Pacific Gas and Electric Company

Diablo Canyon Power Plant
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January 22, 2003

PG&E Letter DCL-03-003

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

Docket No. 50-323, OL-DPR-82
Diablo Canyon Unit 2
Licensee Event Report 2-2002-003-01
Technical Specification 3.7.7 Not Met Due to Cable Fault

Dear Commissioners and Staff:

PG&E is submitting the enclosed revised licensee event report regarding Technical Specification 3.7.7 not being met due to a cable fault, which caused Diablo Canyon, Unit 2, to exceed the completion time of restoring vital Component Cooling Water Pump 2-3 to operable status. The revision contains the final cause analysis and corrective actions to prevent recurrence.

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

Sincerely,

David H. Oatley
Vice President and General Manager – Diablo Canyon

smg/2246/N0002150
Enclosure
cc/enc: Ellis W. Merschoff
David L. Proulx
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INPO

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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 7

TITLE (4)

Technical Specification 3.7.7 Not Met Due to Cable Fault

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
08	22	2002	2002	- 0 0 3 -	0 1	01	22	2003		

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	
Larry 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
X	C C	C B L 5	O 0 4 0	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 August 22, 2002, at 0332 PDT with Unit 2 in Mode 1 (Power Operation) at 100 percent power, Required Action A.1 for Technical Specification 3.7.7, Vital Component Cooling Water (CCW) System, was not met when the completion time was exceeded due to a cable fault.

On August 19, 2002, after receiving brief CCW Pump 2-3 ground alarms, operators started CCW Pump 2-1, shut down Pump 2-3, and declared CCW Pump 2-3 inoperable until the cause could be determined.

On August 21, 2002, in response to a request for enforcement discretion, the NRC granted verbal enforcement discretion for 72 hours until the motor feeder cable replacement and post-maintenance testing could be completed. On August 23, 2002, at 1342 PDT, repairs and testing were completed, and CCW Pump 2-3 was declared operable.

The immediate cause of the event was a ground fault in the "C" phase power cable to CCW Pump 2-3, resulting in pump inoperability. Immediate corrective actions included replacing all three phases of the CCW Pump 2-3 cables. The root cause of the event was a manufacturing defect based on the presence of isolated contaminant particles in the insulation. Corrective actions to prevent recurrence include replacing 4 kV cables in both units.

TEXT

I. Plant Conditions

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

II. Description of Problem

A. Background

The Component Cooling Water (CCW) System [CC] provides a heat sink for the removal of heat from safety related components during a Design Basis Accident (DBA) or transient. During normal operation, the CCW System provides this function for safety-related components, various nonessential components, and the spent fuel storage pool [DA].

The CCW system consists of three CCW pumps [P] powered by separate vital 4.16 kV [EB] buses [BU], two CCW heat exchangers [HX], and a two-chamber CCW surge tank. The piping system consists of three parallel headers. The headers extend from the outlet of the heat exchangers through the header heat loads to the suction of the CCW pumps. Headers A and B supply cooling to safety-related components while header C supplies cooling to nonsafety-related components. Normally, two CCW pumps are operating with the third CCW pump in standby.

Technical Specification (TS) 3.7.7, "Vital Component Cooling Water System," requires that two vital CCW loops shall be operable. TS 3.7.7, Bases, Limiting Condition for Operation (LCO), states that in the event of a design basis accident, one vital CCW loop is required to provide the minimum heat removal capability assumed in the safety analysis for the systems to which it supplies cooling water assuming occurrence of a single failure. To ensure this requirement is met, two vital loops of CCW must be operable. To meet the LCO on CCW loops, vital Headers A and B, both CCW heat exchangers, the surge tank, and all three CCW pumps must be operable.

B. Event Description

On August 18, 2002, at 2200 PDT, with Diablo Canyon Power Plant (DCPP) Unit 2 at 100 percent power and CCW Pumps 2-2 and 2-3 running, a brief CCW Pump 2-3 feeder ground alarm [VA] was received. A walkdown of CCW Pump 2-3 and the associated breaker did not identify any problems. The CCW Pump 2-3 stator current and temperature were also normal.

TEXT

On August 18, 2002, at 2251 PDT and on August 19, 2002, at 0004 PDT, additional CCW Pump 2-3 feeder ground alarms were received. The duration of each alarm was less than 0.3 seconds. Following the alarm that occurred on August 19 at 0004 PDT, CCW Pump 2-1 was started and CCW Pump 2-3 was shut down. The CCW Pump 2-3 breaker cubicle was opened and inspected for abnormal indications. No abnormal odors or problems were noted in the breaker cubicle. A review of the plant drawings determined that Relay 50NHH12, which was the source of the alarm, senses a ground between the CCW Pump 2-3 motor [MO] and breaker, indicating an actual ground fault had occurred.

On August 19, 2002, at 0332 PDT, Operations declared CCW Pump 2-3 inoperable until investigations of the pump relay, motor, and cable [CBL5] could be completed.

On August 19, 2002, the feeder cable and motor were meggered at 2500V dc, and no problems were identified. The feeder cable and motor were subsequently tested using a high potential tester. They failed this test when ramping up from 2500V to 4000V. The motor and cables were then determinated and each was tested independently. The motor and feeder cable "A" and "B" phases tested satisfactorily at 2500V, but the "C" phase cable failed this test.

Following the identification of the ground in the CCW Pump 2-3 motor feeder cable, additional work was performed to develop the repair plan, repair schedule, work orders, and clearances required to support the removal of the cable for all three phases and the installation of replacement cables.

On August 21, 2002, PG&E submitted letter DCL-02-100 to formally request enforcement discretion. On August 21, 2002, at 1320 PDT, PG&E telephoned the NRC to request enforcement discretion regarding compliance with TS 3.7.7, and at 1410 PDT, the NRC verbally granted enforcement discretion until August 25, 2002, at 0332 PDT (72 hours past the required completion time).

On August 22, 2002, at 0332 PDT, Required Action A.1 of TS 3.7.7 was not met when the required completion time was exceeded.

On August 23, 2002, at 1342 PDT, CCW Pump 2-3 was declared operable following completion of cable replacement and post-maintenance testing, and on August 25, 2002, at 0332 PDT, the enforcement discretion expired. CCW Pump 2-3 was inoperable for 106.2 hours.

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

There were no other inoperable structures, systems, or components that contributed to the event.

D. Other Systems or Secondary Functions Affected

To ensure personnel safety during the cable replacement, Safety Injection (SI) [BQ] Pump 2-2 and Residual Heat Removal (RHR) [BP] Pump 2-2 were cleared due to the proximity of their power cables to the CCW Pump 2-3 motor feeder cable.

E. Method of Discovery

On-shift PG&E licensed operators received CCW Pump 2-3 feeder ground alarms in the control room during normal operation. After pump and breaker walkdowns, operators inspected the breaker cubicle and identified Relay 50NHH12 as the source of the alarms. High potential testing of the cables identified the ground fault.

F. Operator Actions

After receiving a third brief ground alarm, operators started CCW Pump 2-1 and shut down CCW Pump 2-3 and declared it inoperable.

G. Safety System Responses

None

III. Cause of the Problem

A. Immediate Cause

TS 3.7.7 LCO and Required Action A.1 were not met because the "C" phase power cable to CCW Pump 2-3 shorted to ground and could not be replaced within the TS required completion time.

B. Root Cause

All three phases of the feeder cable were sent to an offsite vendor for failure analysis. Evaluations performed by the offsite vendor included a detailed visual examination to locate the fault site and any other anomalies, characterization of the fault site (microscopic examination of thin cross sections, identification of possible water trees, and infrared spectroscopy to identify gross changes in the base compound), and testing of the tensile and elongation properties of the cable insulation and jacket.

The electrical evaluation of the cable included partial discharge inception (per ICEA T-24-380-1994) and AC breakdown of cable sections (per ASTM D 149, voltage values per IEEE Standard 4). Investigation of the cable environment identified no chemical contaminants. PG&E determined that the cable was not submerged in water and no water, excessive heat, or foreign agents were present in the cable conduit. In addition, installation damage, increased electrical operating stresses, thermal aging, and damage due to maintenance practices were ruled out.

Observation of the "C" phase fault site by the offsite vendor revealed an unusual square-shaped area in the insulation, suggesting the presence of a foreign particle. Further observation of the "B" phase AC breakdown site revealed a discrete contaminant particle in the insulation containing bonds similar to a cellulose-containing polymer, suggesting the molecule contained a bonded hydroxyl.

The root cause of this event was determined to be a manufacturing defect, based on the presence of isolated contaminant particles within the cable insulation, as identified by the offsite vendor. Over time, water (moisture) most likely diffused into the insulation and was attracted to the hydroxyl groups in the contaminant particle, thus changing the particle's dielectric properties and making it more conductive.

The CCW Pump 2-3 motor feeder cable failure is the first cable failure at DCPP in the last five years and not indicative of a negative trend. The potential presence of contaminant particles in the insulation of the remaining safety-related cables is not an immediate operability concern, although under the right conditions, it could lead to a reduction in the life of the cable.

IV. Assessment of Safety Consequences

There were no actual safety consequences involved in this event since one vital CCW loop, which included two CCW pumps and one heat exchanger, remained operable after CCW Pump 2-3 was declared inoperable. In the event of a design basis accident, the CCW system serves as a mitigating system and one vital loop provides the minimum heat removal capability assumed in the safety analysis for the systems to which it supplies cooling water. The design basis of the CCW System is for one vital CCW loop to remove the post-DBA heat load without exceeding a CCW supply temperature of 120 degrees Fahrenheit with an allowable transient not to exceed 140 degrees Fahrenheit for more than 6 hours.

With one vital CCW loop inoperable, PG&E used the "at power" probabilistic risk assessment model to calculate the change in core damage frequency associated with increasing the completion time to 144 hours (72 hours beyond the 72-hour TS completion time). Three configurations were considered in the risk assessment:

1. CCW Pump 2-3 out of service.
2. The combination of CCW Pump 2-3 and Auxiliary Feedwater (AFW) Pump 2-1 out of service (for planned maintenance).
3. CCW Pump 2-3 out of service, with SI Pump 2-2 and RHR Pump 2-2 de-energized to ensure personnel safety of the maintenance workers.

The corresponding change in core damage frequency (ΔCDF) was calculated as 2.60E-7 and, therefore, not significantly sensitive to small changes in duration of each one of the configurations. Based on the above information and analyses, PG&E used the NRC's significance determination process and believes the event was very low risk.

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

V. Corrective Actions

A. Immediate Corrective Actions

PG&E replaced all three phases of the CCW Pump 2-3 motor feeder cables with similar Okonite 5 kV cable (red ethylene propylene rubber (EPR) insulation, copper foil shield, linear low density polyethylene (LLDPE) jacket). The pump was declared operable on August 23, 2002, at 1342 PDT and the failed cable was shipped to a laboratory for failure analysis.

B. Corrective Actions to Prevent Recurrence

PG&E plans to replace safety-related 4 kV cables manufactured prior to 1974 as a conservative corrective action to prevent recurrence. There is a possibility that cables manufactured prior to 1974 may have had contaminants introduced in the insulation due to the insulation extrusion process used at that time. This conclusion is based on the fact that the cable vendor's manufacturing process changed, in 1974, from an open bulk material handling system to a closed system, which controlled exposure of bulk materials to the environment.

PG&E plans to replace the suspect cables using a risk-based approach. In determining cable replacement priority and sequence, a number of factors were considered, including probabilistic risk assessment ranking for single component failure impact, safe shutdown (SSD) equipment requirements as described in the Final Safety Analysis Report, allowed outage times of affected components, and the duration the various circuits have been energized. Cable replacements will include those cables associated with components such as RHR Pumps, Charging Pumps, CCW Pumps, Safety Injection Pumps, AFW Pumps, and Diesel Generator feeders. Initial replacement activities will ensure that the cables associated with a complete train of SSD equipment will be replaced concurrently, and that all suspect cables will be replaced during the next several refueling outages for each unit.

VI. Additional Information

A. Failed Components

The CCW Pump 2-3 motor feeder cable was Okonite 5 kV cable (copper conductor, black EPR insulation, copper foil shield, neoprene jacket).

B. Previous Similar Events

DCPP has experienced eight medium voltage cable failures since 1989. Five of these cases involved water accumulation in the cable vaults and pull boxes. All of these failures were associated with cables exposed to an outside environment, but in all cases a root cause could not be determined. For the three cases in which water was not a factor, the CCW Pump 2-3 cable failure is similar in that the preliminary evaluation shows no evidence of installation damage, manufacturing defects, electrical operating stresses, inadequate maintenance practices, thermal aging, or degradation.