



**Arizona Nuclear Power Project**

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REGIONAL

February 5, 1987  
ANPP-39982-JGH/DJW/DRL-92.11

U. S. Nuclear Regulatory Commission  
Region V  
1450 Maria Lane - Suite 210  
Walnut Creek, California 94596-5368

Attention: Mr. D. F. Kirach, Director  
Division of Reactor Safety and Projects  
Palo Verde Nuclear Generating Station (PVNGS)  
Units 1, 2, 3  
Bucket Nos. 50/528, 529, 530

Subject: Final Report - DER 86-31  
A 50.55(e) and 10CFR21 Reportable Condition Relating to Loose  
Rotor Windings on Diesel Generator  
File: 87-006-216

References: (A) Telephone conversation between Jo Bianchi for R. C. Sorenson  
and D. R. Larkin on December 5, 1986. (Initial Notification  
- DER 86-31)  
(B) ANPP-39576, dated January 2, 1987. (Interim Report - DER  
86-31)

Dear Sirs:

The NRC was notified of a potentially reportable deficiency in reference (A),  
and an interim report by reference (B). Attached, is our final written report  
of the Reportable Deficiency under the requirements of 10CFR 50.55(e). The  
10CFR21 evaluation is also included.

Very truly yours,

J. G. Haynes  
Vice President  
Nuclear Production

JGH/DRL:kp

Attachments

cc: See Page 2

PEEBLES NEMP 12.4 REV. 1 ATT. B

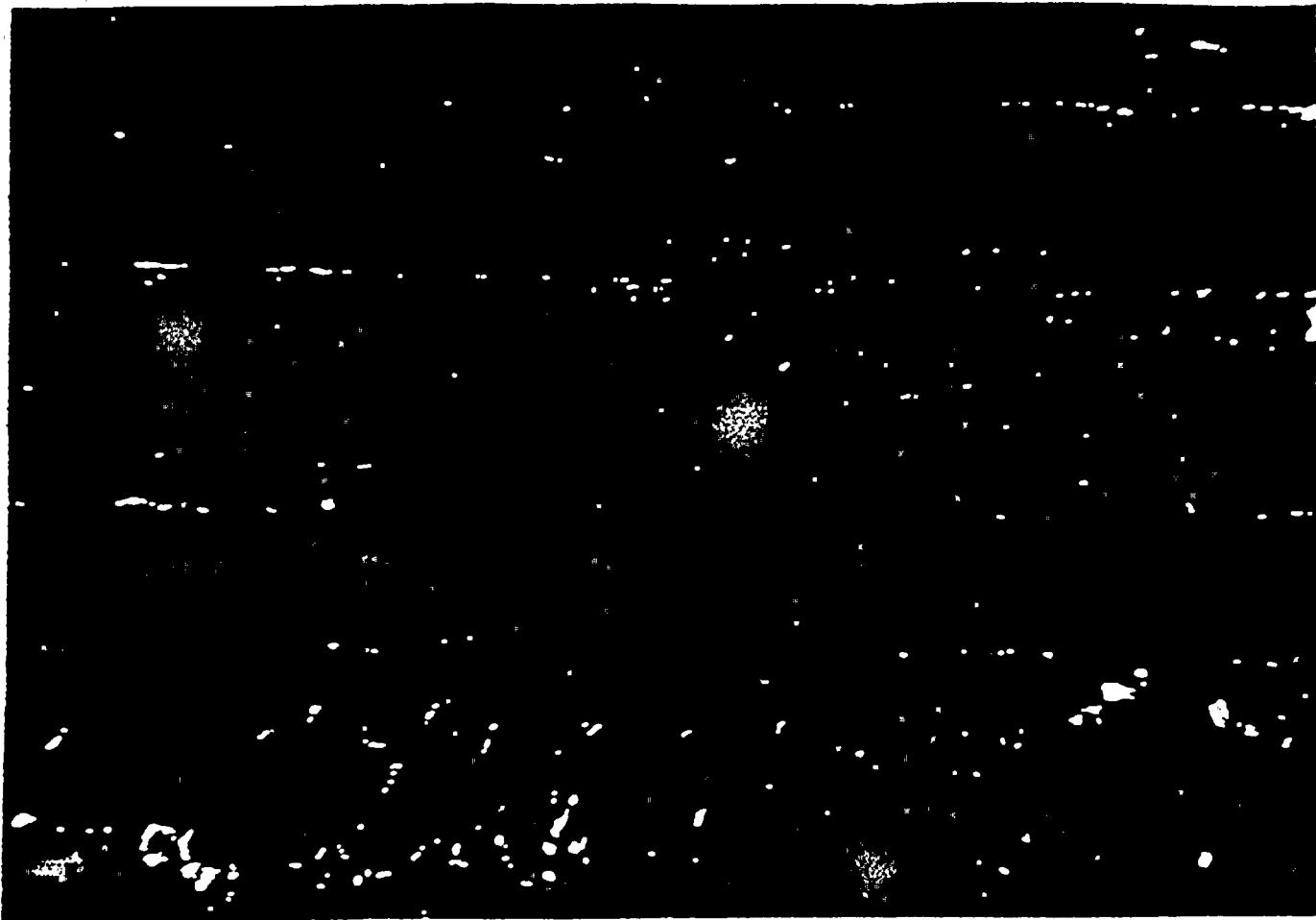
Provided by: LIS Pg 33 of 116

Licensing Information Service  
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Photograph No. 4 (approximately 5 times the actual size)

Magnified view of a 1 x 1.5 in. area located outside the field of Photograph No. 3 showing the typical appearance of either end of the area of failure where a more normal bond begins to become evident. There are still some signs of resin dilution to the left but "brittle fracture" of the resin layer is becoming noticeable to the right even though the bonding still lacks uniformity. Note the presence of "craze lines" where a relatively good bond was broken while the 1st layer was being "peeled off" from the coil. Also note a few "pinheads" still evident next to the void zones indicating some presence of a solvent before and during the cure.

*PEEBLES NEMP 12.4 REV. 1 ATT. B pg 31 of 116*

SUBJECT	ENGINEERING LABORATORY RECORD	SC NO	17609956 and 569
		ID NO	W-1037
	NEI PEBBLES—ELECTRIC PRODUCTS, INC. 17045 EUCLID AVENUE • CLEVELAND OHIO 44112	BY	CJM/JVP
		Date	1-26 to 1-30 1987
		SHEET NO	4 OF 4

ATTACHMENT A



PE	KVA OR HP	KW	VOLTS	AMPS	PHASES	CYCLES	RPM	PF	FRAME	DIFF

ELECTRIC PRODUCTS DIVISION

PORTEC, INC.

1725 Clarkstone Road

Cleveland, Ohio 44112

TEST PER <i>IEEE NO. 115</i>	PARAGRAPH	TYPE	CONTRACT
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MOTOR				GENERATOR						
STAGE 1		STAGE 2		STAGE 3		OUTPUT		FIELD		RPM
VOLTS	AMPS	VOLTS	AMPS	VOLTS	AMPS	KW	PF	VOLTS	AMPS	
<i>25% OVERSPEED FOR 5 MINUTES - MECHANICAL BALANCE - METHOD 2 - 45.01</i>										
<i>VIBRATION</i>										
<i>STUB END</i>		<i>OPP. END</i>		<i>x25</i>		<i>x25</i>		<i>x1</i>		<i>x3</i>
<i>HORIZ.</i>	<i>.0016</i>		<i>.0007</i>	<i>167</i>		<i>167</i>		<i>36.5</i>	<i>31.3</i>	<i>600</i>
<i>VERT.</i>	<i>.001</i>		<i>.0004</i>							<i>600</i>
<i>AXIAL</i>	<i>.0012</i>		<i>.001</i>							
<i>5 MINUTE S</i>										
<i>HORIZ.</i>	<i>.0008</i>		<i>.0004</i>	<i>167</i>		<i>167</i>		<i>28</i>	<i>22.5</i>	<i>750</i>
<i>VERT.</i>	<i>.0005</i>		<i>.0004</i>							
<i>AXIAL</i>	<i>.0005</i>		<i>.0003</i>							
<i>HORIZ.</i>	<i>.002</i>		<i>.0006</i>	<i>167</i>		<i>167</i>		<i>36.8</i>	<i>30.7</i>	<i>600</i>
<i>VERT.</i>	<i>.0009</i>		<i>.0008</i>							
<i>AXIAL</i>	<i>.0013</i>		<i>.0009</i>							
<i>THERE WAS NO EXCESSIVE NOISE OR VIBRATION DURING THE TEST AND NO EVIDENCE OF INJURY OR CHANGE IN ANY PART AFTER SHUTDOWN</i>										
<i>DIRECT AXIS TRANSIENT &amp; SUBTRANSIENT REACTANCES &amp; TIME CORRESPONDING TIME CONSTANTS BY OSCILLOGRAPH.</i>										
	<i>x25</i>	<i>x2000</i>	<i>x25</i>	<i>x2000</i>	<i>x25</i>	<i>x2000</i>		<i>x1</i>	<i>x2</i>	
	<i>167.5</i>	<i>0</i>	<i>167.5</i>	<i>0</i>	<i>167.5</i>	<i>0</i>		<i>36.5</i>	<i>45.2</i>	<i>600</i>
	<i>-</i>	<i>.30</i>	<i>-</i>	<i>.30</i>	<i>-</i>	<i>.30</i>		<i>35.5</i>	<i>46.5</i>	<i>600</i>
	<i>162</i>	<i>0</i>	<i>162</i>	<i>0</i>	<i>162</i>	<i>0</i>		<i>36.5</i>	<i>45.5</i>	<i>600</i>

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1953-1954

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ARIZONA POWER, PALO VERDE LETTER TO NRC

DATED FEBRUARY 5, 1987

DEFICIENCY EVALUATION FOR 10 CFR 21



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FINAL REPORT - DER 86-31  
DEFICIENCY EVALUATION 50.55(e)  
ARIZONA NUCLEAR POWER PROJECT (ANPP)  
PVNGS UNITS 1, 2, 3

1. Description of Deficiency

This report addresses two deficiencies associated with the Unit 3 Train B (3E-PEB-G02) Diesel Generator:

- A. During normal maintenance of this diesel generator, rotor unbalance was detected. It was discovered that the copper windings on one of the rotor poles were loose. Startup Field Report (SFR) 3PE-019 was initiated to document this condition.
- B. During rework of the defective pole it was discovered that pole piece fasteners were also loose. This condition was documented on SFR 3PE-023.

Evaluation

Investigations, Tests, Analyses

- A. The defective rotor was removed from the diesel generator and visually inspected at the jobsite by a representative of the generator manufacturer (NEI Peebles). It was observed that the two outer layers of the coil associated with the defective pole were separated.

The evaluation by NEI Peebles was that a manufacturing defect, identified as a substandard bond of the polyester resin encapsulant on the field coil conductor, exists in certain localized areas of the wire-wound rotor pole. The manufacturer does not consider voids to be unusual. Therefore, these localized areas of substandard bonds are not to be misconstrued as voids. The manufacturer was prepared to calculate an acceptable percentage of voids. However, this would not have satisfied ANPP concerns because of the impossibility of physically determining the actual amount of voids within the winding resin.

Centrifugal force apparently broke the resin bond, and the wires separated from each other and from the coil. NEI Peebles has confirmed that resin degradation does not occur over a period of time; therefore, aging is not a concern.

NEI Peebles confirmed that polyester resin from the same batch was used on the Unit 3 Train A and Train B diesel generator rotors and the spare rotor pole pieces. Train A diesel generator has successfully operated for over 140 hours both loaded and unloaded. The Train B diesel generator had been run for only three hours unloaded at PVNGS jobsite. However, the train B diesel generator was run both loaded and unloaded at 100% speed, with the engine rigged up for a total period of 10 hrs. as a part of extended running time test by the vendor (Cooper Energy Services). Both Unit 3 diesel generators have been subjected to overspeed trip verification. The

PEEBLES  
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Also, according to NEI Peebles, at normal operating speed of the diesel generators, none of the pole piece fasteners (bolts) are stressed higher than 45% (average) of the yield strength of the bolts. Loosening of an entire pole piece assembly due to the existence of loose pole piece fasteners, could occur as a result of an unbalanced load distribution of these fasteners, but only if the diesel generator were to be subjected to a prolonged period of overspeed run (125%).

Based on the above evaluation, as long as there exists a positive torque on these pole piece fasteners, the chances of an individual pole assembly becoming loose, with subsequent damage to the diesel generator, is very remote.

#### Root Cause

- A. The root cause attributed to the pole winding separation is a manufacturing defect resulting from improper application of resin and/or poor workmanship.
- B. The loose pole piece fasteners condition is attributable to an isolated case of deviation from specified torque values used at the factory prior to shipping.

#### Transportability

NEI Peebles states that there are approximately 1200 poles in machines presently in service that have been encapsulated with this resin. The reported defect identified in PVNGS Unit 3 diesel generator B is the only known case of failure. Additionally, the same rotor design, type of resin, and pole piece fasteners were used in over 50 similar machines, some of which have been used in nuclear facilities since 1972, with no similar conditions being reported. These failures do not represent a latent generic design or manufacturing deficiency since, these types of failures would always be found and corrected during startup testing or initial stages of operation.

#### Safety Assessment

- A. If left uncorrected, continued operation of the diesel generator with the defective rotor pole could further stress the resin bond and cause deterioration of the winding wire insulation. This could result in electrical failure of the equipment and prevent the diesel generator from performing its intended function of providing power for safe shutdown in the event of loss of Class 1E bus voltage.
- B. It is assumed that loose pole piece fasteners (no positive torque) if left uncorrected may become unsecured and cause extensive internal damage to the diesel generator, thereby, precluding it from performing its intended safety function.

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Final Report - DER 86-31  
Mr. D. F. Kirsch  
Director  
Page Two

February 5, 1987  
ANPP-39982-JGH/DJM/DRL-92.11

cc: J. M. Taylor  
Office of Inspection and Enforcement  
U. S. Nuclear Regulatory Commission  
Washington, D. C. 20555

A. C. Gehr (4141)  
... P. Zimmerman (6295)

Records Center  
Institute of Nuclear Power Operations  
1100 Circle 75 Parkway - Suite 1500  
Atlanta, Georgia 30339

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Train A rotor poles, the remaining Train B rotor poles and the spare rotor poles were inspected by the vendor at the jobsite and checked for pole winding alignment and any obvious damage. No deficiencies were noted.

The defective windings were shipped to the NEI Peebles' factory for additional analysis. NEI Peebles evaluated that resin bond failure leading to separation of layers and physical displacement of conductors could have been caused by the following conditions:

- (a) Mechanical damage by impact or excessive overspeed.
- (b) Improper formulation, mix, or cure of the resin.
- (c) Improper application of resin or contamination of the wire surface.

No mechanical damage was found in the areas where the winding separation occurred. Therefore, condition (a) was excluded from further consideration. Since the other poles using the same batch of resin are in satisfactory condition and only one pole was damaged, the probability of defective resin, condition (b) is small. Peebles' engineer observed that resin was sparingly applied on the defective windings. Based on inspection of the defective rotor pole and operating history of the affected and similar rotors, the cause of this defect is considered to be an isolated case of improper application of resin and/or poor workmanship, condition (c).

NEI Peebles suggested that a new test be performed wherein if no apparent damage to any rotor pole takes place during a five minute deenergized run at a speed in excess of that required to "set overspeed trips" (typically 110%), the rotor should be acceptable. PVNGS cannot justify such a prolonged overspeed test utilizing the actual diesel generators and concurs with the Cooper Energy position that the overspeed test be limited to a momentary excursion to 10% overspeed. PVNGS agrees with NEI Peebles that inspections for voids, visual and tap test, are required. The PVNGS diesel generator startup tests performed comply with Cooper's recommendation.

- B. Loose pole piece fasteners were found during examination of the defective rotor. The evaluation by NEI Peebles indicated that there may have been some deviation in torque values used at the factory during fabrication. Since the extent of deviation concerning Unit 3 diesel generators was unknown, NEI Peebles furnished the design torque values to PVNGS jobsite so that the pole piece fasteners could be properly retorqued.

According to NEI Peebles the loose fasteners are not the only devices used to hold the individual pole piece to the rotor spider rim. The bolts are secured by the use of the heavy lockwashers and "locktite" Compound which effectively glues ferrous compounds together. In addition, the pole laminations are held together by a series of fillet welds and the end bolts (1st, 5th, 6th and 10th) of each pole piece assembly are threaded into solid metal (steel) inserts which are in turn welded into the laminations for extra-strength and rigidity of the pole piece assembly.

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## II. Units 1 and 2

The Units 1 and 2 diesel generators have approximately 700 hours and 300 hours of operation respectively. The successful operation of both A and B trains of diesel generators in Units 1 and 2 during testing and normal operation provide additional assurance that these are isolated cases of these types of failures. Since there is no evidence that the Units 1 and 2 diesel generators are affected by these defects, their continued use does not pose a hazard to the safe operation of Units 1 and 2.

A random inspection made to determine whether voids existed in the other operating units verified voids also to be present. The extent of those voids was not able to be analyzed, but their existence did confirm that operability with voids has been demonstrated.

## III. Analysis of Safety Implications

Both deficiencies discussed herein are evaluated as Reportable under the requirements of 10CFR50.55(e) and 10CFR21, since if left uncorrected, they would represent a significant safety condition. This report addresses the requirements of 10CFR21 with the exception of 21.21(b)(3) subpart vi.

## IV. Corrective Action

1. The defective rotor pole piece has been replaced with a spare rotor pole. The rework was supervised and inspected by the vendor representative and documented on SFR 3PE-019. This pole piece has been in operation approximately 40 hours.
2. The spare pole pieces will be evaluated to verify acceptability for installation within ANPP generators by NCR 0-020-87, prior to being placed into service.
3. NEI Peebles Performed a chemical analysis on the resin from the defective rotor pole in order to eliminate the remote possibility of defective resin. The purpose of this analysis was to confirm Peebles evaluation. An evaluation of the report on the chemical analysis has been completed and the resin is acceptable.
4. The pole piece fasteners of Unit 3 Train B have been retorqued to NEI Peebles specified values. The results of the torque value verification are documented on SFR 3PE-023. Unit 3 Train A and one of the Unit 2 trains will be retorqued. An evaluation on the inspection/retorque of these units will determine the necessity for retorquing all PVNGS units. This evaluation is forecast for completion by March 1, 1987.
5. Copies of this report will be sent to Cooper Energy Services and NEI Peebles for their information/action.

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GULF STATES UTILITIES LETTER TO NRC  
DATED NOVEMBER 16, 1987  
10 CFR 21 REPORT OF DEFECT ON GENERATOR



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