LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
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TITLE (4)
Equipment Qualification Of Electrical Connectors May Not Be Adequately Demonstrated

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 7	2 9	9 8	9 8	- 0 0 8	- 0 0	1 0	2 4	9 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)	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)	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)	
		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)	VOLUNTARY

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
Daniel G. Marks, Section Leader, 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
D	J C	C O N N	L 2 3 2	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 July 29, 1998, at approximately 1600 MST, Palo Verde Units 1, 2, and 3 were in Mode 1 (POWER OPERATION), operating at approximately 100 percent power when Engineering personnel determined that a condition related to equipment qualification that did not meet the criteria contained in 10 CFR 50.73(a) might be of generic interest to other licensees. This Voluntary LER identifies that CE Qualification reports used to qualify Litton-Veam (LV) electrical connectors (CIR series models) for In-Core Instrumentation (ICI) used in Combustion Engineering (CE) plants may not adequately demonstrate appropriate equipment qualification. Qualification testing of LV connectors by CE did not represent the installed configuration at Palo Verde. Qualification reports from LV do support equipment qualification for the installed configuration provided that replacement of the silicone seal in the connector is performed each time the connector is cycled.

No previous similar events have been reported pursuant to 10 CFR 50.73 in the last three years.

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1. REPORTING REQUIREMENT:

This voluntary LER 528/98-008-00 is being submitted to report a condition related to equipment qualification that does not meet the criteria contained in 10 CFR 50.73(a) for submitting a LER, but might prove useful and be of generic interest to the nuclear industry. In addition to this report, APS submitted an operating experience report (OE9201) to INPO for posting on Nuclear Network.

Specifically, on July 29, 1998, at approximately 1600 MST, Palo Verde Units 1, 2, and 3 were in Mode 1 (POWER OPERATION), operating at approximately 100 percent power when Engineering personnel determined that a condition related to equipment qualification that did not meet the criteria contained in 10 CFR 50.73(a) might be of generic interest to other licensees. Specifically, engineering personnel determined that Combustion Engineering (CE) Qualification reports used to qualify Litton-Veam (LV) electrical connectors (CIR series models)(CON) for In-Core Instrumentation (ICI)(IG)(JC) used in CE plants, may not adequately demonstrate appropriate environmental qualification. Qualification testing of LV connectors by CE did not represent the installed configuration at Palo Verde. Qualification reports from LV do support equipment qualification for the installed configuration provided that replacement of the silicone seal in the connectors is performed each time the connector is cycled.

2. EVENT DESCRIPTION:

The CE qualification tests (CE NPSD-230-P and CE NPSD-240-P) for CE's Fixed ICI design containing the neutron detectors (DET)(IG) and core exit thermocouples (CETs)(JC) resulted in moisture entering the LV connector during the design basis event test. The CE tests were conducted with only a CET (2-wire thermocouple) circuit connected to a single LV connector. PVNGS uses circuits configured with both one LV connector and two LV connectors. PVNGS also uses more than one circuit connected to a LV connector. Typically, the circuits connected to an ICI LV connector consist of a CET (2-wire thermocouple), five rhodium detectors (1 wire each), a background wire, a ground reference wire, and a second LV connector approximately 30 feet from the ICI LV connector. Combustion Engineering Standard Safety Analysis Report (CESSAR) Section 7.7.1.1.8 and Appendix B Section II.F.2, Item 2.1.3 also state that an ICI assembly contains a CET and five Rhodium detectors. The two LV connectors connected in series to an ICI will have contact to plant ground (outside the connector) when wetted. CE has not analyzed or tested to determine the effect these other circuits and two connectors may have on the CET

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signal current (and accuracy range) with moisture present outside the connectors and/or inside the connectors due to a failed moisture seal during post-accident conditions. The various potential current leakage paths may result in insufficient or excessive CET signal current outputs (i.e., beyond the accuracy range) and could result in misleading control room indications of the post-accident core exit temperatures.

Moisture in-leakage and seal degradation of LV connectors was previously identified in NRC Information Notice (IN) 89-23, "Environmental Qualification of Litton Veam CIR Series Electrical Connectors." Leakage concerns were also identified in NRC IN 98-21, "Potential Deficiency of Electrical Cable/Connection Systems." However, neither the CE qualification tests, nor the NRC IN's indicate that other electrical circuits and additional connectors may be configured as in the CE ICI connector design at PVNGS. The CE ICI design configuration with the LV connectors could present other current leakage pathways and other sources (e.g., plant grounds, rhodium detectors, etc.) which may effect the CET signal current.

The basis for NRC IN 89-23 was NRC Inspection Report 99900401/88-01, dated 1/26/89. This NRC inspection of CE facilities focused on moisture effects on the environmental qualification of LV connectors used for CETs and Reactor Vessel Level Monitoring Systems (RVLMS) supplied by CE. The inspection report concluded that the CE documentation " . . .does not establish LOCA qualification of unclamped Litton-Veam connectors for any application other than very low voltage CET circuits. Further, the connector behavior during the LOCA tests indicates unsuitability for any other use requiring LOCA qualification." The inspection report's conclusion was based on CE qualification report (NPSD-230-P, dated 4/83) and on additional information provided by CE. The conclusions from the inspection did not address:

- The effect on CETs with moisture (boron spray) ingress (failed moisture seal) in the LV connector from the ICI circuits (including plant ground and rhodium detectors) and multiple connectors actually used in the CE fixed ICI design installed in CE plants, or

- The effects on the signal (i.e., defined the uncertainties and accuracy range) at higher core exit temperatures due to multiple ground current paths created by the moisture ingress when two connectors are used in series as in typical installations.

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- Concerns regarding separation of class 1E and non-1E circuits with moisture in the connector.

Based on the CE investigation and a "battery effects" test (CE NPSD-230-P Supplement 1), CE concluded that there were increased temperature uncertainties associated with the CETs and concerns regarding the heater circuit on the RVLMS. CE provided retrofit kits consisting of a clamping mechanism for the LV connectors in the RVLMS applications to preclude moisture ingress into the LV connectors. In addition, CE performed the "battery effects" test in an attempt to quantify the signal uncertainty for "wetted" LV connectors in CET applications. CE notified PVNGS (V-CE-34676, dated 5/21/87) and other commercial nuclear utilities, that the Qualified Safety Parameter Display System (QSPDS) CET processing algorithm can accommodate the increased CET temperature uncertainty. CE concluded that the CET processing algorithm would reject the CET signals affected by the "battery effect," therefore, a failed/degraded silicone seal and consequential moisture ingress into the LV connectors, post-DBE, is acceptable. However, the CE testing for the postulated core exit temperatures, in Palo Verde's opinion, did not prove this conclusion. Since the CE testing showed moisture leakage into every connector (i.e., common mode failure), it was not clear how the algorithm could provide correct output values. Thus errors of varying magnitude could be introduced into the CET input signals to QSPDS. Palo Verde believes that this qualification testing is not representative of the actual ICI design since the testing did not replicate and/or address the following:

1) CET signal with the other ICI circuits present in the "wetted" LV connector.
2) The effects on the CET signal due to electrical coupling with plant ground via the boron spray solution through two (2) LV connectors (in series with 30 feet to 40 feet interval between connectors), compounded by the separate, various "battery effects."
3) The CET signal at higher post-accident core exit temperatures under the conditions identified in #1 & #2. CET signal testing occurred at only the single temperature of 400 degrees Fahrenheit (Regulatory Guide 1.97, Table 2, Type B and C Variables required CET range is 200 degrees Fahrenheit to 2300 degrees Fahrenheit). With moisture in-leakage, CET signal errors will vary depending on the core exit temperatures post-accident.
4) Accuracy of temperature output values provided by the CET QSPDS processing algorithm with moisture intrusion present in all connectors creating multiple common mode failures in the CET circuits with varying magnitudes of error.

5) Concerns regarding separation of class 1E and non-1E circuits with moisture in the connector.

As such, Palo Verde believes that the installed ICI configuration is not supported by the conclusions from the CE qualification report, the NRC inspection report, and/or NRC IN. Therefore, the frequency of replacing the silicone seals in order to maintain appropriate environmental qualification of LV electrical connectors cannot be based on these documents.

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

The silicone seal (square o-ring) is the critical component to preclude moisture ingress at the mated connector interface. A LV sponsored qualification test (Report #558-1657A) successfully tested LV CIR Series connectors without evidence of moisture in-leakage. The LV test conditions and results appropriately envelope the environmental qualification of the PVNGS installed connectors when the silicone seal is replaced each time the LV connector is cycled (e.g., connected/disconnected).

4. STRUCTURES, SYSTEMS, OR COMPONENTS INFORMATION:

Litton-Veam (LV) electrical connectors (CIR series models).

5. CAUSE OF THE EVENTS:

The CE qualification tests (CE NPSD-230-P and CE NPSD-240-P) for the ICIs resulted in moisture in-leakage during the design basis event. The test was conducted with only a single LV connector, a CET (2-wire thermocouple circuit), and without fully ranged inputs (i.e., signal uncertainties change as the CET mV output increases/decreases). There are also other circuits configured in the LV connector at PVNGS, which were not simulated in the CE qualification testing.

6. CORRECTIVE ACTIONS TO PREVENT RECURRENCE:

In February 1997 the Palo Verde equipment qualification requirements were revised to require replacement of the silicone seal each time the LV

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connector is connected/disconnected. The silicone seals have been replaced in all three units and the maintenance procedure requires that the seals be replaced prior to reassembly of the connector. This ensures that the internals of the LV connector will remain dry, resolving the concerns identified in this LER.

7. PREVIOUS SIMILAR EVENTS:

No other previous events have been reported pursuant to 10 CFR 50.73 in the last three years.