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FACIL:50-275 Diablo Canyon Nuclear Power Plant, Unit 1, Pacific Ga 05000275
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RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 94-018-00:on 940831,determined that defects existed in battery charger printed circuit boards.Caused by manufacturing error.Procurement of battery charger printed circuit boards.W/940930 ltr.

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PRIORITY 1 DOCUMENT

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Gregory M. Rueger
Senior Vice President and
General Manager
Nuclear Power Generation

September 30, 1994

PG&E Letter DCL-94-215

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Licensee Event Report 1-94-018-00
Battery Chargers Degraded Due to Manufacturing Error and Inadequate Commercial Grade Dedication of Replacement Printed Circuit Boards

Gentlemen:

Pursuant to 10 CFR 50.73(a)(2)(v), PG&E is submitting the enclosed licensee event report regarding vital battery chargers degraded printed circuit boards.

This condition did not affect the health and safety of the public.

Sincerely,

Gregory M. Rueger

cc: L. J. Callan
Mary H. Miller
Kenneth E. Perkins
Sheri R. Peterson
Diablo Distribution
INPO

Enclosure

DC0-94-EM-N036

6643S /KWR/2246

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PDR ADOCK 05000275
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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 8

TITLE (4) Battery Charger Degraded Due to Manufacturing Error and Inadequate Commercial Grade Dedication of Replacement Printed Circuit Boards

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MON	DAY	YR	YR	SEQUENTIAL NUMBER	REVISION NUMBER	MON	DAY	YR	FACILITY NAMES	DOCKET NUMBER (S)
08	31	94	94	- 0 1 8 -	0 0	0 9	30	94	Diablo Canyon Unit 2	0 5 0 0 0 3 2 3
										0 5 0 0 0

OPERATING MODE (9): 1

POWER LEVEL (10): 1 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR: (11)

X 10 CFR 50.73(a)(2)(v)

OTHER -

(Specify in Abstract below and in text, NRC Form 366A)

LICENSEE CONTACT FOR THIS LER (12)

	TELEPHONE NUMBER	
	AREA CODE	
David P. Sisk, Senior Regulatory Compliance Engineer	805	545-4420

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	
1	E I	B Y C	E 3 5 6	Y							

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
[ ] YES (If yes, complete EXPECTED SUBMISSION DATE)	[X] NO				

ABSTRACT (16)

On August 31, 1994, at 1420 PDT, PG&E conservatively determined that defects existed in battery charger printed circuit boards that could potentially prevent the fulfillment of the safety function to maintain battery voltage following a seismic event. On August 31, 1994, at 1745 PDT, a 4-hour non-emergency report was made to the NRC in accordance with 10 CFR 50.72(b)(2)(iii)(A).

The circuit board defects were deficient hand-soldered connections. The root cause of this event is manufacturing error. A contributory cause is inadequate pre-installation dedication criteria for the battery charger commercial grade circuit boards.

Corrective action to prevent recurrence includes implementing specific receipt inspection of soldered connections for all in-stock and future procurement of battery charger printed circuit boards.

I. Plant Conditions

Units 1 and 2 have operated in various Modes and at various power levels with the potentially degraded condition of the vital battery charger printed circuit boards.

II. Description of Problem

A. Summary

On August 31, 1994, at 1420 PDT, PG&E conservatively determined that defects existed in battery charger (BTC) [EJ][BYC] printed control circuit boards [EJ][CBD] that could potentially prevent the fulfillment of the safety function to maintain battery voltage following a postulated seismic event. On August 31, 1994, at 1745 PDT, a 4-hour non-emergency report was made to the NRC in accordance with 10 CFR 50.72(b)(2)(iii)(A).

B. Background

Technical Specification (TS) 3/4.8.2 requires that each 125 volt direct current (DC) bus [EJ][BU] be energized from its associated battery bank [EJ][BTRY] and its associated full-capacity charger. TS 3/4.8.3 requires that each 125 volt DC battery and its associated full-capacity charger be operable. Diablo Canyon has five safety-related battery chargers in each unit; three of which are dedicated to a safety-related DC bus, and two are installed spare (backup) chargers that may be placed into service by manual operator action.

C. Event Description

On July 21, 1994, during preparation to perform a post-maintenance Surveillance Test Procedure (STP) M-16P1, "Continuity Testing of Train A/B Slave Relays K627, K628 and K635," licensed utility operating personnel observed that the vital DC switchgear bus voltage was above the maximum of 136 volts permitted by STP M-16P1. BTC 11 output voltage was noted to be 138.9 volts. The high output voltage was determined to be caused by some defect in the voltage control module [EJ][EC] (printed circuit board). Examination of the printed circuit board identified a missing solder connection at a capacitor [EJ][CAP] lead. The mechanical connection between the capacitor lead and the board had previously been adequate for proper BTC operation (BTC 11 operated successfully for three years). Over a period of time, the electrical connection degraded as evidenced by the as-found high resistance (i.e., due to oxidation or charger vibration). This degraded

connection resulted in the abnormal high voltage condition on the battery charger.

Although the charger was functional, the battery bank was placed on the backup charger, BTC 121, within two hours and the TS 3/4.8.2, 14-day action statement was entered as a precautionary measure. The voltage control module was then replaced, BTC 11 was returned to service, and the TS action statement was exited. A preliminary engineering evaluation of the missing solder connection concluded that the connection would be functional following a seismic event. However, it was decided to conservatively consider the connection non-functional following a seismic event since the seismic testing had been prototype tested, and actual seismic testing had not been performed on a printed circuit board with this type of a defective connection.

On July 29, 1994, examination of the spare warehouse BTC printed circuit boards was completed and four circuit boards were identified with soldering deficiencies. Three of the deficiencies were partially soldered connections. The fourth deficiency was a missing solder connection similar to that found in BTC 11. An evaluation concluded that although the partially soldered connections did not meet soldering quality standards, they were capable of providing an adequate electrical connection. As discussed above, a printed circuit board with connections that did not have any solder was conservatively considered as not being capable of performing its intended function following a seismic event.

Since printed circuit board connection soldering deficiencies had been identified in an operating battery charger and on four spare printed circuit boards in the warehouse, a decision was made to inspect all installed battery charger control module printed circuit boards.

On August 26, 1994, a filtering module [EJ][CBD][FLT] for BTC21 was found to have inadequate solder coverage on an isolation transformer [EJ][CBD][EB][XFMR] lead. The control module was replaced. An evaluation concluded that the electrical and mechanical connection was sound and that battery charger operation was not affected by this condition.

On August 27, 1994, a filtering module for BTC 221 was found with an unsoldered diode [EJ][CBD][IIS] lead. In addition, an amplifier module [EJ][CBD][AMP] was found with excessive solder between the base and collector of a transistor [EJ][CBD][XIS]. The charger output was not affected by these conditions. Both of these modules were replaced. Upon initial startup of BTC 221 for post maintenance testing, there was no output voltage. An

investigation identified a deficient solder connection on one of the two modules that had just been replaced. Initial visual inspection of this connection appeared good, but a more detailed visual inspection found the lead was not making electrical contact. This board was replaced and the charger was successfully tested and returned to service.

On August 31, 1994, a control module for BTC 22 was found to have a partially soldered connection. The module was replaced. An evaluation concluded that the partially soldered connection had no effect on charger operation.

On August 31, 1994, a technical review group (TRG) conservatively determined that the number of deficiencies found on the control module printed circuit boards was a condition that alone could have prevented the fulfillment of a safety function; i.e., maintain the reactor in a safe shutdown condition. On August 31, 1994, at 1745 PDT, a 4-hour non-emergency report was made in accordance with 10 CFR 50.72(b)(2)(iii)(A).

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

None.

E. Dates and Approximate Times for Major Occurrences

1. July 21, 1994:	Event date: BTC 11 experienced high voltage and was declared inoperable. A circuit board with missing solder connection was identified.
2. July 29, 1994:	Four warehouse spare circuit boards were identified with soldering deficiencies.
3. August 26, 1994:	BTC 21 inspection identified one circuit board with a soldering deficiency.
4. August 27, 1994:	BTC 221 inspection identified two circuit boards with soldering deficiencies.
5. August 31, 1994:	BTC 22 inspection identified one circuit board with a soldering deficiency.
6. August 31, 1994, 1420 PDT:	Discovery Date: TRG determined that defects exist in battery chargers that alone

could potentially prevent the fulfillment of the safety function to maintain battery voltage.

7. August 31, 1994, 1745 PDT: A 4-hour non- emergency report was made to the NRC in accordance with 10 CFR 50.72(b)(2)(iii)(A).

F. Other Systems or Secondary Functions Affected

None.

G. Method of Discovery

During performance of a scheduled surveillance test, licensed utility operating personnel identified a safety-related vital battery charger with a control module printed circuit board with a missing solder connection. Other battery charger printed circuit board soldering deficiencies were identified during the follow-up investigation.

H. Operator Actions

BTC 11 was declared inoperable, TS 3/4.8.2 action statement was entered, and the installed backup charger was placed in service. The other battery chargers were individually removed from service to perform circuit board inspections. When circuit board deficiencies were identified, the circuit boards were replaced and tested satisfactorily prior to the battery chargers being returned to service.

I. Safety System Responses

None.

III. Cause of the Problem

A. Immediate Cause

Battery charger printed circuit boards had inadequate electrical connections.

B. Root Cause

The root cause of this event is manufacturer error (missing or inadequate solder connection), during the fabrication of the replacement printed circuit boards supplied for the battery chargers.

C. Contributing Cause

PG&E commercial grade component dedication inspection process failed to detect the defective (inadequate solder joint) printed circuit boards due to inadequate receipt inspection criteria.

IV. Analysis of the Event

The specified safety function of the battery chargers is to supply power to vital DC loads and maintain the batteries in a fully charged condition. The batteries are required to supply the essential DC loads for a minimum of two hours during any design basis event (DBE) associated with loss of off-site power and failure of the emergency diesel generators [EK][DG] to start. After two hours, 480 volt vital bus [ED][BU] power will be restored, at which time the chargers are assumed to be available to provide a continuous essential DC load power supply and to recharge the battery bank.

The vital DC buses have annunciation alarms [NA][EA] for both low and high DC bus voltage. If a primary vital charger were to fail, due to a high or low voltage condition, plant operators would immediately be aware of the condition due to alarms received in the control room. The installed backup charger could be manually placed into service within the two hour DBE capability of the batteries. In the event that the voltage or current control modules within the charger fails, the chargers are capable of being switched to "manual control," which allows the charger output to be set to a desired output level until repair of the voltage or current control module can be accomplished.

The commercial grade dedication process for the battery charger replacement circuit boards requires operability testing for all printed circuit boards prior to returning the charger to service. This dedication testing, combined with routine surveillance testing, has demonstrated that the battery chargers have been capable of performing their safety function.

Therefore, a safety concern is whether a seismic event might cause one or more of the chargers to become inoperable due to control module circuit board soldering deficiencies. For partially soldered connections, an engineering evaluation determined that the weights of the electronic components are very light and the partially soldered lead wires make it highly unlikely that the electrical contact would

lose its continuity. Only one charger on Unit 1 was found with a missing solder connection that, conservatively, could have affected the battery charger output. The two other vital DC bus chargers and the installed backup charger would have been available to supply the vital DC loads. All other missing solder connections either did not affect charger output or were found prior to placing the charger into service (warehouse inspection or dedication testing).

Therefore, the health and safety of the public was not adversely affected by this condition.

V. Corrective Actions

A. Immediate Corrective Actions

1. The affected battery was switched to the installed spare battery charger and electrical maintenance investigative and corrective actions were initiated.

2. An inspection plan for all safety-related battery charger printed circuit boards was implemented.

3. A review of the effectiveness of commercial grade dedication processes for other vendor printed circuit boards utilized in safety-related applications was performed and found satisfactory based upon a warehouse stock sampling inspection and a problem report history search.

4. All installed battery charger printed circuit boards were inspected and any deficiencies have been repaired.

B. Corrective Actions to Prevent Recurrence

1. The existing stock of battery charger printed circuit boards was re-inspected to enhanced criteria specific to soldered connections and any deficiencies were immediately placed on hold for repair.

2. Receipt inspection criteria have been enhanced to provide specific attention to soldered connections on printed circuit boards for all future procurement of battery charger printed circuit boards.

VI. Additional Information

A. Failed Components

Component: Filtered Constant Voltage Float Charger
Manufacturer: Exide
Model No.: UPC 130-3-400, Three Phase 480 Volt AC input, 125 Volt DC output.

Degraded Components Identified

Firing Module	101-070-212G (Lot 41, 2 cards)
Gate Filter Module	101-071-629 (Lot 41, 1 card)
Gate Filter Module	101-071-629L (Lot 44, 1 card)
Amplifier (Aux Pwr)	101-071-205A (Lot A41, 1 card)
Amplifier (Aux Pwr)	101-071-205A (Unknown, 1 card)
Voltage Control Module	101-070-619 (Lot 73, 2 cards)
Voltage Control Module	101-070-619 (Unknown, 1 card)

B. Previous LERs on Similar Problems

None.