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RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 94-005-00:on 940819,reactor trip occurred following degradation of MF flow.FWCS cabinets,SG-1 economizer & MFW pumps quarantined & FWCS-1 master controller replaced.W/ 940916 ltr.

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NOTES:Standardized plant. 05000530

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A0

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

192-00906-JML/BAG/KR
September 16, 1994

JAMES M. LEVINE
VICE PRESIDENT
NUCLEAR PRODUCTION

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

Dear Sirs:

Subject: **Palo Verde Nuclear Generating Station (PVNGS)**
Unit 3
Docket No. STN 50-530 (License No. NPF-74)
Licensee Event Report 94-005-00
File: 94-020-404

Attached please find Licensee Event Report (LER) 94-005-00 prepared and submitted pursuant to 10CFR50.73. This LER reports an August 19, 1994 reactor trip on low steam generator water level following the degradation of main feedwater flow. The unit also received an Engineered Safety Feature Actuation System (ESFAS) actuation of the Auxiliary Feedwater Actuation System on low-low steam generator water level. In accordance with 10CFR50.73(d), a copy of this LER is being forwarded to the Regional Administrator, NRC Region IV. If you have any questions, please contact Burton A. Grabo, Section Leader, Nuclear Regulatory Affairs, at (602) 393-6492.

Sincerely,

James M. Levine

JML/BAG/KR/rv

Attachment

cc: L. J. Callan (all with attachment)
K. E. Perkins
K. E. Johnston
INPO Records Center

IE22

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Palo Verde Unit 3	0 5 0 0 0 5 3 0	1 OF 0 8

TITLE (4)
Reactor Trip Following the Degradation of Main Feedwater Flow

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 NUMBERS
									N/A	0 5 0 0 0
0 8	1 9	9 4	9 4	- 0 0 5	- 0 0	0 9	1 6	9 4	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
Burton A. Grabo, Section Leader, Nuclear Regulatory Affairs	AREA CODE 6 0 2 3 9 3 - 6 4 9 2

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
X	S J	M C B D	F 1 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-spaced typewritten lines) (16)

On August 19, 1994, at approximately 1319 MST, Palo Verde Unit 3 was in Mode 1 (POWER OPERATION), operating at approximately 100 percent power when a reactor trip occurred when Steam Generator Number 1 (SG-1) water level reached the Reactor Protection System trip setpoint for low steam generator water level following the degradation of main feedwater flow. Immediately following the reactor trip, a low steam generator water level alarm annunciated for SG-1, followed by the Engineered Safety Feature Actuation System (ESFAS) actuation of the Auxiliary Feedwater Actuation System (AFAS-1) on low-low steam generator water level for SG-1. The Steam Bypass Control System responded as designed to control the secondary system pressure. Required plant equipment and safety systems responded to the event as designed. No other ESF actuations occurred and none were required. Steam generator water level was restored to normal using auxiliary feedwater flow. The Control Room Supervisor diagnosed the event as an uncomplicated reactor trip. By approximately 1356 MST on August 19, 1994, the plant was stabilized in Mode 3 (HOT STANDBY).

The reactor trip was initiated by an unexplained and unwarranted closing of the economizer valve on SG-1 which was later determined to be caused by an intermittent component failure of the feedwater control system (FWCS-1), most probably the master controller or associated circuitry. As corrective action, the controller was replaced.

I. DESCRIPTION OF WHAT OCCURRED:

A. Initial Conditions:

At 1319 MST on August 19, 1994, Palo Verde Unit 3 was in Mode 1 (POWER OPERATION) operating at approximately 100 percent power.

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

Event Classification: An event that resulted in the automatic actuation of an Engineered Safety Feature (ESF) (JE), including the Reactor Protection System (RPS) (JC).

At approximately 1319 MST on August 19, 1994, a reactor (AC) trip occurred when Steam Generator Number 1 (SG-1) (AB) water level reached the Reactor Protection System (RPS) trip setpoint for low steam generator water level following the degradation of main feedwater (SJ) (MFW) flow. Immediately following the reactor trip, a low steam generator water level alarm annunciated for SG-1, followed by the Engineered Safety Feature Actuation System (ESFAS) actuation of the Auxiliary Feedwater Actuation System (AFAS-1) (JE)(BA) on low-low steam generator water level for SG-1. The Steam Bypass Control System (SBCS) (JI) responded as designed to control the secondary system pressure. Required plant equipment and safety systems responded to the event as designed. No other ESF actuations occurred and none were required. Steam generator water level was restored to normal using auxiliary feedwater (BA) flow. The Shift Supervisor (utility, licensed) diagnosed the event as an uncomplicated reactor trip. By approximately 1356 MST on August 19, 1994, the plant was stabilized in Mode 3 (HOT STANDBY).

Prior to the reactor trip, at approximately 1318 MST, Control Room (NA) personnel (utility, licensed) observed that SG-1 water level was decreasing rapidly. Control Room personnel also observed that the SG-1 economizer (SJ) valve was closing and that the speed of both main feedwater pumps (MFWP) was decreasing. The mismatch in feedwater supply to steam flow resulted in a rapid decrease in SG-1 water level. The plant responded as expected and at approximately 1319 MST, a reactor trip occurred when SG-1 water level reached the RPS trip setpoint for low steam generator water level. All control element assemblies (CEA) (AA) inserted as designed. The reactor trip was followed by a Main Turbine/Main Generator (TA/TB) trip. The SBCS responded as designed to control the secondary system pressure.

TEXT

Immediately following the reactor trip, an ESFAS AFAS-1 actuation was generated on low-low SG-1 water level. The AFAS-1 actuation initiated auxiliary feedwater injection from the auxiliary feedwater pumps (AFWP A and AFWP B) to restore steam generator level. Other ESF equipment responded as expected to the AFAS-1 actuation [e.g., the Emergency Diesel Generators (EDG-A and EDG-B) (EK) started]. At approximately 1325 MST, Control Room personnel initiated manual control of the feedwater to prevent overcooling of the primary system. The Shift Supervisor diagnosed the event as an uncomplicated reactor trip. By approximately 1356 MST on August 19, 1994, the plant was stabilized in Mode 3. No other ESF actuations occurred and none were required. Required plant equipment and safety systems responded to the event as designed. At approximately 1424 MST, AFAS-1 was reset. By approximately 1454 MST, EDG-A and EDG-B were secured.

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

There are no indications that any structures, systems, or components were inoperable at the start of the event which contributed to this event. However, during the investigation of this event, the malfunction within the Feedwater Control System (SJ) (FWCS-1) was attributed to an intermittent component failure, most probably the FWCS-1 master controller (MCBD) or associated circuitry.

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

An independent investigation of this event is being conducted in accordance with the APS Incident Investigation Program. Following the reactor trip, the FWCS cabinets, SG-1 economizer valve, and the MFWPs were quarantined. A troubleshooting plan was developed to determine the cause of the malfunction within the FWCS-1. Although extensive troubleshooting by APS Engineering personnel (utility, nonlicensed) was performed, no discrepancies or hard failure could be identified. The identical FWCS malfunction could not be duplicated.

The dynamics of the event pointed towards an intermittent failure of the FWCS-1 master controller or a temporary grounding or loss of signal of the FWCS-1 master controller's output. If the failure had originated in the economizer valve controller, MFWPs A and B speed would have increased to restore SG-1 level. In this event, the FWCS-2 master controller was controlling MFWP speed based on SG-2 level. A contingency action plan was developed prior to restarting the unit. The plan established a long range monitoring program using several triggered recorders to help

determine the cause of the malfunction should it recur. In addition, Control Room personnel were apprised of plant conditions and actions to be taken.

Based on the results of the troubleshooting and the contingency plan, the Plant Review Board authorized a unit restart on August 20, 1994. Following startup, Combustion Engineering (ABB-CE) personnel notified APS Engineering personnel that they were able to approximately duplicate the FWCS malfunction. Based on this information, additional points in the compensated level circuitry were selected for monitoring to help determine the cause of the FWCS-1 malfunction should it recur.

Approximately eleven days following the FWCS-1 malfunction and the reactor trip reported in this LER (530/94-005), a second malfunction within the FWCS occurred in Unit 3. At approximately 1500 MST on August 30, 1994, Unit 3 was in Mode 1, operating at approximately 100 percent power when a second reactor trip was initiated by an unwarranted speed increase of both MFWPs A and B. An attempt by Control Room personnel to manually drive the FWCS-2 master controller's output down failed. SG-2 water level rapidly increased to approximately 95 percent narrow range resulting in an ESFAS actuation of the Main Steam Isolation System (JE)(SB) and a reactor trip. This event is being reported in LER 530/94-007. The equipment root cause of failure analysis (ERCFA) performed by APS Engineering personnel, with the assistance of ABB-CE and Foxboro representatives, determined that a fuse failure caused the FWCS-2 master controller to fail with maximum output. Although the cause of the initial FWCS-1 malfunction remained unknown, it did not appear to be related to the FWCS-2 malfunction.

A third malfunction within the FWCS occurred in Unit 3 on September 3, 1994 which approximately duplicated the initial August 19, 1994 FWCS-1 malfunction. Since an attempt to manually control the FWCS-1 master controller's output failed again, Control Room personnel took the economizer valve to manual and averted a reactor trip. Based on the data attained from the triggered recorders, APS Engineering personnel were able to isolate the master controller output as the most probable cause of the FWCS-1 malfunction. The FWCS-1 master controller was replaced.

As part of the investigation, an ERCFA of the FWCS-1 master controller is being performed by APS Engineering personnel. The preliminary evaluation has not identified any specific FWCS-1 master controller subcomponent failure(s) which caused the low output and has determined that the master controller or associated circuitry experienced an intermittent component failure. If the

final evaluation results differ from this determination and would affect the understanding or perception of this event, a supplement to this report will be submitted to describe the final root cause of failure. The investigation determined that no maintenance or troubleshooting activities in progress could have contributed to this event.

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

The reactor trip on low SG-1 water level was initiated by an unexplained and unwarranted closing of the economizer valve on SG-1 caused by an intermittent component failure of the FWCS-1, most probably the master controller or associated circuitry. In order to better understand the failure mode, mechanism, and effect of the FWCS-1 malfunction, the following description specific to Palo Verde is included:

> The Palo Verde steam generators use dual feedwater flow paths (SJ) during normal operation. One flow path is through the six (6) inch downcomer line (SJ). The other flow path is through the 24 inch economizer line (SJ). From initial startup to approximately 15 percent power, feedwater to the steam generators is directed through the downcomer line. At approximately 15 percent power, feedwater flow is redirected from the downcomer line to the economizer line. This swapover is accomplished by the FWCS automatically closing the downcomer valve and then throttling the economizer valve open.
>
> Following the generation of a turbine trip on reactor trip, a Reactor Trip Override (RTO) signal is generated in the FWCS in order to reduce feedwater flow to 5 percent of nominal full power flow. The RTO signal closes the SG economizer valves, reduces the speed of the MFWP, and modulates the downcomer valves to maintain reactor coolant system (RCS) (AB) average temperature (Tave) at the "no-load" setpoint. Immediately following a trip, Tave is above the no-load setpoint, therefore, the downcomer valves should respond by opening. If the low-low steam generator level setpoint is reached due to continued steaming through the SBCS, an AFAS is generated and the auxiliary feedwater pumps will actuate to provide additional feedwater.

Specific to the event reported in this LER and prior to the malfunction within the FWCS-1, the economizer valve was approximately 47 percent open and maintaining SG-1 water level. The economizer valve rapidly closed to 12 percent open, reopened

to 20 percent open position for approximately 10 seconds, went fully closed, and finally began to reopen. When the reactor trip occurred, the economizer valve had reached approximately 10 percent open, however, the RTO signal rapidly reclosed the valve.

The mismatch in feedwater supply to steam flow resulted in a rapid decrease in SG-1 water level. The reduction in SG-1 feedwater flow resulted in overfeeding SG-2. FWCS-2 responded to the mismatch in feedwater supply to steam flow in SG-2 and reduced the speed of both MFWPs down to minimum speed to maintain SG-2 level.

The reactor trip was generated from a valid low level SG-1 signal of approximately 44.2 percent wide range level. The ESFAS responded as expected when an AFAS-1 was generated due to a valid low-low level SG-1 signal of approximately 25.8 percent wide range. SG-1 water level decreased to a low of approximately 17 percent wide range due to the degradation of main feedwater flow prior to recovery initiated by the auxiliary feedwater injection from AFWPs A and B.

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 malfunction within the FWCS-1 (i.e., SG-1 economizer valve closed and the speed of both MFWPs decreased) was immediately recognized as the cause of the reactor trip. There were no procedural errors which contributed to this event.

I. Cause of Event:

The reactor trip on low SG-1 water level was initiated by an unexplained and unwarranted closing of the economizer valve on SG-1 caused by an intermittent component failure of the FWCS-1, most probably the master controller or associated circuitry (SALP Cause Code E: Component Failure). The cause of the component failure

and the failure mode, mechanism, and effect of the failed component is discussed in Sections I.D and I.E. No unusual characteristics of the work location (e.g., noise, heat, poor lighting) directly contributed to this event. There were no procedural errors or personnel errors which contributed to this event.

J. Safety System Response:

The following safety systems actuated automatically as a result of the event:

- Emergency Diesel Generators (EK), Trains A and B,
- Essential Spray Pond Systems (BS), Trains A and B,
- Essential Chilled Water System (KM), Trains A and B,
- Essential Cooling Water System (BI), Trains A and B, and
- Essential Auxiliary Feedwater System (BA), Trains A and B.

K. Failed Component Information:

The FWCS master proportional integral controller is manufactured by Foxboro. The model number is 2AC-R3+T4+AM.

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

A safety limit evaluation was performed as part of the APS Incident Investigation Program. The evaluation determined that the plant responded as designed, that no safety limits were exceeded, and that the event was bounded by current safety analyses. The event reported by this LER is bounded by the Palo Verde Updated Final Safety Analysis Report (FSAR) Chapter 15 accident scenarios concerning decreases in heat removal by the secondary system. In addition, the Updated FSAR Chapter 6 scenarios concerning loss of coolant accidents were not challenged by this event. The impact of the transients [i.e., concurrent decrease in primary system temperature and pressure and pressurizer (AB) level] posed no threat to fuel integrity as adequate subcooling margin and RCS inventory were maintained throughout the event. The maximum RCS pressure recorded during the event was 2240 psia, which did not exceed the 2750 psia safety limit.

There were no Departure from Nucleate Boiling Ratio (DNBR)-related fuel failures since the Specified Acceptable Fuel Design Limit (SAFDL) for DNBR was not exceeded during the event. Therefore, there were no safety consequences or implications as a result of this event. This event did not adversely affect the safe operation of the plant or health and safety of the public.

III. CORRECTIVE ACTION:

A. Immediate:

The FWCS cabinets, SG-1 economizer valve, and the MFWPs were quarantined. A troubleshooting plan was developed to determine the cause of the malfunction within the FWCS-1. An independent investigation of this event is being conducted in accordance with the APS Incident Investigation Program.

B. Action to Prevent Recurrence:

The FWCS-1 master controller was replaced. The FWCS-1 monitoring program using triggered recorders to help determine the cause of the malfunction should it recur remains in effect indefinitely.

As part of the investigation, an ERCFA of the FWCS-1 master controller is being performed by APS Engineering personnel. The preliminary evaluation has not identified any specific FWCS-1 master controller subcomponent failure(s) which caused the low output and has determined that the master controller or associated circuitry experienced an intermittent component failure. If information is developed which would significantly affect the readers' understanding or perception of this event, a supplement will be submitted.

IV. PREVIOUS SIMILAR EVENTS:

Reactor trips attributed to an FWCS malfunction have been previously reported in LERs 529/92-001 and 530/93-001. However, in the previous events, the cause of the specific FWCS component failure has been identified and appropriate corrective actions taken. Based on the information available at this time, the cause and specific scenario of the event reported by this LER does not appear to be related to the previous FWCS malfunctions.

V. ADDITIONAL INFORMATION:

Based on the contingency action plan and on reviews by the Plant Review Board, the Management Response Team, and the Incident Investigation Team, unit restart was authorized by the Operations Director in accordance with approved procedures. At approximately 1834 MST on August 20, 1994, Unit 3 entered Mode 2 (STARTUP), at approximately 0106 MST on August 21, 1994, Unit 3 entered Mode 1, and at approximately 0505 MST on August 21, 1994, Unit 3 was synchronized on the grid.