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BRADISH,T.R. Arizona Public Service Co. (formerly Arizona Nuclear Power
LEVINE,J.M. Arizona Public Service Co. (formerly Arizona Nuclear Power
RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 91-004-01:on 910816,reactor trip occurred due to high pressurizer pressure.Caused by generator/turbine trip in combination w/coginitive personnel error.Generrex AC/DC gate board was replaced.W/920124 ltr.

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NOTES:Standardized plant. 05000529

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Arizona Public Service Company
PALO VERDE NUCLEAR GENERATING STATION
P.O. BOX 52034 • PHOENIX, ARIZONA 85072-2034

JAMES M. LEVINE
VICE PRESIDENT
NUCLEAR PRODUCTION

192-00768-JML/TRB/KR
January 24, 1992

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Mail Station P1-37
Washington, D.C. 20555

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Unit 2
Docket No. STN 50-529 (License No. NPF-51)
Licensee Event Report 91-004-01
File: 92-020-404

Attached please find Supplement 01 to Licensee Event Report (LER) 91-004 prepared and submitted pursuant to 10CFR50.73. This supplement is being submitted to provide the results of an APS Engineering root cause of failure analysis of a Generrex A.C./D.C. gate board's static switch. In accordance with 10CFR50.73(d), a copy of this supplement is being forwarded to the Regional Administrator of the Region V office.

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

Very truly yours,

James M. Levine

JML/TRB/KR/nk

Attachment

cc: W. F. Conway (all with attachment)
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U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/88

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Palo Verde Unit 2	0 5 0 0 0 5 2 9	1 OF 0 9

TITLE (4)
Reactor Trip Following Generator/Turbine Trip

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)
									N/A	0 5 0 0 0
0 8	1 6	9 1	9 1	0 0 4	0 1	0 1	2 4	9 2	N/A	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)	X 50.73(a)(2)(iv)	73.71(b)
		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(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)	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	TELEPHONE NUMBER
Thomas R. Bradish, Compliance Manager	AREA CODE 6 0 2 3 9 3 - 2 5 2 1 1

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
C	T L	E C B D	G 0 8 0	N					

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 August 16, 1991, at approximately 0839 MST, Palo Verde Unit 2 was in Mode 1 (POWER OPERATION), operating at approximately 64 percent power when a reactor trip occurred due to high pressurizer pressure. Immediately prior to the reactor trip, the Main Generator tripped initiating a Main Turbine trip. At approximately 0900 MST on August 16, 1991, the plant was stabilized in Mode 3 (HOT STANDBY) at normal operating temperature and pressure. The event was diagnosed as an uncomplicated reactor trip. No other safety system responses occurred and none were required.

The reactor trip on high pressurizer pressure has been determined to be the normal plant response to a load rejection at 64 percent power with 7 of the 8 steam bypass control valves (SBCVs) in service. The cause of the reactor trip was a generator/turbine trip in combination with a cognitive personnel error by the Control Room personnel who did not comply with procedural requirements to have the 8 SBCVs in service at power levels below 75 percent. Control Room personnel were disciplined in accordance with the PVNGS Positive Discipline Program. The Main Generator trip was caused when a Generrex A.C./D.C. gate board's static switch failed and the Generrex excitation control system entered an abnormal state (i.e., excessively high field voltage, current and VARS). The gate board was replaced and the Generrex System was successfully retested and returned to service.

A previous similar event was reported in Unit 1 LER 528/90-006.

I. DESCRIPTION OF WHAT OCCURRED:

A. Initial Conditions:

On August 16, 1991, at 0839 MST, Palo Verde Unit 2 was in Mode 1 (POWER OPERATION) at approximately 64 percent power.

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

Event Classification: Any event or condition that resulted in automatic actuation of the Reactor Protection System (RPS)(JC).

On August 16, 1991, at approximately 0839 MST, Palo Verde Unit 2 experienced an automatic reactor (RCT)(AC) trip from approximately 64 percent power due to high pressurizer (PRZ)(AB) pressure. Immediately prior to the reactor trip, the Main Generator (TB) tripped initiating a Main Turbine (TA) trip. At approximately 0900 MST on August 16, 1991, the plant was stabilized in Mode 3 (HOT STANDBY) at normal operating temperature and pressure. The event was diagnosed as an uncomplicated reactor trip. No other safety system responses occurred and none were required.

Prior to the event, on August 16, 1991, Palo Verde Unit 2 was in the process of returning to normal full power operation following a manual reactor trip which occurred on August 9, 1991 (LER 529/91-003). The plant was started up using the Train A Main Feedwater pump (P)(SJ) to supply feedwater to the steam generators (AB). With only one main feedwater pump in service, power may be increased up to approximately 70 percent, as long as main feedwater pump suction pressure is maintained greater than 300 pounds per square inch gauge (psig). At approximately 0300 MST, the reactor power increase was stopped at approximately 64 percent due to the inability to open the Train B Main Feedwater pump discharge valve (V)(GATE)(P)(SJ) [a motor operated gate valve]. At approximately 0700 MST, an APS Engineering investigation was initiated. The investigation determined that a hydraulic lock between the check valve on the discharge piping and the downstream discharge gate valve prevented the discharge gate valve from opening. The hydraulic lock was a result of overpressurization of the approximately seven foot section of the Main Feedwater discharge piping between the discharge check valve and the discharge gate valve. The overpressurization was due to thermal expansion of the water trapped between the two valves as a result of plant heatup. The measured pressure was approximately 7000 psig. The discharge piping was depressurized. At approximately 0831 MST, Train B Main Feedwater pump was removed from service.

Train A Main Feedwater pump remained in service. Reactor power remained at approximately 64 percent pending resolution of the Train B Main Feedwater System problem and Engineering evaluation of the overpressurized section of Main Feedwater discharge piping (see Section V for additional information).

At approximately 0838 MST on August 16, 1991, Palo Verde Unit 2 was operating at approximately 64 percent power when the Control Room (NA) received a Main Generator excitation trouble alarm (ALM). The Control Room operators (utility, licensed) checked the Generrex excitation control system (TL) and found indications that the Generrex exciter (EXC) cubicle was in an abnormal state (i.e., excessively high field voltage, current and VARS). The voltage/hertz timing light was flashing, indicating an overexcited condition in the Main Generator. The secondary operator (utility, licensed) attempted to lower the A.C. voltage manually. However, the A.C. voltage regulator (RG)(TL) tripped followed by a Main Generator trip which initiated a Main Turbine trip.

When the Main Turbine tripped, the Steam Bypass Control System (JI) (SBCS) generated a quick open signal. The seven in-service steam bypass control valves (PCV)(JI) (SBCVs) automatically opened to 100 percent in response to the quick open signal. The open SBCVs resulted in an excess steam demand and subsequent rapid power increase, generating variable overpower pretrip signals to the four channels of the Plant Protection System (JC) (PPS). The magnitude of the power increase was not sufficient to cause the channels of the PPS to trip on variable over power. The main steam (SB) pressure decreased as a result of the SBCVs quick opening. The SBCVs then began to modulate closed to maintain main steam pressure. Pressurizer pressure and main steam pressure began increasing as the SBCVs modulated closed. The main steam pressure increase due to reactor power operation caused the SBCVs to modulate open. However, the seven SBCVs did not modulate open fast enough to prevent pressurizer pressure from increasing up to the high pressurizer pressure trip setpoint. The high pressurizer pressure pretrips were received on four channels of the PPS. Channels A and D high pressurizer pressure trip signals were generated at approximately 0839 MST, satisfying the two-out-of-four trip logic for the Reactor Protection System. This resulted in a reactor trip.

The Control Room Supervisor (utility, licensed) diagnosed the event as a reactor trip and entered the approved reactor trip procedure. At approximately 0900 MST, the plant was stabilized in Mode 3 (HOT STANDBY). No other safety system responses, including Engineered Safety Features Actuations (JE), occurred and none were required. The Shift Supervisor (utility, licensed) declared the

event an uncomplicated reactor trip. No significant anomalies were noted in the control system or overall plant response to the event which would adversely affect plant operation.

The Steam Bypass Control System (JI) (SBCS) responded to the transient (i.e., increase in Main Steam [SB] pressure) as designed. At the time of the event, seven of the eight steam bypass control valves (PCV)(JI) (SBCVs) were in service. One SBCV had been placed in permissive "off" mode, contrary to an approved Operations procedure.

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

One of the eight steam bypass control valves (SBCVs) was in permissive "off" mode (i.e., the valve would not automatically operate). The procedure requires eight SBCVs to be in automatic at power levels less than 75 percent.

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

The cause of the Generrex excitation control system being in an abnormal state (i.e., excessively high field voltage, current and VARS) was due to the malfunctioning of the A.C./D.C. gate board's static switch. A root cause of failure analysis, performed by APS Engineering personnel, determined that the failure to the circuit card would be the expected result whenever this type of electronic equipment is exposed to voltage transients (i.e., noise) over a period of time.

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

The failure of the A.C./D.C. gate board's static switch in the A.C. mode put a high positive output signal into the field voltage regulator card. This condition would turn off the firing of the silicon control rectifiers (SCR), thus allowing all the available current to flow across the generator field. Indications were that the current rapidly exceeded normal values, the field current and voltage increased, the generator output voltage increased, the VARS increased, and the A.C. voltage regulator tripped on maximum excitation limits. The Main Generator trip was a result of the over-excitation of the field. The timing function of the maximum excitation level (MEL) circuitry caused the Generrex protective feature to trip the Main Turbine.

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

Not applicable - no failures of components with multiple functions were involved.

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

Not applicable - no failures that rendered a train of a safety system inoperable were involved.

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

The failure of the A.C./D.C. gate board's static switch was discovered during Engineering troubleshooting and evaluation. There were no procedural errors which contributed to this event.

I. Cause of Event:

The cause of the reactor trip was a generator/turbine trip in combination with a cognitive personnel error by the Control Room personnel (utility, licensed) who did not comply with procedural requirements to have all eight SBCVs in service at power levels below 75 percent (SALP Cause Code A: Personnel Error).

The cause of the Main Generator/Turbine trip is discussed in Section I.D. The reactor trip on high pressurizer pressure has been determined to be the normal plant response to a load rejection at 64 percent power with seven of the eight steam bypass control valves (SBCVs) in service. A Combustion Engineering (CE) study predicts that a reactor trip is the expected result of a large load reject from 64 percent power with one SBCV out of service. The CE study predicts that pressurizer pressure will remain below the trip setpoint with all eight SBCVs in service.

Prior to the reactor trip, on August 15, 1991, Palo Verde Unit 2 was in the process of returning to normal full power operation. In accordance with an approved procedure for plant startup, the Main Turbine was placed on-line in preparation for the power ascension. After placing the turbine on-line, the procedure requires that eight SBCVs be placed in service. The Assistant Shift Supervisor and Shift Supervisor (utility, licensed) reviewed the procedure and decided to place only seven of the eight SBCVs in service. Seven SBCVs in service is the normal operating configuration at power levels of 75 percent or above. During a

Control Room shift turnover that occurred during startup, the on-coming Control Room personnel (utility, licensed) reviewed the SBCS lineup. The on-coming Control Room personnel missed an opportunity to identify and correct the condition (one SBCV out of service).

No unusual characteristics of the work location (e.g., noise, heat, poor lighting) directly contributed to this event. There were no procedural errors which contributed to this event.

J. Safety System Response:

The Plant Protection System responded to the transient as designed. The reactor was automatically tripped when Channels A and D high pressurizer pressure trip signals were generated, satisfying the two-out-of-four trip logic for the Reactor Protection System. No other safety system responses, including Engineered Safety Features actuations, occurred and none were required.

K. Failed Component Information:

The Generrex A.C./D.C. gate board with the failed static switch is manufactured by General Electric Company. The manufacture's model number is 304A8496 Revision 1A1A.

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

A reactor trip following a Main Generator/Turbine trip has been determined to be the expected result based on the current control systems design and the plant configuration at the initiation of the event. A Combustion Engineering evaluation performed on the Steam Bypass Control System shows that a reactor trip will occur on high pressurizer pressure after a load reject with the reactor at 64 percent power and with one steam bypass control valve in permissive "off" mode. The event did not result in any challenges to the fission product barriers or result in any releases of radioactive material. Based on the post trip review and safety assessment of the event, there were no significant safety consequences or any affect on the health and safety of the public.

III. CORRECTIVE ACTION:

A. Immediate:

The Shift Supervisor and Assistant Shift Supervisor were disciplined in accordance with the PVNGS Positive Discipline Program.

The Generrex A.C./D.C. gate board with the failed static switch was replaced and the Generrex System was successfully retested and returned to service.

B. Action to Prevent Recurrence:

An independent investigation of this event was conducted in accordance with the PVNGS Incident Investigation Program. As part of the investigation, a root cause of failure analysis of the Generrex gate board was performed by APS Engineering personnel as discussed in Section I.D. Based on the results of the investigation, the failure was found to be the expected result of exposure to voltage transients. A preventive maintenance task will be performed to change the gate board's power supply capacitors on a periodic basis.

A memo was written to Unit 2 licensed operators to emphasize the need for procedural compliance and the need to thoroughly understand the effects of any procedure deviations. The memo was transmitted to Units 1 and 3 licensed operators for review.

IV. PREVIOUS SIMILAR EVENTS:

A previous similar event was reported in Unit 1 LER 528/90-006 when Palo Verde Unit 1 manually tripped the Main Turbine at approximately 65 percent power. Approximately 30 seconds after the Main Turbine trip, the reactor tripped on high pressurizer pressure. The reactor trip was determined to be the expected result of a load rejection with the reactor at 65 percent power and with one SBCV out-of-service. As a result of the Unit 1 event, a procedural revision was incorporated to require eight SBCVs to be in-service when operating at power levels less than 75 percent and seven SBCVs to be in-service at 75 percent and above.

As discussed in Section I.I, the cause of the event reported in this LER (529/91-004) was a cognitive personnel error. Therefore, the corrective actions for the previous event would not have prevented this event.

V. ADDITIONAL INFORMATION:

An APS Engineering evaluation was performed for material stress considerations resulting from the overpressurization of a section of the Train B Main Feedwater pump discharge piping between the discharge check valve and the discharge gate valve. The measured pressure was approximately 7000 psig and the valve body surface temperature was approximately 250 degrees Fahrenheit. The piping is designed for 1875 psig and 350 degrees Fahrenheit.

The stresses encountered by the piping section during this overpressurization resulted in a calculated hoop stress of 52,980 psig or 1.68 times the theoretical yield stress of 31,450 psig for the material at 249 degrees Fahrenheit. The predicated strain for this calculated stress level is less than 0.3 percent. Based upon this low strain computation, no visible signs of yielding are anticipated.

In addition, the section of piping was examined for indications of yielding and plastic deformation. The examination results support and verify that straining, if it occurred, was not visible, as the stress calculation predicted. Based upon the approximate strain calculated and the examination results, it is reasonable and practical to conclude that the actual strain fell into the strain hardening range of the stress-strain curve. Therefore, it is likely that the material work hardened to a higher elastic allowable. Strain hardening does not affect the ultimate strength of the material. Its only effect is a slight reduction in the overall ductility or total straining capacity prior to failure. This reduction in ductility has no impact on the piping, since the design stress values for the piping are well below the theoretical yield stress and do not approach this ultimate strain region during normal service conditions.

Based upon visual and non-destructive testing (NDT) examinations of the affected components (i.e., discharge check valve, piping, discharge gate valve, and vent (VTV) and drain valves), technical input from the valve vendors, and stress calculations performed by APS Nuclear Engineering, APS determined that the piping overpressurization did not result in any long term detrimental effects to the components. The components were deemed acceptable for continued unrestricted use in this application. In addition, independent evaluations of the event were performed by Bechtel and Sargent & Lundy. Both of these evaluations reached the same conclusion as APS Engineering.

To prevent recurrence of this event, appropriate Operations procedures were revised to open Train A and B discharge gate valves to prevent piping overpressurization due to thermal expansion of the entrapped water.

FACSIMILE

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

FACILITY NAME	DOCKET NUMBER	LER NUMBER			PAGE
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Palo Verde Unit 2	0 5 0 0 0 5 2 9	9 1	— 0 0 4	— 0 1	0 9 OF 0 9

TEXT

Based on the Incident Investigation Team review, unit restart was authorized by the Plant Manager in accordance with approved procedures. Unit 2 entered Mode 2 (STARTUP) at 1756 MST on August 19, 1991, and was placed back on the grid at 0434 MST on August 20, 1991.

bcc:

J. M. Levine	6125
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R. J. Adney	7394
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