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SUBJECT: LER 98-003-01:on 980424,TS 3.6.2.3 was not being met.Caused by inadequate splicing methods.CFCU 2-4 & 2-5 motors were replaced w/spare motors.W/980526 ltr.

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May 26, 1998

PG&E Letter DCL-98-070

U.S. Nuclear Regulatory Commission
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Docket No. 50-323, OL-DPR-82
Diablo Canyon Unit 2
Licensee Event Report 2-1998-003-00
Technical Specification 3.6.2.3. Not Met Due to Inadequate Splice Connections on Containment Fan Cooler Units Due to Inadequate Procedural Guidance

Dear Commissioners and Staff:

PG&E is submitting the enclosed licensee event report, regarding Technical Specification 3.6.2.3, "Containment Cooling Systems," not being met due to inadequate procedural guidance.

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

Sincerely,

Robert P. Powers

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

Enclosure

TLH/2246/N0002053

IE22

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Diablo Canyon Unit 2	0 5 0 0 0 3 2 3	1 OF 10

TITLE (4)

Technical Specification 3.6.2.3. Not Met Due to Inadequate Splice Connections on Containment Fan Cooler Units Due to Inadequate Procedural Guidance

EVENT DATE (5)				LER NUMBER (6)		REVISION NUMBER	REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER			MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
04	24	1998	1998	- 0 0 3	-	0 0	05	26	1998		

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)
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	
Vickie A. Backman - Senior Regulatory Services Engineer	805	545-4289

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

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 April 24, 1998, with Unit 2 in Mode 1 (Power Operation), PG&E identified that Technical Specification (TS) 3.6.2.3. had not been met in the past. The TS requires that the containment cooling system be operable with either: (1) at least four containment fan cooler units (CFCUs), or (2) at least three CFCUs, each of the three supplied from a different vital bus during Modes 1 through 4 (Hot Shutdown). During the eighth refueling outage, failures of CFCU 2-5 and 2-4 motor leads occurred on February 17, 1998, and February 21, 1998, after the leads became overheated at splice connections. PG&E believes the condition of leads prior to failure did not assure the motors would have fulfilled their safety function prior to entering Mode 5 (Cold Shutdown) on February 15, 1998.

The cause of failure was inadequate splicing methods which created a degraded condition in the CFCU 2-4 and 2-5 motor lead extensions. The splices degraded over time and caused premature failure of the motors. The degraded condition is considered to be unique to CFCU 2-4 and 2-5.

The CFCU 2-4 and 2-5 motors were replaced with spare motors. The replacement motors had new motor lead extensions and lead extension splices installed by Westinghouse. The PG&E splicing guidance will be revised to specify the proper fill when making a splice between two different size wires.

TEXT

I. Plant Conditions

Unit 2 was in Mode 1 (Power Operation) at 100 percent power.

II. Description of Problem

A. Summary

On April 24, 1998, with Unit 2 in Mode 1, PG&E identified that Technical Specification (TS) 3.6.2.3., "Containment Cooling Systems," (BK) may not have been met in the past when an insufficient number of containment fan cooling units (CFCUs) may have been operable. During the Unit 2 eighth refueling outage (2R8), failures of CFCU 2-5 and 2-4 motor (MO) leads (CBL4) occurred on February 17, 1998, and February 21, 1998, after the leads became overheated at splice connections. PG&E believes that the condition of leads prior to failure did not assure the motors would have fulfilled their safety function prior to entering Mode 5 (Cold Shutdown) on February 15, 1998.

B. Background

TS 3.6.2.3. requires: (1) at least four CFCUs, or (2) at least three CFCUs, each of the three supplied from a different vital bus be operable during Modes 1 through 4 (Hot Shutdown).

The containment cooling system (CCS) helps maintain containment integrity by:

- Reducing postaccident containment pressure by condensing steam and removing heat in conjunction with the containment spray system (CSS)(BE);
- Circulating containment atmosphere to prevent localized formation of postaccident hydrogen in flammable concentrations; and
- Supplementing the CSS by removing postaccident iodine by circulating air above and below the operating deck.

The CFCU motors are two speed, 460 V, 60 hertz, single winding, squirrel cage induction motors. During operation in Modes 1 through 4, three CFCUs are normally at high speed to provide the normal containment cooling function. During accident conditions, all CFCUs operate in low

speed to prevent motor overload due to the high density steam/air mixture present in containment. The equipment qualification (EQ) file for the CFCU motors requires that they remain operable for 1 year after the start of the event. The EQ file is part of the design basis for the plant.

Diablo Canyon Power Plant design also includes a CSS consisting of two trains of containment spray pumps that take suction from the refueling water storage tank and spray the containment atmosphere. The CSS reduces postaccident containment pressure by condensing steam. The CSS removes radioactive iodine, released from damaged fuel during the accident, from the containment atmosphere. It also raises the pH of the water in the containment sump to prevent the release of the removed iodine back into the atmosphere.

C. Event Description

On February 17, 1998, with Unit 2 in Mode 5 during 2R8, operators started CFCU 2-5 in low speed. One minute later the fan was shifted to high speed. At approximately the same time, a technician standing near the fan reported smoke coming from the motor terminal box and immediately notified the control room. Operators deenergized the motor and opened the power supply breaker. Investigation revealed a butt splice on the T3 low speed motor lead extension had burnt open. PG&E initiated actions to investigate the event, perform root cause and failure analyses, and obtain current and temperature readings at the motor terminal boxes on the available Unit 2 CFCU motors.

On February 21, 1998, during a test run of CFCU 2-4 motor, done as part of the investigation for the CFCU 2-5 failure, a T-2 motor lead extension splice became excessively hot. The Raychem insulation covering the splice was found charred and cracked open. The control room was notified and the motor was deenergized. The T2 lead had overheated at a butt splice connection used to extend the motor lead. The cracked Raychem covering the butt splice invalidated the motor's environmental qualification. Although the lead did not completely fail (total separation), it was determined that complete failure was imminent. This lead was removed and submitted for failure analysis.

Both events occurred during 2R8. Therefore, neither motor lead failure created an operability concern at the time because the CFCUs are not required to be operable in Modes 5 or 6 (Refueling).

TEXT

PG&E routinely replaces CFCU motors during outages with refurbished spare motors. After preventive maintenance, the refurbished motors are installed in other positions in subsequent outages. PG&E determined the original motor lead extensions had been installed on CFCU 2-4 motor on February 16, 1991, when it was in the Unit 1, 1-4 position. The motor was moved from the Unit 1, 1-4 position, to the Unit 2, 2-4 position, on October 11, 1994. On June 3, 1995, a lead failure occurred (see discussion below).

The original lead extensions had been installed on CFCU 2-5 motor on February 13, 1991, when it was in the Unit 1, 1-5 position. The motor was moved to the Unit 2, 2-5 position, on October 6, 1994.

Previous Failures

PG&E also determined that previous failures of CFCU motor leads had occurred since 1990.

On February 5, 1991, a CFCU 1-5 motor lead failed near a lugged connection and was caused by a loose connection due to personnel error. Other CFCUs in Units 1 and 2 were inspected for damage. The lead was replaced and no other damaged leads were identified.

On August 13, 1994, a CFCU 2-3 lead failure occurred at a bolted splice connection. An analysis and mockup testing of this failure could not determine the precise cause of failure, nor could it duplicate the failure. The lead was repaired. Thermography scans were performed on all other CFCUs with satisfactory results.

On June 3, 1995, a CFCU 2-4 lead extension failure occurred at the T3 lead splice, a #3 AWG to #5 AWG termination. The termination was burnt open and heavily damaged, so that the analysis could not determine the cause of failure. Six lead extensions were replaced on this motor, and thermography scans were performed on other CFCUs with satisfactory results.

Motor Differences

PG&E determined several differences existed between the CFCU 2-4 and 2-5 CFCU motors and the other installed motors and spares.

- The CFCU 2-4 and 2-5 motors were originally supplied in 1986 and are newer than the other motors.
- The CFCU 2-4 and 2-5 motors use a different internal motor lead connection configuration. The two T3 low speed motor leads carry more current than the other low speed leads when the motor is run in high speed. The low speed leads for the other motors do not carry this higher current when the fan is run in high speed.
- The CFCU 2-4 and 2-5 motors were unique because the supplied low speed lead size was #3 AWG (12 conductors). The motor lead extension used for all motors was AWG #5 (7 conductors), resulting in a reduction of conductor sizes at the motor lead extension splices. This size reduction at the butt splice required the installation of filler strands in the splice. The other motors have #5 AWG motor low speed lead extensions which are the same size as the lead extension wire.
- The lead extensions for the CFCU 2-4 and 2-5 motors were installed by PG&E personnel. The lead extension for the other motors were installed by Westinghouse.

Failure Analysis

On April 3, 1998, PG&E completed the motor lead failure analyses and reached the following conclusions:

Due to the damage sustained, the only conclusion that could be made for the 2-5 motor lead was that the crimp around the AWG #5 conductor was the point of failure. The analysis for the 2-4 motor lead showed that the splice was near the point of failure. Inadequate fill (number of additional strands at the AWG #5 to AWG #3 splice) was the primary cause of the failure, with poor workmanship (i.e., cut and nicked strands) as a secondary contributor. The analysis report also examined the nonfailed connections from CFCU 2-4. Splice deficiencies were noted including the presence of wire insulation and

epoxy, accumulation of corrosion products, and one case of a conductor not fully inserted into the crimp connector.

On April 24, 1998, based on the above analysis, PG&E concluded that the CFCU 2-4 and 2-5 motor lead extensions had been installed using less than adequate methods which created a degraded condition. Although a degraded condition was created at the time of motor lead extension installation, the condition did not adversely affect motors for an extended period. However, PG&E assumed that as the condition worsened, a point was reached when the motors would not have been able to carry out their safety function during accident conditions. At this point, the motors could have been considered inoperable, and TS 3.6.2.3. would not have been met.

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

None.

E. Dates and Approximate Times for Major Occurrences

1.	February 17, 1998:	CFCU 2-5 motor leads failed due to overheating
2.	February 21, 1998:	CFCU 2-4 motor leads identified as degraded due to raychem jacket failure.
3.	April 24, 1998:	PG&E determined the condition was reportable pursuant to 10 CFR 50.73 (a)(2)(i)(B).

F. Other Systems or Secondary Functions Affected

None.

G. Method of Discovery

The condition was discovered by visual observation.

TEXT

H. Operator Actions

Operators immediately deenergized the CFCU motors.

I. Safety System Responses

None.

III. Cause of the Problem

A. Immediate Cause

The immediate cause of splice failure was high temperature at the motor lead extension splice due to a high resistance connection.

B. Root Cause

The cause of failure was less than adequate splicing methods which created a degraded condition in the CFCU 2-4 and 2-5 motor lead extensions. The condition caused premature failure of splice connections with inadequate fill as the primary cause of failure and poor workmanship as a significant contributor.

IV. Analysis of the Event

PG&E believes that the period of time that CFCU 2-4 and 2-5 may have been significantly degraded is limited to the latter part of the eighth fuel cycle, which ended in February 1998. This safety analysis was performed for the period from February 1997 through February 1998.

The CCS is comprised of five CFCUs to assure that, in the event of a single active failure, there will be at least two CFCUs operable during an accident. The loss-of coolant accident (LOCA) analyses demonstrates that two CFCUs are adequate to provide the needed containment atmospheric mixing to prevent localized hydrogen accumulation and to provide adequate heat removal capability. The CCS is designed such that a combination of one containment spray train and any two CFCUs are capable of providing adequate containment heat removal to assure that the maximum containment design pressure is not exceeded following a LOCA.

TEXT

The power supplies and associated protection system trains for the CFCUs and the CSS pumps are as follows.

VITAL BUS AND TRAIN		
F (A)	H (A / B)	G (B)
CFCU 2-1	CFCU 2-4	CFCU 2-3
CFCU 2-2		CFCU 2-5
	CS Pump 2-2	CS Pump 2-1

The loss of either vital Bus G or H would leave one train of containment spray and at least two nondegraded CFCUs (2-1 and 2-2) operable. Therefore, a failure of either of these buses during a LOCA would not have resulted in the plant being outside its design bases.

Maintenance records from January 1, 1997, to the beginning of 2R8, indicate that CFCUs 2-1, 2-2, and 2-3 were available for operation except for brief periods of time (approximately 5 days total for each CFCU) for inspections and a control circuit modification (timing relay replacement). In each case, the CFCUs were cleared electrically only, and could have been returned to service in a few hours if required. Additionally, except for one case during the periods when the nondegraded CFCUs were inoperable, the other two CFCUs and their vital buses and associated emergency diesel generators were operable. Therefore, for all but one case, it is reasonable to assume that two CFCUs would have been operable had a LOCA occurred.

In one case, from July 21, 1997, at 0958 PST, to July 22, 1997, at 1515 PST, both CFCUs 2-1 and 2-2 were cleared at the same time for timer replacement. TS 3.6.2.3 Action Statement a. was entered. During this period, a single failure is not required to be postulated, and CFCU 2-3 would be available. Because both CFCUs 2-1 and 2-2 are fed from vital Bus F, this case is bounded by the single failure of vital Bus F, considered below.

The bounding scenario for this event would be a large break LOCA with a single failure of vital Bus F. In this case, two trains of containment spray and one nondegraded CFCU (2-3) would be operable. The two remaining CFCUs (2-4 and 2-5) contained degraded splices. However, even if one or both of the CFCUs had failed, an engineering evaluation indicates that two trains of containment spray and the remaining CFCU 2-3 would have maintained containment pressure and temperature less than design bases values during a LOCA.

Although CFCU 2-4 and 2-5 motor leads were degraded and would have been required to operate in a harsh LOCA environment, PG&E does not believe a simultaneous and immediate failure of the CFCUs 2-4 and 2-5 at the start of a large break LOCA is credible. Several variables would affect the life of each splice, including differences in the quality of workmanship and the motor's previous operating history (number of starts and stops). Additionally, quarterly surveillance testing indicated that the motors started successfully in low speed on each demand during the previous operating cycle.

Finally, the vital 480V switchgear rooms are located adjacent to each other, and near nonvital 480V switchgear. If additional fan coolers were desirable, power could have been restored to CFCUs 2-1 and 2-2 through the use of jumpers within a day following the assumed loss of the vital F Bus.

The degraded condition of CFCUs 2-4 and 2-5 would not affect the main steam line break in containment analysis. The limiting (highest temperature and pressure in containment) transients reach their peak in less than 10 minutes after the break occurs. The main steam line break transient is essentially ended when the associated steam generator blows down, and long term cooling from the CFCUs is not necessary.

Therefore, because sufficient engineered safety feature equipment was available to meet accident analysis limits, this condition did not adversely affect the health and safety of the public.

V. Corrective Actions

A. Immediate Corrective Actions

Both fans were deenergized and were replaced with spare motors which had been repaired and had the lead extensions replaced by Westinghouse. Temperature, current, and lead diameter readings were taken on the remaining Unit 2 motors and all Unit 1 motors with satisfactory results.

PG&E performed current and temperature measurements on all other CFCU motors at the lead extension splices.

All other motors had lead extension splices performed by Westinghouse or do not have lead extensions.

TEXT

CFCUs 2-4 and 2-5 were placed in Category A.1 under the Maintenance Rule Program.

B. Corrective Actions to Prevent Recurrence

CFCU 2-4 and 2-5 motors will be sent to Westinghouse for lead extension replacement.

The PG&E splicing guidance will be revised to specify the proper fill when making a splice between two different size wires.

Craft training will be performed to address the splicing condition described in this LER.

VI. Additional Information

A. Failed Components

None.

B. Previous Similar Events

None.