10 CFR 50.73

A subsidiary of Pinnacle West Capital Corporation

Palo Verde Nuclear Generating Station

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102-05907-DCM/SAB/DCS
October 08, 2008

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Unit 2
Docket No. STN 50-529
License No. NPF 51
Licensee Event Report 2007-005-00

Attached, please find Licensee Event Report (LER) 50-529/2007-005-00 that has been prepared and submitted pursuant to 10 CFR 50.73. This LER reports the inoperability of an Emergency Diesel Generator in excess of the time permitted by Technical Specifications.

In accordance with 10 CFR 50.4, copies of this LER are being forwarded to the NRC Regional Office, NRC Region IV and the Senior Resident Inspector. If you have questions regarding this submittal, please contact James A. Proctor, Section Leader, Regulatory Affairs, at (623) 393-5730.

Arizona Public Service Company makes no commitments in this letter.

Sincerely,

DCM/JAP/DCS/gat

Attachment

cc: E. E. Collins Jr. NRC Region IV Regional Administrator
B. K. Singal NRC NRR Project Manager - (send electronic and paper)
R. I. Treadway NRC Senior Resident Inspector for PVNGS

IE22
NRR

NRC FORM 366 (9-2007) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 08/31/2010

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/PriVacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

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4. TITLE

Emergency Diesel Generator Inoperability Resulting from a Degraded Speed Control Actuator

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
										05000
12	13	2007	2007	- 005 -	00	10	08	2008	FACILITY NAME	DOCKET NUMBER
										05000

9. OPERATING MODE

1

10. POWER LEVEL

100

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: *(Check all that apply)*

- ☐ 20.2201(b)
- ☐ 20.2201(d)
- ☐ 20.2203(a)(1)
- ☐ 20.2203(a)(2)(i)
- ☐ 20.2203(a)(2)(ii)
- ☐ 20.2203(a)(2)(iii)
- ☐ 20.2203(a)(2)(iv)
- ☐ 20.2203(a)(2)(v)
- ☐ 20.2203(a)(2)(vi)
- ☐ 20.2203(a)(3)(i)
- ☐ 20.2203(a)(3)(ii)
- ☐ 20.2203(a)(4)
- ☐ 50.36(c)(1)(i)(A)
- ☐ 50.36(c)(1)(ii)(A)
- ☐ 50.36(c)(2)
- ☐ 50.46(a)(3)(ii)
- ☐ 50.73(a)(2)(i)(A)
- ☒ 50.73(a)(2)(i)(B)
- ☐ 50.73(a)(2)(i)(C)
- ☐ 50.73(a)(2)(ii)(A)
- ☐ 50.73(a)(2)(ii)(B)
- ☐ 50.73(a)(2)(iii)
- ☐ 50.73(a)(2)(iv)(A)
- ☐ 50.73(a)(2)(v)(A)
- ☐ 50.73(a)(2)(v)(B)
- ☐ 50.73(a)(2)(v)(C)
- ☐ 50.73(a)(2)(v)(D)
- ☐ 50.73(a)(2)(vii)
- ☐ 50.73(a)(2)(viii)(A)
- ☐ 50.73(a)(2)(viii)(B)
- ☐ 50.73(a)(2)(ix)(A)
- ☐ 50.73(a)(2)(x)
- ☐ 73.71(a)(4)
- ☐ 73.71(a)(5)
- ☐ OTHER

Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

FACILITY NAME	TELEPHONE NUMBER (Include Area Code)
James A. Proctor, Section Leader, Regulatory Affairs	623-393-5730

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

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
B	EK	TD	W290	Y					

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR

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

On March 30, 2008, during surveillance testing on the Unit 2 A-train emergency diesel generator (EDG 2A), the Technical Specification (TS) Surveillance Requirement (SR) acceptance criteria for steady state frequency (≥ 59.7 and ≤ 60.7 Hz) was not met. EDG 2A output frequency was oscillating outside of the TS range. Investigation into the oscillation determined the failure mechanism that caused the oscillation had existed since the EDG was shutdown on December 13, 2007. This constituted operation in a condition prohibited by TS in that EDG 2A was inoperable longer than the TS Limiting Condition for Operation (LCO) time period without the associated action being taken.

The cause of the frequency oscillation was a degraded component within the Woodward® EGB50-PLS hydraulic actuator which is believed to be an age related issue. Corrective actions include replacement of the actuators on all 6 EDGs, 3 of which had been completed at the time of this report. In addition, the frequency will be monitored when the EDG is unloaded after a loaded run.

There were no previous reportable events identified with the same cause.

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All times are Mountain Standard Time and approximate unless otherwise indicated.

1. REPORTING REQUIREMENT(S):

This LER is being submitted pursuant to 10 CFR 50.73 (a) (2) (i) (B) to report operation in a condition prohibited by Technical Specifications (TS). Specifically, on August 9, 2008, Engineering, Operations and Regulatory Affairs personnel concluded that the Unit 2 emergency diesel generator (EDG) A was inoperable on December 13, 2007, due to an inability to maintain the TS required frequency. This conclusion was a result of reviewing the evidence and conclusions of a root cause investigation into frequency oscillation of the EDG. TS Limiting Condition for Operation (LCO) 3.8.1 b requires that, in operating modes 1, 2, 3 and 4, two EDGs each capable of supplying one train of the onsite Class 1E AC Electrical Power Distribution System be operable. Contrary to this requirement, the condition described in this report demonstrates that the LCO was not met and the associated TS Actions were not satisfied from December 13, 2007, to March 30, 2008, when the unit entered Mode 5 for a refueling outage.

2. DESCRIPTION OF STRUCTURE(S), SYSTEM(S) AND COMPONENT(S):

The standby power supply for each of two safety-related load groups per unit consists of one EDG (EIIS: EK), complete with its accessories and fuel storage and transfer systems. The standby power supply functions as a source of alternating current (AC) power for safe plant shutdown in the event of loss of preferred (offsite) power and for post-accident operation of engineered safety feature (ESF) loads.

There are two modes of EDG Operation, test mode and emergency mode and there are two types of loads applied to the EDG, safety-related loads and offsite loads (during paralleling with off-site power). In the test mode the engine speed governor is operating in droop and manual adjustments from the control room result in speed changes. For monthly surveillance testing, the EDG is started in the emergency mode then placed in the test mode to facilitate paralleled operation with offsite power. Note that "droop" allows the EDG to operate in parallel with offsite power.

In the emergency mode the EDG engine speed governor is operating in isochronous, regulating to 60 Hz to supply power to safety-related loads. The frequency is not manually

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adjustable from the control room. This is the mode of operation when the EDG is automatically started for accident conditions.

The station Technical Specifications provide the voltage and frequency requirements of the EDG output to assure AC powered safety related equipment will function as required when offsite power is not available. The steady state frequency requirements are established as greater than or equal to 59.7 Hz and less than or equal to 60.7 Hz (due to instrument inaccuracy the procedure acceptance criteria is 59.9 to 60.5 Hz). At synchronous speed the generator output frequency is 60.0 Hz and engine speed is 600 rpm. When the EDG is operated independent of the grid, adjustments to engine speed are directly proportional to changes in generator frequency.

The EDG speed regulating governor consists of two basic components; the Woodward 2301 electronic governor and the Woodward EGB50-PLS reverse acting, hydraulic actuator.

3. INITIAL PLANT CONDITIONS:

On March 30, 2008, at 21:31, Palo Verde Unit 2 was shutdown for refueling in Operating Mode 5 (Cold Shutdown) at 0% power. Station personnel were performing Integrated Safeguards Surveillance Testing (73ST-9DG01) to test the proper response of the Class 1E Diesel Generator and the Engineered Safety Features on Train A to simulated design basis events as required every 18 months.

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

4. EVENT DESCRIPTION:

On March 30, 2008, while performing an 18-month Integrated Safeguards (ISG) surveillance test, EDG 2A was paralleled to offsite power and loaded to approximately 1000 KW. A Safety Injection Actuation Signal was then manually generated and, as expected, caused the EDG output breaker to open. Immediately afterwards, an abnormal engine speed oscillation began while the EDG was idling. This was indicated by frequency oscillation occurring with a period of approximately 1 second and a magnitude of approximately 1 Hz (10 RPM) which did not satisfy the acceptance criteria

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in the Surveillance Test procedure for steady state conditions of between 59.9 and 60.5 Hz.

As a part of subsequent troubleshooting on April 1, 2008, the EDG was paralleled to the grid and load oscillation (indicated by MW oscillation) began after being fully loaded (5 MW) for greater than 15 minutes. As the engine was unloaded, the load oscillation diminished to the point of appearing steady state at approximately 4 MW of load. The oscillation recurred at 3 MW and diminished to steady state conditions at 2 MW. The oscillation recurred at 1 MW of load. However, the oscillation became divergent with increasing magnitude at this 1 MW load. Operations opened the EDG output breaker to stop the load oscillation.

Frequency oscillation had been reported prior to the March 30, 2008, event. Each of these occurred after a loaded run and immediately after the output breaker was opened. The first occurrence was on June 28, 2006, with an approximate 0.175 Hz oscillation. The second occurrence was on March 6, 2007, with a 0.2 Hz oscillation. The EDG is typically started and loaded every 31 days. Load oscillation was not seen on the EDG loaded runs between these two occurrences. Seven other frequency oscillation events occurred on EDG 2A prior to March 30, 2008. The interval between loaded runs that exhibited the frequency oscillation became shorter until the EDG experienced oscillation after each loaded run.

Sequence of Events:

On June 28, 2006, frequency oscillation was detected at the end of the EDG run, after the EDG output breaker was opened. The magnitude was approximately 0.175 Hz.

In November of 2006, the 2R13 18-month Integrated Safeguards Test was performed and no oscillation was noted.

On March 6, 2007, frequency oscillation was detected after the EDG output breaker was opened. The magnitude was approximately 0.2 Hz. It was believed that a minor tuning adjustment would resolve the problem. However, since retest following the tuning adjustment would require a Unit shutdown, the tuning was not performed. The EDG remained operable.

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On August 3, 2007, minor frequency oscillation similar to the March 6, 2007, event was observed. EDG data from both events were compared and no new problems were identified during the review.

On August 23, 2007, the oscillation recurred similar to that observed on March 6, 2007.

On November 15, 2007, the minor frequency oscillation was again observed.

On December 13, 2007, the minor frequency oscillation recurred. Note: In this case the frequency oscillation was identified during the event investigation through the review of low resolution performance indicator data. The condition was apparently not detected on December 13.

On January 10, 2008, the minor frequency oscillation again recurred but on this occasion it was documented that the EDG speed oscillation was from 596 to 604 rpm. During the root cause investigation of the April 1, 2008 event this speed oscillation was translated to a frequency oscillation from 59.6 Hz to 60.4 Hz. The 59.6 Hz is below the TS allowable value of 59.7 Hz.

On February 15, 2008, and March 5, 2008, the frequency oscillation recurred except the oscillations remained within the TS allowable band.

On March 30, 2008, while performing an 18-month Integrated Safeguards (ISG) surveillance test, EDG 2A was paralleled to offsite power and loaded to approximately 1000 KW. A Safety Injection Actuation Signal was then manually generated and, as expected, caused the EDG output breaker to open. Immediately afterwards, an abnormal engine speed oscillation began while the EDG was idling. This was indicated by frequency oscillation occurring with a period of approximately 1 second and a magnitude of approximately 1 Hz (10 RPM) which did not satisfy the acceptance criteria in the Surveillance Test procedure for steady state conditions of between 59.9 and 60.5 Hz. The SIAS signal also shifted the EDG to the "emergency" mode of operation. All the prior occurrences were in the "test" mode of operation.

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On April 1, 2008, EDG 2A was loaded to support troubleshooting of the March 30, 2008, event. Large load (MW) oscillation occurred during the loaded run. Prior to this event, there had only been minor load fluctuations and occasional load step changes typically expected when paralleled to the grid, but no load oscillation.

5. ASSESSMENT OF SAFETY CONSEQUENCES:

The event did not result in a transient more severe than those previously analyzed in the PVNGS UFSAR, Chapter 15. EDG 2A was capable of supplying emergency loads with AC electrical power within the TS range of steady state frequency requirements until after the EDG was shutdown on March 30, 2008.

From June 2006, until the March 30, 2008, event, EDG 2A remained capable of performing its safety function based on the following:

- Emergency mode engine starts were normal. The monthly operability surveillance tests consistently demonstrated the engine was capable of meeting the Technical Specification required steady state criteria for frequency.

- EDG 2A was run for four hours during monthly surveillance tests without any oscillatory load changes that would challenge the integrity of surveillance tests.

- Integrated Safeguards Testing of EDG 2A was completed successfully in November 2006, during a refueling outage.

- The failure mechanism (see section 6) demonstrates that the EDG was capable of supplying connected safety related loads at the required frequency until after the EDG was shutdown on March 30, 2008.

There were no actual safety consequences as a result of this condition; the condition would not have prevented the fulfillment of the safety function (EDG 2A was not required to be operable on April 1, 2008) and did not result in a safety system functional failure as defined by 10 CFR 50.73 (a)(2)(v).

6. CAUSE OF THE EVENT:

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The direct cause of the frequency oscillation was a degraded component within the Woodward® EGB50-PLS hydraulic actuator. Specifically, the transducer assembly, two electrical coils fabricated as an assembly, degraded over time. Surface defects appeared on the inside diameter of the potting material that surrounds the coils (see Figure 1 at the end of this report). These defects protruded far enough into the inside diameter to cause friction with a positioning magnet. Frequency oscillation occurred as the magnet would stick and the electronic 2301 governor controls would continue to change voltage until the friction was overcome. The sudden release of friction would cause the magnet to overshoot. This cycle of being stuck and then released occurred repeatedly resulting in the oscillation.

The transducer surface defects grew as a result of engine start and stop cycles. Continued growth of these surface defects initially caused the minor frequency oscillation to occur more often and then increased the magnitude of the oscillation. Frequency oscillation occurred after the actuator had been heated up and load was removed from the engine. Load oscillation (swing in MW indication) was not observed until April 1, 2008, during troubleshooting, which indicated the surface defects had grown large enough to adversely impact steady state capability with the EDG connected to loads.

The root cause of the frequency oscillation was the surface defects growth as a result of a wicking action that drew small amounts of oil into the transducer after the EDG was shutdown and the actuator slowly cooled to ambient temperature. When the EDG was subsequently started, the actuator would heat up and the ingested oil was essentially trapped within the transducer. Thermal expansion of the oil would exert pressure on the potting material, distorting the shape, causing surface defect growth.

As a result of the root cause investigation, station personnel determined on August 9, 2008, that the inability to meet the TS SR for steady state frequency during unloaded operation had existed since EDG 2A was shutdown on December 13, 2007. This determination was based on the failure mechanism, which requires an engine cooldown to ingest oil into the potting material and a subsequent engine run to heat the trapped oil causing potting material deformation. Investigation personnel reviewed past operation of the EDG to determine if the EDG operated outside the required TS SR frequency range. The January 10, 2008, engine run was the only occurrence prior to March 30, 2008,

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when the frequency was observed to have exceeded the TS allowable range. Thus, the EDG shutdown prior to this run (December 13, 2007) was conservatively determined to be the time that the required steady state frequency could not be reasonably assured. Note: As noted above, subsequent EDG surveillance runs on February 15, 2008, and March 5, 2008, did not result in oscillations outside the TS allowable range.

Based on the failure mechanism, the ability to supply emergency loads with required steady state frequency was not lost until after the March 30, 2008, loaded run. On April 1, 2008, load oscillation occurred while paralleled to off-site power reflecting continued degradation consistent with the failure mechanism. The degradation that caused this load oscillation would have caused frequency oscillation had the EDG been called upon to supply power independently to safety-related loads.

The remaining 5 EDGs at PVNGS have not exhibited the oscillation seen on EDG 2A.

7. CORRECTIVE ACTIONS:

As immediate corrective action the EDG 2A governor was replaced.

Interim actions have been established by Standing Order 190 to monitor EDG frequency following an EDG run to detect oscillation. Longer-term actions will incorporate this frequency monitoring guidance into procedures.

The root cause will be corrected by the completion of a modification to upgrade the governor and the actuator. Three EDGs have already been upgraded and the other three EDGs (1A, 1B & 3A) will receive the upgrade during their next respective refueling outages. Note: It has been determined that the new actuator could be susceptible to the same defect over time. However, the defective actuator in 2A EDG had been in service since initial plant operation indicating that the defect develops slowly.

Purchase Order instructions for future refurbishments of the new EGB50-P hydraulic actuators, which contain a similar transducer, will be revised to require specific inspections for potting material surface defects.

8. PREVIOUS SIMILAR EVENTS:

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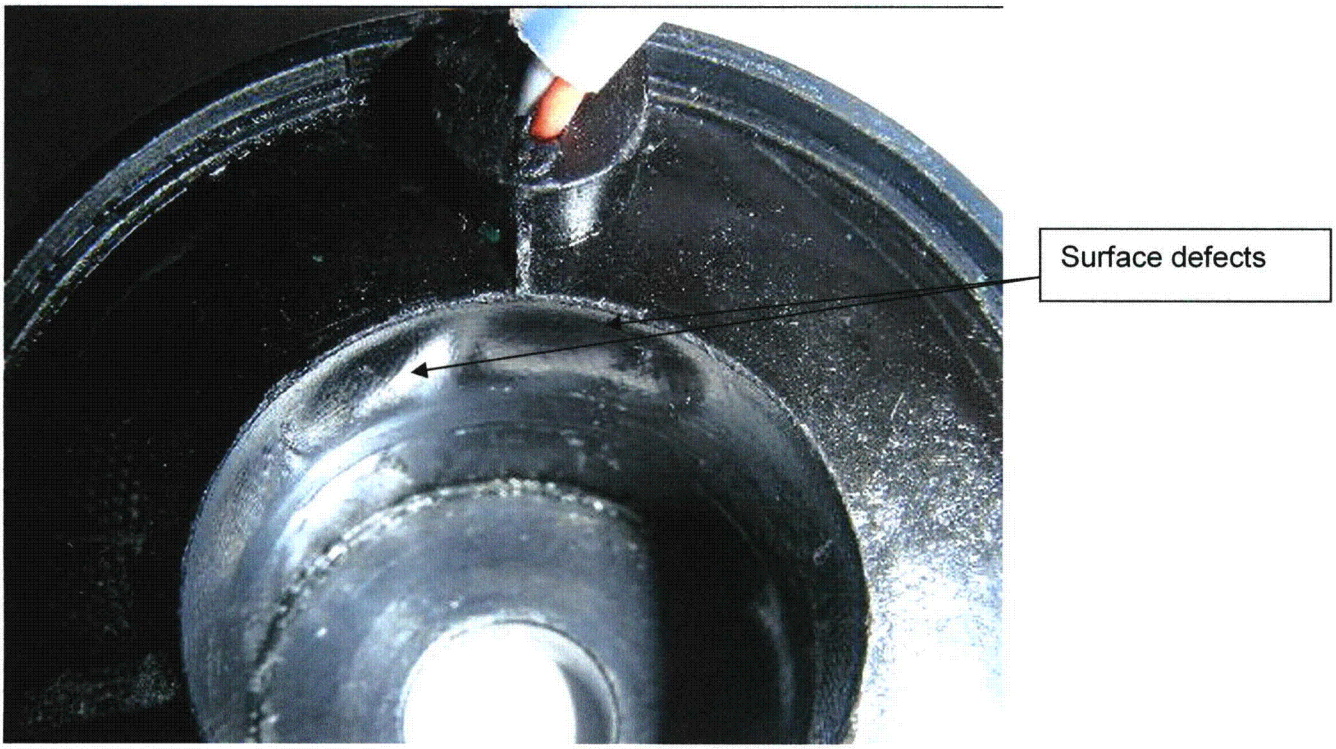
FIGURE 1

Picture showing some of the potting material surface defects discovered during investigation.



The positioning magnet (not shown) sits inside the transducer. Friction between the potting material and the positioning magnet occurred when the surface defects grew.