# 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 5 |

TITLE (4)

## Reactor Trip Following Spurious Opening of All Four Reactor Trip Switchgear Breakers

| 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 |
| 0 5 | 3 1 | 9 7 | 9 7 | - 0 0 2 | - 0 0 | 0 6 | 1 3 | 9 7 | N/A | 0 5 0 0 0 |
| | | | | | | | | | 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 |
| | | | 20.405(a)(1)(iii) | | 50.73(a)(2)(i) | | 50.73(a)(2)(viii)(A) | | below and in Text, NRC Form |
| | | | 20.405(a)(1)(iv) | | 50.73(a)(2)(ii) | | 50.73(a)(2)(viii)(B) | | 366A) |
| | | | 20.405(a)(1)(v) | | 50.73(a)(2)(iii) | | 50.73(a)(2)(x) | | |

LICENSEE CONTACT FOR THIS LER (12)

| NAME | TELEPHONE NUMBER |
|---|---|
| Daniel G. Marks, 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 |
|---|---|---|---|---|---|---|---|---|---|
| B | J C | C B D | E 1 4 6 | 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 May 31, 1997, at approximately 2312 MST, Palo Verde Unit 3 was in Mode 1 (POWER OPERATION), operating at approximately 100 percent power when a reactor trip occurred following the spurious opening of all four reactor trip switchgear (RTSG) breakers. The core protection calculator (CPC) generated a low departure from nucleate boiling ratio (DNBR) signal due to all control element assemblies (CEA) inserting. By approximately 2325 MST, the unit was stabilized in Mode 3 (HOT STANDBY) and the Shift Supervisor classified the event as an uncomplicated reactor trip. There were no engineered safety features (ESF) actuations and none were required. Required safety systems responded to the event as designed.

The preliminary cause of all four RTSG breakers spuriously opening, and the subsequent reactor trip was attributed to a combination of two incorrectly assembled ring-tongue terminals, in conjunction with a missing jumper on the spare trip parameter, all within the BD matrix logic of the plant protection system (PPS). Maintenance and engineering personnel were troubleshooting previous spurious RTSG breaker openings at the time of the reactor trip. The wiring error and termination deficiencies are believed to have occurred during original construction by Combustion Engineering/Electro-Mechanics. The lugs were replaced and the jumper was installed. The other 5 matrices in Unit 3 were visually verified to have their jumpers installed.

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



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1. REPORTING REQUIREMENT:

This LER 530/97-002-00 is being written to report an event that resulted in the automatic actuation of an Engineered Safety Feature (ESF) (JE), including the Reactor Protection System (RPS) (JC) as specified in 10 CFR 50.73(a)(2)(iv).

Specifically, on May 31, 1997, at approximately 2312 MST, Palo Verde Unit 3 was in Mode 1 (POWER OPERATION), operating at approximately 100 percent power when a reactor (AC) trip occurred following the spurious opening of all four reactor trip switchgear (RTSG) breakers. The core protection calculator (CPC) (JC) generated a low departure from nucleate boiling ratio (DNBR) signal due to all control element assemblies (CEA) (AA) inserting. Maintenance and engineering personnel (other utility personnel) were troubleshooting previous spurious RTSG breaker openings at the time of the reactor trip.

2. EVENT DESCRIPTION:

Prior to the event, on May 20, 1997 at approximately 0109 MST and on May 31, 1997 at approximately 1356 MST, reactor trip switchgear (RTSG) breakers A and C opened simultaneously for no apparent reason. At approximately 2015 MST on May 31, 1997, Control Room personnel (utility-licensed operator), instrumentation and control (I&C) personnel (other utility personnel), and engineering personnel (other utility personnel) held a prejob briefing prior to initiation of troubleshooting to determine the cause of the spurious opening of RTSG breakers A and C. At approximately 2214 MST and 2248 MST, the RTSG breakers spuriously opened during the troubleshooting activities.

As part of the troubleshooting plan, the I&C technicians touched two wires on the matrix relay terminal board and all four RTSG breakers opened, and at approximately 2312 MST, all CEAs inserted and the reactor tripped. Due to the CEA insertion, the CPC generated DNBR and local power density (LPD) trip signals. The reactor trip was followed by a Main Turbine/Main Generator (TA/TB) trip. The Steam Bypass Control System (SBCS) (JI) responded as designed to control the secondary system pressure.

By approximately 2325 MST, the unit was stabilized in Mode 3 (HOT STANDBY) and the Shift Supervisor (utility-licensed operator) classified the event as an uncomplicated reactor trip. Required safety systems responded to the event as designed. No ESF actuations occurred and none were required.

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

A safety limit evaluation was performed as part of the APS Incident Investigation. 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 reactor trip experienced by Unit 3 did not result in a transient more severe than those already analyzed in the Updated Final Safety Analysis Report (FSAR) Chapter 15 or Chapter 6. Although not specifically identified in the Updated FSAR, this event is classified as a moderate frequency anticipated operational occurrence (AOO). There is no indication that the DNBR SAFDLs were violated nor would any violation be expected based on the more limiting scenarios in the Updated FSAR.

The primary and secondary system pressure boundary limits were not approached. The event did not result in any challenges to the fission product barriers or result in any release of radioactive materials. Therefore, there were no adverse 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.

4. CAUSE OF THE EVENT:

An independent investigation of this event is being conducted in accordance with the APS Corrective Action Program. The investigation concluded that the reactor trip was attributed to the spurious opening of all four RTSG breakers (SALP Cause Code B: Design, Manufacturing, Installation Error). The cause of the component failure and the failure mode, mechanism, and effect of the failed component is discussed in Section 5.

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

5. STRUCTURES, SYSTEMS, OR COMPONENTS INFORMATION:

Prior to the event, on May 20, 1997 at approximately 0109 MST, RTSG breakers A and C opened simultaneously for no apparent reason. Troubleshooting efforts did not identify the source of the problem. Although a bad connection was suspected, the problem could not be duplicated nor could it be limited to one of the six logic matrices (AB, AC, AD, BC, BD, or CD). Again, on May 31, 1997 at approximately 1356 MST, RTSG breakers A and C opened simultaneously for no apparent reason.

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Following this recurrence, troubleshooting continued in accordance with an approved engineering action plan and the problem was isolated to the BD logic matrix. At approximately 2214 MST and 2248 MST, the RTSG breakers A and C spuriously opened again. Troubleshooting activities detected a decreased voltage on BTB-3001 terminal 10. Before additional voltage readings were taken, the voltage returned to normal. When two of three wires were touched to determine if they were the source of the decreased voltage, all four RTSG breakers opened and the reactor tripped. Troubleshooting was terminated and the equipment was quarantined.

An independent investigation of this event and a determination of the cause were initiated in accordance with the APS Corrective Action Program. Subsequent evaluation revealed that wiggling both back wires on BTB-3001 terminal 10 could repeatedly cause the 1-3 and/or 2-4 trip paths on the BD matrix to drop out. Further evaluation revealed that a jumper, necessary to prevent loss of voltage on the A and C breaker circuits from affecting the B and D breakers, was not installed (i.e., parallel power was not available to the relays). The jumper placement was indicated on plant drawings and the as-built wire lists from Combustion Engineering/Electro-Mechanics.

A preliminary evaluation has determined that the apparent cause of the 1-3 trip path dropping out was attributed to an incorrectly assembled ring-tongue terminal (i.e., a bad lug crimp on a wire) attached to the matrix relay terminal board (BTB-3001 terminal 10). In addition, the evaluation determined that the wrong size lug was installed on the matrix relay terminal board. The cause of all four RTSG breakers spuriously opening, and the subsequent reactor trip was attributed to a combination of two incorrectly assembled ring-tongue terminals (i.e., the bad lug crimps and lug size on both wires on BTB-3001 terminal 10 for 1-3 and 2-4 trip paths), in conjunction with the missing jumper on the spare trip parameter, all within the BD logic matrix of the plant protection system (PPS). The wiring error and termination deficiencies were determined to have occurred during original construction by Combustion Engineering/Electro-Mechanics (SALP Cause Code B: Design, Manufacturing, Installation Error). Circuit continuity for the past 10 years of operation was provided with one or more of the seven wire strands touching the tongue area of the ring lug. If the evaluation results differ significantly from this determination, a supplement to this report will be submitted to describe the final root cause determination. The lugs were replaced and the jumper was installed. The other 5 matrices in Unit 3 were visually verified to have the jumper installed.

The matrix relay terminal board (component number BTB-3001) was installed by Combustion Engineering/Electro-Mechanics, Inc. The terminal board

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manufacturer is Kulka and the model number is 603JJ-3. No failures of components with multiple functions were involved.

6. CORRECTIVE ACTIONS TO PREVENT RECURRENCE:

An independent investigation of this event is being conducted in accordance with the APS Corrective Action Program. Actions to prevent recurrence are being developed based upon the results of the investigation and are being tracked to completion under the PVNGS Commitment Action Tracking System. These actions may include addressing configuration, transportability, and generic issues concerning the missing jumper and improper crimping of the wires. If information is developed that would significantly change the readers' understanding or perception of the significance of the event, a supplement will be submitted.

7. PREVIOUS SIMILAR EVENTS:

No other previous events have been reported pursuant to 10 CFR 50.73 where a reactor trip has been attributed to problems with the matrix relay terminal boards in the last three years.

8. 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 0002 MST on June 2, 1997, Unit 3 entered Mode 2 (STARTUP), at approximately 0254 MST on June 2, 1997, Unit 3 entered Mode 1, and at approximately 0533 MST on June 2, Unit 3 was synchronized on the grid.