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March 10, 1994

Charles Bechhoefer, Chairman
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555

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Jerry R. Kline
Administrative Judge
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U.S. Nuclear Regulatory Commission
Washington, DC 20555

Re: Pacific Gas and Electric Co. (Diablo Canyon Nuclear Power Plant, Units 1 and 2), Docket Nos. 50-275-OLA, 50-323-OLA (Construction Period Recapture) - 2

Dear Administrative Judges:

In keeping with our continuing obligation to apprise the Licensing Board of new information potentially relevant to matters before the Board, attached is a copy of Pacific Gas and Electric Company's LER 1-93-012-01, dated March 8, 1994. This LER revision concerns the past capability of the Auxiliary Saltwater ("ASW") system to meet its design basis, i.e., the same issue addressed in the San Luis Obispo Mothers for Peace motion of February 25, 1994.

The LER revision specifically supplements the PG&E evaluation, previously submitted to the NRC Staff on February 15, 1994 (PG&E Letter No. DCL-94-037), of the safety significance of past conditions related to the ASW system. The PG&E submittal of

DS03

February 15, 1994, was provided to the Board and parties as part of PG&E's filing in this proceeding of March 7, 1994.

Very truly yours,

David A. Repka

David A. Repka

Counsel for Pacific Gas and Electric Company

Attachment

cc: Service List

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Gregory M. Rueger
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March 8, 1994

PG&E Letter DCL-94-049

U.S. Nuclear Regulatory Commission
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Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Licensee Event Report 1-93-012-01
Auxiliary Saltwater System Outside Design Basis Due to Fouling

Gentlemen:

Pursuant to 10 CFR 50.73(a)(2)(ii)(B), PG&E is submitting the enclosed revision to Licensee Event Report 1-93-012-00 concerning the auxiliary saltwater (ASW) system being outside its design basis due to fouling. This revision is being submitted to report the results of a comprehensive evaluation of the past capability of the ASW system to meet its design basis. This revision provides the safety significance, root cause, and corrective actions.

PG&E's comprehensive evaluation concluded that this event had no safety significance and that the health and safety of the public were not affected.

Sincerely,

Gregory M. Rueger

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

DC0-93-EN-N022

Enclosure

6398S/DPS/2246

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 15

TITLE (4) AUXILIARY SALTWATER SYSTEM OUTSIDE DESIGN BASIS DUE TO FOULING

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 (8)
12	30	93	93	- 0 1 2 -	0 1	03	08	94	DIABLO CANYON UNIT 2	0 5 0 0 0 3 2 3
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OPERATING MODE (9)	3	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR: (11)
POWER LEVEL (10)	0 0 0	X 10 CFR 50.73(a)(2)(ii)(B)
		OTHER (Specify in Abstract below and in text, NRC Form 366A)

LICENSEE CONTACT FOR THIS LER (12)

NAME	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

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

ABSTRACT (16)

On December 30, 1993, at 1150 PST, with Unit 1 in Mode 3 (Hot Standby) at 0 percent power and Unit 2 in Mode 1 (Power Operation) at 100 percent power, PG&E determined that the auxiliary saltwater (ASW) system and its associated component cooling water (CCW) heat exchangers for both units may not have met their design basis for certain time periods prior to implementation of continuous chlorination. Continuous chlorination was fully implemented in September and November 1992 for Units 1 and 2, respectively. This condition was reported to the NRC as a one-hour, non-emergency report in accordance with 10 CFR 50.72 (b)(1)(ii)(B) at 1150 PST on December 30, 1993.

The cause of this condition was an inadequate understanding of the effects of fouling on the CCW heat exchangers.

The ASW systems for both units currently are operable given the present maintenance, operational, and testing activities. These activities assure that the ASW system will remain sufficiently clean such that fouling will not prevent the system from performing its design basis functions. CCW heat exchanger tests on both units will be performed to provide additional confirmation of the adequacy of operational and maintenance practices to assure that the CCW heat exchangers meet their design basis requirements. An equipment control guideline was implemented to ensure compensating actions are taken if the ASW chlorination system becomes inoperable.

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I. Plant Conditions

Unit 1 and Unit 2 operated in various modes at various power levels while this condition existed.

II. Description of Event

A. Summary:

On December 30, 1993, at 1150 PST, with Unit 1 in Mode 3 (Hot Standby) at 0 percent power and Unit 2 in Mode 1 (Power Operation) at 100 percent power, PG&E determined that the auxiliary saltwater (ASW) system (BI) and its associated component cooling water (CCW) heat exchangers (BI)(HX) for both units may not have met their design basis requirements for certain time periods prior to implementation of continuous chlorination. Continuous chlorination was fully implemented in September and November 1992 for Units 1 and 2, respectively. This condition was reported to the NRC as a one-hour, non-emergency report in accordance with 10 CFR 50.72 (b)(1)(ii)(B) at 1150 PST on December 30, 1993.

B. Background:

1. Design

Following a loss of coolant accident (LOCA) or a main steam line break (MSLB) inside containment, the CCW system is required to provide cooling water to the containment fan cooling units (CFCUs) (BK)(FAN) for containment heat removal, and to the various engineered safeguards features (ESF) pump coolers. During the recirculation phase of the LOCA, the CCW system also cools the residual heat removal (RHR) heat exchangers (BP)(HX). In order for the CCW system to perform its function, CCW water temperature must remain at or below 120°F for continuous operation and may exceed 120°F, up to a maximum of 132°F, for no longer than 20 minutes.

The CCW system is also designed to remove heat during normal operation from the CFCUs, ESF pump coolers, and various non-essential heat loads. The CCW system includes three pumps (BI)(P), two heat exchangers, two vital headers and one non-vital header. The heat transferred to the CCW system is transferred to the ASW system through the two heat exchangers. Following an accident, the temperature of the CCW system is primarily a function of heat input to the system from the CFCUs and RHR heat exchangers (during recirculation), and heat removal from the system by the ASW system.

2. Biological Fouling and Scaling

Biological fouling consists of two main components, microfouling and macrofouling.

Macrofouling is the blockage of flow through the heat exchanger tubes due to mussels and barnacles or other foreign materials in the seawater environment. Blocked tubes reduce heat transfer capability by reducing the effective surface area.

Microfouling includes both organic and inorganic materials that adhere to the ASW heat exchanger tubes and, by their presence, degrade heat transfer at the tube surface. Scaling is related to the operation of the cathodic protection system. Calcium carbonate can be expected to plate out on the inside surface near the end of the tubes. Since the calcium carbonate deposit is a thin layer and the affected area is small, the overall impact of calcification on the heat transfer capability is small.

C. Event Description:

1. Previous Reportable Events on ASW System

In LER 1-84-040, submitted March 24, 1989, PG&E reported that engineering recommendations for plant operation to assure compliance with the design bases for the CCW system and the ASW system were not incorporated in plant procedures and emergency procedures. Emergency Operating Procedure (EOP) E-0, "Reactor Trip on Safety Injection," was revised to add a new step to verify that both ASW pumps start following a safety injection. If only one pump starts, the operator is instructed to place the second CCW heat exchanger in service.

In LER 1-91-018, submitted January 17, 1992, PG&E determined that the heat load on the CCW system during the cold-leg recirculation phase following a LOCA could potentially exceed the CCW system design basis temperature limits. Because the injection phase had previously been considered the limiting case for CCW temperature, this condition was considered to be outside the design basis of the CCW system. EOP E-1.3, "Transfer to Cold Leg Recirculation," was revised to require reducing CFCU and RHR heat loads if two ASW pumps and two CCW heat exchangers are not operating.

2. Heat Exchanger Reevaluation

In response to GL 89-13, PG&E performed testing of the Units 1 and 2 CCW heat exchangers in February 1991 and September 1991, respectively. Based on engineering judgement at the time, PG&E

concluded that the testing adequately demonstrated that the CCW heat exchangers met design basis requirements.

A QA surveillance report of the ASW system, issued July 28, 1993, identified a concern regarding the ability of the ASW system to satisfy its design basis heat removal requirements with the CCW heat exchanger(s) in the fouled condition corresponding to a differential pressure (dp) of 140 inches of water.

An NRC inspection performed in December 1993 (Inspection Report 50-275/323-93-36) identified a concern with the basis for the operability of the ASW system with regard to CCW heat exchanger macrofouling, microfouling, and tube plugging.

In response to those concerns, PG&E initiated a Technical Review Group (TRG) to perform a comprehensive evaluation of the present and past capability of the ASW system to meet its design basis. The following is a summary of the results of the investigation of the parameters affecting ASW system operability. Detailed results of the investigation are discussed in PG&E Letter No. DCL-94-037 (February 15, 1994).

3. Operability Parameters

a. Biological Controls on the ASW System

DCPP has implemented chlorination to control both micro- and macrofouling. Batch chlorination was in use at DCPP from late-1984 through 1991, although a few periods existed during this timeframe when equipment problems or system enhancement modifications precluded the use of chlorination. Since 1992, the method used has been continuous chlorination. Both methods of chlorination can control the growth of macrofouling as well as microfouling, although continuous chlorination is a superior method. The control of macrofouling requires higher chlorine concentrations than the control of microfouling; however, DCPP maintains sufficient chlorine in the ASW system to control both types of biofouling in the piping and the heat exchangers.

On August 23, 1990, microfouling samples were taken from CCW 1-2 heat exchanger. Biofouling was noted on the waterbox walls and along the interior surfaces of the individual tubes. This was an unusual circumstance since appreciable microfouling in the four CCW heat exchangers had not been found in previous CCW heat exchanger inspections. CCW 1-1 heat exchanger was inspected September 5, 1990, and no biofouling buildup was noted. In response to the observations noted in CCW 1-2 heat exchanger, daily chlorine injections were made for two weeks following the inspection.

In 1992 continuous chlorination of the ASW system was implemented as follows:

- January 1992 ASW line 1-1
- March 1992 ASW line 2-1
- September 1992 ASW line 1-2
- November 1992 ASW line 2-2

b. Maintenance Practices

Cleaning of heat exchangers during operation is periodically performed to remove debris such as mussels, barnacles, shells, or other debris that is obstructing flow (macrofouling). As discussed below, during operation, differential pressure (dp) is used as a threshold indicator to determine when cleaning is required. In addition, based on an inspection of the heat exchanger during the cleaning activities, waterjetting may also be performed if necessary to remove accumulated biofouling.

In accordance with Maintenance Procedure MP M-56.16, "Heat Exchanger Tube Cleaning," the heat exchanger tubes are mechanically scraped during each refueling outage (nominally every 18 months: ref. Recurring Task Numbers 51872, 551872, 53587, and 551886). Cleaning of the tubes with a waterjet has been performed periodically in the past during macrofouling cleaning (whenever the dp reaches its administrative limit).

c. CCW Heat Exchanger Differential Pressure

Continuous monitoring of the dp across the heat exchanger is a diagnostic tool and cannot, by itself, quantitatively be used to determine operability. However, it can be used as a threshold indicator to assess the heat exchanger condition during operation. Differential pressure is monitored by taking shift readings of dp, as well as by a dp alarm in the control room. Differential pressure provides an indication of the heat exchanger condition and is used to determine when the heat exchanger should be cleaned. Differential pressure provides an indication of the heat exchanger condition that is qualitatively linked to each heat exchanger's heat transfer capability. Although the measured dp across the heat exchanger does not provide an all-inclusive indicator of heat exchanger performance, it does give a general indication of the combined effect of macrofouling and heavy scaling.

Therefore, the dp measurement, with microfouling under control, is one indicator of overall heat exchanger functionality. Maintenance, surveillance testing, and inspections during cleanings are also other indicators.

Mechanical cleaning of the heat exchangers every outage, and continuous chlorination and periodic waterjetting during operation minimizes microfouling and scaling. Therefore, differential pressure is a reasonable indicator of overall heat exchanger functionality.

The dp setpoint from plant startup until January 1986 was 110 inches, which resulted in a standing alarm. From January 1986 until April 1988, the dp setpoint was 170 inches. From April 1988 until September 1989, the dp setpoint was 167 inches. From September 1989 until November 1989, the setpoint was 120 inches. The current setpoint of 140 inches was initiated in November 1989.

Based on a review of the above macrofouling information, it was determined that the limiting combination of macrofouling and high ocean temperature occurred on November 8, 1987.

d. Operational Controls

As discussed above, PG&E enhanced its emergency procedures in February 1989 to place a second CCW heat exchanger in service if both ASW pumps fail to start following an accident. The emergency procedures were further enhanced in 1991 to include directions regarding equipment configurations to control CCW temperature during recirculation.

4. Heat Exchanger Performance Testing

On February 2, 1991, in response to the requirements of GL 89-13, PG&E performed testing of the Unit 1 CCW heat exchangers to verify their capability to meet design basis (nameplate) heat removal requirements. The performance results were:

COMPONENT	HEAT EXCHANGE RATIO
CCW HX 1-1	1.080
CCW HX 1-2	0.987

On September 1, 1991, PG&E performed testing of the Unit 2 CCW heat exchangers. The performance results were:

COMPONENT	HEAT EXCHANGE RATIO
CCW HX 2-1	1.112
CCW HX 2-2	1.109

Based on consultation with an industry heat exchanger expert and further evaluation of the test results, PG&E now concludes that the CCW 1-2 heat exchanger testing results (which were evaluated using Heat Transfer Consultants, Inc.'s HTC-STX computer model) did not meet the design basis. However, PG&E requested HOLTEC, International to analyze the GL 89-13 test data for the CCW 1-2 heat exchanger. The HOLTEC model was specifically developed for GL 89-13 evaluation and has been widely used by the nuclear power industry. It has been validated using an approved software quality assurance program and has been used in audit responses; therefore, it is considered a good validation of the HTC-STX program. The results of the HOLTEC model reanalysis of the GL 89-13 test data predicted that the CCW 1-2 heat exchanger performance at nameplate condition would be 101 percent with a 95 percent confidence level.

5. Conclusion

On December 30, 1993, at 1150 PST, with Unit 1 in Mode 3 (Hot Standby) at 0 percent power and Unit 2 in Mode 1 (Power Operation) at 100 percent power, PG&E determined that the CCW heat exchangers for both units may have not met their design basis prior to implementation of continuous chlorination. This condition was reported to the NRC as a one-hour, non-emergency report in accordance with 10 CFR 50.72 (b)(1)(ii)(B) at 1150 PST on December 30, 1993. Continuous chlorination was fully implemented in September and November 1992 for Units 1 and 2, respectfully.

The continuing investigation reviewed the current maintenance, operational, and testing practices. The maintenance practices that provide assurance that the heat exchangers will remain sufficiently clean of biofouling include continuous chlorination, scraping of the tubes during refueling outages, cleaning of the tubes and tubesheet when the measured dp is 130 inches of water, and declaring the heat exchanger inoperable at 140 inches of water.

The review of historical information determined that a combination of three factors led to the microfouling growth discovered in CCW 1-2 heat exchanger in August 1990. Chlorination was not performed for a period of approximately six months prior to the Unit 1 heat exchanger inspections. During this period, the gaseous chlorine system was out of service for replacement of cast iron piping. Concurrent with the absence of chlorine, the following unusual environmental conditions contributed to the microfouling:

- Beginning in March 1990 and continuing through June, coastal upwelling was experienced. This upwelling increased the nutrient level of the ocean surface waters.
- The high nutrient level, when combined with the rising ambient ocean temperature in July and August, and the absence of

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chlorine injection, produced ideal conditions for microfouling organisms such as bacteria, diatoms, and filamentous algae.

- CCW 1-2 heat exchanger was the only CCW heat exchanger that was not waterjetted or scraped within seven months prior to conducting the performance test.

In summary, PG&E's review of the operating history of the CCW heat exchangers from plant startup to date resulted in further review of the following periods for potential safety significance:

- Current ASW system condition (after full implementation of continuous chlorination in November 1992).
- System condition between August 1990 and February 1991.
- Operation between August 1986 and March 1988 (operation with a dp setpoint alarm of 170 inches).

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

Chlorination was not performed for a six-month period of time in 1990 due to the replacement of cast iron piping in the chlorination and associated systems.

E. Dates and Approximate Times for Major Occurrences:

1. July 18, 1989: Generic Letter 89-13 was issued.
2. August 23, 1990: Samples taken from CCW 1-2 heat exchanger, indicating excessive microfouling.
3. February 1991: Unit 1 GL 89-13 heat exchanger testing.
4. September 1991: Unit 2 GL 89-13 heat exchanger testing.
5. November 1992: Continuous chlorination fully implemented for ASW system.
6. July 28, 1993: QA surveillance report issued.
7. December 30, 1993: Event/Discovery date. PG&E determined that CCW 1-2 heat exchanger may have had sufficient microfouling to preclude the CCW

system from meeting its design basis on August 23, 1990.

F. Other Systems or Secondary Functions Affected:

None.

G. Method of Discovery:

During a TRG evaluation of an engineering reanalysis, PG&E determined that CCW 1-2 heat exchanger may have had sufficient fouling to have precluded the CCW system from meeting its design basis on August 23, 1990.

H. Operators Actions:

None required.

I. Safety System Responses:

None required.

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

A. Immediate Cause:

Fouling.

B. Root Cause:

The root cause of this event is an inadequate understanding of the effects of fouling on the CCW heat exchangers.

C. Contributing Cause:

1. Chlorination frequency.

2. Mechanical cleaning frequency.

IV. <u>Analysis of the Event</u>

The key parameters affecting the performance of the ASW and CCW systems include: macrofouling and microfouling, ASW flow, and ocean temperature. An extensive review of historical maintenance, testing, operational, and biological factors was performed to identify time periods with a high potential for macrofouling and microfouling. During this review of past operation, specific periods of time have been identified during which one or more of these key parameters may have been outside current acceptance criteria. These time periods, and the safety significance of the associated fouling, are discussed below.

Biological Fouling Conditions

The potential for significant microfouling of CCW heat exchanger tubes occurs when certain conditions are met. These conditions include:

- An upwelling of cold, nutrient-rich water from deep ocean layers, which occurs as a result of strong northwesterly winds that characteristically blow during the spring.

- A period of high ocean temperatures, which, following an upwelling period, allows the microorganisms to "bloom." Experience indicates that ocean temperatures of approximately 58°F or greater must be reached over a several week period for the "bloom" to occur.

- The chlorination system is out-of-service for a considerable period prior to and during the "bloom." Without chlorination during the "bloom" period, microfouling could form on the tubes of the heat exchanger. If chlorination is restarted after the "bloom" has occurred, further microfouling is stopped. However, residual material placed by the microorganisms remains in the tubes as a coating and continues to impact heat exchanger performance. Once deposited, waterjetting or scraping of the tubes is needed to remove the residual material.

Bounding Microfouling Condition

PG&E's evaluation of maintenance and operational practices over Diablo Canyon's operating history indicates that the bounding conditions for potentially significant microfouling only occurred during August 1990. Prior to this period, upwelling of nutrients had occurred and was followed by a period of ocean warming. As a result, a microfouling "bloom" occurred. PG&E's analysis indicates that microfouling reached significant levels in August 1990 as ocean temperature exceeded 58°F. In addition, the chlorination system was out-of-service during this period while PG&E was replacing cast iron piping in the system. When batch chlorination was restored on August 21, 1990, further microfouling ceased. However, the residual material from the microorganisms remained in the CCW heat exchanger tubes until waterjetting or tube scraping was performed. PG&E's review indicates that there were no other time periods when the lack of chlorination and maintenance was coupled with favorable environmental conditions for microfouling.

Of the four CCW heat exchangers, the 1-2 heat exchanger was the most susceptible to microfouling based on its chlorination, maintenance, and operating history. The remaining three heat exchangers received waterjet cleanings between the period of high microfouling potential and the performance of the GL 89-13 performance testing. In addition, two of the other three heat exchangers were operated less frequently during the period of high microfouling potential.

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The CCW 1-2 heat exchanger was not waterjetted or scraped during the period from August 1990 until after the performance of the GL 89-13 performance test in February 1991. However, as discussed above, batch chlorination was resumed on August 21, 1990, and PG&E's reanalysis of the February 1991 CCW 1-2 heat exchanger performance test using a certified test model indicates that the CCW 1-2 heat exchanger met its design basis (nameplate) heat removal capacity at that time. PG&E believes that the heat transfer microfouling characteristics of the CCW 1-2 heat exchanger during its associated GL 89-13 testing represent the bounding microfouling case.

PG&E evaluated the highest macrofouling that may have existed coincident with high microfouling. During August 1990, the CCW 1-2 heat exchanger was taken out of service for cleaning. It was not again taken out of service until the test in February 1991, at which time the dp was about 110 inches. The August 1990 dp of about 130 inches represented the highest macrofouling reached during this bounding microfouling period. The level of macrofouling associated with a dp of 130 inches, coupled with an assumed level of microfouling found during the testing of the CCW 1-2 heat exchanger, represents the most limiting fouling of a CCW heat exchanger.

Bounding Macrofouling Condition

PG&E's review of macrofouling data identified periods of operation at an elevated dp (greater than 140 inches). The historical data focused attention on a period from August 1986 to March 1988 during which, on three occasions, the combination of recorded dp and actual ASW temperatures indicated the potential for excessive macrofouling. The apparent bounding case of macrofouling identified in this period occurred on November 8, 1987, when CCW 1-2 heat exchanger was removed from service with a dp of about 170 inches in conjunction with an ocean water daily mean temperature of 59.9° F. A review of environmental conditions associated with this period of high dp determined that coincident conditions required for significant microfouling did not exist. PG&E believes that microfouling levels at that time were consistent with the low levels observed during the Unit 2 CCW heat exchanger GL 89-13 tests.

Safety Significance

PG&E has analyzed the bounding cases of heat exchanger fouling for safety significance. These analyses were performed using the mass and energy (M&E) release model that is the licensing basis for DCPP.

The impact of bounding fouling cases on the containment integrity analyses was performed by Westinghouse. Westinghouse evaluated the design basis LOCA, as well as the limiting MSLB accidents for impacts on containment pressure and temperature. The conclusion of these evaluations is that the containment design basis pressure and temperature would not have been exceeded during a postulated LOCA or MSLB.

The design basis CCW temperature limits allow a transient temperature maximum of 132° F for 20 minutes. The temperature limit for continuous operation is 120° F. PG&E has evaluated the impact of the bounding fouling cases on the limiting post-LOCA CCW temperature transients. Using the current licensing basis M&E release model, PG&E and Westinghouse have determined that the peak CCW temperature would have remained within the design basis CCW temperature limits during the injection phase following a LOCA. The containment conditions calculated by Westinghouse were then used by PG&E to evaluate the CCW temperature transient that would result during the recirculation phase. These evaluations concluded that the CCW temperature could have exceeded its design basis temperature limits in recirculation for an extended period if operator action is not taken.

The potential for the CCW system to overheat during the post-LOCA recirculation phase of an accident was previously identified by PG&E in 1991. LER 1-91-018, "Component Cooling Water System Outside Design Basis," reported that the heat load during cold leg recirculation may exceed the CCW system design basis temperature limits. Specific recirculation transient analyses were not performed. At that time, it was reported that operator action to keep CCW temperatures within design limits was required if the two ASW pump/two CCW heat exchanger configuration could not be established. In response to the LER, guidance to address conditions when both ASW pumps and both CCW heat exchangers were not available was incorporated into step 3.d of EOP E-1.3 in 1991. The potential for elevated CCW temperatures identified in the bounding fouling cases above is due primarily to the heat loads imposed on the system during recirculation, and not specifically caused by the identified heat exchanger fouling. Calculations indicate that, had the 1991 EOP guidance been in place at the time that the bounding conditions existed, the CCW system temperature would have remained within its design basis.

To bound the conditions in place during the 1990 high macro- and microfouling case, as well as the 1987 high macrofouling case, PG&E evaluated the CCW temperature transient assuming the likely operator actions for each period. Prior to the 1991 revision of EOP E-1.3, EOP E-0 was revised in 1989 to require placing a second CCW heat exchanger in service when only one ASW pump is available (post-LOCA). Because of the enhanced procedural guidance available to the operators in 1990, the timeline for the period of high microfouling had the operators align the second heat exchanger within 20 minutes following the initiation of the LOCA (This is consistent with operator action described in SSER 16.). A different timeline was used for the period of high macrofouling as this case preceded the 1989 EOP changes. While not formally proceduralized, operator actions believed to be representative of those actions that would have occurred prior to the 1989 EOP changes were used. The timeline would have operators secure two CFCUs 15 minutes after the start of recirculation in response to high CCW temperature alarms and subsequently place the second CCW heat exchanger into service 10 minutes later.

Assuming operator action as described above, the limiting CCW temperature transients were evaluated. The peak CCW temperature for the high macro- and microfouling case was approximately 139°F, and the cumulative time above 120°F was approximately 30 minutes. The peak CCW temperature for the high

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macrofouling period was approximately 136°F, and the cumulative time above 120°F was approximately 34 minutes. The impact of the elevated CCW temperatures on the components of the vital CCW headers was evaluated. Westinghouse analyzed the impact of the CCW temperature profile and has determined that the SI and RHR pumps and the CFCU fan motors would perform their design basis function. The CCW pump manufacturer confirmed that the CCW pumps would perform their design basis function at the elevated CCW temperatures. The post-LOCA sampling system may have been temporarily disabled by the elevated CCW temperatures. However, the ability to assess core damage remained available from alternate proceduralized means. The centrifugal charging pumps (CCPs) cannot be shown to continue to be available at these elevated temperatures, although the exact point of failure is not known. However, the CCPs are available for the entire injection phase of the accident. Regardless of the availability of the CCPs for the recirculation phase, Westinghouse and PG&E analyses have determined that during the recirculation phase, other ECCS pumps are available to perform required ECCS functions.

Based on the foregoing detailed analysis of this event, PG&E concludes the following:

- The fouling identified on the CCW heat exchangers would not have resulted in the containment design pressure or temperature being exceeded.
- The CCW design basis temperature limits would only have been exceeded during post-LOCA recirculation.
- All vital components served by the CCW system would have continued to perform their design basis function, or redundant equipment would have been available to perform these functions.

Accordingly, this event had no safety significance and the health and safety of the public would not have been affected.

V. Corrective Actions

A. Immediate Corrective Actions:

1. An operations standing order was prepared to notify the system engineer if the ASW chlorination system becomes inoperable. This will provide assurance that the chlorination system is returned to service quickly enough to prevent excessive CCW heat exchanger microfouling.

2. An operations standing order was prepared to ensure that the CCW heat exchangers are cleaned when the dp reaches 130 inches. In addition, the associated ASW train will be declared inoperable whenever the dp reaches 140 inches. This standing order is applicable for an operating

configuration of one ASW pump running with one CCW HX aligned.

3. STP I-1A, " Routine Shift Checks Required by Licenses," has been revised to require that the CCW heat exchanger dp be verified to be less than 140 inches of water. This revision will incorporate the existing standing order to begin preparations to clean the heat exchangers at 130 inches.

B. Corrective Actions to Prevent Recurrence:

1. The continuous chlorination program for the ASW system has been fully implemented. ASW system continuous chlorination effectively controls the effects of biofouling.

2. In addition to inspections performed when dp limits are reached, a recurring task work order will be initiated to assure that each heat exchanger will be inspected at a frequency of six months and cleaned as required.

3. Additional CCW heat exchanger performance tests on both units will be performed to verify the adequacy of operational and maintenance practices to assure that the CCW heat exchangers meet design basis requirements. The tests will be conducted during the 1R6 and 2R6 refueling outages and will include dp measurement Upon completion of additional heat exchanger performance tests scheduled for 1R6 and 2R6, PG&E will reevaluate the dp setpoint.

4. Enhanced ASW flow instrumentation will be installed with local readouts.

5. ECG 17.2 has been approved to provide administrative controls on the ASW chlorination system. This ECG will document compensating actions to be taken if the ASW chlorination system is inoperable for greater than 14 days.

6. PG&E agrees that trending of the dp increase on each CCW heat exchanger would be useful in anticipating calcification and other buildup that may affect dp. Consequently, PG&E will revise STP M-26 to require a formal trending program to monitor this parameter.

7. An Integrated Problem Response Team (IPRT) will be conducted on the ASW, CCW, and interfacing systems by the end of 1994. This IPRT will thoroughly and critically review these systems. Membership of the IPRT will include operations, quality services, maintenance, Westinghouse, and engineering personnel. Based on the results of the IPRT, DCM S-17B will

be revised to provide additional information on ASW system heat removal capacity.

VI. Additional Information

A. Failed Components:

None.

B. Previous LERs on Similar Problems:

1. LER 1-91-018-01, "Component Cooling Water System Outside Design Basis Due to Personnel Error."

   PG&E determined that the heat load on the CCW system during the cold-leg recirculation phase following a LOCA could potentially exceed the CCW system design basis temperature limits. Because the injection phase had previously been considered the limiting case for CCW temperature, this condition was considered to be outside the design basis of the CCW system. The root cause was attributed to personnel error. The corrective actions to prevent recurrence included additional training for design engineers to emphasize that data known to be conservative for one application may be nonconservative for another application. Because this event did not address the potential for biofouling of heat exchangers, the corrective actions taken would not have prevented the current event.

2. LER 1-84-040, "CCW and ASW System Design Basis Requirements Not Incorporated into Plant Procedures Due to Inadequate Tracking of Resolution from Correspondence and Communication."

   Engineering recommendations for plant operation to assure compliance with the design basis for the CCW and ASW systems were not incorporated in plant procedures. Since this event involved incorporation of design constraints in plant procedures, corrective actions taken to prevent recurrence could not have prevented the current event since they would not affect biofouling in the CCW heat exchangers.