LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Palo Verde Unit 1	0 5 0 0 0 5 2 8	1 OF 0 9

TITLE (4)
Inappropriate Grounding Of Equipment Results In A Condition Outside the Design Basis of the Plant

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
									Palo Verde Unit 2	0 5 0 0 0 5 2 9
0 4	0 4	9 6	9 6	- 0 0 1	- 0 1	0 6	1 1	9 6	Palo Verde Unit 3	0 5 0 0 0 5 3 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)	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)	X 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
B	F G	X F M R	S 2 5 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 April 6, 1996, at approximately 1725 MST, it was determined that the fire in Unit 2 on April 4, 1996, was associated with a condition outside the design basis of the plant. The condition exists in all three units where a fault in either regulating transformer in the Train A or B Direct Current Equipment Room could cause a fire in the equipment room and the control room.

The apparent cause of the fire was a short/failure of the hot lead to ground at the 100 foot Control Building transformer winding between terminals one and two of transformer 2E-QBB-V02. The existing design for this power circuit does not utilize a ground at this point or any point within the transformer; therefore, the fault propagated through the building grounding system.

Fire watches were established and a night order for heightened awareness of the situation was issued. An investigation for inappropriate grounding of low voltage power distribution systems was initiated and to date has identified twelve components (per unit) requiring modifications. The equipment root cause of failure is complete.

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

TEXT

1. REPORTING REQUIREMENT:

This LER 528/96-001-01 is being written to report an event that resulted in the nuclear power plant being in a condition that was outside the design basis of the plant, as specified in 10 CFR 50.73(a)(2)(ii)(B).

PVNGS is committed to IEEE Standard 142, Section 1.6.1, "Grounding of Industrial and Commercial Power Systems," which requires that the system ground points be at the power source. Contrary to the above requirement the Essential Lighting Isolation Transformers (ELIT, E-QBA-V01 and E-QBB-V02)(100 foot level, Control Building)(NA) were not grounded in accordance with this requirement. Additionally, it was determined that the conductor between the ELIT and the Essential Lighting Distribution Panels (ELDP, E-QBN-D81 and E-QBN-D84) may not have been sized large enough to handle a fault current and circuit protection may need to be provided. It was also determined that the Control Room Emergency Lighting Inverter Batteries (E-QDN-F01 and E-QDN-F02) do not have industry accepted forms of circuit protection from the battery to the inverter DC inputs and the 120 VAC instrument power supply voltage regulators (E-NNN-V16 and E-NNN-V18) secondary cable is not sized properly to handle the potential fault current.

An investigation determined that an inadequate electrical design by the architect-engineer (Bechtel) was not in accordance with electrical design requirements. Although, specific to PVNGS design, the electical design deficiencies did not adversely affect the ability of the plant to achieve and maintain safe shutdown, APS believes that the information provided in this LER might be of generic concern to the nuclear industry in that this deficiency may affect some safety systems, depending on plant-specific design.

On April 6, 1996, PVNGS Unit 1 was in Mode 1 (POWER OPERATION) at approximately 100 percent power, Unit 2 was in Mode 6 (REFUELING) with the Reactor Coolant System (RCS, AB) at approximately 87 degrees Fahrenheit (F) and at atmospheric pressure and Unit 3 was in Mode 1 (POWER OPERATIONS) at approximately 100 percent power when the design basis condition was identified.

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2. EVENT DESCRIPTION:

On April 6, 1996, at approximately 1725 MST, the incident investigation team (other utility personnel) concluded that the Unit 2 fire on April 4, 1996, was associated with a condition outside the design basis of the plant and a one hour 10 CFR 50.72 notification was made. The investigation conducted subsequent to the fire identified that the circuits associated with the fire were improperly grounded and inadequately protected when initially designed. The inadequate electrical design was not in accordance with electrical design requirements.

Prior to the discovery, on April 4, 1996, at approximately 1700 hours MST, Unit 2 was in Mode 6 for its sixth refueling outage, and reactor core offload was in process when smoke was discovered in the back boards area of the control room by a security officer (other utility personnel) who was performing an hourly fire watch tour. Smoke was emanating from the Emergency Lighting Uninterruptible Power Supply (ELUPS, 2E-QDN-N02) and the Essential Lighting Distribution Panel (ELDP, 2E-QBN-D84) which are located near and on the north wall of the control room. The security officer immediately notified the Operations Shift Supervisor (Utility, Licensed) and the Security Central Alarm Station, requesting emergency response from the fire department and support from security. Subsequently, an Auxiliary Operator (AO, utility nonlicensed operator), who had been dispatched by control room personnel to survey his duty area, discovered smoke and fire in the Train B DC Equipment Room on the 100 foot level of the Control Building. The fire in the DC Equipment Room (Channel B) was contained within the Essential Lighting Isolation Transformer (ELIT, 2E-QBB-V02).

At approximately 1714 MST, the control room staff evaluated the condition, noted the potential degradation to safety related equipment, and classified the event as an ALERT. At approximately 1725 MST, the control room was informed that the fires at both the 100 and 140 foot levels of the Control Building were extinguished. At approximately 1805 MST, the ALERT classification was terminated.

On April 5, 1996, qualified personnel with electrical and equipment expertise performed a walkdown of the fire damage and adjacent equipment. The conduits attached to the damaged equipment were traced and the next in succession junction box/equipment inspected to ensure that smoke migration did not deposit products of combustion or cause damage. Other equipment

in the vicinity was also inspected for any signs of smoke or damage. Damage was determined to be confined to the ELUPS (2E-QDN-N02), ELDP (2E-QBN-D84), junction box (2EZ3ANKKJ15), ELIT (2E-QBB-V02) and adjoining cables. No other damage was identified. No smoke related residue was identified which eliminates any long term issues associated with equipment degradation.

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

The April 4, 1996 event did not require control room evacuation. The fire on the 140 foot level of the control building was extinguished in approximately nine minutes, and the fire on the 100 foot level of the control building was extinguished in approximately twenty-five minutes. Damage was restricted to the ELUPS (2E-QDN-N02), ELDP (2E-QBN-D84), junction box (2EZ3ANKKJ15), ELIT (2E-QBB-V02) and adjoining cables. No other damage was identified and no safe shutdown equipment was affected by the fire.

The short circuit currents causing the fires in the control room ELUPS and DC equipment room ELIT were terminated by different means. For the control room fire, the short circuit current flowing through and igniting the conductors in the ELUPS was terminated automatically by the opening of the AC circuit breaker in the ELDP, which caused the transfer relay in the ELUPS to drop out, interrupting the short circuit current. On this basis, the fire was self-limiting, demonstrating with reasonable assurance that the fire would not have progressed into an exposure fire.

The fire in the DC equipment room ELIT required manual operator action to open the 480V transformer primary circuit breaker to terminate the short circuit current flowing in the transformer secondary. The need to manually open the breaker would be expected under these circumstances due to the intentional isolation characteristics of this transformer. The fire was contained within the transformer enclosure and involved only the internal transformer insulation on the windings. This is a dry-type transformer. The amount of combustibles is limited and the enclosure is constructed of heavy gauge metal. Heat is dissipated through a ventilation opening on the top of the enclosure which is covered by a solid heavy gauge metal plate which provides a protective shield. Adjacent equipment is also enclosed in heavy gauge metal cabinets which minimizes ignition from external sources. There are no exposed cables in raceways in the room that are in close proximity. There is a PVC jacketed

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flexible conduit adjacent to and above the transformer, but it is not in close proximity to other exposed combustibles. Transient combustibles are limited and controlled by procedure. It is reasonable to assume that the fire would not have progressed into a fire outside the enclosure.

The actual combustible fire loading for the DC equipment room is classified as low. A low fire loading is defined as fire areas where quantity and/or combustibility of content is low with relatively low rates of heat release expected (BTU rating less than 60,000 BTU per square foot).

Additionally, the DC equipment rooms are provided with the following fire detection/protection features:

- Ionization smoke detectors
- Three-hour fire rated barrier walls and three-hour fire rated doors
- Primary fire protection is fire hose stations
- Backup fire protection is portable fire extinguishers
- Fire prevention administrative controls

These fire protection features limited fire damage such that both trains of systems necessary to achieve and maintain safe shutdown were free of fire damage. Additionally, the affected equipment within these rooms is contained within metal cabinets and conduit. Therefore, fire propagation is not expected, and the buildup of combustible gases from the fire would be minimal. Smoke conditions could be compensated for by personnel who are trained and capable of performing their duties by donning self-contained breathing apparatus. Actual smoke conditions in the Channel C DC Equipment Room were light and did not adversely affect visibility to perform operator actions had they been required.

The event did not result in any challenges to the fission product barriers or result in any releases 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 the health and safety of the public.

The electrical design deficiencies identified during the post-event investigation have been evaluated and have been determined to not adversely affect the ability of the plant to achieve and maintain safe

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shutdown. An evaluation has been performed to determine pre-1992 raceway configuration to evaluate the safety significance of the Emergency Lighting Batteries (E-QDN-F01 and E-QDN-F02) circuits prior to shunts being installed which act as a protective device (see Section 6) on safe shutdown common enclosures. It has been determined that there was no potential to adversely affect the ability to achieve and maintain safe shutdown prior to 1992. An evaluation is currently in progress to validate circuit protection for non-safe shutdown common enclosures for conductors routed in the same raceway as the battery circuits.

Testing has been completed to determine the ability of the cable connected between the ELIT and the ELDP (4/0 cable) to carry the maximum current-limited short circuit output current. Preliminary test results indicate that this cable is able to carry this short circuit current without approaching the cables' rated short circuit temperature rating of 250°C. This test demonstrates that for a control room fire that could cause the shorting of this cable that the resultant short circuit would not cause a fire outside the control room.

4. CAUSE OF THE EVENT:

On April 6, 1996, at approximately 1725 MST, the incident investigation team (other utility personnel) concluded that the Unit 2 fire on April 4, 1996, was associated with a condition outside the design basis of the plant and a one hour 10 CFR 50.72 notification was made. The investigation conducted subsequent to the fire revealed that the design engineering performed during the design phase of the plant resulted in an improperly grounded circuit and inadequate circuit protection for the circuits involved with the fire.

The root cause of failure for the ELIT has been determined to be a loss of mechanical bonding of the varnish insulation material within the third harmonic choke, thereby allowing normal transformer vibration to result in delamination of the transformer core (SALP Cause Code B: Design). This delamination failure resulted in a short of the loose core plate to the transformer winding and an intermittent open winding in the third harmonic choke, resulting in an electrical overload and fire in the fifth harmonic choke.

The root cause for the secondary fire (Control Room 140 foot) was an incorrect grounding scheme used in the transformer secondary circuits. A

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related finding resulting from the post-fire broadness review was the apparent engineering reliance on the isolation transformer primary circuit breakers for protection of the secondary circuits in the transformer (SALP Cause Code B: Design).

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

If evaluation results differ from this determination or if information is developed which would affect the reader's understanding or perception of this event, a supplement to this report will be submitted.

5. STRUCTURE, SYSTEM, OR COMPONENT INFORMATION:

ELIT is manufactured by Solidstate Controls Inc., model number TL74025014XMXXX; the transformer steps down 480 VAC to 120 VAC and has a volt-ampere rating of 25 KVA. The transformer provides electrical isolation between safety related power sources and non-safety related lighting and fire protection systems.

The Emergency Lighting System is designed to provide sufficient illumination to allow safe personnel access/egress throughout the plant in the event of a loss of lighting or for the local manual operation of safe shutdown equipment in the event of a fire.

In the normal configuration, the Essential Lighting System provides power to the ELUPS, to it's battery charger for maintaining the battery at fully charged state, and to the power supply transferring circuit. In the emergency configuration the Emergency Lighting System back-up DC power provides power to the assigned emergency lighting.

ELDP are the normal AC supply for fire panels throughout the power block. As a result of the fire the ELDP was deenergized resulting in thirty-seven fire protection related panels and six water fire suppression system pressure switches losing power. Fire protection panels associated with safety related areas swapped to their battery back-up power supply. Since, the AC power outage was going to be greater than the four hours credited for battery operation, fire watches were established as required.

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No structures, systems, or components were inoperable at the start of the event which contributed to this event. No failures of components with multiple functions were involved. No failures that rendered a train of safety system inoperable were involved. There were no safety system actuations and none were required.

6. CORRECTIVE ACTIONS TO PREVENT RECURRENCE:

Investigation into the equipment root cause of failure has been completed. As part of the investigation, a broadness review for appropriate grounding in 120V circuits has been conducted. To date, twelve components (limited to regulating transformers, battery supplies and inverters) per unit have been identified that require modifications for electrical circuit protection and/or grounding. Compensatory measures are in place, as appropriate. A "vertical slice" review of 125 VDC and 480 VAC and above power distribution systems is expected to be completed by the end of June 1996.

On April 4, 1996, fire watches were established as required for affected areas, and affected equipment was quarantined.

On April 5, 1996, the inspection of fire damage was completed, and a temporary modification was developed to restore power to ELDP (2E-QBN-D84).

On April 6, 1996, the installation of temporary power to ELDP was completed, and the affected fire panels were verified to be operable. Compensatory measures were established as required in all three units.

Repairs to fire damaged equipment in Unit 2 have been completed. Modifications, in all three units, to ensure circuitry protection and proper grounding have been completed on the two ELUP and ELIT in each unit. Two instrument power supply regulating transformers in each of Unit 1 and 2 have been modified to provide proper circuit protection and will be modified during the next refueling outage in Unit 3.

On May 2, 1996, testing was completed on the shunts currently installed in the 125 VDC power circuit from the Emergency Lighting Batteries (E-QDN-F01 and F02) to the control room ELUPS. These tests proved conclusively that the shunts will interrupt relatively high levels of fault current; therefore, these devices are an adequate interim means of isolating faults

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in these cables that could potentially initiate fires outside of the battery rooms. Since these shunts have only been installed since 1992, an evaluation is being performed to determined what the safety significance of the design inadequacy was prior to 1992. Since the raceway configuration has been changed since 1992, the safety significance is not readily apparent.

Design modifications have been issued to permanently install fuses near the batteries that will provide proper protection for these cables. Installation of the battery circuit modification is currently scheduled for completion in all three units by July 1996.

The above actions have been developed to prevent recurrence and will be tracked by APS' Commitment Action Tracking System (CATS). If the evaluation results differ from this determination or if information is developed which would affect the reader's understanding or perception of this event, a supplement to this report will be submitted.

7. PREVIOUS SIMILAR EVENTS:

There have been no previous events reported within the last three years pursuant to 10CFR50.73 for being outside of the design basis with causes similar to this event. Therefore, the corrective actions of the previous events associated with being outside the design basis would not have prevented this event.