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October 10, 2003

PG&E Letter DCL-03-125

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 2-2003-007-01
Technical Specification 3.8.4 Violation Due To Common Mode Battery Charger Failures

Dear Commissioners and Staff:

PG&E is submitting the enclosed Revision 1 to licensing event report (LER) 2-2003-007, regarding the violation of Technical Specification 3.8.4, "DC Sources – Operating," due to common mode battery charger failures in multiple trains. This LER revision provides the results of the completed root cause analysis and corrective actions to prevent recurrence. The changes are noted with revision marks.

This event did not adversely affect the health and safety of the public.

Sincerely,

D H Oatley

David H. Oatley

ddm/2246/N0002168
Enclosure
cc/enc: Bruce S. Mallett
David L. Proulx
Girija S. Shukla
Diablo Distribution
INPO

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LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
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TITLE (4)

Technical Specification 3.8.4 Violation Due To Common Mode Battery Charger Failures

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
05	27	2003	2003	- 0 0 7 -	0 1	10	10	2003	Diablo Canyon Unit 1	0 5 0 0 0 2 7 5

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

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER AREA CODE	
Lawrence M. Parker – Senior Regulatory Services Engineer	805	545-3386

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
B	E J	B Y C	E 3 5 6	Yes					

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

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

On May 27, 2003, with Unit 2 in Mode 1 (power operation) at 100 percent power, battery charger (BTC) 2-1 failed a 1-hour load test. The cause of the BTC failure was electrolytic capacitor degradation on the gate filter module and/or firing module.

On June 21, 2003, a review of equipment operating history identified 3 of 5 vital BTCs for Unit 1 and 3 of 5 vital BTCs for Unit 2 failed in service upon demand within the past 15 months. Based on the past history of BTC failures, it was concluded that BTC 2-1 failure did not occur at the time of discovery and was inoperable for a period greater than the completion time of Technical Specification (TS) 3.8.4, "DC Sources – Operating," prior to discovery. Thus, the failure of BTC 2-1 constituted a TS violation in accordance with 10 CFR 50.73(a)(2)(i)(B) and 10 CFR 50.73(a)(2)(vii).

The immediate corrective actions included replacement of failed modules with verified acceptable replacements and accelerated testing of all BTCs. The causes of this condition were aged capacitors, and premature capacitor failure, due to a control circuit design deficiency that exposed the capacitors to reverse voltage beyond their intended operating conditions that reduced the electrolytic capacitor service life.

Corrective actions to prevent recurrence include revision of plant procedures regarding problem identification and review, initiation of operability assessment(s), and inclusion of maintenance rule corrective actions in the readiness for restart review requirements. PG&E will revise the design of the BTC circuitry to install components that are correct for the subject electrical environment or replace the BTCs.

I. Plant Conditions

Unit 2 was in Mode 1 (Power Operation) at 100 percent power at the time of discovery. Units 1 and 2 have operated in all modes with the identified condition.

II. Description of Problem

A. Background

The vital direct current (DC)[BJ] power sources and associated distribution systems help ensure that sufficient instrumentation and control capability is available for monitoring and maintaining the plant status in the unlikely event all alternating current (AC) power is lost.

Each Diablo Canyon Power Plant (DCPP) Unit has three 60-cell, 125 Volt DC (VDC) vital batteries and 5 full capacity battery chargers (BTCs)[BYC]. Each of the three vital 125 VDC busses has a dedicated battery and charger. The design of the vital 125 VDC system is such that a battery may be supplied by two full capacity chargers: one supplied from its associated 480 volt alternating current (480 VAC) vital bus, or an alternate charger supplied by another 480 VAC vital bus. The first additional charger can be switched to either of two of the batteries. The second charger is a dedicated backup charger for the third vital battery. See Figure 1 – "Single Line Diagram of the 125 Volt DC Vital Power Supply System."

Normally, the battery chargers supply the total load requirements of the DC system as well as maintaining a constant floating charge on the batteries. The batteries are paralleled with the chargers and are sized to supply DC power to the system for approximately 6 to 7 hours if the AC power or battery chargers should fail. The chargers are sized to have sufficient capacity to carry the normal loads and recharge a fully discharged battery within 12 hours if necessary.

Battery charger maintenance and testing may be performed during power operation because a battery may be transferred to one of the additional chargers for up to 14 days. Because full capacity backup chargers are available, charger failures do not contribute to DC system unavailability. Battery charger failures are unlikely to occur during power operations as the chargers are rarely challenged to their design capability. Normally, the chargers are called upon to maintain trickle and floating charges and carry normal 125 VDC loads. Heavy demands are only placed on the chargers during loss of power events, charger tests, or after a battery discharge test when the charger is called upon to recharge the battery.

Technical Specification (TS) 3.8, "Electrical Power Systems," TS 3.8.4, "DC Sources – Operating," requires three Class 1E DC electrical power subsystems to be operable in Modes 1, 2, 3, and 4. TS 3.8.4. Action A requires that with one DC electrical power subsystem inoperable restore the DC electrical power subsystem to operable status within two hours.

TS 3.8.4 Action B, requires, in part, that if any DC bus is not receiving power from its associated AC electrical power distribution subsystem the subsystem shall be restored to a configuration wherein each charger is powered from its associated 480 volt vital bus within 14 days, or be in Mode 3, in 6 hours, and in Mode 5 in 36 hours.

Surveillance Requirement (SR) 3.8.4.6 verifies "each BTC supplies $\geq$400 amps at $\geq$130 V for $\geq$4 hours," a condition for BTC operability, and is required on a 24-month frequency.

Surveillance Test Procedure (STP) M-12A, "Vital Station Battery Modified Performance Test," verifies the operability of the vital 125 VDC batteries in accordance with SR 3.8.4.7, SR 3.8.4.8, and, in part, SR 3.8.5.1.

STP M-12B, "Battery Charger Performance Test," verifies the operability of the BTCs in accordance with SR 3.8.4.6 and, in part, SR 3.8.5.1.

B. Event Description

On May 27, 2003, BTC 21 failed a 1-hour battery charger load test.

Discovery Date: On June 21, 2003, a review of equipment operating history identified 3 of 5 vital BTCs for Unit 1 and 3 of 5 vital BTCs for Unit 2 failed in service upon demand within the past 15 months. The BTC failures were due to component failures associated with the gate and filter modules. Based on the past history, the BTC 2-1 failure could not be assumed to occur at the time of discovery and was inoperable for a period greater than the TS 3.8.4 completion time prior to discovery, and therefore a TS violation in accordance with 10 CFR 50.73(a)(2)(i)(B). Furthermore due to the common cause failure of multiple BTCs this condition is being reported in accordance with 10 CFR 50.73(a)(2)(vii).

Maintenance History:

On December 14, 2001, a 4-hour battery charging load test was satisfactorily performed for BTC21 in accordance with STP M-12B as required by SR 3.8.4.6 for Unit 2.

On March 22, 2002, Unit 1 BTC 132 failed in service. The gate and filter modules were replaced with warehouse spares and returned to service by satisfactory performance of STP M-12B.

On May 7, 2002, Unit 1 BTC12 failed when placed in service following battery discharge testing in accordance with STP M-12A during the Unit 1 eleventh refueling outage (1R11). The failed gate and filter module was replaced with a warehouse spare and STP M-12B satisfactorily performed.

On May 8, 2002, Unit 1 BTC121 failed when placed in service following battery discharge testing in accordance with STP M-12A during 1R11. The failed amplifier module was replaced with a warehouse spare and STP M-12B satisfactorily performed.

On June 12, 2002, the Unit 1 BTC12 and BTC121 failures were determined to be Maintenance Rule Functional Failures (MRFF) per implementing procedures for 10 CFR 50.65, "the Maintenance Rule." System engineering requested maintenance preventable cause determination.

On June 21, 2002, the Unit 1 BTC12 and BTC121 failures were determined to be maintenance preventable functional failures (MPFF).

On July 7, 2002, as a corrective action to prevent recurrence (CAPR), engineering requested a revision to maintenance procedure MP E-67.3A, "Maintenance and Overhaul of Exide Station Battery Chargers," to verify appropriate electrolytic capacitors service life.

On July 26, 2002, Unit 1 BTC 132 gate and filter module capacitors were replaced and the BTC tested in accordance with STP M-12B.

On August 23, 2002, the Unit 1 BTC 11 C6 capacitor in the current control module and the C17 and C18 capacitors of the amplifier module were replaced. All gate and filter module capacitors were determined to be acceptable based upon their date codes. The BTC was satisfactorily tested in accordance with STP M-12B.

On August 23, 2002, the BTCs are placed in Maintenance Rule Goal Setting with a goal of expeditiously inspecting and replacing capacitors as required for the remaining BTCs.

On December 20, 2002, Unit 1 BTC 131 gate and filter module capacitors were replaced and the BTC was tested in accordance with STP M-12B.

On December 21, 2002, the Unit 2 BTC 221 C6 capacitor in the current control module was replaced. All gate and filter module capacitors were determined to be acceptable based upon their date codes. The BTC was satisfactorily tested in accordance with STP M-12B.

On February 19, 2003, Unit 2 BTC 22 failed when placed in service following battery discharge testing in accordance with STP M-12A during the Unit 2 eleventh refueling outage (2R11). All suspect modules were replaced and the BTC was tested in accordance with STP M-12B.

On February 22, 2002, Unit 2 BTC 232 failed when placed in service following battery discharge testing in accordance with STP M-12A during 2R11. All suspect modules were replaced and the BTC was tested in accordance with STP M-12B.

On March 13, 2003, Unit 2 BTC 231 passed a 1-hour load test during 2R11, prior to replacement of 3 control modules with suspect capacitors, and tested in accordance with STP M-12B.

On May 27, 2003, BTC 21 failed a 1-hour battery charger load test due to a failed capacitor on gate filter module number 4. The failed module capacitors were replaced and the BTC tested in accordance with STP M-12B.

On August 21, 2003, the Unit 1 BTC 131 failed a 1-hour load test due to the DC output breaker tripping open at approximately 40 minutes into the test. The breaker pole contact resistance was measured to be 296 microhms on the positive pole and 1460 microhms on the negative pole. Following replacement with a new breaker the pole resistance was measured to be approximately 100 microhms. Based upon these readings, a review of maintenance history, and before and after thermography, PG&E believes that this failure is a DC output breaker only, and not related to the electrolytic capacitor issues reported in this LER.

Additional investigations during accelerated testing and circuit inspections identified additional workmanship issues related to inadequate solder joints, cold solder joints, degraded motherboard mounting studs, etc. These issues were entered into the corrective action program and actions taken promptly to correct the findings. Each condition was evaluated and found to be independent of the BTC capacitor failure issues and determined not to significantly degrade the ability of the BTCs to perform their safety function.

C. Status of Inoperable Structures, Systems, or Components that Contributed to the Event

None.

D. Other Systems or Secondary Functions Affected

None.

E. Method of Discovery

Demand loading of the battery chargers identified the BTC failures. A PG&E management review of equipment operating history identified 3 of 5 vital BTCs for Unit 1 and 3 of 5 vital BTCs for Unit 2 failed in service upon demand within the past 15 months.

F. Operator Actions

Plant operators responded to alarms and indications in the control room, removed equipment from service, and maintained plant systems as necessary to perform DC system testing and repair.

G. Safety System Responses

None.

III. <u>Cause of the Problem</u>

A. Immediate Cause

Failure of electrolytic capacitors on the gate filter module and/or firing module caused the BTCs to fail to supply adequate charging current.

B. Root Cause

Failed electrolytic capacitors were identified in BTC 131, 12, 121, and 22. Two of these failures were attributed to electrolytic capacitor use beyond their service life due to replacement of printed circuit boards with aged electrolytic capacitors that were not subject to appropriate component verification prior to installation. Two failures were due to premature capacitor aging and early end-of-life failure. A BTC circuit design deficiency was identified that exposed the electrolytic capacitors to reverse voltage beyond their intended operating conditions that reduced the service life of the capacitors.

C. Contributory Causes

1. Ineffective barrier in that procedure OM7.ID1, "Problem Identification and Resolution," did not provide adequate criteria for problem report review of demand failure recognition, past operability status, and impact on reportability.

2. Ineffective barrier in that procedure OM7.ID12, "Operability Determination," did not provide specific guidance on actions required when a potential common mode failure is identified.

3. Ineffective barrier in that procedure OP1.ID1, "Readiness for Restart Program," did not require corrective actions identified in accordance with 10 CFR 50.65(a)(1) to be listed as "readiness for restart" items to ensure management awareness of equipment issues prior to a unit restart.

IV. Assessment of Safety Consequences

Units 1 and 2 have control room alarms and indications for the condition of the vital 125 VDC batteries and chargers. Each division of DC power inputs to a common annunciator window alarm and each division has its own indication in the control room. DCPP annunciator response procedures contain guidance regarding these control room alarms and indications.

The loss of a single vital 125 VDC train is addressed by Abnormal Operating Procedure (OP) AP-23, "Loss of Vital DC Bus." OP AP-23 contains direction to stabilize the plant and restore power to the affected DC bus. The auxiliary feedwater and residual heat removal systems are used to maintain adequate core cooling, and the loss of a single safety-related DC train or bus during normal plant operation does not impact the ability of these systems to provide reactor coolant system (RCS) cooling. Likewise, such a loss does not impact the ability of the redundant power-operated relief valves (PORV) to maintain RCS integrity nor the ability of the PORV block valves or the reactor vessel head vent valves to maintain RCS integrity.

This event is not considered a safety system functional failure as the vital DC battery, even with the most conservative assumptions, was fully capable of performing its intended function for the approximately 6 to 7 hours of battery life, allowing time to place the unit in a stable shutdown condition. Thus, this condition did not adversely affect the health and safety of the public.

An evaluation of the risk associated with an assumed potential for loss of all DC charging following restoration of AC power after a unit loss of all offsite and onsite

AC was performed. A best estimate probabilistic risk analysis (PRA) was performed that determined the incremental effect of this condition on core damage frequency was less than the risk significant determination threshold identified in Regulatory Guide 1.174, "An Approach for Using PRA in Risk Informed Plant-Specific Changes to the Licensing Basis," dated July 1998. Therefore, this condition is not considered risk significant and it did not adversely affect the health and safety of the public.

V. Corrective Actions

A. Immediate Corrective Actions

1. The gate filter module and/or the firing modules stored in the warehouse with electrolytic capacitors were verified to have appropriate equipment service life remaining.

2. The suspect gate filter modules and/or the firing modules capacitors were replaced for all five BTCs on each unit.

3. A 4-hour load test was satisfactorily performed for each BTC module replacement in accordance with STP M-12B.

4. Maintenance Procedure (MP) E-67.3A was revised to verify appropriate electrolytic capacitor service life.

B. Corrective Actions to Prevent Recurrence

1. Procedure OM7.ID1, "Problem Identification and Resolution," will be revised to provide additional criteria for demand failure recognition, past operability status review, and impact on reportability.

2. Procedure OM7.ID12, "Operability Assessments," will be revised to require a formal documented assessment when a potential common mode failure is identified.

3. Procedure OP1.ID1, "Readiness for Restart Program," will be revised to require maintenance rule 10 CFR 50.65(a)(1) identified corrective actions to be listed as "readiness for restart" items to ensure management awareness of equipment issues prior to a unit restart.

4. PG&E will revise the design of the BTC circuitry to install components that are correct for the subject electrical environment or replace the BTCs.

VI. Additional Information

A. Failed Components

Component: Filtered Constant Voltage Float Charger
Manufacturer: Manufacturer: Exide Power Systems
Model No.: UPC 130-3-400,
Three Phase 480 VAC Input,
125 VDC output.
Gate and filter module 101-071-629L

B. Previous Similar Events

LER 1-94-018-00, "Battery Charger Degraded Due to Manufacturing Error and Inadequate Commercial Grade Dedication of Replacement Printed Circuit Boards," reported 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. The circuit board defects were deficient hand-soldered connections. The root cause of this event is manufacturing error. A contributory cause was inadequate preinstallation 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.

LER 2-99-001-00, "Voluntary Entry Into Technical Specification 3.0.3 to Open the Containment Recirculation Sump Sensor Hatch to Verify Level Transmitter Operability," reported opening of the containment recirculation sump sensor hatch to remove the sensor assembly for narrow range level transmitters (LTs). Corrective actions included replacement of electrolytic capacitors for all narrow range sump LTs on a recurring frequency.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

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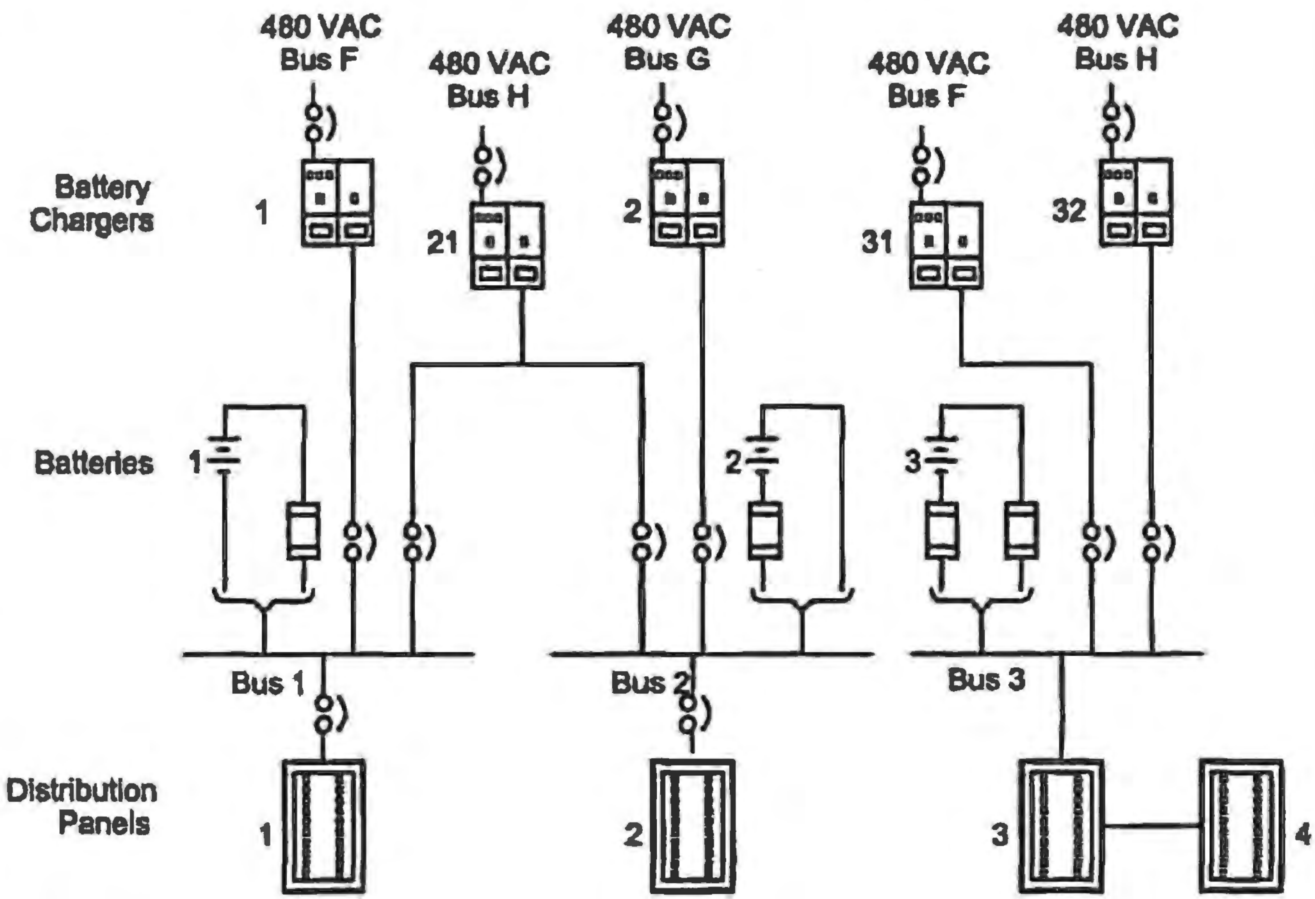

Figure 1 – Single Line Diagram of the 125 Volt DC Vital Power Supply System