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 9

TITLE (4)

Technical Specification 3.4.2.2 Not Met due to Pressurizer Safety Valves' Low Loop Seal Temperatures

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
03	21	1998	1998	- 0 0 6 -	0 1	07	23	1999	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)		
4	X	10 CFR	50.73(a)(2)(ii)(B)
POWER LEVEL (10)	X	OTHER	50.73(a)(2)(i)(B)
0 0 0			(SPECIFY IN ABSTRACT BELOW AND IN TEXT, NRC FORM 366A)

LICENSEE CONTACT FOR THIS LER (12)	TELEPHONE NUMBER	
	AREA CODE	
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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 March 21, 1998, at approximately 0630 PST, with Unit 2 in Mode 4 (Hot Shutdown), Technical Specification 3.4.2.2, regarding operability of the pressurizer safety valves (PSVs), was not met when the reactor coolant system (RCS) cold leg temperatures increased to greater than 270 degrees Fahrenheit with the loop seal temperatures of the three PSVs below 217 degrees Fahrenheit. A minimum loop seal temperature is required to assure PSV discharge piping integrity. Excessive stress on the PSV discharge pipe may affect PSV setpoints. On March 22, 1998, at 1044 PST, Unit 2 entered Mode 3 (Hot Standby) with loop seal temperatures of two PSVs below 217 degrees Fahrenheit. On March 23, 1998, at 0023 PST, the last loop seal temperature increased above 217 degrees Fahrenheit, thus returning the PSVs to an operable condition. PG&E believes there were similar events during previous Units 1 and 2 heatups.

PG&E discovered this event on December 19, 1998, while investigating low PSV loop seal temperatures during a forced outage (see LER 2-1998-005-00).

The cause of this event was personnel error, cognitive. The loop seal temperature requirements were never procedurally established when the RCS was less than normal operating conditions.

PG&E will revise the operating procedure for RCS heatup to ensure minimum loop seal temperatures are reached before exceeding 270 degrees Fahrenheit in any of the RCS cold legs.

TEXT

I. Plant Conditions

Unit 2 was in Mode 4 (Hot Shutdown) with increasing reactor coolant system (RCS) temperature and pressure.

II. Description of Problem

A. Summary

On March 21, 1998, at approximately 0630 PST, with Unit 2 in Mode 4, Technical Specification (TS) 3.4.2.2, which requires operability of all three pressurizer safety valves (PSVs)(RV) with RCS temperature greater than 270 degrees Fahrenheit, was not met when the RCS cold leg temperatures increased to greater than 270 degrees Fahrenheit with the loop seal (SEAL) temperatures of the three PSVs below 217 degrees Fahrenheit. A minimum loop seal temperature is required to assure PSV discharge piping integrity. Excessive stress on the PSV discharge pipe may affect PSV setpoints. On March 22, 1998, at 1044 PST, Unit 2 entered Mode 3 (Hot Standby) with loop seal temperatures of two PSVs below 217 degrees Fahrenheit. On March 23, 1998, at 0023 PST, the last loop seal temperature increased above 217 degrees Fahrenheit, thus returning all the PSVs to an operable condition. PG&E believes there were similar events during previous Units 1 and 2 heatups.

B. Background

There are three PSVs per unit at DCPP. The PSVs are Valves 8010A, 8010B, and 8010C.

TS 3.4.2.2 states that all pressurizer Code safety valves shall be operable in Modes 1 (Power Operation), 2 (Startup), 3, and 4. The TS qualifies the Mode 4 operability requirement to apply only when the RCS cold leg temperatures are greater that 270 degrees Fahrenheit.

Loop seals are provided on the inlet piping of the PSVs to maintain PSV body temperature below the vendor recommended limits. This prevents PSV seat leakage that can result from spring relaxation with increased temperature. However, the water in the loop seals must be maintained at a minimum temperature to allow it to flash to steam when a PSV lifts. Because of its low density and low mass, a PSV discharge fluid of steam

imposes minimal loading on the discharge piping and results in acceptable pipe stresses.

Conversely, if cooler water is maintained in the loop seals, it tends not to flash and a water and steam mixture could be discharged when the PSV lifts. Because of its higher density and higher mass, a discharge fluid of water and steam could impose high loading on the discharge piping that results in unacceptably high pipe stresses. These high stresses could result in deformation or breakage of the discharge pipe. Either of these conditions could result in a condition of unacceptably high PSV nozzle loading that could render the PSVs inoperable.

C. Event Description

In November 1982, a Westinghouse piping analysis recognized that the PSV loop seals needed to be at an elevated temperature to reduce downstream pipe loads during a PSV discharge. Therefore, loop seal insulation was designed and installed, and loop seal temperatures were verified during initial startup testing to meet the minimum 260 degrees Fahrenheit established by Westinghouse to assure PSV operability.

During operation of the plant from approximately 1985 to 1989, Diablo Canyon Power Plant (DCPP) and the nuclear industry experienced PSV seat leakage and setpoint drift. In 1990, PG&E embarked on a research and development effort to address the issue. It was determined that a predominant factor for PSV setpoint drift was high nozzle loading and that the loading resulted from thermal expansion of the inlet piping containing the loops seals. One of several corrective actions was to modify the loop seal insulation to decrease valve body and pipe support temperature while maintaining the minimum loop seal temperature.

Temperature instrumentation was installed because of a concern regarding the potential loss of the loop seals as a result of PSV leakage and was used to ensure the loop seals were still present and that the PSVs remained operable if seat leakage were occurring. The instrumentation provided an indication that loops seals were present, and that the PSVs could be considered operable. The instrumentation did not provide for continuous temperature monitoring.

In April 1998, high tailpipe, or PSV discharge piping, temperature on Unit 2 PSV 8010A was identified. High tailpipe temperature is indicative

of leakage past the seat. As required by Operating Procedure (OP) O-24, "Evaluation of Pressurizer Safety Valve High Tailpipe Temperature or Leakage," the RCS system engineer was responsible for evaluating and trending tailpipe temperature data. If certain conditions were met, the procedure also required that operators verify loop seal temperatures were less than 500 degrees Fahrenheit, thereby ensuring the presence of a loop seal. A higher temperature would indicate the loop seal is gone and that steam is at the valve seat. With steam available at the valve seat, heating of the valve occurs, and the valve's setpoint could be reduced. In this condition, the valve would be declared inoperable.

During the summer of 1998, as part of the continuing evaluation of tailpipe temperature data, the system engineer noted that loop seal temperatures for one of the Unit 1 PSVs and two of the Unit 2 PSVs were consistently below 260 degrees Fahrenheit. The engineer recognized that this condition was contrary to the minimum temperature loop seal temperature requirement of 260 degrees Fahrenheit specified in the RCS design criteria memorandum. The engineer initiated an action request to address the problem. PG&E performed a prompt operability assessment to substantiate that the lower loop seal temperatures did not impact PSV operability and discharge piping integrity. An analysis was also performed to validate a new lower limit of 217 degrees Fahrenheit.

As immediate corrective actions, periodic PSV loop seal temperature monitoring was initiated to ensure the loop seal temperatures remained above the new lower limit of 217 degrees Fahrenheit, and the operators were given instructions to immediately restore any loop seal temperature which dropped below this limit.

During the summer and fall of 1998, PG&E's focus was on maintaining minimum loop seal temperatures when the RCS was at normal operating conditions. However, on December 11, 1998, while investigating low PSV loop seal temperatures during a forced outage (see LER 2-1998-005-00, "Manual Reactor Trip due to Heavy Debris Loading of the Circulating Water System During a Pacific Ocean Storm"), PG&E engineers recognized that the requirement for meeting the minimum loop seal temperatures should be applicable during the heatup following a unit shutdown. PG&E engineers determined from a review of previous heatup data that on March 21, 1998, at approximately 0630 PST, with Unit 2 in Mode 4, the RCS cold leg temperatures increased above 270 degrees Fahrenheit while the loop seal temperatures for the three PSVs remained

below 217 degrees Fahrenheit. On March 22, 1998, at 1044 PST, Unit 2 entered Mode 3 with loop seal temperatures of two PSVs below 217 degrees Fahrenheit. On March 23, 1998, at 0023 PST, the last loop seal temperature increased above 217 degrees Fahrenheit.

On December 19, 1998, after review and consideration of the possible effects of discharge pipe deformation or breakage upon the PSVs, PG&E conservatively determined that the events of March 21 and 22, 1998, constituted violations of TS 3.4.2.2.

From subsequent reviews of available loop seal temperature data, PG&E has determined that there were similar events during previous Unit 1 and Unit 2 heatups.

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

None.

E. Dates and Approximate Times for Major Occurrences

1.	March 21, 1998, at 0630 PST	Event date: Unit 2 PSVs became inoperable when RCS temperature exceeded 270 degrees Fahrenheit while loop seal temperatures remained below 217 degrees Fahrenheit.
2.	On December 19, 1998:	Discovery date: PG&E determined that the event of March 21, 1998, constituted a violation of TS 3.4.2.2.

F. Other Systems or Secondary Functions Affected

None.

G. Method of Discovery

PG&E engineers discovered the event while investigating low PSV loop seal temperatures.

H. Operator Actions

None.

I. Safety System Responses

None.

III. Cause of the Problem

A. Immediate Cause

The RCS temperature was increased in accordance with normal plant heatup procedures without assuring the PSV loop seal design basis temperatures were met.

B. Root Cause

The cause of the event was personnel error, cognitive, in that PG&E engineering personnel did not properly recognize, document, and provide requirements that PSV loop seal temperatures be established and maintained above the minimum required temperatures during RCS heatup operations. The requirements were only considered for conditions when the RCS temperature was at normal operating conditions.

IV. Analysis of the Event

The effect of the PSVs' low loop seal water temperatures is of concern only if the PSVs lift. For the PSVs to lift, there needs to be a rapid or unchecked heat (power) input or mass increase to the RCS. A review of the Final Safety Analysis Report (FSAR) accident analyses determined that for Modes 3 and 4, the uncontrolled rod cluster control assembly withdrawal, uncontrolled boron dilution, loss of external load or turbine trip, and loss of feedwater do not cause sufficient power or mass increase to challenge the PSVs because there is sufficient time for operators to diagnose and correct these conditions. A steam line break could result in a safety injection (SI) and a resultant mass increase into the RCS. However, this event would be enveloped by the inadvertent SI analysis. Therefore, only the inadvertent SI challenge to the PSVs needs to be addressed.

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In accordance with OP L-5, "Plant Cooldown from Minimum Load to Cold Shutdown," the automatic SI signals are blocked when RCS pressure decreases below 1915 psig during plant shutdown, and are automatically unblocked at 1915 psig during plant startup. Therefore, with RCS pressure less than 1915 psig, only manual SI actuation or a spurious actuation of the solid state protection system (SSPS) master relay could initiate the event.

Above 1915 psig, either an actual or inadvertent signal from steam line break, containment high pressure, or pressurizer low pressure could initiate the event. It is unlikely that these events would occur during the short period of low loop seal temperatures.

A review of data obtained during heatup following the Unit 2 eighth refueling outage revealed that an RCS pressure of 1915 psig was reached shortly after 2030 PST on March 22, 1998. At that time, PSV loop seal temperatures were approximately 209, 219, and 246 degrees Fahrenheit. The lowest loop seal water temperature is close to the minimum design value, so it is expected that conservative assumptions in the piping analyses would offset the resultant increased piping stresses. Review of available data indicates that these loop seal temperatures are typical at this point during past plant heatups and that piping integrity would have been maintained.

The inadvertent SI event is typically analyzed not crediting operation of the pressurizer power operated relief valves (PORVs). However, during past Mode 4 and 3 conditions, the PORVs would have been available. The only planned activity which would remove a PORV from service is a functional test following transition from the low temperature overpressure protection mode of operation, to normal mode of operation. However, this test contains a precaution that only one PORV be tested at a time. The test closes the block valve, manually strokes the PORV, then reopens the block valve. Additionally, the test is accomplished in a very short period of time.

The TS do allow all PORVs to be isolated by a closed block valve for seat leakage, and for short periods, operation with only one Class 1 PORV operable.

PG&E performed a RETRAN analysis of a Mode 3 SI, with the RCS at 1915 psig, which indicates that without PORVs or pressurizer spray, the pressurizer pressure would reach the PSV setpoint in approximately 4.6 minutes. However, due to the expected availability of the PORVs, PG&E performed other RETRAN analyses crediting the operation of one PORV. Each Class I PORV has a backup nitrogen accumulator which permits at least 150 valve strokes. The

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analysis determined that there is approximately 33 minutes, with no pressurizer spray, and approximately 39 minutes, with pressurizer spray, before the PORV would no longer relieve pressurizer pressure and the PSV setpoint would be reached. This is in excess of the time needed to terminate the event.

During mode transitions, there are more operators available in the control room and increased operator attention to RCS parameters and equipment status. Thus, there is high confidence that operator actions, such as termination of SI or unblocking of a PORV, would be taken to avoid any actuation of the PSVs.

The original Westinghouse analysis for loop seal water temperatures of approximately 100 degrees Fahrenheit indicates that code allowable stresses would be exceeded in the discharge piping "immediately upstream of, into and along the common header where the safety lines branch in." This area is several supports downstream from the PSV discharge flanges. Therefore, PG&E has judged that because of the location of the suspected deformation or break, and because of the restraint that would be provided by the supports, it is unlikely that low temperature loop seal water discharging through any given safety valve would adversely affect the operation of all PSVs.

Should the PSV be actuated and unable to reopen, the remaining PSVs should be available. The above mentioned RETRAN analysis indicates that only one PSV is required to prevent overpressurization of the RCS.

A probabilistic evaluation was performed to obtain a risk perspective of loop seal temperature below the minimum temperature. Operation in this configuration was assumed to be limited to Modes 3 and 4. The results of the probabilistic risk analysis model indicate that the change in core damage would be insignificant (less the 1.0E-6) even if the plant were to operate in this condition for an entire year. Additionally, it was noted that even if all the at-power initiating events were assumed to be applicable to the low loop seal temperature case (e.g. loss of offsite power and anticipated transients without scram initiating events were to be included), the change in risk would be less than 1.0E-06 if the low loop seal temperature condition would last as much as 4000 hours.

The condition in which a PSV opens and fails to close results in an accidental RCS depressurization, which is a previously analyzed event. The DCPP FSAR classifies both the inadvertent SI event and the accidental RCS depressurization event as Condition II faults, faults of moderate frequency. Therefore, if an inadvertent SI were to cause a PSV to stick open, any resulting depressurization would still be a Category II event, thus complying with the FSAR statement that a

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Category II event will not propagate to cause a more serious (Category III or IV) event.

V. Corrective Actions

A. Immediate Corrective Actions

During the heatup following the forced shutdown of December 1998 (see LER 2-1998-005-00), the loops seals were partially drained and new seals were formed at higher temperatures to meet the minimum requirements.

B. Corrective Actions to Prevent Recurrence

1. The Unit 1 OP L-1, "Plant Heatup from Cold Shutdown to Hot Standby," has been revised to check PSV loop seal minimum temperature prior to increasing RCS cold leg temperature above 270 degrees Fahrenheit.

2. The Unit 2 OP L-1 will be revised prior to heatup from the next Unit 2 shutdown to check PSV loop seal minimum temperature prior to increasing RCS cold leg temperature above 270 degrees Fahrenheit.

3. The principle engineering personnel currently responsible for the RCS have participated in the preparation of this LER and are sufficiently cognizant of the lessons learned to preclude further events of a similar nature.

VI. Additional Information

A. Failed Components

None.

B. Previous Similar Events

None.