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SUBJECT: LER 88-018-00:on 880729,Potter & Brumfield relay malfunctions.

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NOTES:Standardized plant. 05000528

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	ARM/DCTS/DAB	1	1	DEDRO	1	1
	NRR/DEST/ADS 7E	1	0	NRR/DEST/CEB 8H	1	1
	NRR/DEST/ESB 8D	1	1	NRR/DEST/ICSB 7	1	1
	NRR/DEST/MEB 9H	1	1	NRR/DEST/MTB 9H	1	1
	NRR/DEST/PSB 8D	1	1	NRR/DEST/RSB 8E	1	1
	NRR/DEST/SGB 8D	1	1	NRR/DLPQ/HFB 10	1	1
	NRR/DLPQ/QAB 10	1	1	NRR/DOEA/EAB 11	1	1
	NRR/DREP/RAB 10	1	1	NRR/DREP/RPB 10	2	2
	NRR/DRIS/SIB 9A	1	1	NUDOCS-ABSTRACT	1	1
	REG FILE 02	1	1	RES TELFORD,J	1	1
	RES/DSIR DEPY	1	1	RES/DSIR/EIB	1	1
	RES/DSR DEPY	1	1	RGN5 FILE 01	1	1
EXTERNAL:	EG&G WILLIAMS,S	4	4	FORD BLDG HOY,A	1	1
	H ST LOBBY WARD	1	1	LPDR	1	1
	NRC PDR	1	1	NSIC HARRIS,J	1	1
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NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/88

LICENSEE EVENT REPORT (LER)

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TITLE (4)
Potter & Brumfield Relay Malfunctions

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 7	2 9	8 8	8 8	— 0 1 8 —	0 0	0 8	0 3	8 8	Palo Verde Unit 2	0 5 0 0 0 5 2 9
									Palo Verde Unit 3	0 5 0 0 0 5 3 0

OPERATING MODE (9): 5

POWER LEVEL (10): 0 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check one or more of the following)* (11)

[ ] 20.402(b)	[ ] 20.405(c)	[ ] 50.73(a)(2)(iv)	[ ] 73.71(b)
[ ] 20.405(a)(1)(i)	[ ] 50.36(c)(1)	[X] 50.73(a)(2)(v)	[ ] 73.71(c)
[ ] 20.405(a)(1)(ii)	[ ] 50.36(c)(2)	[ ] 50.73(a)(2)(vii)	[X] OTHER *(Specify in Abstract below and in Text, NRC Form 366A)*
[ ] 20.405(a)(1)(iii)	[ ] 50.73(a)(2)(i)	[ ] 50.73(a)(2)(viii)(A)	10CFR21
[ ] 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	TELEPHONE NUMBER: AREA CODE	
Timothy D. Shriver, Compliance Manager	6 0 2	3 9 3 - 2 5 2 1

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

CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS
B	J E	R L Y	P 2 9 7	Y					

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
[X] YES *(If yes, complete EXPECTED SUBMISSION DATE)*	[ ] NO		1 0	1 5	8 8

ABSTRACT *(Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines)* (16)

At approximately 1030 MST on July 29, 1988 Palo Verde Unit 1 was in Mode 5 (COLD SHUTDOWN), Units 2 and 3 were at approximately 100 percent when it was determined that deficiencies discovered as a result of ANPP's on-going investigation into identified relay failures constituted a reportable condition pursuant to 10CFR21 and consequently 10CFR50.73.

Approximately 15 Potter & Brumfield relay failures have been experienced at Palo Verde over the last two years. These failures have occurred with relays located in the Nuclear Steam Supply System Engineered Safety Features Actuation System cabinets. The identified failure mode is that contaminants plate out and/or corrosion occurs on the internal surfaces of the relay's motor chamber. This prevents full rotor movement upon de-energization of the relay coil thereby preventing the contacts from properly changing state and actuating the associated safety equipment.

ANPP is in the process of evaluating potential design changes which would eliminate the identified failure mechanism. In the interim, until the final evaluation is completed, increased relay exercising will be used to ensure that the appropriate level of relay reliability is maintained. This involves increasing the test frequency of the high risk relays. A supplement will be provided describing the final root cause analysis and corrective actions.

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

This report is also being provided pursuant to the provisions of 10CFR21. The narrative below includes the information requested by 10CFR21.21(b)(3); however, it is being formatted to report this event in accordance with the requirements of 10CFR50.73.

I. DESCRIPTION OF WHAT OCCURRED:

A. Initial Conditions:

The following plant conditions existed when the event described in this LER was determined to be reportable at approximately 1030 MST on July 29, 1988.

Palo Verde Unit 1 was in Mode 5 (COLD SHUTDOWN) at atmospheric pressure and 100 degrees Fahrenheit.

Palo Verde Unit 2 was in Mode 1 (POWER OPERATION) at approximately 100 percent power.

Palo Verde Unit 3 was in Mode 1 at approximately 98 percent power.

B. Reportable Event Description (Including Date and Approximate Times of Major Occurrences):

Event Classification: Condition which could have prevented the fulfillment of a safety function.

Note: This section includes information requested by 10CFR21 concerning the nature of the defect and dates for which information was obtained/developed.

On July 29, 1988 at approximately 1030 MST ANPP determined that the deficiencies discovered as a result of a root cause analysis conducted to evaluate failures of Potter & Brumfield relays (RLY) constituted a reportable condition pursuant to 10CFR21 and consequently 10CFR50.73.

Approximately fifteen (15) type MDR relay failures have been identified at Palo Verde during approximately the last 2 years. The relay failures were detected during either routine surveillance testing or during safety system actuations at Palo Verde. The identified failures have occurred in the Nuclear Steam Supply System (NSSS) Engineered Safety Features Actuation Systems (ESFAS)(JE). The following is a listing of the failures which have occurred at ANPP.

TABLE 1 - RELAY MALFUNCTIONS AT PALO VERDE

RELAY MODEL #	RELAY #	FUNCTION	UNIT #	TRAIN
MDR-7032	K111	CSAS	1	B
MDR-7032	K111	CSAS	1	B
MDR-7034	K101	SIAS	2	B
MDR-7032	K113	AFAS-1	2	A
MDR-7034*	K206	CIAS	2	B
MDR-7032	K413	AFAS-2	2	B
MDR-7034	K405	RAS	2	B
MDR-7032	K110	SIAS	2	B
MDR-7032*	K312	RAS	3	A
MDR-7034	K101	SIAS	3	B
MDR-7032	K111	CSAS	3	B
MDR-7032	K110	SIAS	3	A
MDR-7033	K213	CIAS	3	A
MDR-7032	K110	SIAS	3	B
MDR-7032*	K111	CSAS	3	A

AFAS-1 = auxiliary feedwater actuation signal for Steam Generator #1 (JE)(BA)
AFAS-2 = auxiliary feedwater actuation signal for Steam Generator #2 (JE)(BA)
RAS = recirculation actuation signal (JE)(BU)
CIAS = containment isolation actuation signal (JE)(BD)
SIAS = safety injection actuation signal (JE)(BP)(BQ)
CSAS = containment spray actuation signal (JE)(BE)

* Relay failure resulted in non-vital equipment not actuating. All vital equipment actuated per design.

C. Status of structures, systems, or components that were inoperable at the start of the event that contributed to the event:

Not applicable - there were no structures, systems or components inoperable at the start of the events which contributed to the events.

D. Cause of each component or system failure, if known:

Note: This section includes information requested by 10CFR21 concerning the nature of the defect and dates for which information was developed.

An extensive investigation of the MDR relay failures is currently being conducted. Combustion Engineering, the suppliers of the NSSS ESFAS cabinets (CAB), is supporting the investigation. The relay manufacturer, Potter & Brumfield, is also involved in the effort. ANPP has also obtained materials analysis support from two independent laboratories (SEAL and HI-REL).

ANPP provided four MDR-7032 rotary relays to Scanning Electron Analysis Laboratories, Inc. (SEAL) for examination. SEAL disassembled the relays for visual examination of the internals and observed large amounts of a brown/black powdery material in the magnet and coil areas of two of the relays. Some brown material was observed on the brass plates at the top of the coils. Additionally, there was evidence of shaft wear and metal chips in these samples. SEAL conducted Scanning Electron Microscope (SEM) examinations of the powdery contaminant, the metal chips, and the brown enamel (varnish) that coats the coil. SEAL concluded that the source of the contaminants was most likely the varnish applied to the windings of the coil. The contaminants caused the binding of the shaft and led to the observed shaft wear. SEAL did not find any evidence of corrosion on the shaft or brass bushings.

ANPP also contracted HI-REL laboratories to perform examinations of relays. ANPP initially sent four failed MDR relays to HI-REL for failure analysis. Two of the relays were model MDR-7032, one was model MDR-7034, and one was a model MDR-136-1. HI-REL first performed electrical tests on the relays. It was observed that three of the relays would not move through the complete 30-degree arc upon de-energization as designed. These relays were restricted to an arc of not more than 12 degrees. The fourth sample rotated through the full 30-degree arc. HI-REL then disassembled the relays and performed an internal visual inspection. The internal inspection revealed corrosion of the rotor, the dome-shaped metal shield over the coils, and the upper and lower races. HI-REL attributed the rotational problems to this corrosion. Energy Dispersive Spectrum (EDS) analysis revealed extensive chlorine contamination on the brass races, the armature, and the metal coil shield. ANPP also sent HI-REL a model MDR-7033 relay from stock for a second analysis. This relay was obtained from a Washington Public Power Supply cabinet that ANPP had purchased for use as a spare. The relay had been previously energized for shop testing at Combustion Engineering (CE). Internal inspection of this relay revealed possible contamination on the lower bearing race and the upper heat shield. EDS analysis revealed a small amount of chlorine contamination on the surface of the upper heat shield but not on the surface of the bearing race. HI-REL believes that the presence of these products may have mechanically bound the relays in their energized positions. HI-REL concluded that the coils are the most likely source of the contamination.

One of the potential root causes that was investigated was the impact of coil voltages on the relays. Higher coil voltages would increase the operating temperature of the coils and increase the out-gassing rate. The rated coil voltage for the relays used in the NSSS ESFAS cabinets is 28 VDC. However, the NSSS ESFAS cabinets are equipped with 36 VDC power supplies. CE changed the power supplies from 28

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VDC to 36 VDC after problems were experienced with relay pick up at other CE plants. This modification was completed prior to startup of the Palo Verde units. As an additional part of this change, CE asked Potter & Brumfield (P&B) to lower the pick-up voltage for the NSSS ESFAS relays. P&B accomplished this by fine tuning the contact pressures on the 7033 and 7034 relays. For the 7032 relays, P&B decreased the spring force on the relays which would result in less force being available to return the rotor to the de-energized position.

ANPP measured the voltage differential across the relay coils at Palo Verde Unit 3. In the NSSS ESFAS cabinets, an average of 31 VDC was observed across the coils. In the Balance of Plant (BOP) ESFAS (JE) cabinets, the coil differential is approximately 27 VDC. Thus, the relays in the NSSS ESFAS cabinets experience a higher voltage across the coils than the BOP ESFAS relays. This factor leads to higher out-gassing rates which lead to relay binding. Therefore, ANPP has determined that higher coil voltages contribute significantly to relay failures. The highest relay failure rates have been experienced in the Palo Verde NSSS ESFAS cabinets which have higher operating voltages than the BOP ESFAS cabinets.

The relay operating environment could also be a contributor to premature failure. Specifically, high operating temperatures inside the cabinet could increase the coil out-gassing rate in a manner similar to the higher coil voltages discussed previously. The P&B specification for ambient temperature requires that temperature should be maintained less than 149 degrees Fahrenheit. ANPP collected temperature data from inside an NSSS ESFAS cabinet and a BOP ESFAS cabinet. The ambient temperature inside the Train B NSSS ESFAS cabinet in Unit 2 was measured at 104°F. The external surface of the K109 relay in this cabinet had a temperature of 157°F. The Train A BOP ESFAS cabinet in Unit 2 had an internal ambient temperature of 81°F. The highest measurement from the relays in the BOP ESFAS cabinet was 112°F for the K207 relay. The temperature differences between the NSSS ESFAS cabinets and the BOP ESFAS cabinets can be explained by the fact that the BOP ESFAS cabinets are equipped with forced ventilation and the NSSS ESFAS cabinets are not. Additionally, the higher relay operating voltages in the NSSS ESFAS directly contribute to the higher cabinet temperatures.

The temperature data from PVNGS implies that the out-gassing rate may be higher in the NSSS ESFAS relays than the BOP ESFAS relays. Thus, more relay failures would be expected in the NSSS ESFAS cabinets. This is supported by the actual relay failure history at PVNGS. However, the forced ventilation was not installed in the BOP ESFAS cabinets until approximately 2 years ago. Therefore, ANPP suspects that the BOP ESFAS relays experienced out-gassing during operation prior to the addition of forced ventilation. This hypothesis will be tested by examination of a Unit 1 BOP ESFAS relay.

P&B has conducted a preliminary investigation of the relay failures at Palo Verde. Their analysis was based upon a review of the independent laboratory (SEAL and HI-REL) reports and a sample of failed relays that had been disassembled and reassembled and then returned to P&B. Based on this information, P&B has hypothesized that the cause of the relay failures is a combination of continuous exposure to high coil voltages, high ambient temperatures, and infrequent de-energizing activity. These factors have created coil varnish out-gassing products. These out-gassing products then are deposited on and/or react with various metals within the motor chamber. This results in residues and corrosion which inhibit rotor movement upon de-energization.

ANPP is continuing to investigate each of the possible root causes discussed above. Based upon the final results of ANPP's investigation, a supplement to this report will be submitted.

E. Failure mode, mechanism, and effect of each failed component, if known:

The MDR relay malfunctions occur when the relays do not change position after they are de-energized. Normally, when the coils are de-energized, the rotor rotates approximately 30 degrees due to the spring force. However, during the identified failures, the spring force was not able to return the rotor to its de-energized position. The relays were "sticking" in their energized position. This condition resulted in the relay contacts not properly changing state. The consequence of the relay failures is that the related safety equipment would not be actuated as required. It should be noted that not all of the relay failures listed in Table 1 resulted in safety related components not actuating. The failures involved instances where only non-vital equipment did not actuate properly.

F. For failures of components with multiple functions, list of systems or secondary functions that were also affected:

The information concerning the functions of the relays is discussed in Section I.K.

G. For failure that rendered a train of a safety system inoperable, estimated elapsed time from the discovery of the failure until the train was returned to service:

The information required by the above is not considered appropriate for the particular event being reported in this LER. However, in general, it takes approximately 8-12 hours to replace a failed relay and conduct appropriate retests to return safety systems to full operability.

H. Method of discovery of each component or system failure or procedural error:

The relay failures were detected during routine surveillance testing or safety system actuations at Palo Verde.

I. Cause of Event:

See Section I.D above. There were no operator actions that affected the course of the event. There were no personnel errors involved.

J. Safety System Response:

There were no safety system responses as a result of the failures and none were necessary.

K. Failed Component Information:

Note: This section includes information requested by 10CFR21 concerning the identification of the firm supplying the basic component and the number and location of the relays at Palo Verde.

The MDR series relay is manufactured by Potter & Brumfield and is used in equipment supplied to Palo Verde by Combustion Engineering (CE) and General Atomics (GA). The MDR relay consists of a rotary actuator mechanism with the contact sections mounted in insulating rings on top. The actuator mechanism embodies a stator assembly on which two relay coils are mounted. The two coils are connected in series inside the relay. When the coils are energized, a rotor turns through an arc of approximately 30 degrees. This operates the contact section on the extension of the rotor shaft. The travel of the rotor is confined to a 30-degree arc between the stator faces and the stop ring. Two springs return the rotor to the stop ring when the coils are de-energized. This also returns the contacts to their normal position. Thus, the MDR series relay provides an energized and a de-energized position.

The MDR relays are supplied in a variety of sizes, coil voltage ratings, and contact numbers. At Palo Verde, seven (7) different models of MDR relays are utilized. Failures have only been experienced with the 7032, 7033, and 7034 model relays at Palo Verde. However, due to the similarities in construction and materials, all models could be subject to the same failure mechanism.

The MDR relays are used in three systems at PVNGS. These systems are:

i) The Nuclear Steam Supply System Engineered Safety Features Actuation System (NSSS ESFAS)(JE).

ii) The Balance of Plant Engineered Safety Features Actuation System (BOP ESFAS)(JE).

iii) The Reactor Trip Switchgear (RTSG)(AA)(JD).

The NSSS ESFAS uses the MDR relays as actuation relays. They are used to control valves (V) and motors (MTR) and to provide indication. There are a total of 57 relays used in each NSSS ESFAS train. At two trains per unit, this adds up to a total of 342 relays used in the NSSS ESFAS systems for the three Palo Verde units.

The BOP ESFAS uses the MDR relays as actuation relays to provide control of motors, valves, dampers, and emergency diesel generators (EK) (DG) following an actuation signal. Each BOP ESFAS train has 30 MDR relays. At two trains per unit, this adds up to a total of 180 relays in the BOP ESFAS systems for the three PVNGS units.

The reactor trip switchgear uses two MDR relays for each reactor trip breaker. The relay is used to provide an indication signal to the Plant Protection System (PPS)(JC) after a reactor trip breaker has opened. Failure of a MDR relay in this application would not prevent the reactor trip breaker from performing it's safety function of opening. There are 4 reactor trip breakers in each unit. This leads to a total of 24 MDR relays used in the reactor trip switchgear (RTSG) system (AA) at PVNGS.

Table 2 provides a listing of all of the MDR relays used at PVNGS. The Table provides some of the key information on each MDR relay.

TABLE 2 - LIST OF MDR RELAYS USED AT PVNGS

SYSTEM	RELAY #	MODEL #	FUNCTION	NORMAL STATE	TESTING FREQUENCY
NSSS ESFAS	K402	7034	AFAS-1	E	62 Days
NSSS ESFAS	K307	7033	AFAS-1	E	62 Days
NSSS ESFAS	K113	7032	AFAS-1	E	**
NSSS ESFAS	K211	7034	AFAS-1	E	*
NSSS ESFAS	K413	7032	AFAS-2	E	62 Days
NSSS ESFAS	K310	7034	AFAS-2	E	62 Days
NSSS ESFAS	K112	7033	AFAS-2	E	*

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

TABLE 2 - LIST OF MDR RELAYS USED AT PVNGS
(Continued)

SYSTEM	RELAY #	MODEL #	FUNCTION	NORMAL STATE	TESTING FREQUENCY
NSSS ESFAS	K404	7034	MSIS	E	*
NSSS ESFAS	K406	7032	SPARE	E	N/A
NSSS ESFAS	K411	7034	MSIS	E	62 Days
NSSS ESFAS	K313	7034	MSIS	E	62 Days
NSSS ESFAS	K306	7034	MSIS	E	62 Days
NSSS ESFAS	K305	7034	MSIS	E	*
NSSS ESFAS	K303	7034	MSIS	E	62 Days
NSSS ESFAS	K107	7032	SPARE	E	N/A
NSSS ESFAS	K106	7032	SPARE	E	N/A
NSSS ESFAS	K105	7034	MSIS	E	62 Days
NSSS ESFAS	K309	7034	RAS	E	62 Days
NSSS ESFAS	K312	7032	RAS	E	62 Days
NSSS ESFAS	K405	7034	RAS	E	62 Days
NSSS ESFAS	K104	7034	RAS	E	62 Days
NSSS ESFAS	K203	7034	CIAS	E	62 Days
NSSS ESFAS	K204	7033	CIAS	E	*
NSSS ESFAS	K205	7034	CIAS	E	62 Days
NSSS ESFAS	K206	7034	CIAS	E	62 Days
NSSS ESFAS	K213	7033	CIAS	E	62 Days
NSSS ESFAS	K212	7034	CIAS	E	62 Days
NSSS ESFAS	K210	7034	CIAS	E	62 Days
NSSS ESFAS	K209	7034	CIAS	E	62 Days
NSSS ESFAS	K208	7034	CIAS	E	62 Days
NSSS ESFAS	K201	7034	CIAS	E	62 Days
NSSS ESFAS	K202	7034	CIAS	E	*
NSSS ESFAS	K101	7034	SIAS	E	62 Days
NSSS ESFAS	K102	7033	SIAS	E	62 Days
NSSS ESFAS	K103	7033	SIAS	E	62 Days
NSSS ESFAS	K108	7033	SIAS	E	*
NSSS ESFAS	K109	7032	SIAS	E	62 Days
NSSS ESFAS	K110	7032	SIAS	E	62 Days
NSSS ESFAS	K301	7034	SIAS	E	62 Days
NSSS ESFAS	K302	7034	SIAS	E	62 Days
NSSS ESFAS	K308	7034	SIAS	E	62 Days
NSSS ESFAS	K311	7033	SIAS	E	62 Days
NSSS ESFAS	K401	7034	SIAS	E	62 Days
NSSS ESFAS	K403	7034	SIAS	E	62 Days
NSSS ESFAS	K408	7034	SIAS	E	62 Days

TABLE 2 - LIST OF MDR RELAYS USED AT PVNGS
(Continued)

SYSTEM	RELAY #	MODEL #	FUNCTION	NORMAL STATE	TESTING FREQUENCY
NSSS ESFAS	K409	7034	SIAS	E	*
NSSS ESFAS	K410	7034	SIAS	E	62 Days
NSSS ESFAS	K412	7034	SIAS	E	62 Days
NSSS ESFAS	K304	7034	CSAS	E	*
NSSS ESFAS	K111	7032	CSAS	E	*
NSSS ESFAS	K114	7032	CSAS	E	*
NSSS ESFAS	K627	136-1	AFAS	E	62 Days
NSSS ESFAS	K628	136-1	AFAS	E	62 Days
NSSS ESFAS	K629	136-1	AFAS	E	62 Days
NSSS ESFAS	K727	136-1	AFAS	E	62 Days
NSSS ESFAS	K728	136-1	AFAS	E	62 Days
NSSS ESFAS	K729	136-1	AFAS	E	62 Days
BOP ESFAS	K201	167-1	CPIAS	E	18 mo ***
BOP ESFAS	K202	167-1	LOP/LS	D	18 mo ***
BOP ESFAS	K203	167-1	LOP/LS	E	18 mo ***
BOP ESFAS	K204	172-1	LOP/LS	D	18 mo ***
BOP ESFAS	K205	172-1	LOP/LS	E	18 mo ***
BOP ESFAS	K206	172-1	CRVIAS	E	18 mo ***
BOP ESFAS	K207	172-1	CREFAS	E	18 mo ***
BOP ESFAS	K208	172-1	SPARE	N/A	N/A ***
BOP ESFAS	K209	172-1	SPARE	N/A	N/A ***
BOP ESFAS	K221	136-1	LS	E	18 mo ***
BOP ESFAS	K222	136-1	LS	E	18 mo ***
BOP ESFAS	K223	136-1	LS	E	18 mo ***
BOP ESFAS	K225	136-1	LS	E	18 mo ***
BOP ESFAS	K226	136-1	LS	E	18 mo ***
BOP ESFAS	K227	136-1	LS	E	18 mo ***
BOP ESFAS	K231	136-1	LS	E	18 mo ***
BOP ESFAS	K232	136-1	LS	E	18 mo ***
BOP ESFAS	K233	136-1	LS	E	18 mo ***
BOP ESFAS	K234	136-1	LS	E	18 mo ***
BOP ESFAS	K235	136-1	LS	E	18 mo ***
BOP ESFAS	K236	136-1	LS	E	18 mo ***
BOP ESFAS	K125	136-1	LS	E	18 mo ***
BOP ESFAS	K126	136-1	LS	E	18 mo ***
BOP ESFAS	K127	136-1	LS	E	18 mo ***
BOP ESFAS	K128	136-1	LS	E	18 mo ***
BOP ESFAS	K124	136-1	DGSS	E	18 mo ***
BOP ESFAS	K123	136-1	CRVIAS	E	18 mo ***
BOP ESFAS	K112	136-1	FBEVAS	E	18 mo ***
BOP ESFAS	K121	136-1	FBEVAS	E	18 mo ***
BOP ESFAS	K122	136-1	CREFAS	E	18 mo ***
RTSG	52Z	5053	INDICATION	E	18 mo
RTSG	ISOL.	4094	ISOL. RELAY	E	18 mo

Notes for Table 2:

- * These relays are exempt from testing during power operations. The relays are tested at least once every 18 months during refueling outages and during each shutdown unless tested within the previous 62 days (refer to Technical Specification Table 4.3-2).
- ** B-train only.
- *** BOP ESFAS has an automatic test function which "rocks" the relay but does not de-energize the relay.

- Abbreviations used in Table 2:

E = energized
D = de-energized

AFAS-1 = auxiliary feedwater actuation signal for Steam Generator #1 (JE)(BA)
AFAS-2 = auxiliary feedwater actuation signal for Steam Generator #2 (JE)(BA)
MSIS = main steam isolation signal (JE)(SB)
RAS = recirculation actuation signal (JC)(BO)
CIAS = containment isolation actuation signal (JE)(BD)
SIAS = safety injection actuation signal (JE)(BP)(BQ)
CSAS = containment spray actuation signal (JE)(BE)
CPIAS = containment purge isolation actuation signal (JE)(JM)
LOP/LS = loss of power/load shed (JE)(EB)
CRVIAS = control room isolation actuation signal (JE)(VI)
CREFAS = control room essential filtration actuation signal (JE)(VI)
DGSS = diesel generator start system (LC)(EK)
FBEVAS = fuel building essential ventilation actuation system (JE)(VG)

II. ASSESSMENT OF THE SAFETY CONSEQUENCES AND IMPLICATIONS OF THIS EVENT:

Note: This section contains the information requested by 10CFR21 concerning the nature of the safety hazard which is created or could be created.

The failure of a relay in the ESF to properly rotate by spring tension upon being de-energized by a valid safety system actuation signal would prevent the associated valves, pump motors, etc. from operating as required for a safe plant shutdown. The failure of the relays in the RTSG to properly rotate results in erroneous indication of reactor trip breaker (BKR) position to the PPS and in the Control Room. There are no other components which perform the same function as the relays that would be available during an event.

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Palo Verde Unit 1	0 5 0 0 0 5 2 8	8 8	— 0 1 8	— 0 0	1 2 OF 1 3

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

ANPP has conducted a statistical analysis of the relay failure data at PVNGS. Failure rates were determined for each relay model and then compared to typical industry relay failure rates. The computed failure rates at PVNGS are as follows:

MODEL NUMBER	FAILURE RATE (FAILURES/HOUR)
7032	1.36E-05
7033	1.40E-06
7034	1.10E-06

When comparing these failure rates to the industry average failure rate of 4.0E-07 failures per hour, only the model 7032 failure rate is statistically different from the industry failure rates. Although the failure rates for the model 7033 and 7034 relays do appear to be higher than the industry average, statistical hypothesis tests could not establish that there is a statistical difference.

The next step of the reliability analysis was to evaluate the impact of the higher failure rate of the model 7032 relays on equipment and/or system reliability. The results of this analysis show that the reliability of safety related systems is not significantly affected by the increased relay failure rate if the relay exercise frequencies are appropriately increased.

III. CORRECTIVE ACTIONS:

This section contains the information requested by 10CFR21 concerning the corrective action which has been, is being, and will be taken; the organizations responsible for the corrective action; and the length of time for accomplishing the corrective action.

A. Immediate:

Following the relay failures described in Section I.B, the affected relays were replaced.

Based upon the results of the reliability analysis discussed in Section II, the frequency for testing the model 7032 relays will be increased such that the reliability of safety-related systems is not significantly degraded. The increased exercising will also improve relay performance by ensuring that any out-gassing products

do not accumulate on internal surfaces in quantities sufficient to prevent rotary movement. The increased testing will be continued pending completion of the appropriate long-term corrective actions discussed below.

B. Action to Prevent Recurrence:

Long term corrective actions will be developed pending completion of the final, definitive root cause determination. Some of the potential solutions that are being considered at this time include:

i) Replacement of the varnished coil relays with epoxy coated coil relays.

ii) Reducing the power supply voltage from its current level of 36 VDC in the NSSS ESFAS cabinets.

iii) Adding forced ventilation cooling in the NSSS ESFAS cabinets.

iv) Installing voltage reducing devices to drop the voltage seen by the relays in the NSSS ESFAS cabinets.

A supplement to this report will be provided describing the final corrective action and due dates.

IV. PREVIOUS SIMILAR EVENTS:

There have been no previous similar events reported pursuant to 10CFR50.73.

Arizona Nuclear Power Project
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192-00397-JGH/TDS/DAJ
August 3, 1988

U. S. Nuclear Regulatory Commission
NRC Document Control Desk
Washington, DC 20555

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Unit 1
Docket No. STN 50-528 (License No. NPF-41)
Licensee Event Report 88-018-00
File: 88-020-404

Attached please find Licensee Event Report (LER) No. 88-018-00 prepared and submitted pursuant to 10CFR50.73. In accordance with 10CFR50.73(d), we are herewith forwarding a copy of the LER to the Regional Administrator of the Region V office.

This report is also being submitted pursuant to 10CFR21 and includes the information requested in 10CFR21.21(b)(3). In accordance with 10CFR21.21(b)(2), three copies of this report are being provided to the Director, Office of Nuclear Reactor Regulation.

If you have any questions, please contact T. D. Shriver, Compliance Manager at (602) 393-2521.

Very truly yours,

J. G. Haynes

J. G. Haynes
Vice President
Nuclear Production

JGH/TDS/DAJ/kj

Attachment

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