fire in Division One Diesel Generator Caused by Generator Thrust 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 NAMES				DOCKET NUMBER(S)												
0	5	2	7	9	0	9	0	0	0	1	2	0	0	0	6	2	5	9	0	0	5	0	0	0	0
OPERATING MODE (9) 5			THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)																						
POWER LEVEL (10) 0 0 0		20.402(b)				20.405(e)				60.73(a)(2)(iv)				73.71(b)											
		20.406(a)(1)(i)				60.36(c)(1)				60.73(a)(2)(v)				73.71(c)											
		20.406(a)(1)(ii)				60.36(c)(2)				60.73(a)(2)(vi)				X OTHER (Specify in Abstract below and in Text, NRC Form 366A)											
		20.406(a)(1)(iii)				60.73(a)(2)(i)				60.73(a)(2)(viii)(A)				10CFR21											
		20.406(a)(1)(iv)				60.73(a)(2)(ii)				60.73(a)(2)(viii)(B)															
		20.406(a)(1)(v)				60.73(a)(2)(iii)				60.73(a)(2)(x)															
LICENSEE CONTACT FOR THIS LER (12)																									
NAME W. S. Davison, Compliance Engineer										TELEPHONE NUMBER AREA CODE 5 0 9 3 7 7 - 2 5 0 1															
COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13). X 2 7 2 6																									
CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NRC		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NRC															
B	E D	D G	S 4 0 7	Yes																					
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 fifteen single-space typewritten lines) (16)

On May 27, 1990, at 1742 hours, the Division 1 emergency diesel generator (DG-GEN-DG1) failed approximately six hours into a 24 hour full load run. The failure of the diesel generator slip ring end bearing resulted in a small fire in the area of the bearing itself which was quickly extinguished. An Emergency Classification of Unusual Event was declared by the Shift Manager and the event was reported to the NRC Bethesda Operations Center. There were four root causes determined to be responsible for occurrence of this event: 1) Equipment - Manufacturing Error - Not made per design - an extra O-ring groove was found machined into the generator thrust bearing bracket which prevented the bearing oil reservoir from obtaining a tight seal. This resulted in oil leakage from the reservoir, oil starvation of the thrust bearing and eventual bearing failure; 2) Equipment - Design Deficiency - Specification less than adequate - the oil level band for the oil reservoirs is too narrow to allow practical maintenance of level; 3) Equipment - Design Deficiency - Loss of monitoring alertness - the temperature and vibration alarm instrumentation and the oil reservoir sight glass were evaluated as inadequate to provide the operators with sufficient warning to respond to this type of event; and 4) Personnel - Management Programs - Failure to heed precursors - Nineteen instances of thrust

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TEXT CONTINUATION

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

Abstract (contd.)

bearing oil level problems occurred over an approximate five year period. Attempts to correct the problem were unsuccessful. Further corrective actions consisted of; removing the extra O-ring groove from the DGI generator thrust bearing bracket, reviewing the records to determine possible effects on the remaining diesel generator units, and inspection of the oil reservoir sight glasses for the remaining diesel generators to determine their adequacy. Evaluations will be performed to explore widening the operating band for the oil reservoirs, propose methods of improving the instrumentation and explore installation of a forced circulation oil system for the generator bearings. A reliability centered maintenance program is being developed which will address the issue of detecting equipment problem trends associated with maintenance activity and initiation of corrective actions to preclude failure. At the time of the event, the plant was in the Refueling Mode (Operational Condition 5) and, as a result, DGI was not required to be operational. The small fire associated with this event was handled quickly and correctly in accordance with approved emergency procedures. This report is also being used to report this event under the requirements of 10CFR21. This event posed no threat to the safety of Plant personnel or the Public.

Plant Conditions

- a) Plant Mode - 5 (Refueling)
- b) Power Level - 0%

Event Description

On May 27, 1990, at 1742 hours, the Division 1 emergency diesel generator (DG-GEN-DGI) failed approximately six hours into a 24 hour full load run. The load run was part of the Logic System Functional Test for the diesel backed 4.16 KV Division 1 emergency AC electrical power system. The purpose of the test was to demonstrate the ability of the system to respond to design basis accident requirements as mandated by the 18 month Technical Specification surveillance requirements.

At 1742 hours while taking individual cylinder temperature readings, the local diesel system operator noticed a change in pitch of the sound coming from the DGI engines. Thinking that the Main Control Room had adjusted load, he continued taking readings. Shortly thereafter, he noticed a different smell and heard a rumbling coming from the 1A2 (south side) diesel engine. He proceeded to the control panel to see if there were any changes. While observing the panel, the "Generator Stator or Bearing Temperature" alarm sounded. After the alarm was silenced, the operator called the main control room to report the alarm. While on the phone, the operator heard the engine start to rumble again and the "Excessive Vibration Generator" alarm sounded. The Main Control Room operator tripped the diesel generator at that point. At the same time, two maintenance men working in the diesel room reported a fire in the engine area. The diesel operator reported the fire to the Main Control

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Room and then proceeded to the generator area where he noted fire coming out of the generator slip ring end bearing. The small fire was immediately extinguished with a dry chemical fire extinguisher. The fire re-flashed one time before being completely suppressed.

Immediate Corrective Action

The plant operators utilized the emergency operating procedures to successfully deal with the small fire at the DG1 generator slip ring end bearing. An Emergency Classification of Unusual Event was declared by the Shift Manager and the event was reported to the NRC Bethesda Operations Center by telephone at 1810 hours. The DG1 unit was shut down and danger tagged by plant operators.

Further Evaluation and Corrective ActionA. Further Evaluation

1. This LER is written to document this event as a voluntary report and to document a manufacturing defect discovered in the generator of DG1 as reportable per the requirements of 10CFR21. The required information pertaining to the Part 21 report is listed below in paragraphs 2 through 8.

2. Name and address of the individual or individuals informing the Commission.

Washington Nuclear Plant - Unit 2  
3000 George Washington Way  
Richland, Washington 99352

3. Basic Component which contains a defect.

Division 1 Emergency Diesel Generator (E-DG-1)

4. Identification of firm supplying the component.

Stewart & Stevenson Services, Inc.  
P. O. Box 637  
Houston, Texas 77001

5. Nature of the defect and the safety hazard which is created.

Failure analysis results concluded that the diesel generator failure was due to loss of lubrication to the generator thrust bearing which was caused by leakage of oil from the bearing oil reservoir which supplies the bearing. The oil leakage was caused by an inadequate O-ring seal between the walls of the thrust bearing bracket and the bearing cover which form

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form the oil reservoir. The inadequate O-ring seal was caused by the existence of an extra O-ring groove machined into the generator thrust bearing bracket which prevented the O-ring from being compressed to obtain a tight seal. This extra groove does not appear on the design drawings. The existence of this extra O-ring groove in the generator housing is a DEFECT.

This defect could have resulted in the failure of DGI to perform its emergency function of supplying power to the 4160 VAC emergency electrical bus (SM-7) during accident conditions (a LOCA with a simultaneous loss of offsite power). The inability of DGI to reliably perform its emergency function is a major degradation of safety-related equipment and as such constitutes a SUBSTANTIAL SAFETY HAZARD.

6. The date on which the information of defect was obtained.

June 20, 1990

7. The number and location of affected components in use.

The only affected component at WNP-2 is DGI which located in the DGI room of the Diesel Generator Building.

8. Corrective Action.

The faulty O-ring groove was corrected under the direction of WNP-2 Technical Staff at the Eastern Electric repair shop in Spokane, Washington, by June 11, 1990. The Division 2 diesel generator was confirmed to not contain an extra O-ring groove in its generator thrust bearing bracket.

9. There were no structures, components or systems that were inoperable at the start of this event that contributed to the event.

10. The failure analysis performed for this event resulted in the following observations and conclusions:

- The small fire was caused by excessive heat generated when the generator slip ring end bearing failed. This bearing failed due to extreme misalignment caused by axial thrust applied from the opposite end of the generator as the thrust bearing failed. This led to an overload failure of the slip ring end bearing.
- The thrust bearing oil reservoir allowable level band is only 3/8 inch from top to bottom. Operating with oil level too low causes loss of lubrication to the bearing. Operating with level too high promotes undesirable foaming of the oil.

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- c. The oil level in the slip ring end bearing was high enough to provide adequate lubrication to the bearing during and after the failure.
- d. The application of unacceptable axial thrust to the generator slip ring end bearing was caused by catastrophic failure of the generator thrust bearing.
- e. The generator thrust bearing failed due to loss of lubricant. Nineteen instances of inability to maintain proper oil level in the bearing reservoir have occurred over a five year period and were evaluated as event precursors. These problems were not solved in time to prevent the low oil event which led to total failure of the thrust bearing.
- f. The long term leakage from the thrust bearing oil reservoir was caused by an extra O-ring groove improperly machined into the generator thrust bearing bracket. The only O-ring groove present should have been the one machined into the thrust bearing cover. This extra groove allowed excessive space for the O-ring and precluded proper ring compression, thus, allowing a slow oil leak to exist.
11. There were four root causes determined to be responsible for occurrence of this event:
- a. Equipment - Manufacturing Error - Not made per design. It was determined that an extra "O" ring groove was machined into the generator thrust bearing bracket (the oil reservoir is contained in the bearing cover) which was not in accordance with the design drawings. No groove should have been present. The second groove prevented the O-ring from being compressed to produce an adequate seal to prevent oil leakage from the bearing oil reservoir. This oil leakage ultimately led to failure of the generator thrust bearing.
- b. Equipment - Design Deficiency - Specification less than adequate. The prescribed operating band for the generator thrust bearing oil level is only 3/8 inch. This was evaluated as impractical and very difficult to maintain.
- c. Equipment - Design Deficiency - Loss of monitoring alertness. The temperature alarm instrumentation, the vibration alarm instrumentation and the oil sump level indicators on DGI are all deficient in their ability to perform the intended function of alerting the operating personnel to abnormal conditions. The vibration alarms were evaluated as not being sensitive enough to predict an event as

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experienced. The diesel operator did not have sufficient time to respond to the vibration alarm and secure the machine prior to the occurrence of catastrophic damage. The temperature alarms should also have given sufficient warning of impending bearing failure to allow the operator to secure the machine prior to the occurrence of catastrophic damage. The thrust bearing oil reservoir level indicator contained three different marks, any one of which could have been interpreted to be the minimum oil level indication.

- d. Personnel - Management Programs - Failure to heed precursors. Failure to communicate and act upon long term problems of oil leakage from the generator thrust bearing and difficulties in maintaining levels in the thrust bearing oil reservoir led to the eventual oil starvation of the bearing. Nineteen documented instances of DGI thrust bearing oil level problems occurred over an approximate five year period. Attempts to correct the problem were unsuccessful. The existence of the second O-ring groove was not discovered nor were sufficient compensatory measures to counteract the oil leakage problem implemented.
12. The root cause analysis is currently still in progress. Any substantive changes in cause or corrective action will be addressed in a supplemental report.
13. The failure of DGI during performance of a technical specification required surveillance was evaluated as a failure during a valid test in accordance with regulatory position c.2.e of NRC Regulatory Guide 1.108 Revision 1, August 1977. The surveillance frequency was not required to be increased since the number of failures did not exceed the criteria listed in WNP-2 Technical Specification paragraph 4.8.1.1.2.

**B. Further Corrective Action**

1. The second O-ring groove in the thrust bearing bracket of the DGI generator was eliminated to bring the machine into compliance with design drawings.
2. A detailed review of the records of the remaining emergency diesel generators was conducted to discover possible effects on the operability of those machines. This review also included examination of photographs of the Division 2 diesel generator taken during a factory repair in 1984. Examination of these photos showed that the Division 2 Diesel Generator thrust bearing bracket does not contain an additional O-ring groove.
3. The remaining diesel generators were inspected to determine that oil level indicators were readable with the correct indicated level.



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4. Further measurements will be taken on the Division 2 generator to confirm proper oil level indication.
5. Widening the level control band for the generator oil reservoirs for the Division 1 and 2 diesel generators will be evaluated.
6. An evaluation will be performed to propose methods of improving the vibration, temperature, and oil level instrumentation.
7. An evaluation will be performed to explore installing of a forced lubrication system for the generator bearings.
8. An effort is currently in progress to institute a reliability centered maintenance program. One of the objectives is to improve the ability to monitor and trend lubricating oil levels in order to correct problems prior to failure.

Safety Significance

At the time of the event, the plant was in the Refueling Mode (Operational Conditional 5) and, as a result, DGI was not required to be operational. Since no common mode failure was identified, even if the event had occurred during power operation, the loss of a single diesel generator is within the bounds of the Technical Specification LCO Action requirements. The remaining redundant Division 2 emergency AC electrical power system and associated safety-related equipment was unaffected by the event and could have responded to accident conditions. The defect associated with the existence of the extra O-ring groove could have resulted in the failure of DGI to perform its emergency function of supplying power to the Division 1 safety-related equipment in the event of a Design Basis LOCA accompanied by simultaneous loss of offsite electrical power. The small fire associated with this event was handled quickly and correctly in accordance with approved emergency procedures. This event posed no threat to the safety of Plant personnel or the Public.

Similar Events

No similar events involving the diesel generators have occurred at WNP-2.

EIIS InformationText ReferenceEIIS Reference

DG-GEN-DGI  
Division 1 emergency power system  
Generator  
Emergency electrical bus SM-7

<u>System</u>	<u>Component</u>
ED	DG
ED	---
ED	GEN
ED	BU

