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 AUTH. NAME      AUTHOR AFFILIATION  
 POCHE, R.J.      Washington Public Power Supply System  
 BAKER, J.W.      Washington Public Power Supply System  
 RECIPIENT NAME      RECIPIENT AFFILIATION

SUBJECT: LER 92-006-01: on 910412, plant shutdown due to TS  
 requirement. Caused by inoperable Div 1 DG lube oil sys not  
 adequately cleaned. Mod to lube oil sump made to eliminate  
 sump leakage. W/930217 ltr.

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WASHINGTON PUBLIC POWER SUPPLY SYSTEM

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

G02-93-038  
February 17, 1993

Docket No. 50-397

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Washington, D.C. 20555

**SUBJECT: NUCLEAR PLANT WNP-2, OPERATING LICENSE NPF-21  
LICENSEE EVENT REPORT NO. 92-006-01**

Transmitted herewith is Licensee Event Report No. 92-006-01 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. This supplement also provides final results and conclusions from the root cause analysis and updates previously provided information.

Sincerely,

*JW Baker for*

J. W. Baker  
WNP-2 Plant Manager (Mail Drop 927M)

JWB/RJP/cgeh  
Enclosure

cc: Mr. J. B. Martin, NRC - Region V  
Mr. R. Barr, NRC Resident Inspector (Mail Drop 901A, 2 Copies)  
INPO Records Center - Atlanta, GA  
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*JWB*

# LICENSEE EVENT REPORT (LER)

FACILITY NAME (1) <b>Washington Nuclear Plant - Unit 2</b>	DOCKET NUMBER (2) 0   5   0   0   0   3   9   7	PAGE (3) 1   OF   8
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TITLE (4)  
**PLANT SHUTDOWN DUE TO TECHNICAL SPECIFICATION REQUIREMENT CAUSED BY INOPERABLE DIVISION 1 DIESEL GENERATOR**

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														
0	4	1	2	9	1	9	1	0	0	6	0	1	0	2	1	1	9	3					
										DOCKET NUMBERS(S) 0   5   0   0   0													

OPERATING MODE (9) | 1 | THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

POWER LEVEL (10) 1   0   0	20.402(b)	20.405(C)	50.73(a)(2)(iv)	77.71(b)
	20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.73(c)
	20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
	20.405(a)(1)(iii)	X 50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
	20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)		

LICENSEE CONTACT FOR THIS LER (12)

NAME <b>R. J. Poche, Licensing Engineer</b>	TELEPHONE NUMBER 5   0   9   3   7   7   -   4   1   4   5
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COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

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<input type="checkbox"/> YES (If yes, complete EXPECTED SUBMISSION DATE) <input checked="" type="checkbox"/> NO	EXPECTED SUBMISSION DATE (15)	MONTH   DAY   YEAR
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ABSTRACT (16)

At 1600 hours on April 12, 1991, a Technical Specification required plant shutdown was initiated due to inoperability of the Division 1 emergency diesel generator (DG1). This action was taken after generator lube oil samples indicated higher than expected wear particle concentration. Cold shutdown was achieved at 1100 hours on April 14. Subsequent disassembly and inspection of the generator revealed that the bearings were in satisfactory condition. Therefore, it is concluded that DG1 was capable of performing its safety function at the time it was declared inoperable, and that this event had minimal safety significance.

The root causes of this event are: 1) the DG1 generator lube oil system was not adequately cleaned after a previous bearing failure; 2) the generator lube oil system design did not provide adequate access for cleaning and inspection; 3) periodic oil changes recommended by the manufacturer were not adequate to reduce contamination levels following bearing break-in, and 4) welds in the lube oil sumps were not oil tight.

Corrective actions included: installation of an additional lube oil reservoir and improved sight glass for the DG1 thrust bearing oil system, repair of the leak in the thrust bearing oil sump, venting of bearing oil sumps, flushing and cleaning of the bearing lube oil systems, and actions taken to trend diesel generator lube oil condition and perform routine sampling on a more frequent basis.

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TITLE (4) PLANT SHUTDOWN DUE TO TECHNICAL SPECIFICATION REQUIREMENT CAUSED BY INOPERABLE DIVISION 1 DIESEL GENERATOR							

Plant Conditions

Power Level - 100

Plant Mode - 1 (Power Operation)

Event Description

Beginning on April 12, 1991, at 1600 hours WNP-2 was Shutdown due to inoperability of the Division 1 emergency diesel generator (DG1). This shutdown was initiated because DG1 could not be restored to operability within 72 hours as required by Plant Technical Specifications; however, the shutdown also fell within the planned window for the start of the Spring 1991 Maintenance and Refueling Outage.

On April 5, 1991, at 0733 hours DG1 was started to demonstrate operability per Technical Specification Action Statement 3.8.1.1.a due to DG2 testing. The surveillance was completed successfully, but when the diesel was taken from idle speed to rated speed (900 rpm), the Shift Support Supervisor, a licensed operator, observed that a larger than expected drop to 3/4 of an inch below the low level mark occurred in the north-end thrust bearing oil sight glass of the generator (DG-GEN-DG1). The unit was returned to idle speed and the observed oil level returned to approximately 1/8 to 3/8 of an inch below the low level mark. The Plant System Engineer was notified and he observed the bearing oil levels with the diesels running in idle. (The DG1 and DG2 design has the generator centered between two diesel engines). DG1 was shutdown and returned to its normal standby configuration and per direction from the System Engineer oil was added to raise the oil level to a level just above the low level mark. The 225 ml of oil added is equal to approximately a 1/8 inch increase at the sight glass. At 1508 hours the scheduled testing for DG2 was completed and it was declared operable. At 1629 DG1 was run for one hour with the Plant System Engineer present. During the run the thrust bearing oil level sight glass was video taped. Also, generator vibration and bearing temperatures were monitored. All parameters remained within expected ranges. Following the run, a generator thrust bearing oil sample was taken and sent to a Supply System vendor for analysis.

On April 10, 1991, the results of the vendor analysis of the thrust bearing oil sample were received and identified a higher than expected concentration of wear particles. This was cause for concern and additional investigation. Based on engineering evaluation and consultation with the analysis laboratory, a new sample from both the south straight roller bearing sump and the north thrust bearing sump of the DG1 generator were taken. Then, both bearing oil sumps were flushed by draining and filling each sump three times with new oil, after which another set of oil samples were taken. Beginning at 0418 hours on April 11, 1991, DG1 was run for 12 hours with no indication of abnormal performance. At the completion of the run an additional bearing oil sump sample was taken from each of the two bearing sumps. All the samples were flown by chartered plane to the vendor laboratory for analysis. On April 12, 1991, the results of the vendor analysis of the bearing lube oil samples were received. Although the wear particle concentrations in the thrust bearing lube oil were lower in the post 12-hour run sample than in the sample

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taken on April 5, 1991, (see Table 1), the concentrations were still higher than would be expected. Based on the limited amount of lube oil history available for this generator and engineering judgement by Utility and Contract Engineers it was concluded that DG1 could not be relied upon. At 0830 on April 12, 1991, DG1 was declared inoperable. Based on the declaration of DG1 inoperability and the recognition that DG1 would not be restored to operable status within the 72 hour Technical Specification Action Statement window, Plant Management determined that WNP-2 would be shutdown to begin the Spring 1991 Maintenance and Refueling Outage.

At 1600 hours on April 12, 1991, Plant Operations began reducing reactor power. Maintenance and testing activities scheduled for the outage shutdown were conducted as planned during the shutdown. As previously planned, at 1200 hours on April 13, 1991, Reactor Operators scrammed the reactor. At 1100 hours on April 14, 1991, the reactor reached cold shutdown conditions.

TABLE 1  
DG1 THRUST BEARING OIL WEAR PARTICLE CONCENTRATION LEVELS  
(by direct reading ferrography)

Sample Date	Large Particle Concentration (greater than 5um/ml)	Small Particle Concentration (less than 5um/ml)	Total Wear Particle Concentration
4/5/91	88.4	32.4	120.8
4/11/91 (before fill and drain)	56.4	22.2	78.6
4/11/91 (after fill and drain)	3.3	0.1	3.4
4/11/91 (after 12 hour run)	43.1	8.6	51.7

Immediate Corrective Action

1. On April 5, 1991, upon discovery of a possible low level condition in the DG1 generator thrust bearing lube oil system, oil was added and DG1 was run and monitored for vibration, lube oil level, and bearing temperature. Additionally, as an added measure of assurance a DG1 generator thrust bearing lube oil sample was taken after the run and sent to a vendor laboratory for analysis.

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2. On April 5, 1991, the operating procedure for DG1 was revised to specify how the emergency diesel generator is to be shutdown if bearing oil sump levels are found outside of the acceptable range.
3. On April 10, 1991, when the results of the analysis of the DG1 thrust bearing lube oil sample taken on April 5, 1991, was received and indicated higher than expected wear particle concentration, both DG1 bearing lube oil systems were flushed by draining and filling each sump three times. DG1 was then run for 12 hours and additional lube oil samples were taken and flown to the vendor laboratory for analysis.
4. On April 12, 1991, when the results of the analysis of the thrust bearing lube oil samples taken on April 11, 1991, were received and indicated higher than expected wear particle concentrations, DG1 was declared inoperable and an orderly plant shutdown was begun.

Further Evaluation and Corrective Action

A. Further Evaluation

1. This event is being reported per the requirements of 10CFR50.73(a)(2)(i)(A): "The completion of any nuclear plant shutdown required by the plant's Technical Specifications". On April 14, 1991, a 1-hour report was made at 1141 hours, pursuant to 50.72(b)(i)(A) "The Initiation of any Nuclear Plant Shutdown Required by the Plant's Technical Specifications" to the Bethesda Operations Center. This report was delayed by the circumstances surrounding the schedule for the annual refueling outage. The shutdown for the refueling outage was originally scheduled for the period between April 12, 1991, and April 19, 1991. In fact, the plan as of April 11, 1991, was to continue to run through April 19, 1991, to help meet the regional energy demand. Direction was given to initiate the planned outage shutdown schedule at 1600 hours on April 12, 1991. The shutdown fell within the 72 hour out of service window allowed by Technical Specification Action Statement 3.8.1.1.a.
2. At the time of the April 5, 1991 event, a Plant Procedure was in place which essentially stated that if the oil level decreased to less than 3/8" below the sight glass low level mark to take immediate action to secure the unit (disable from start and declare unit inoperable). For the April 5, 1991 event, the diesel had been running for a few minutes when the low sight glass oil level for the generator thrust bearing was first noticed and measured. The Shift Support Supervisor present at the DG left the room (due to high noise in the room) and called the Control Room Supervisor to discuss the situation. A decision was made to take the diesel back to idle speed at which point the oil level returned to the allowable range. The period between first discovering the low oil level and taking the DG to idle speed is estimated to have been from 2 to 5 minutes. The intent of the above procedure instruction

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was to immediately shutdown the DG; however, the Plant Operators believed that they were following the procedure and were taking actions to "immediately secure the unit". Immediately following the event, the procedure was revised to clarify the method of shutdown (depress the emergency stop button).

3. The DG1 generator was manufactured by the NEI Peebles Company (previously Electric Products Company), serial number 17310200-200. The Diesel Generator Unit was purchased from Stewart and Stevenson Inc. The generator was shipped off-site on April 16, 1991, for disassembly and inspection of the bearings to determine the root cause of the high concentration of wear particles in the thrust bearing lube oil system. Two consulting firms experienced in performing failure analyses were contracted to assist the Supply System staff in determining the root cause of the high wear particle concentration in the thrust bearing lube oil.
4. Disassembly and inspection of the DG1 generator bearings and associated lube oil systems revealed that although the wear particle concentration in the bearing oil systems was higher than expected, the bearings were not functionally effected by the oil impurities and DG1 could have fulfilled it's safety function if required.
5. The bearing inspection revealed two areas where design improvements, some previously identified in LERs 90-012-00 and 90-012-01, were possible.
  - a. It has been observed that the DG1 generator bearing lube oil tended to foam during operation. In an effort to reduce or eliminate this foaming, the tangs on the lock washer for each bearing were machined down approximately 3/8 of an inch since they were suspected of contributing to the foaming problem. In prior discussions, the bearing manufacturer stated that foaming would not appreciably impact expected bearing life.
  - b. The second area of improvement was the discovery at an air volume trapped in the upper portion of the oil sump when the oil is at or above the high level. This air volume could change as a function of temperature and possibly as a function of turbulence in the oil. This may have been the cause of the low level observed at the thrust bearing sight glass during the April 5, 1991 event. This air volume has been vented to the rest of the lube oil system in an effort to reduce the probability of lube oil level transients caused by thermal expansion and contraction of the oil.

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6. A leak in the thrust bearing lube oil system that was being monitored and tracked by the Supply System but which had not been specifically located, was positively located. On each bearing lube oil system the weld joint where the air channel meets the bottom of the bearing bore were not oil tight and allowed a small amount of oil to leak. A modification was made to restore the leak tightness of the lube oil systems.
7. The root causes identified for this event are:
  - a. Personnel - The DG1 generator lube oil system was not adequately cleaned after the 1990 bearing failure and resulting repair work. This resulted in excessive debris in the lube oil systems of both bearings. During the 1990 DG1 repairs, the thrust bearing oil sump was steam cleaned twice and inspected, however, due to the access problems this effort was not sufficient to preclude this event.
  - b. Equipment Design - The design of the emergency diesel generator bearing lube oil systems does not provide access for adequate cleaning and inspection.
  - c. Maintenance - Annual oil changes recommended by the manufacturer were not adequate to reduce particulate contamination levels following bearing break-in. Also, there was no program for routine sampling and trending of lube oil condition.
  - d. Equipment - Manufacturing Error - The welds at the upper edge of the air passages through the lubricating oil sumps were not oil tight and thus did not comply with the design drawings.
8. The inoperability of DG2 in order to do the quarterly pole drop test was the direct cause of DG1 being operated; however, the inoperability of DG2 did not contribute to this event. There were no other structures, systems or components inoperable at the start of this event which contributed to this event.
9. DG2 has not experienced generator lube oil problems similar to those described in this report for DG1. Prior to this event, the bearings on DG2 typically ran cooler, experienced less lube oil foaming, did not evidence lube oil leakage, and did not experience lube oil level transients similar to those associated with DG1. The DG2 operating history, combined with knowledge gained from disassembly and inspection of DG1, provides confidence that DG1 and DG2 are both operable and fully capable of performing their safety function. As a note, neither DG1 nor DG2 have experienced generator bearing problems since the time when this event occurred, and operating temperatures for generator bearings associated with DG1 have decreased as a result of actions taken in response to this event.



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**B. Further Corrective Action**

1. An additional lube oil reservoir was installed for the DG1 thrust bearing with a new additional sight glass to make it to easier to read the oil level. The additional reservoir provides a greater volume of oil within the acceptable bearing operating range, approximately 1200 ml versus the previous 250 ml. The new sight glass will provide better access and visibility for personnel monitoring the oil sump level. The increase in the oil sump capacity within the control band was a corrective action planned as a result of the event reported in LER 90-012-00.
2. The bearing lube oil systems were thoroughly cleaned and flushed in an effort to reduce the level of impurities in the sump, including wear particles. It is believed that this extensive cleaning overcame the cumbersome design that made cleaning so difficult.
3. The generator bearing lube oil sumps for DG1 were drained and refilled after an appropriate bearing break-in period.
4. The bearing lube oil trapped air pockets were vented to the remainder of the lube oil system.
5. A modification to the lube oil sump was made to eliminate the sump leakage.
6. A preventative maintenance task has been scheduled to perform trending of diesel generator lube oil condition and routine sampling on a semi-annual basis under the Lubrication Oil Analysis Program.

**Safety Significance**

At the time DG1 was declared inoperable the plant was in Operating Condition 1, Power Operation, at 100% of rated power. The redundant emergency diesel generator (Division 2), the emergency diesel generator supporting the high pressure core spray system (Division 3), and both off-site power sources were all operable. Additionally, the subsequent inspection of the DG1 generator bearings revealed that the generator was capable of performing it's safety function at the time it was declared inoperable. This event had limited safety significance since the electrical power sources, including DG1, required to mitigate postulated accidents were available and capable of performing their safety functions at the time of the plant shutdown. The conservative decision to declare DG1 inoperable ensured that plant safety was maintained.

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Similar Events

On May 27, 1990, the DG1 generator experienced failure of both bearings due to inadequate lubrication of the thrust bearing during outage testing. This failure was voluntarily reported in LERs 90-012-00 and 90-012-01.

EIIS Information

<u>Text Reference</u>	<u>EIIS Reference</u>	
	<u>System</u>	<u>Component</u>
Division 1 Emergency Diesel Generator (DG1)	ED	---
Division 2 Emergency Diesel Generator (DG2)	ED	---
Division 1 Emergency Power System Generator	ED	---
	ED	GEN1