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PG&E Letter DCL-00-026

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Licensee Event Report 1-1999-007-01
Plant Outside Design Basis Due to Degraded Indicating Lamp Sockets

Dear Commissioners and Staff:

In accordance with 10 CFR 50.73 (a)(2)(ii)(B), PG&E is submitting the enclosed revised licensee event report regarding the plant being outside design basis due to degraded indicating lamp sockets. PG&E committed in letter DCL-99-160, dated December 15, 1999, to provide results of a probabilistic risk assessment regarding the safety significance of the degraded lamp sockets. The supplement also makes other minor corrections. The changes are identified by revision bars.

This event was not considered risk significant and did not adversely affect the health and safety of the public.

Sincerely,

Lawrence F. Womack

cc: Steven D. Bloom
Ellis W. Merschoff
David L. Proulx
Diablo Distribution
INPO

Enclosure

TLH/2246/N0002102

IE22

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Diablo Canyon Unit 1	0 5 0 0 0 2 7 5	1 OF 14

TITLE (4)

Plant Outside Design Basis Due to degraded Indicating Lamp Sockets

EVENT DATE (5)				LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
11	15	1999	1999	- 0 0 7 -	0 1	02	18	2000	Diablo Canyon Unit 2	0 5 0 0 0 3 2 3

OPERATING MODE (9)	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR: (11)		
1	X	10 CFR	50.73(a)(2)(ii)(B)
POWER LEVEL (10)		OTHER	
1 0 0			(SPECIFY IN ABSTRACT BELOW AND IN TEXT, NRC FORM 366A)

LICENSEE CONTACT FOR THIS LER (12)

	TELEPHONE NUMBER
	AREA CODE
Roger L. Russell - Senior Regulatory Services Engineer	805 545-4327

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
A	J	L I L	W 1 2 0	NO					

SUPPLEMENTAL REPORT EXPECTED (14)	EXPECTED	MON	DAY	YR

[ ] YES (If yes, complete EXPECTED SUBMISSION DATE) [X] NO SUBMISSION DATE (15)

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines.) (16)

On November 15, 1999, with Units 1 and 2 in Mode 1 (Power Operation), at 100 percent power, PG&E identified a condition outside the design basis of the plant. Multiple degraded indicating lamp sockets in the control room control boards were discovered which could have caused redundant safety-related equipment to become inoperable due to a postulated seismic event. The lamp sockets provide indication for various safety and nonsafety-related equipment. During a seismic event, the degraded sockets could separate and create a short circuit. This could adversely affect the operation of the associated equipment due to the control power circuit fuse opening because of electrical shorting. On November 15, 1999, at 1120 PST, PG&E made a 1-hour non-emergency notification to the NRC in accordance with 10 CFR 50.72(b)(1)(ii)(B).

The cause of the condition is lamp socket design. An easily achievable torque in the socket assembly retaining nut generates a stress in the plastic socket material exceeding its yield value. Time dependent deformation occurs, eventually leading to cracking and failure.

Lamp sockets in Units 1 and 2 have been inspected and either replaced or evaluated to use-as-is. PG&E is evaluating the present lamp socket design and alternatives for long term corrective actions. Applicable vendors have been notified.

TEXT

I. Plant Conditions

Units 1 and 2 were in Mode 1 (Power Operation) at 100 percent power.

II. Description of Problem

A. Summary

On November 15, 1999, PG&E identified a condition outside the design basis of the plant. Multiple degraded indicating lamp sockets (IL) in the control room control boards (BD) were discovered which could have caused redundant safety-related equipment to become inoperable due to a postulated seismic event. The lamp sockets provide status indication for various safety and nonsafety-related equipment. During a seismic event, the degraded sockets could separate and create a short circuit. This could adversely affect the operation of the associated equipment due to the control power circuit fuse (FU) opening because of electrical shorting.

B. Background

Minalite, Type EZC, lamp sockets are the predominant indication lamp type installed in the Units 1 and 2 control room control boards. The lamps provide status indication for various safety and nonsafety-related equipment.

The socket assemblies were originally supplied by Westinghouse as a subcomponent of the control boards. Refer to Figures 1 and 2 for illustrations of the lamp socket placement within a switch module and identification of major components, respectively.

PG&E found two specific degraded conditions in the sockets. Some sockets were broken (separated). Others were cracked to various extents but the socket remained integral. PG&E has replaced broken sockets and cracked sockets that broke during a 3-lb force check. PG&E has also replaced many of the cracked sockets.

The 3-lb criterion was established by Engineering to be the force which is approximately 200 percent of that needed to install a light bulb.

In addition, PG&E determined, through progressive testing, that a socket with a crack 90 percent or less of its circumference could withstand a 7-lb

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force without breaking and remain operable. In its operability evaluation and safety analyses, PG&E determined that any lamp socket which passes the force test will remain functional during a postulated seismic event. Therefore, only broken sockets are considered inoperable and are evaluated in Section IV of this report.

C. Event Description

On August 25, 1999, PG&E identified an increasing trend in control room lamp socket failures. Between 1985 and September 1999, approximately 109 degraded sockets were identified and replaced in both units. However, 39 of the 109 broken sockets were identified since January 1998.

On September 1 and 2, 1999, while collecting data for evaluation of the adverse trend, lamp sockets in Unit 1 and 2 for Valves MU-1-FCV-724 and MU-2-FCV-724 were found broken. The lamp socket was broken for Valve MU-2-FCV-724; however, the lamp had been lit prior to the inspection.

On September 3, 1999, based on sample inspections performed during the two previous days which identified two undetected failures, PG&E started an inspection of all indicating lamp sockets in Units 1 and 2 control room boards.

Between September 3 and September 7, 1999, PG&E inspected approximately 525 sockets in Unit 1 and 2 control boards and found a failure rate between 3 and 4 percent.

On September 7, 1999, PG&E initiated a nonconformance report to perform failure analysis, root cause evaluation, and provide corrective action to prevent recurrence. PG&E procured the services of a vendor experienced in failure analysis to determine the cause of the failures.

On September 13, 1999, during a teleconference, PG&E briefed the NRC on the status of the inspections and the overall plan for socket inspection. See Section V.A.3. for plan details.

On September 17, 1999, during a teleconference with the NRC, PG&E committed to submit a voluntary licensee event report on the broken sockets. In addition, PG&E submitted a detailed Operating Experience

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Report to INPO.

On October 12, 1999, PG&E received a preliminary failure analysis from its vendor. See Section III for details.

On November 15, 1999, PG&E completed a preliminary safety analysis for the broken sockets in Units 1 and 2. The analysis indicated that several of the broken sockets were within control circuits for redundant safety-related components in Units 1 and 2, which are necessary to achieve and maintain safe shutdown and are part of the emergency core cooling system.

On November 15, 1999, at 1120 PST, PG&E made a 1-hour non-emergency notification to the NRC in accordance with 10 CFR 50.72(b)(1)(ii)(B).

D. Inoperable Structures, Components, or Systems that Contributed to the Event

None.

E. Dates and Approximate Times for Major Occurrences

1.	August 25, 1999:	PG&E identified an adverse trend in the number of degraded lamp sockets.
2.	September 2, 1999:	PG&E identified two broken lamp sockets that were broken prior to the inspection.

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3. November 15, 1999 at 1120 PST: PG&E completed a preliminary safety analysis indicating a condition outside the design basis in Units 1 and 2 and made a 1-hour non-emergency notification to NRC in accordance with 10 CFR 50.72(b)(1)(ii)(B).

F. Other Systems or Secondary Functions Affected

None.

G. Method of Discovery

The condition was discovered by a system engineer via informal trending.

H. Operator Actions

None.

I. Safety System Responses

None.

III. Cause of the Problem

A. Immediate Cause

The condition was caused by breakage of the lamp sockets.

B. Root Cause

The root cause was determined to be lamp socket design. An easily achievable torque in the socket assembly retaining nut generates a stress in the plastic socket material exceeding its yield value. Plasticity occurs along with creep (time dependent deformation) at the socket operating temperature.

The creep eventually leads to cracking at the top edge of the socket's

thinnest section. The crack continues to grow as long as some stress remains. The failure mechanism proceeds until either the stress is relieved by the crack opening further, or the socket breaks.

C. Contributory Cause

1. A contributory cause of the lamp socket increasing failure rate was the heat generated by the lamp and the socket current limiting resistor body, which increased the rate of creep.

2. Another contributory cause of the lamp socket increasing failure rate was the sudden impact force applied at the final insertion depth of the light bulb during its replacement.

IV. Analysis of the Event

The Diablo Canyon Power Plant (DCPP) design basis states that safety-related structures, systems, and components must be able to perform their required active safety function, during, as well as following, a design basis earthquake (DE). Therefore, a conservatively deterministic evaluation has been performed to verify DCPP maintained the capability for successfully mitigating all of the DCPP Final Safety Analysis Report (FSAR) Condition II events since these could be reasonably expected to occur following a DE. Condition III and IV events are not considered credible due to the low probability of occurrence of these events in combination with a DE. In addition, past specific maintenance activities which may have rendered redundant equipment inoperable were not identified and evaluated. However, the DCPP probabilistic risk assessment (PRA) model has been used to assess the overall significance of the lamp socket failures.

Deterministic Evaluation

An evaluation has also been performed to verify that DCPP maintained the capability for placing the plant in a safe shutdown condition following such a DE. These evaluations were performed assuming the worst case failure of broken lamp sockets following a DE. As stated in Section II.B., only broken sockets had the potential for creating a short circuit condition during a DE. The broken lamp sockets listed in Section V.A.3. affected approximately 23 components on Unit 1 and 32 components on Unit 2. Since each unit had a vital 480 VAC bus lamp socket broken, this bus was assumed to deenergize which added approximately 27 and 21 components to the Unit 1 and Unit 2 evaluations, respectively.

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Evaluation of Condition II Event Mitigation

The Safety Analysis Report analyzes 14 limiting Condition II events which are bounding for any DE event based on selecting the offsite power availability assumption which generates the most limiting results. The Condition II analysis acceptance criteria are met by demonstrating that the minimum departure from nucleate boiling ratio remains above the applicable limit such that no fuel failure occurs and the reactor coolant system (RCS) is not overpressurized. The evaluation assessed the potential impact on all of the plant functions required to successfully mitigate Condition II events with a summary of the most critical functions listed below:

1. The appropriate reactor trip signal must be generated within the designated time frame.

2. Any RCS flow coastdown meets the design basis magnitude and duration.

3. Sufficient control rod negative reactivity must be inserted into the core to ensure the minimum shutdown margin is met.

4. There is adequate secondary heat removal capacity available from the auxiliary feedwater (AFW) system and main steam safety valves.

5. Feedwater isolation occurs as necessary to protect against excessive secondary cooldown.

6. The pressurizer safety valves are available for RCS over pressure protection.

7. Onsite emergency power is maintained to all components required for these functions.

The Condition II safety assessment assumed that all broken lamp sockets short during a DE such that a worst case failure or loss of control function (both automatic and manual) to all associated components occurs. This is conservatively bounding since in reality, it is unlikely that all sockets would short. Each socket short would be an independent event influenced by specific wiring details, socket orientation, and location on the control boards. The assessment determined that the required plant functions including the critical functions described above were either not impacted or redundant equipment is available (as part of the plant design) to assure there would be no adverse impact on any Condition II analysis results.

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Evaluation of Safe Shutdown Following a Design Basis Earthquake

The design basis also requires the ability to place the plant in stable cold shutdown conditions in a timely manner and assuming that offsite power is unavailable following a DE. The evaluation assessed the potential impact on all of the plant functions required to successfully place the plant in a safe shutdown condition. A summary of the most critical functions is listed below.

1. Adequate RCS inventory control is maintained with charging and letdown.

2. Adequate RCS pressure control is maintained with power operated relief valves (PORVs) and/or sprays and heaters.

3. Adequate RCS boration capability is maintained to ensure the minimum shutdown margin is met.

4. Short term RCS heat removal is available via AFW and/or steam generator PORVs.

5. Long term RCS heat removal is available via normal or alternate residual heat removal system cooling.

6. Ultimate heat sink and component cooling capacity is maintained with the auxiliary saltwater and component cooling water systems.

7. Operator access and control to remote plant components is maintained with the appropriate HVAC and backup air/nitrogen supply systems.

8. Onsite emergency power is maintained to all components required for these functions.

The evaluation determined that the required plant functions including the critical functions described above were either not impacted, had redundant equipment available as part of plant design, or had operator action able to establish the appropriate function in a reasonable time. Therefore, there is no adverse impact on the ability to place the plant in a safe shutdown condition following a DE.

In summary, PG&E has determined that the degraded lamp sockets would not cause any adverse safety significant impact on the ability to mitigate any associated FSAR Condition II events or place the plant in a safe shutdown condition if a DE were to occur. However, PG&E conservatively determined the

condition to be a Safety System Function Failure as defined in NEI 99-02 draft, Rev. D, dated November 12, 1999, because the safety function of some systems may not have been fulfilled during a postulated seismic event.

Probabilistic Risk Assessment (PRA)

PG&E developed a customized PRA seismic model to analyze the lamp socket condition and evaluate safety significance, as represented by the increase in probability of core damage frequency (CDF), large early release frequency (LERF), and shutdown risk. Two PRA calculations (one for each unit) were performed. The methodology and results are presented below.

Methodology

Based on an engineering assessment, the PRA analysis assumed that control circuit shorting due to failure of the lamp sockets was an independent event, i.e., if one lamp socket shorts, then there is no noticeable increase in probability that another would short. PG&E developed a distribution curve for the conditional probability of failure of lamp sockets depending on the magnitude of the seismic event and the type of switch module. PG&E also addressed the risk of combinations of lamp socket deficiencies and regularly scheduled maintenance. PG&E also performed qualitative assessments of LERF for the at-power PRA and shutdown risk.

Results

Several sensitivity analyses of the delta CDF, which included human reliability analysis values and maintenance on both units from the lamp socket condition were conducted. Based on the considerations above, the bounding delta CDF was 1.22E-7 per year. This increase is considered very small based on Regulatory Guide 1.174.

The LERF estimate, which is dominated by the seismically-induced failure of components and structures (i.e., it is not dominated by the random failure of components following or during core damage), was found to be an increase of 1.85 E -9 per year. This increase is considered very small based on Regulatory Guide 1.174.

The analysis of actual risk profile of the Units 1 and 2 ninth refueling outages indicated that there was no noticeable risk increment due to the control room lamp sockets condition.

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Conclusion

Based on the deterministic and a probabilistic risk analysis, PG&E concluded that this event did not adversely affect public health and safety.

V. Corrective Actions

A. Immediate Corrective Actions

1. PG&E sent letters to the past supplier (Westinghouse) and the present supplier (Cutler Hammer) of the condition and requested appropriate action regarding 10 CFR 21 reportability.

2. Affected systems were evaluated and determined to be operable.

3. PG&E developed a plan and procedure for systematically inspecting Unit 1 and 2 lamp sockets during power operations and unit shutdown conditions. The plan categorized the sockets as follows.

   Category 1 - Sockets which are not a reactor trip hazard, may be inspected and, if necessary, replaced with shift foreman concurrence.

   Category 2 - Sockets which are not a reactor trip hazard, may be inspected and, if necessary, replaced with preapproved clearances, preapproved work orders, and staged parts.

   Category 3 - Sockets which are not a reactor trip hazard but cannot be cleared. Initially the sockets were visually inspected only. Replacement or repair of broken sockets require Engineering and Operations concurrence, preapproved clearances and work orders, and staged parts.

   Category 4 - Sockets which are a trip hazard. Replacement or repair of broken sockets is considered to be work performed during an outage unless otherwise directed by Operations and Engineering.

   In addition to categorizing the sockets, PG&E performed inspections based on priority or significance (e.g., safe shutdown equipment using PRA insights were inspected first).

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Using this plan and procedure PG&E has completed the following inspections and repairs to date.

Control Room	Unit 1	[redacted]
Total Population	949	941
Non-EZC type	103	107
Inspected	759	713
Replaced w/o Inspection	16	80
Ventilation Lights	13*	13*
Remaining to be Inspected	58**	28**
Outside Control Ro[redacted]	[redacted]1	Un[redacted]2
Total Population	52	51
Inspected	2	51
Remaining to be Inspected	50**	0
Total Sockets Found Broken or Broke During Test	23	33

*Excluded from the inspection process due to the existence of foam material that prevents circuit damage.
**These sockets are considered adequate without undergoing full inspection and testing because they 1) are nonsafety-related or, 2) have no adverse impact on safe shutdown equipment or, 3) have had external visual inspections which confirmed the that they were not broken.

The inspections include a visual inspection of the socket with an insulated boroscope to identify cracking or breakage. In addition, a structural integrity check is performed by applying 3-lbs of force using an insulated force gage. The remaining sockets will be inspected and replaced as necessary.

B. Corrective Actions to Prevent Recurrence

PG&E is evaluating the present lamp socket design and alternatives for long term corrective actions.

TEXT

VI. Additional Information

A. Failed Components

None.

B. Previous Similar Events

None.

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Figure 1
Broken Minalite Socket Installed

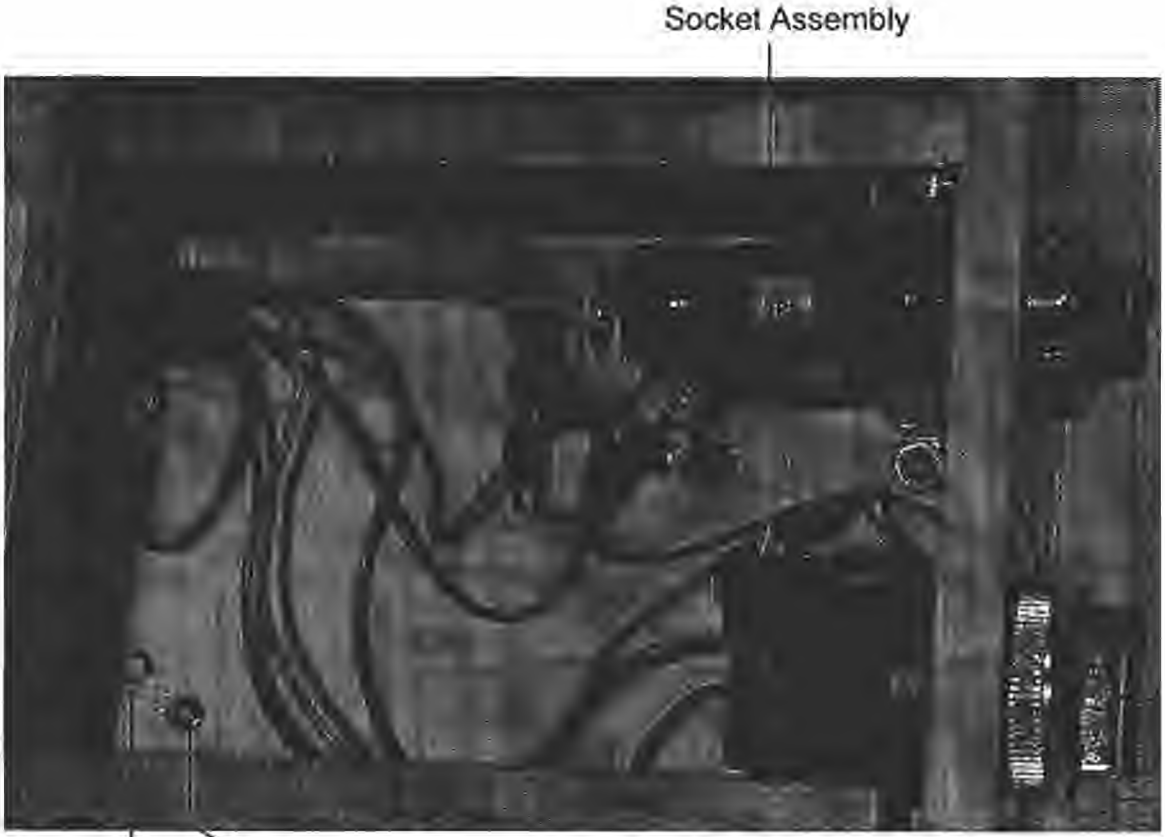

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Figure 2
Disassembled Lamp Socket Assembly