ACCELERATED DISTRIBUTION DEMONSTRATION SYSTEM

REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR:8901130005 DOC.DATE: 89/01/06 NOTARIZED: YES DOCKET #
FACIL:50-275 Diablo Canyon Nuclear Power Plant, Unit 1, Pacific Ga 05000275
50-323 Diablo Canyon Nuclear Power Plant, Unit 2, Pacific Ga 05000323
AUTH.NAME AUTHOR AFFILIATION
SHIFFER,J.D. Pacific Gas & Electric Co.
LOCKE,H.V. Pacific Gas & Electric Co.
RECIP.NAME RECIPIENT AFFILIATION
Document Control Branch (Document Control Desk)

SUBJECT: Forwards response to Generic Ltr 88-17, "Loss of DHR."

DISTRIBUTION CODE: A061D COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 20
TITLE: OR/Licensing Submittal: Loss of Residual Heat Removal (RHR) GL-87-12

NOTES:

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
	PD5 LA	1	0	PD5 PD	1	1
	ROOD,H	1	1			
INTERNAL:	ACRS	6	6	ARM/DAF/LFMB	1	0
	NRR BALUKJIAN,H	2	2	NRR TRAMMELL,C	1	1
	NRR/DEST/ADE 8H	1	1	NRR/DEST/ADS 7E	1	1
	NRR/DOEA/TSB 11	1	1	NUDOCS-ABSTRACT	1	1
	OGC/HDS2	1	0	REG FILE 01	1	1
	RES SPANO,A	1	1	RES/DSIR/EIB	1	1
	RES/DSR/PRAB	1	1			
EXTERNAL:	LPDR	1	1	NRC PDR	1	1
	NSIC	1	1			

R I D S / A D D S

R I D S / A D D S

NOTE TO ALL "RIDS" RECIPIENTS:

PLEASE HELP US TO REDUCE WASTE! CONTACT THE DOCUMENT CONTROL DESK, ROOM P1-37 (EXT. 20079) TO ELIMINATE YOUR NAME FROM DISTRIBUTION LISTS FOR DOCUMENTS YOU DON'T NEED!

TOTAL NUMBER OF COPIES REQUIRED: LTTR 25 ENCL 22

M/A 4 cc

Pacific Gas and Electric Company

77 Beale Street
San Francisco, CA 94106
415/972-7000
TWX 910-372-6587

James D. Shiffer
Vice President
Nuclear Power Generation

January 6, 1989

PG&E Letter No. DCL-89-005

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Re: Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Response to Generic Letter 88-17, Loss of Decay Heat Removal

Gentlemen:

Generic Letter 88-17, "Loss of Decay Heat Removal" dated October 17, 1988, requested a response to eight items related to the loss of decay heat removal while the plant was shutdown. PG&E's response is provided in the enclosure.

Kindly acknowledge receipt of this material on the enclosed copy of this letter and return it in the enclosed addressed envelope.

Subscribed to in San Francisco, California this 6th day of January 1989.

Respectfully submitted,

Pacific Gas and Electric Company

By _____
J. D. Shiffer
Vice President
Nuclear Power Generation

Howard V. Golub
Richard F. Locke
Attorneys for Pacific
Gas and Electric Company

By _____
Richard F. Locke

Subscribed and sworn to before me
this 6th day of January 1989

_____
Therese Toliver, Notary Public in
and for the City and County of
San Francisco, State of California

My commission expires December 25, 1990.

OFFICIAL SEAL
THERESE TOLIVER
NOTARY PUBLIC - CALIFORNIA
CITY AND COUNTY OF SAN FRANCISCO
My Comm. Expires Dec. 25, 1990

cc: J. B. Martin
M. M. Mendonca
P. P. Narbut
B. Norton
H. Rood
B. H. Vogler
CPUC
Diablo Distribution

Enclosure

2438S/0066K/DJH/2197

A061
1/1

ENCLOSURE

PG&E RESPONSE TO THE EXPEDITIOUS ACTIONS RECOMMENDED IN GENERIC LETTER 88-17, "LOSS OF DECAY HEAT REMOVAL"

INTRODUCTION AND SUMMARY

This enclosure provides PG&E's response to the NRC concerns identified in Generic Letter 88-17: (1) prevention of a loss of decay heat removal, (2) mitigation of an accident before events progress to core damage, and (3) control of radioactive material should core damage occur. PG&E has addressed these issues as briefly summarized below.

1. Prevention

   a. Current operator training emphasizes that a loss of decay heat removal can lead to a serious accident in a relatively short time. The operators are therefore aware that reducing reactor coolant system (RCS) inventory with irradiated fuel in the reactor vessel is a process that must be performed with close attention and great care. Discussions have taken place informing operators of lessons learned and their implications.

   b. The Diablo Canyon Technical Specifications have been changed to allow for lower Residual Heat Removal (RHR) flow for mid-loop operation. This reduces the likelihood of a loss of RHR by pump cavitation due to air entrainment in the RHR pump suction.

   c. Operating procedures have been revised to provide the operators with guidance as to the RCS level necessary to prevent RHR pump cavitation caused by air entrainment.

   d. RCS level is indicated on three level indications. Procedures for the proper installation and maintenance of these level indications ensure their reliability and availability.

   e. All ongoing and planned outage activities are reviewed before RCS mid-loop operation to ensure that none of these activities will inadvertently reduce RCS inventory.

   f. The steam generator (SG) U-tubes are drained using nitrogen injection into the RCS flow instrumentation taps in the crossover legs. This enables operators to more easily control RCS inventory during the draindown to mid-loop. Controlled draindown further reduces the possibility of RHR pump air entrainment and vortexing.

2. Mitigation

   a. In the event of a loss of RHR, operating procedures specify that RCS temperature indications be monitored to track temperature rise. The RCS heatup rate and the time to reach 200°F as a function of decay heat load are provided in tabular form in plant procedures.

b. The removal and reinstallation sequences of the steam generator manways and nozzle dams are controlled to prevent the presence of cold leg vent paths when no hot leg vent paths exist.

c. Makeup to the RCS is provided by a charging pump, gravity feed from the Refueling Water Storage Tank and a Safety Injection Pump which can quickly be put in service should RHR be lost.

d. Recovery procedures are in place to ensure expeditious actions are taken during a loss of RHR while in mid-loop.

3. Control of Radioactive Materials

Procedures and controls are in place to assure that containment evacuation and closure occur, the containment equipment hatch is closed and secured by a minimum of four bolts, and major environmental release pathways are closed within 30 minutes after the loss of RHR flow.

The following provides background information and a detailed response to each of the expeditious actions recommended in the Generic Letter. A separate response addressing the programmed enhancements will be submitted in accordance with the schedule noted in GL 88-17.

BACKGROUND

The Diablo Canyon Nuclear Power Plant (DCPP) operating procedures that govern mid-loop operations, the drain down to mid-loop, and the refilling of the Reactor Coolant System (RCS) after mid-loop are:

OP A-2:I. Reactor Vessel - Filling and Venting the RCS. Unit 1. Revision 13; July 9, 1988.

OP A-2:I. Reactor Vessel - Filling and Venting the RCS. Unit 2. Revision 6; November 1, 1988.

OP A-2:II. Reactor Vessel - Draining the RCS to the Vessel Flange. Unit 1. Revision 2; May 5, 1988.

OP A-2:II. Reactor Vessel - Draining the RCS to the Vessel Flange. Unit 2. Revision 6; September 19, 1988.

OP A-2:III. Reactor Vessel - Draining to Half Loop/Half Loop Operations. Unit 1. Revision 5; May 5, 1988.

OP A-2:III. Reactor Vessel - Draining to Half Hoop/Half Loop Operations. Unit 2. Revision 1; September 30, 1988.

OP AP-16. Malfunction of the RHR System. Units 1 and 2. Revision 5; November 9, 1988.

OP-L-6. Refueling. Units 1 and 2. Revision 8; September 20, 1988. (This procedure is not intended to provide detailed instructions for operation of the various systems and equipment, but rather to provide a plan or sequence for coordinating maintenance and operations activities).

Presently, Unit 1 is in its third fuel cycle with a refueling outage scheduled for October of 1989, and Unit 2 is in its third fuel cycle with a refueling outage scheduled for the Spring of 1990. The earliest anticipated mid-loop operation with irradiated fuel in the vessel is October 1989.

The following plant specific information is applicable to both units and should clarify PG&E's responses to the expeditious actions outlined in GL 88-17: 1) During normal operation of the RHR system, suction is from the reactor coolant system (RCS) through the loop No. 4 hot leg. 2) The RHR system injects into two or all four cold legs. 3) The pressurizer is attached to the RCS loop No. 2 hot leg.

The following elevations are useful for an understanding of the mid-loop procedures (elevations are in feet and inches with sea level as zero elevation):

Top of the Reactor Vessel Head	121'-0"
Junction of the Head and Reactor Vessel	114'-1 1/2"
Elevation at which water would spill from an open steam generator manway	108'-11"
Top of a Hot Leg (ID)	108'-2"
Hot Leg Centerline	107'-0"
Bottom of a Hot Leg (ID)	105'-10"
Top of the Core	102'-11 1/2"

A Figure from Operating Procedure A-2:III is attached which shows the various RCS elevations.

RESPONSES TO ITEMS 1 THRU 8

The following is PG&E's detailed response to each of the eight expeditious actions which are to be implemented before the next entry into a mid-loop condition with irradiated fuel in the reactor vessel at DCPP.

Item 1

> Discuss the Diablo Canyon event, related events, lessons learned, and implications with appropriate plant personnel. Provide training shortly before entering a reduced inventory condition.

Response to Item 1

Subsequent to the April 10, 1987, loss of RHR cooling event, the DCPP Training Department conducted training to ensure that all licensed operators were made aware of the operational concerns which exist when the RCS is in a reduced inventory condition. All licensed operators have received this training. In addition to receiving training on the April 10, 1987, event at DCPP, the Waterford 3 event has been discussed with the Diablo Canyon licensed operators. Lessons learned from these events have been factored into the training sessions at DCPP and include the following:

- Maintaining the RCS level high enough to avoid air entrainment in the RHR pumps.
- Monitoring RCS level continuously.
- Reducing RHR flow rate to prevent vortexing, air entrainment, and cavitation in the RHR pumps.
- To minimize the effects on the wide range and narrow range Reactor Vessel Refueling Level Indication System (RVRLIS) indications, drain down of the RCS is not to exceed 75 gpm.
- Time for RCS boiling to occur is less than originally estimated.
- Increased pressure build-up in the RCS after the loss of RHR may prevent gravity feed from the RWST.
- Activities which have the potential for influencing RCS level perturbations are not allowed or carefully controlled.
- Level gradients could exist in the RCS as a result of pressure disturbances within the primary system during transient conditions.
- Installation and removal of nozzle dams and manways need to be sequenced to ensure that a proper hot leg vent path from the core exists.

- The importance of containment closure in a timely manner.
- The necessity for minimizing the time in mid-loop operation when fuel is in the vessel.
- The importance of core temperature monitoring.
- The importance of the heat removal capability of the secondary side.
- Understanding the importance of the injection flow path during recovery operations.
- The implementation of Westinghouse Owners Group studies of mid-loop operation.
- Understanding the core thermal hydraulic behavior following a loss of RHR event.
- The importance of accurate RVRLIS indication.

Listed below are seven requalification sessions and a summary of the topics presented in each session that all licensed operators have attended since the April 10, 1987 event.

Requalification Session 86-6. (3/30/87 to 5/8/87)

The PG&E Operations Incident Summary, "Loss of Residual Heat Removal > 1 HR With Unit in Mode 5," was used as a reference to discuss the event using the INPO Case Study Format.

Specific items reviewed were:

- Personnel errors that led to the loss of RCS inventory and subsequent loss of RHR cooling.
- Indications and phenomena observed in the Control Room, Auxiliary Building and Containment during the event.
- Problems encountered with the then existing loss of RHR procedure: OP AP-16 (Revision 0) "Malfunction of the RHR System."
- The revised procedure OP AP-16.

Requalification Session 86-7. (5/11/87 to 6/12/87)

A lesson plan was developed which presented a more detailed description of the April 10, 1987, event. The operational concerns while at mid-loop operation as well as recent procedural changes were discussed.

Among the topics covered were:

- Precautions from related procedures.

- The priority of operator actions which are needed to restore RHR cooling.
- Estimation of the time to reach bulk boiling after a loss of RHR and its dependency on the time after shutdown.
- The Reactor Vessel Refueling Level Indication System (RVRLIS).
- The level for onset of RHR pump vortexing.
- Makeup flow paths to restore RCS inventory and RHR pump suction.
- Alternate means of core cooling in the event that RHR cooling cannot be restored.
- The revised event classification and notification requirements following a loss of RHR.
- Restoration of RHR cooling using the revised OP AP-16.

Requalification Session 87-3. (11/16/87 to 12/31/87)

This session focused on the new RVRLIS design features including, the location and range of the indications, the control room alarms and the alarm inputs which indicate an abnormal vessel level.

Requalification Session 87-4. (1/11/88 to 2/19/88)

This presentation reviewed aspects of mid-loop operations with the following items being stressed:

- The precautions and prerequisites contained in mid-loop operation procedures.
- The expected responses of the wide range and narrow range RVRLIS during a draindown of the RCS.
- The indications that would signify vortexing or cavitation of the RHR pumps and the RCS level at which vortexing would occur.
- The proper operational response to vortexing or cavitation.
- A review of the new RVRLIS with emphasis on describing connection points and valve configurations.
- The new nitrogen injection procedure to reduce the time for steam generator tube draining.

Requalification Session 88-1. (07/26/88 to 09/02/88)

This session covered the loss of shutdown cooling while at mid-loop operation at Waterford Unit 3. The event and corrective actions were discussed with the objective of instilling operators with the understanding of:

- The undesirability of loop seals in tubing used for RCS level indication.
- How the OP A-2:II procedural steps minimize inaccuracies of the indicated RCS level.

Requalification Session 88-2. (9/5/88 to 10/14/88)

This session covered NRC Information Notice No. 88-36, "Possible Sudden Loss of RCS Inventory During Low Coolant Level Operation". Key topics covered were:

- The mechanism whereby pressurization in bottled up hot legs can expel coolant through opened cold legs which in turn leads to rapid core uncovery.
- The requirement that a hot leg nozzle dam is the last to be installed and the first to be removed.
- Not installing the last nozzle dam until a sufficient vent path is established to mitigate RCS pressurization and thereby reduce the possibility of ejecting a nozzle dam.

Requalification Session 88-3. (10/18/88 to 11/25/88)

In this session the operators viewed a videotape produced by the Westinghouse Owners Group (WOG). The tape shows a scale model RCS hot leg with RHR suction line attached and demonstrates that low RCS level and high RHR flow promotes vortexing whereas high RCS level and low flow prevents vortexing, air entrainment, and pump cavitation.

Licensed operators participated in a simulator training scenario LS-6-1D, "Half Loop RHR Operation," which had the key objectives to highlight draindown to mid-loop, recognizing onset of RHR pump vortexing and RHR pump trip, and use of OP AP-16 to reestablish RHR cooling. In the classroom session associated with this simulator session, mid-loop operations were again reviewed. The topics presented during this classroom session were:

- The loss of RHR flow and its causes.
- Corrective actions to be taken and the associated makeup flow paths.
- Control room indications for RVRLIS.
- The RVRLIS system connection points.
- The alternate methods of core cooling to be used if RHR flow cannot be reestablished.
- Event-related emergency classifications.

The license training program contains lesson LPA-16, "RHR System Malfunctions," which familiarizes students with issues related to mid-loop

operations. This lesson emphasizes the content and format of the loss of RHR recovery procedure. Auxiliary Operators have received training to deal with the items that are applicable to their involvement with RVRLIS through lesson NLR8832, "RVRLIS Update and Review," which discusses:

- RVRLIS setup and operation
- Location of RVRLIS components, connection points, etc., as well as potential problems encountered.
- Proper venting of the RVRLIS.

To ensure that all future operators receive training on mid-loop procedures and concerns, material on RVRLIS design and operation, OP AP-16, "Malfunction of the RHR System," corrective actions, and RCS drain procedures A-2:II and A-2:III have been incorporated into the RHR System Description and License Lesson Guide.

The Westinghouse Owners Group (WOG) studies of the thermal-hydraulics of mid-loop RHR operation and PG&E plant specific analysis have been transmitted to the Training Department for their use in training.

In the License Requalification Program, OP AP-16, "Malfunction of the RHR System," is reviewed with the operators on a biennial basis. Any changes to procedures or equipment associated with mid-loop operations will be covered as part of the standard requalification design change notice and procedure update training. Before a unit is brought to a mid-loop condition, there is a required briefing during which the concerns and procedures associated with mid-loop operations are reviewed with the operating crews.

Item 2

> Implement procedures and administrative controls that reasonably assure that containment closure** will be achieved prior to the time at which a core uncovery could result from a loss of DHR coupled with an inability to initiate alternate cooling or addition of water to the RCS inventory. Containment closure procedures should include consideration of potential steam and radioactive material release from the RCS should closure activities extend into the time boiling takes place within the RCS. These procedures and administrative controls should be active and in use:
>
> (a) prior to entering a reduced RCS inventory* condition for NSSSs supplied by Combustion Engineering or Westinghouse, and
>
> (b) prior to entering an RCS condition wherein the water level is lower than four inches below the top of the flow area of the hot legs at the junction of the hot legs to the RV for NSSSs supplied by Babcock and Wilcox,

and should apply whenever operating in those conditions. If such procedures and administrative controls are not operational, then either do not enter the applicable condition or maintain a closed containment.

---

* A reduced inventory condition exists whenever RV water level is lower than three feet below the RV flange.

** Containment closure is defined as a containment condition where at least one integral barrier to the release of radioactive material is provided.

Response to Item 2

Following the April 10, 1987, loss of RHR event, PG&E committed to the NRC Augmented Inspection Team to revise procedures to ensure that major pathways which communicate between the containment and the outside atmosphere will either be closed (in the case of the equipment hatch and steam generator secondary side isolation) or be identified and capable of easily being closed in a timely manner. In response to this event, PG&E has modified procedures governing draining the RCS, mid-loop operation, abnormal operating procedures, and overall operating procedures concerning refueling operations.

PG&E has defined the criteria for a containment "boundary" as follows:

(a) The equipment hatch is in place and is secured with a minimum of four bolts. Maintenance Procedure (MP) M-45.1, "Containment Equipment Hatch Door Opening and Closing," specifies the bolts must be equally spaced and torqued. A light source is used inside containment to verify that no gaps are visible from outside containment.

(b) No obstructions are present so that each containment airlock shall have at least one door capable of being readily closed.

(c) Containment ventilation isolation can be assured with at least one valve (inside or outside of containment) per penetration capable of being closed.

(d) All steam generator secondary side manways and inspection ports are installed, or,

the steam generator safety valves are installed or blind-flanged, the Main Steam Isolation Valves (MSIV) and the MSIV Bypass Valves are closed, the ten percent atmospheric dump valves are closed and the valves admitting steam into the Auxiliary Feed Turbine (FCV-37 and FCV-38) are closed. All closed valves are to be controlled by an administrative tag out.

(e) A path to the auxiliary building is prevented by one of the following:

The Fuel Transfer Tube (FTT) blind flange is installed, or,

the FTT manual gate valve SFS-1-50 is closed and controlled by an administrative tagout, or,

an operator in communication with the Control Room is continuously stationed at SFS-1-50 and can close the valve when necessary, or,

the refueling canal is flooded greater than a foot above the top of the FTT, if the FTT is open.

PG&E's estimation of the time required for converting the "boundary" to containment closure as defined in GL 88-17 is less than 30 minutes. Operating Procedure OP A-2:III requires that a containment boundary be established prior to draining the reactor vessel level lower than approximately 3 feet below the RCS flange level (111 foot elevation). The requirement remains in effect until level is restored above 111 feet.

If RHR flow should be lost while at mid-loop, OP AP-16 instructs the operator to verify that the major environmental release pathways are closed. These pathways consist of the following:

- Equipment hatch.
- At least one personnel door.
- At least one emergency exit personnel door.
- The steam generator secondary side.
- Containment ventilation.
- The Reactor Vessel Head Vent.

If all release pathways are not closed, operators will ensure the pathways are closed within 30 minutes after a loss of RHR flow. Operators must monitor core exit thermocouples and sound the containment evacuation alarm if the core exit temperature reaches 200°F. The procedure also includes additional guidance to the operators, in tabular form, giving the RCS heatup rate and the time to reach 200°F from an initial temperature of 90°F as a function of days since reactor shutdown.

There is an industry wide issue regarding containment closure of penetrations used for temporary lines into and out of containment during outages. For example, during outages at DCPP, Penetration 63 is used as a cable conduit. The present way of isolating the penetration is to have the cables pass through a water filled loop seal external to the containment. During accident scenarios in which containment pressurization is postulated, the water could potentially be blown out of the loop seal resulting in an open path to the

environment. The Westinghouse Owners Group (WOG) is studying this issue with a resolution expected by mid 1989. PG&E will evaluate the WOG's recommended modification for implementation at DCPP when it is issued.

Item 3

Provide at least two independent, continuous temperature indications that are representative of the core exit conditions whenever the RCS is in a mid-loop condition* and the reactor vessel head is located on top of the reactor vessel. Temperature indications should be periodically checked and recorded by an operator or automatically and continuously monitored and alarmed. Temperature monitoring should be performed either:

(a) by an operator in the control room (CR), or

(b) from a location outside of the containment building with provision for providing immediate temperature values to an operator in the CR if significant changes occur. Observations should be recorded at an interval no greater than 15 minutes during normal conditions.**

---

* A mid-loop condition exists whenever RCS water level is below the top of the flow area of the hot legs at the junction with the RV.

** Guidance should be developed and provided to operators that covers evacuation of the monitoring post. The guidance should properly balance reactor and personnel safety.

Response to Item 3

It is important that operators have direct indication of the RCS temperature during reduced inventory conditions. Temperature measurement can provide an indication of a slow or rapidly degrading decay heat removal capability. Following a loss of RHR, temperature measurement allows observation of the RCS heatup rate and thus the approach to boiling. Temperature measurement also provides an indication of the effectiveness of recovery actions taken after a loss of RHR.

As a prerequisite to mid-loop operation, OP A-2:III requires that, except during preparation for removal or replacement of the reactor vessel head, a minimum of two incore thermocouples (T/C's) must be available when the reactor head is in place. The two T/C's come from different instrumentation trains and are a representative indicator of core exit conditions. These

temperatures are displayed on the Post-Accident Monitoring System (PAMS) panel located in the control room. Operating Procedure A-2:III also contains the precaution to notify Instrumentation and Controls Department (I&C) to place an additional T/C in service before any scheduled maintenance is performed on the T/C conoseal with the active T/C.

Further prerequisites for mid-loop operation are to have in service:

1. A minimum of two Wide Range T_{hot} RTD channels. These are recorded on Control Room Vertical Board No. 2 (VB2).

2. Temperature and flow instrumentation for both RHR trains. These are recorded on Control Room Vertical Board No. 1 (VB1).

The RTD channels and the RHR temperature instrumentation are useful in providing an indication of a slowly degrading decay heat removal condition, should one occur. The RTDs will not provide a reliable indication of core exit temperature after a loss of RHR flow and precautions in the procedures advise the operators of this fact.

Item 4

> Provide at least two independent, continuous RCS water level indications whenever the RCS is in a reduced inventory condition. Water level indications should be periodically checked and recorded by an operator or automatically and continuously monitored and alarmed. Water level monitoring should be capable of being performed either:
>
> (a) by an operator in the CR, or
>
> (b) from a location other than the CR with provision for providing immediate water level values to an operator in the CR if significant changes occur. Observations should be recorded at an interval no greater than 15 minutes during normal conditions.**
>
> ---
>
> ** Guidance should be developed and provided to operators that covers evacuation of the monitoring post. The guidance should properly balance reactor and personnel safety.

Response to Item 4

To supplement the information provided by RCS temperature indication at least two independent, continuous RCS water level indications are provided through the reactor vessel refueling level indication system (RVRLIS). These indications consist of:

1. Wide Range (WR) RVRLIS tapping off the Loop No. 2 cold leg.

2. Narrow Range (NR) RVRLIS tapping off the Loop No. 3 hot leg.

3. A tygon stand pipe tapping off the Loop No. 4 crossover leg.

These water level indications, coupled with RCS temperature indications, are instrumental in providing vital information to operators for early alert of potential RHR suction loss, indication of core coverage, and input for estimating time to uncover the core.

As a prerequisite to draining for reduced inventory operation, OP A-2:II, "Reactor Vessel-Draining the RCS to the Vessel Flange," requires the installation of independent NR and WR level indication in accordance with Instrumentation and Control (I&C) procedure MP 2.28-2, "Activation of the RVRLIS System." This I&C procedure also requires the installation of a multipoint recorder in the control room. The recorder also indicates pressurizer relief tank pressure.

The control room level indicators for the NR and WR RVRLIS are normally used to monitor ECCS accumulators associated with RCS loops 2 and 3, respectively. When used for NR and WR RVRLIS, these level indicators are relabeled and rescaled for reduced inventory conditions. In addition, these level indications are administratively controlled using a keylock switch.

In addition to RVRLIS indication, OP A:2-III requires an operator be stationed inside containment and in communication with the control room at all times when the RCS level is less than 111 feet. The auxiliary operator stationed in the containment is capable of being quickly dispatched to monitor the tygon tube level whenever the need arises.

To assist operators in the use of the RVRLIS as well as assuring reliable indication, the following precautions and limitations are procedurally identified in OP A-2:III:

1. When the head is on the reactor vessel and T/C conoseals are installed, the WR RVRLIS can be expected to indicate slightly higher than the NR RVRLIS if air entrainment or vortexing is present in the RHR suction piping. If a discrepancy between the NR and WR indication occurs, the NR RVRLIS is to be used.

2. When the head is on the reactor vessel with the T/C conoseals installed, rapid changes in reactor vessel level can create unequal pressures between the gas spaces in the pressurizer and the reactor vessel head area due to restriction of the vent crosstie line. By procedural controls, level changes are made slowly (letdown may not exceed 75 gpm) to minimize the effects on the WR and NR RVRLIS indications. If a difference exists between WR and NR RVRLIS indications, the NR level is to be used.

ensure licensed operators awareness of any activities which may affect the RCS. Operators are also cautioned to minimize any conditions which can cause transients (i.e., RHR pump changes, flow rate changes). OP A-2:III also contains measures to prevent a loss of RHR. One such measure, for example, is the revision to the DCPP Technical Specifications to allow a lowered RHR flow rate (1300 gpm rather than the previous 3000 gpm). Lower flow results in a lower probability of vortexing, air entrainment, and pump cavitation. OP A-2:III, Attachment 8.5, gives the control operators quantitative guidance in maintaining level. Operators are instructed to keep the RCS level at or above 107 feet 6 inches and are provided with a table estimating the level where vortexing and air entrainment will begin as a function of RHR flow rate. RCS level can only be reduced below 107 feet 6 inches with prior DCPP management approval.

In light of the guidance contained in Generic Letter 88-17, PG&E reviewed the operating procedures controlling activities that could result in adverse RCS perturbations. It was determined that the procedures could be further strengthened and will be revised before the next entry into mid-loop.

OP A-2:III instructs the operators to inject nitrogen into the RCS flow instrumentation taps in order to drain the steam generator U-tubes. This reduces perturbations in RCS level that can occur when level has to be lowered below the top of the hot leg in order to drain the steam generator U-tubes. Steam generator U-tube draining can now be accomplished at a level above the top of the hot leg thus avoiding level perturbations when operating in the critical level band when the level is below the top of the hot leg.

Item 6

> Provide at least two available* or operable means of adding inventory to the RCS that are in addition to pumps that are a part of the normal DHR systems. These should include at least one high pressure injection pump. The water addition rate capable of being provided by each of the means should be at least sufficient to keep the core covered. Procedures for use of these systems during loss of DHR events should be provided. The path of water addition must be specified to assure the flow does not bypass the reactor vessel before exiting any opening in the RCS.
>
> ---
>
> * Available means ready for use quickly enough to meet the intended functional need.

Response to Item 6

Subsequent to the April 10, 1987, loss of RHR event, PG&E analyzed the amount of water required for continued core coverage. This analysis estimated that

approximately 125 gpm is required assuming a 20 Mw decay heat load. This heat load corresponds to the decay heat from the core after two days of shutdown from full power operation and provides a conservative value as mid-loop operation will not occur prior to this time. To ensure this flow rate is available, PG&E enhanced OP A-2:III to provide at least two available means, different from the normal RHR system, of adding inventory to the RCS in the event of failures of the RHR pumps.

Specifically, OP A-2:III stipulates, prior to draining to mid-loop, that one charging pump be available, gravity fill makeup from the Refueling Water Storage Tank be available, and a Safety Injection (SI) Pump and an associated hot leg flow path to the RCS (available through valve 8802A or B) also be available.

With the above pumps available core coverage can be maintained. The expected flow at mid-loop operation for a centrifugal charging pump is approximately 550 gpm and the expected flow for a safety injection pump is approximately 650 gpm. These pumping rates exceed that required to make up losses due to boiling and are adequate to keep the core covered.

PG&E has developed operating procedure OP AP-16, Section C, to use these systems should loss of RHR occur. This procedure instructs the operators to:

1. Stop RHR pump to prevent damage and dispatch operators to vent RHR pump seal water cooler.

2. Isolate RHR letdown.

3. If the RCS level is less than 108 feet, restore the RCS level to greater than 108 feet by initiating makeup to the RCS by:

   - Opening the Refueling Water Storage Tank (RWST) isolation valve to the RHR to provide cold water to the RHR Pump suction as well as add inventory to the RCS through all four cold legs; or

   - Opening the valves which admit RWST water to the charging system. Start a centrifugal charging pump to overcome system pressure if required and makeup to the Loop No. 4 cold leg; or,

   - Opening the RHR to RWST isolation valve to allow gravity induced back flow from the RWST to the RCS in all four cold legs and hot legs No. 1 and No. 2.

4. If RHR has not been restored, then one of the following two recovery actions to achieve a feed and bleed cooling mode will be taken before the RCS reaches 200°F.

   - If all steam generator nozzle dams or manways are installed, the RCS level will be raised to the 125 foot elevation using a centrifugal charging pump which will provide makeup to cold leg No. 4 and restore RHR letdown by directing coolant into the Liquid Hold-Up Tank; or,

- When manways and nozzle dams are not installed, gravity will be used to bring the RCS level up to the 110 foot level and water will flow from the primary manways.

Before PG&E's next entry into mid-loop, procedure OP AP-16 will be further enhanced to include hot leg injection using a Safety Injection Pump.

Item 7

(Applicable to Westinghouse and Combustion Engineering nuclear steam supply system (NSSS) designs). Implement procedures and administrative controls that reasonably assure that all hot legs are not blocked simultaneously by nozzle dams unless a vent path is provided that is large enough to prevent pressurization of the upper plenum of the RV.

Response to Item 7

In recognition of the importance of assuming that loss of RHR does not result in forcing water out of the reactor vessel (via a cold leg), PG&E has implemented procedures and administrative controls that will reasonably assure a sufficient size vent path exists prior to blocking all hot legs with nozzle dams. This vent path is provided by two different means:

1. Sequencing the steam generator nozzle dam installation so that at least one hot leg nozzle dam is the last to be installed and upon removal a hot leg nozzle dam is removed prior to removal of any cold leg nozzle dams.

2. Assuring the reactor vessel is detensioned thus providing an annular gap at the vessel head.

Specifically, Attachment A to Operating Procedure L-6, "Refueling," provides the following guidance on the installation of the steam generator nozzle dams and requires the following sequence of steps:

(a) Fill or verify that at least two steam generator secondary sides are filled to greater than 15 percent narrow range level.

(b) Remove the manways from steam generators (SG) No. 1, No. 2, No. 3 and No. 4, hot leg first. Install nozzle dams (hot and cold legs) in the No. 1, No. 2 and No. 3 steam generators.

(c) Install the cold leg nozzle dam in the No. 4 steam generator.

(d) Verify that the reactor head is fully detensioned with studs removed and conoseals removed. This provides a RCS vent path before the next step is performed.

(e) Install the No. 4 steam generator hot leg nozzle dam.

(f) Refill the reactor vessel to the approximate level of the flange.

Attachment B to OP L-6 gives guidance in the removal of steam generator nozzle dams and requires that the following steps shall be performed in sequence.

(a) Fill or verify that at least two steam generator secondary sides are filled to greater than 15 percent narrow range level.

(b) Verify that the reactor head is fully detensioned and that the conoseals are removed.

(c) Remove the steam generator No. 1 hot leg nozzle dam.

(d) Remove the remaining nozzle dams and install all but the steam generator No. 4 hot leg manway.

(e) Install the steam generator No. 4 hot leg manway.

(f) Refill the reactor vessel to the approximate level at the flange.

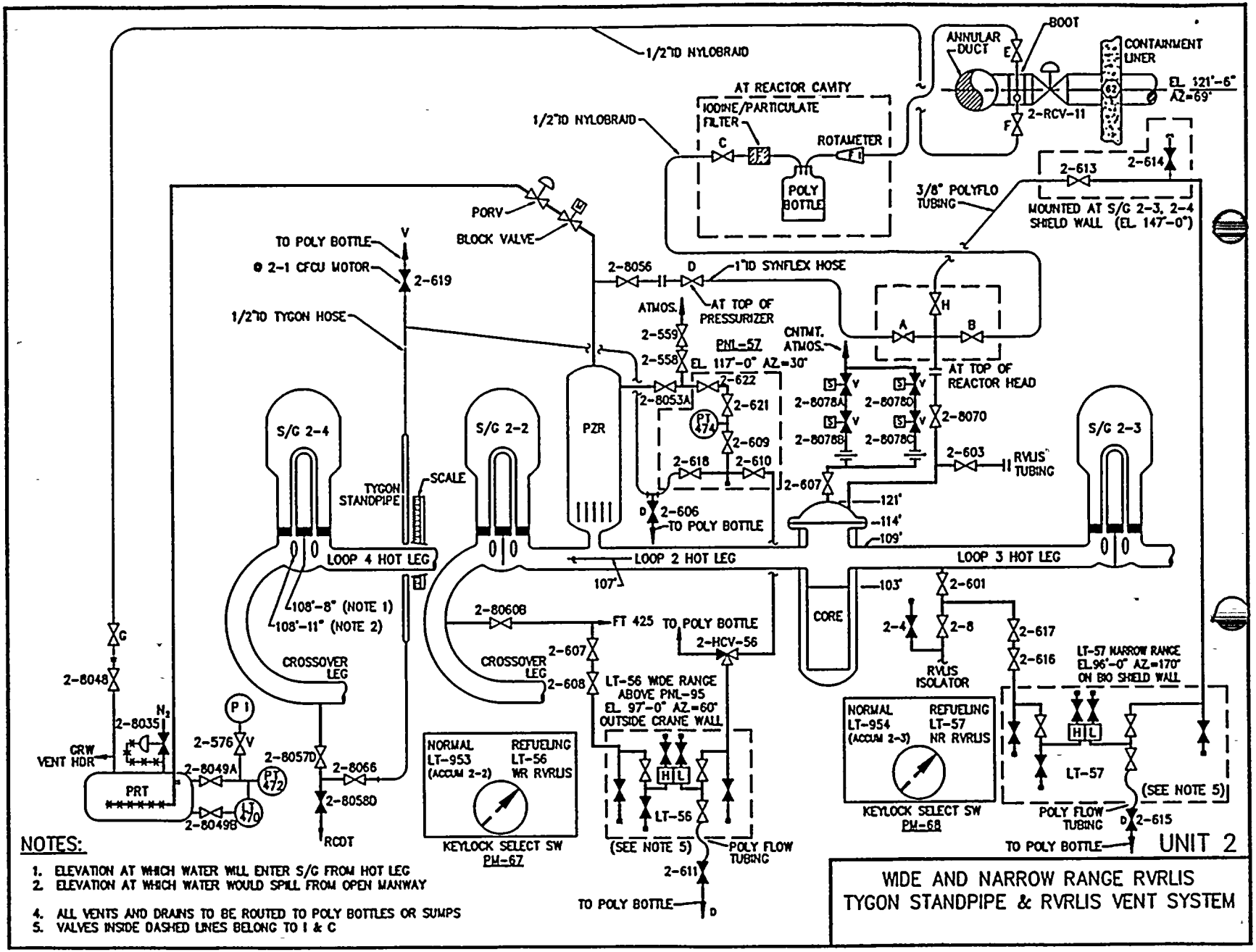
These procedures take into consideration NRC Information Notice No. 88-36, "Possible Sudden Loss of RCS Inventory During Low Coolant Level Operation." The recent Westinghouse Owners Group Report WCAP-11916, "Loss of RHRS Cooling While the RCS is Partially Filled," has been used to generate Diablo Canyon specific estimates of the time to core uncovery if there are large cold leg vents but no hot leg vents. These estimates considered various times after shutdown and are being used in operator training to emphasize the rationale behind opening a hot leg first and closing one last.

Item 8

> (Applicable to NSSSs with loop stop valves) Implement procedures and administrative controls that reasonably assure that all hot legs are not blocked simultaneously by closed stop valves unless a vent path is provided that is large enough to prevent pressurization of the RV upper plenum or unless the RCS configuration prevents RV water loss if RV pressurization should occur. Closing cold legs by nozzle dams does not meet this condition.

Response to Item 8

Not applicable to DCPP: No loop stop valves are used at DCPP.


1/2"ID NYLOBRAID
AT REACTOR CAVITY
IODINE/PARTICULATE FILTER
ROTAMETER
C
POLY BOTTLE
ANNULAR DUCT
E
BOOT
CONTAINMENT LINER
EL. 121'-6" AZ=69°
F
2-RCV-11
62
2-613
2-614
3/8" POLYFLO TUBING
MOUNTED AT S/G 2-3, 2-4 SHIELD WALL (EL. 147'-0")
PORV
BLOCK VALVE
TO POLY BOTTLE
V
@ 2-1 CFCU MOTOR
2-619
1/2"ID TYGON HOSE
2-8056
D
1"ID SYNFLEX HOSE
AT TOP OF PRESSURIZER
ATMOS.
2-559
2-558
PNL-57
EL. 117'-0" AZ=30°
CNTMT. ATMOS.
A
B
H
AT TOP OF REACTOR HEAD
2-622
2-8053A
2-621
PT 474
2-609
2-618
2-610
2-8078A
2-8078D
2-8078B
2-8078C
2-8070
2-603
RVLIS TUBING
S/G 2-4
S/G 2-2
PZR
S/G 2-3
TYGON STANDPIPE
SCALE
2-607
2-606
TO POLY BOTTLE
121'
114'
109'
LOOP 4 HOT LEG
LOOP 2 HOT LEG
LOOP 3 HOT LEG
107'
103'
108'-8" (NOTE 1)
108'-11" (NOTE 2)
2-80608
FT 425 TO POLY BOTTLE
2-HCV-56
CROSSOVER LEG
2-607
2-608
CORE
2-601
2-4
2-8
RVLIS ISOLATOR
2-617
2-616
LT-57 NARROW RANGE EL.96'-0" AZ=170° ON BIO SHIELD WALL
G
2-8048
N2
2-8035
P I
2-576
V
CRW VENT HDR
2-8049A
2-8057D
2-8066
PT 472
PRT
LT 470
2-8049B
2-8058D
RCDT
NORMAL LT-953 (ACCUM 2-2)
REFUELING LT-56 WR RVRLIS
KEYLOCK SELECT SW PM-67
LT-56 WIDE RANGE ABOVE PNL-95 EL. 97'-0" AZ=60° OUTSIDE CRANE WALL
H
L
LT-56
(SEE NOTE 5)
POLY FLOW TUBING
2-611
TO POLY BOTTLE
D
NORMAL LT-954 (ACCUM 2-3)
REFUELING LT-57 NR RVRLIS
KEYLOCK SELECT SW PM-68
LT-57
(SEE NOTE 5)
POLY FLOW TUBING
2-615
TO POLY BOTTLE
UNIT 2
NOTES:
1. ELEVATION AT WHICH WATER WILL ENTER S/G FROM HOT LEG
2. ELEVATION AT WHICH WATER WOULD SPILL FROM OPEN MANWAY
4. ALL VENTS AND DRAINS TO BE ROUTED TO POLY BOTTLES OR SUMPS
5. VALVES INSIDE DASHED LINES BELONG TO I & C
WIDE AND NARROW RANGE RVRLIS
TYGON STANDPIPE & RVRLIS VENT SYSTEM

REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR: 8901130005 DOC. DATE: 89/01/06 NOTARIZED: YES DOCKET #
FACIL: 50-275 Diablo Canyon Nuclear Power Plant, Unit 1, Pacific Ga 05000275
50-323 Diablo Canyon Nuclear Power Plant, Unit 2, Pacific Ga 05000323
AUTH. NAME AUTHOR AFFILIATION
SHIFFER, J. D. Pacific Gas & Electric Co.
LOCKE, H. V. Pacific Gas & Electric Co.
RECIP. NAME RECIPIENT AFFILIATION
Document Control Branch (Document Control Desk)

SUBJECT: Forwards response to Generic Ltr 88-17, "Loss of DHR." Tech Specs changed to allow for lower RHR flow for mid-loop operation & operating procedures revised to provide to operators w/guidance to RCS level.

DISTRIBUTION CODE: A061D COPIES RECEIVED: LTR 1 ENCL 1 SIZE: 20
TITLE: OR/Licensing Submittal: Loss of Residual Heat Removal (RHR) GL-87-12

NOTES:

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
	PD5 LA	1	0	PD5 PD	1	1
	ROOD, H	1	1			
INTERNAL:	ACRS	6	6	ARM/DAF/LFMB	1	0
	NRR BALUKJIAN, H	2	2	NRR TRAMMELL, C	1	1
	NRR/DEST/ADE 8H	1	1	NRR/DEST/ADS 7E	1	1
	NRR/DOEA/TSB 11	1	1	NUDOCS-ABSTRACT	1	1
	OGC/HDS2	1	0	REG FILE 01	1	1
	RES SPANO, A	1	1	RES/DSIR/EIB	1	1
	RES/DSR/PRAB	1	1			
EXTERNAL:	LPDR	1	1	NRC PDR	1	1
	NSIC	1	1			

TOTAL NUMBER OF COPIES REQUIRED: LTTR 25 ENCL 22

M/A 4
cc

DISTRIBUTION CODE: A001D COPIES RECEIVED:LTR [illegible] ENCL [illegible] SIZE: [illegible]
TITLE: OR Submittal: [illegible]

NOTES:

	RECIPIENT ID CODE/NAME	COPIES LTTR ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR ENCL
	PD3 [illegible]	[illegible]	PD3 PD	[illegible]
	[illegible]	[illegible]		
INTERNAL:	ACRS	[illegible]	NRR [illegible]	[illegible]
	NRR [illegible]	[illegible]	NRR [illegible]	1
	NRR [illegible]	[illegible]	NRR [illegible]	1
	NRR [illegible]	[illegible]	NUDOCS-ABSTRACT	1
	OGC [illegible]	[illegible]	REG FILE 01	[illegible]
	RES [illegible]	[illegible]	RES [illegible]	[illegible]
	RES [illegible]	[illegible]		
EXTERNAL:	LPDR	[illegible]	NRC PDR	1
	NSIC	[illegible]		

Pacific Gas and Electric Company

77 Beale Street
San Francisco, CA 94106
415/972-7000
TWX 910-372-6587

James D. Shiffer
Vice President
Nuclear Power Generation

January 6, 1989

PG&E Letter No. DCL-89-005

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Re: Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Response to Generic Letter 88-17, Loss of Decay Heat Removal

Gentlemen:

Generic Letter 88-17, "Loss of Decay Heat Removal" dated October 17, 1988, requested a response to eight items related to the loss of decay heat removal while the plant was shutdown. PG&E's response is provided in the enclosure.

Kindly acknowledge receipt of this material on the enclosed copy of this letter and return it in the enclosed addressed envelope.

Subscribed to in San Francisco, California this 6th day of January 1989.

Respectfully submitted,

Pacific Gas and Electric Company

By _____
J. D. Shiffer
Vice President
Nuclear Power Generation

Howard V. Golub
Richard F. Locke
Attorneys for Pacific
Gas and Electric Company

By _____
Richard F. Locke

Subscribed and sworn to before me
this 6th day of January 1989

_____
Therese Toliver, Notary Public in
and for the City and County of
San Francisco, State of California

My commission expires December 25, 1990.

OFFICIAL SEAL
THERESE TOLIVER
NOTARY PUBLIC - CALIFORNIA
CITY AND COUNTY OF SAN FRANCISCO
My Comm. Expires Dec 25, 1990

cc: J. B. Martin
M. M. Mendonca
P. P. Narbut
B. Norton
H. Rood
B. H. Vogler
CPUC
Diablo Distribution

Enclosure

2438S/0066K/DJH/2197

A061
1/1

PLEASE REDISTRIBUTE DUE TO MISSING PAGES ON FIRST DIST.

8901130005 20pp PDR

ENCLOSURE

PG&E RESPONSE TO THE EXPEDITIOUS ACTIONS RECOMMENDED IN GENERIC LETTER 88-17, "LOSS OF DECAY HEAT REMOVAL"

INTRODUCTION AND SUMMARY

This enclosure provides PG&E's response to the NRC concerns identified in Generic Letter 88-17: (1) prevention of a loss of decay heat removal, (2) mitigation of an accident before events progress to core damage, and (3) control of radioactive material should core damage occur. PG&E has addressed these issues as briefly summarized below.

1. Prevention

   a. Current operator training emphasizes that a loss of decay heat removal can lead to a serious accident in a relatively short time. The operators are therefore aware that reducing reactor coolant system (RCS) inventory with irradiated fuel in the reactor vessel is a process that must be performed with close attention and great care. Discussions have taken place informing operators of lessons learned and their implications.

   b. The Diablo Canyon Technical Specifications have been changed to allow for lower Residual Heat Removal (RHR) flow for mid-loop operation. This reduces the likelihood of a loss of RHR by pump cavitation due to air entrainment in the RHR pump suction.

   c. Operating procedures have been revised to provide the operators with guidance as to the RCS level necessary to prevent RHR pump cavitation caused by air entrainment.

   d. RCS level is indicated on three level indications. Procedures for the proper installation and maintenance of these level indications ensure their reliability and availability.

   e. All ongoing and planned outage activities are reviewed before RCS mid-loop operation to ensure that none of these activities will inadvertently reduce RCS inventory.

   f. The steam generator (SG) U-tubes are drained using nitrogen injection into the RCS flow instrumentation taps in the crossover legs. This enables operators to more easily control RCS inventory during the draindown to mid-loop. Controlled draindown further reduces the possibility of RHR pump air entrainment and vortexing.

2. Mitigation

   a. In the event of a loss of RHR, operating procedures specify that RCS temperature indications be monitored to track temperature rise. The RCS heatup rate and the time to reach 200°F as a function of decay heat load are provided in tabular form in plant procedures.

b. The removal and reinstallation sequences of the steam generator manways and nozzle dams are controlled to prevent the presence of cold leg vent paths when no hot leg vent paths exist.

c. Makeup to the RCS is provided by a charging pump, gravity feed from the Refueling Water Storage Tank and a Safety Injection Pump which can quickly be put in service should RHR be lost.

d. Recovery procedures are in place to ensure expeditious actions are taken during a loss of RHR while in mid-loop.

3. Control of Radioactive Materials

Procedures and controls are in place to assure that containment evacuation and closure occur, the containment equipment hatch is closed and secured by a minimum of four bolts, and major environmental release pathways are closed within 30 minutes after the loss of RHR flow.

The following provides background information and a detailed response to each of the expeditious actions recommended in the Generic Letter. A separate response addressing the programmed enhancements will be submitted in accordance with the schedule noted in GL 88-17.

BACKGROUND

The Diablo Canyon Nuclear Power Plant (DCPP) operating procedures that govern mid-loop operations, the drain down to mid-loop, and the refilling of the Reactor Coolant System (RCS) after mid-loop are:

OP A-2:I. Reactor Vessel - Filling and Venting the RCS. Unit 1. Revision 13; July 9, 1988.

OP A-2:I. Reactor Vessel - Filling and Venting the RCS. Unit 2. Revision 6; November 1, 1988.

OP A-2:II. Reactor Vessel - Draining the RCS to the Vessel Flange. Unit 1. Revision 2; May 5, 1988.

OP A-2:II. Reactor Vessel - Draining the RCS to the Vessel Flange. Unit 2. Revision 6; September 19, 1988.

OP A-2:III. Reactor Vessel - Draining to Half Loop/Half Loop Operations. Unit 1. Revision 5; May 5, 1988.

OP A-2:III. Reactor Vessel - Draining to Half Hoop/Half Loop Operations. Unit 2. Revision 1; September 30, 1988.

OP AP-16. Malfunction of the RHR System. Units 1 and 2. Revision 5; November 9, 1988.

OP-L-6. Refueling. Units 1 and 2. Revision 8; September 20, 1988. (This procedure is not intended to provide detailed instructions for operation of the various systems and equipment, but rather to provide a plan or sequence for coordinating maintenance and operations activities).

Presently, Unit 1 is in its third fuel cycle with a refueling outage scheduled for October of 1989, and Unit 2 is in its third fuel cycle with a refueling outage scheduled for the Spring of 1990. The earliest anticipated mid-loop operation with irradiated fuel in the vessel is October 1989.

The following plant specific information is applicable to both units and should clarify PG&E's responses to the expeditious actions outlined in GL 88-17: 1) During normal operation of the RHR system, suction is from the reactor coolant system (RCS) through the loop No. 4 hot leg. 2) The RHR system injects into two or all four cold legs. 3) The pressurizer is attached to the RCS loop No. 2 hot leg.

The following elevations are useful for an understanding of the mid-loop procedures (elevations are in feet and inches with sea level as zero elevation):

Top of the Reactor Vessel Head	121'-0"
Junction of the Head and Reactor Vessel	114'-1 1/2"
Elevation at which water would spill from an open steam generator manway	108'-11"
Top of a Hot Leg (ID)	108'-2"
Hot Leg Centerline	107'-0"
Bottom of a Hot Leg (ID)	105'-10"
Top of the Core	102'-11 1/2"

A Figure from Operating Procedure A-2:III is attached which shows the various RCS elevations.

RESPONSES TO ITEMS 1 THRU 8

The following is PG&E's detailed response to each of the eight expeditious actions which are to be implemented before the next entry into a mid-loop condition with irradiated fuel in the reactor vessel at DCPP.

Item 1

> Discuss the Diablo Canyon event, related events, lessons learned, and implications with appropriate plant personnel. Provide training shortly before entering a reduced inventory condition.

Response to Item 1

Subsequent to the April 10, 1987, loss of RHR cooling event, the DCPP Training Department conducted training to ensure that all licensed operators were made aware of the operational concerns which exist when the RCS is in a reduced inventory condition. All licensed operators have received this training. In addition to receiving training on the April 10, 1987, event at DCPP, the Waterford 3 event has been discussed with the Diablo Canyon licensed operators. Lessons learned from these events have been factored into the training sessions at DCPP and include the following:

- Maintaining the RCS level high enough to avoid air entrainment in the RHR pumps.
- Monitoring RCS level continuously.
- Reducing RHR flow rate to prevent vortexing, air entrainment, and cavitation in the RHR pumps.
- To minimize the effects on the wide range and narrow range Reactor Vessel Refueling Level Indication System (RVRLIS) indications, drain down of the RCS is not to exceed 75 gpm.
- Time for RCS boiling to occur is less than originally estimated.
- Increased pressure build-up in the RCS after the loss of RHR may prevent gravity feed from the RWST.
- Activities which have the potential for influencing RCS level perturbations are not allowed or carefully controlled.
- Level gradients could exist in the RCS as a result of pressure disturbances within the primary system during transient conditions.
- Installation and removal of nozzle dams and manways need to be sequenced to ensure that a proper hot leg vent path from the core exists.

- The importance of containment closure in a timely manner.
- The necessity for minimizing the time in mid-loop operation when fuel is in the vessel.
- The importance of core temperature monitoring.
- The importance of the heat removal capability of the secondary side.
- Understanding the importance of the injection flow path during recovery operations.
- The implementation of Westinghouse Owners Group studies of mid-loop operation.
- Understanding the core thermal hydraulic behavior following a loss of RHR event.
- The importance of accurate RVRLIS indication.

Listed below are seven requalification sessions and a summary of the topics presented in each session that all licensed operators have attended since the April 10, 1987 event.

Requalification Session 86-6. (3/30/87 to 5/8/87)

The PG&E Operations Incident Summary, "Loss of Residual Heat Removal > 1 HR With Unit in Mode 5," was used as a reference to discuss the event using the INPO Case Study Format.

Specific items reviewed were:

- Personnel errors that led to the loss of RCS inventory and subsequent loss of RHR cooling.
- Indications and phenomena observed in the Control Room, Auxiliary Building and Containment during the event.
- Problems encountered with the then existing loss of RHR procedure: OP AP-16 (Revision 0) "Malfunction of the RHR System."
- The revised procedure OP AP-16.

Requalification Session 86-7. (5/11/87 to 6/12/87)

A lesson plan was developed which presented a more detailed description of the April 10, 1987, event. The operational concerns while at mid-loop operation as well as recent procedural changes were discussed.

Among the topics covered were:

- Precautions from related procedures.

- The priority of operator actions which are needed to restore RHR cooling.
- Estimation of the time to reach bulk boiling after a loss of RHR and its dependency on the time after shutdown.
- The Reactor Vessel Refueling Level Indication System (RVRLIS).
- The level for onset of RHR pump vortexing.
- Makeup flow paths to restore RCS inventory and RHR pump suction.
- Alternate means of core cooling in the event that RHR cooling cannot be restored.
- The revised event classification and notification requirements following a loss of RHR.
- Restoration of RHR cooling using the revised OP AP-16.

Requalification Session 87-3. (11/16/87 to 12/31/87)

This session focused on the new RVRLIS design features including, the location and range of the indications, the control room alarms and the alarm inputs which indicate an abnormal vessel level.

Requalification Session 87-4. (1/11/88 to 2/19/88)

This presentation reviewed aspects of mid-loop operations with the following items being stressed:

- The precautions and prerequisites contained in mid-loop operation procedures.
- The expected responses of the wide range and narrow range RVRLIS during a draindown of the RCS.
- The indications that would signify vortexing or cavitation of the RHR pumps and the RCS level at which vortexing would occur.
- The proper operational response to vortexing or cavitation.
- A review of the new RVRLIS with emphasis on describing connection points and valve configurations.
- The new nitrogen injection procedure to reduce the time for steam generator tube draining.

Requalification Session 88-1. (07/26/88 to 09/02/88)

This session covered the loss of shutdown cooling while at mid-loop operation at Waterford Unit 3. The event and corrective actions were discussed with the objective of instilling operators with the understanding of:

- The undesirability of loop seals in tubing used for RCS level indication.
- How the OP A-2:II procedural steps minimize inaccuracies of the indicated RCS level.

Requalification Session 88-2, (9/5/88 to 10/14/88)

This session covered NRC Information Notice No. 88-36, "Possible Sudden Loss of RCS Inventory During Low Coolant Level Operation". Key topics covered were:

- The mechanism whereby pressurization in bottled up hot legs can expel coolant through opened cold legs which in turn leads to rapid core uncovery.
- The requirement that a hot leg nozzle dam is the last to be installed and the first to be removed.
- Not installing the last nozzle dam until a sufficient vent path is established to mitigate RCS pressurization and thereby reduce the possibility of ejecting a nozzle dam.

Requalification Session 88-3, (10/18/88 to 11/25/88)

In this session the operators viewed a videotape produced by the Westinghouse Owners Group (WOG). The tape shows a scale model RCS hot leg with RHR suction line attached and demonstrates that low RCS level and high RHR flow promotes vortexing whereas high RCS level and low flow prevents vortexing, air entrainment, and pump cavitation.

Licensed operators participated in a simulator training scenario LS-6-1D, "Half Loop RHR Operation," which had the key objectives to highlight draindown to mid-loop, recognizing onset of RHR pump vortexing and RHR pump trip, and use of OP AP-16 to reestablish RHR cooling. In the classroom session associated with this simulator session, mid-loop operations were again reviewed. The topics presented during this classroom session were:

- The loss of RHR flow and its causes.
- Corrective actions to be taken and the associated makeup flow paths.
- Control room indications for RVRLIS.
- The RVRLIS system connection points.
- The alternate methods of core cooling to be used if RHR flow cannot be reestablished.
- Event-related emergency classifications.

The license training program contains lesson LPA-16, "RHR System Malfunctions," which familiarizes students with issues related to mid-loop

operations. This lesson emphasizes the content and format of the loss of RHR recovery procedure. Auxiliary Operators have received training to deal with the items that are applicable to their involvement with RVRLIS through lesson NLR8832, "RVRLIS Update and Review," which discusses:

- RVRLIS setup and operation
- Location of RVRLIS components, connection points, etc., as well as potential problems encountered.
- Proper venting of the RVRLIS.

To ensure that all future operators receive training on mid-loop procedures and concerns, material on RVRLIS design and operation, OP AP-16, "Malfunction of the RHR System," corrective actions, and RCS drain procedures A-2:II and A-2:III have been incorporated into the RHR System Description and License Lesson Guide.

The Westinghouse Owners Group (WOG) studies of the thermal-hydraulics of mid-loop RHR operation and PG&E plant specific analysis have been transmitted to the Training Department for their use in training.

In the License Requalification Program, OP AP-16, "Malfunction of the RHR System," is reviewed with the operators on a biennial basis. Any changes to procedures or equipment associated with mid-loop operations will be covered as part of the standard requalification design change notice and procedure update training. Before a unit is brought to a mid-loop condition, there is a required briefing during which the concerns and procedures associated with mid-loop operations are reviewed with the operating crews.

Item 2

> Implement procedures and administrative controls that reasonably assure that containment closure** will be achieved prior to the time at which a core uncovery could result from a loss of DHR coupled with an inability to initiate alternate cooling or addition of water to the RCS inventory. Containment closure procedures should include consideration of potential steam and radioactive material release from the RCS should closure activities extend into the time boiling takes place within the RCS. These procedures and administrative controls should be active and in use:
>
> (a) prior to entering a reduced RCS inventory* condition for NSSSs supplied by Combustion Engineering or Westinghouse, and
>
> (b) prior to entering an RCS condition wherein the water level is lower than four inches below the top of the flow area of the hot legs at the junction of the hot legs to the RV for NSSSs supplied by Babcock and Wilcox,

and should apply whenever operating in those conditions. If such procedures and administrative controls are not operational, then either do not enter the applicable condition or maintain a closed containment.

---

* A reduced inventory condition exists whenever RV water level is lower than three feet below the RV flange.

** Containment closure is defined as a containment condition where at least one integral barrier to the release of radioactive material is provided.

Response to Item 2

Following the April 10, 1987, loss of RHR event, PG&E committed to the NRC Augmented Inspection Team to revise procedures to ensure that major pathways which communicate between the containment and the outside atmosphere will either be closed (in the case of the equipment hatch and steam generator secondary side isolation) or be identified and capable of easily being closed in a timely manner. In response to this event, PG&E has modified procedures governing draining the RCS, mid-loop operation, abnormal operating procedures, and overall operating procedures concerning refueling operations.

PG&E has defined the criteria for a containment "boundary" as follows:

(a) The equipment hatch is in place and is secured with a minimum of four bolts. Maintenance Procedure (MP) M-45.1, "Containment Equipment Hatch Door Opening and Closing," specifies the bolts must be equally spaced and torqued. A light source is used inside containment to verify that no gaps are visible from outside containment.

(b) No obstructions are present so that each containment airlock shall have at least one door capable of being readily closed.

(c) Containment ventilation isolation can be assured with at least one valve (inside or outside of containment) per penetration capable of being closed.

(d) All steam generator secondary side manways and inspection ports are installed, or,

the steam generator safety valves are installed or blind-flanged, the Main Steam Isolation Valves (MSIV) and the MSIV Bypass Valves are closed, the ten percent atmospheric dump valves are closed and the valves admitting steam into the Auxiliary Feed Turbine (FCV-37 and FCV-38) are closed. All closed valves are to be controlled by an administrative tag out.

(e) A path to the auxiliary building is prevented by one of the following:

The Fuel Transfer Tube (FTT) blind flange is installed, or,

the FTT manual gate valve SFS-1-50 is closed and controlled by an administrative tagout, or,

an operator in communication with the Control Room is continuously stationed at SFS-1-50 and can close the valve when necessary, or,

the refueling canal is flooded greater than a foot above the top of the FTT, if the FTT is open.

PG&E's estimation of the time required for converting the "boundary" to containment closure as defined in GL 88-17 is less than 30 minutes. Operating Procedure OP A-2:III requires that a containment boundary be established prior to draining the reactor vessel level lower than approximately 3 feet below the RCS flange level (111 foot elevation). The requirement remains in effect until level is restored above 111 feet.

If RHR flow should be lost while at mid-loop, OP AP-16 instructs the operator to verify that the major environmental release pathways are closed. These pathways consist of the following:

- Equipment hatch.
- At least one personnel door.
- At least one emergency exit personnel door.
- The steam generator secondary side.
- Containment ventilation.
- The Reactor Vessel Head Vent.

If all release pathways are not closed, operators will ensure the pathways are closed within 30 minutes after a loss of RHR flow. Operators must monitor core exit thermocouples and sound the containment evacuation alarm if the core exit temperature reaches 200°F. The procedure also includes additional guidance to the operators, in tabular form, giving the RCS heatup rate and the time to reach 200°F from an initial temperature of 90°F as a function of days since reactor shutdown.

There is an industry wide issue regarding containment closure of penetrations used for temporary lines into and out of containment during outages. For example, during outages at DCPP, Penetration 63 is used as a cable conduit. The present way of isolating the penetration is to have the cables pass through a water filled loop seal external to the containment. During accident scenarios in which containment pressurization is postulated, the water could potentially be blown out of the loop seal resulting in an open path to the

environment. The Westinghouse Owners Group (WOG) is studying this issue with a resolution expected by mid 1989. PG&E will evaluate the WOG's recommended modification for implementation at DCPP when it is issued.

Item 3

Provide at least two independent, continuous temperature indications that are representative of the core exit conditions whenever the RCS is in a mid-loop condition* and the reactor vessel head is located on top of the reactor vessel. Temperature indications should be periodically checked and recorded by an operator or automatically and continuously monitored and alarmed. Temperature monitoring should be performed either:

(a) by an operator in the control room (CR), or

(b) from a location outside of the containment building with provision for providing immediate temperature values to an operator in the CR if significant changes occur. Observations should be recorded at an interval no greater than 15 minutes during normal conditions.**

---

* A mid-loop condition exists whenever RCS water level is below the top of the flow area of the hot legs at the junction with the RV.

** Guidance should be developed and provided to operators that covers evacuation of the monitoring post. The guidance should properly balance reactor and personnel safety.

Response to Item 3

It is important that operators have direct indication of the RCS temperature during reduced inventory conditions. Temperature measurement can provide an indication of a slow or rapidly degrading decay heat removal capability. Following a loss of RHR, temperature measurement allows observation of the RCS heatup rate and thus the approach to boiling. Temperature measurement also provides an indication of the effectiveness of recovery actions taken after a loss of RHR.

As a prerequisite to mid-loop operation, OP A-2:III requires that, except during preparation for removal or replacement of the reactor vessel head, a minimum of two incore thermocouples (T/C's) must be available when the reactor head is in place. The two T/C's come from different instrumentation trains and are a representative indicator of core exit conditions. These

temperatures are displayed on the Post-Accident Monitoring System (PAMS) panel located in the control room. Operating Procedure A-2:III also contains the precaution to notify Instrumentation and Controls Department (I&C) to place an additional T/C in service before any scheduled maintenance is performed on the T/C conoseal with the active T/C.

Further prerequisites for mid-loop operation are to have in service:

1. A minimum of two Wide Range T_{hot} RTD channels. These are recorded on Control Room Vertical Board No. 2 (VB2).

2. Temperature and flow instrumentation for both RHR trains. These are recorded on Control Room Vertical Board No. 1 (VB1).

The RTD channels and the RHR temperature instrumentation are useful in providing an indication of a slowly degrading decay heat removal condition, should one occur. The RTDs will not provide a reliable indication of core exit temperature after a loss of RHR flow and precautions in the procedures advise the operators of this fact.

Item 4

> Provide at least two independent, continuous RCS water level indications whenever the RCS is in a reduced inventory condition. Water level indications should be periodically checked and recorded by an operator or automatically and continuously monitored and alarmed. Water level monitoring should be capable of being performed either:
>
> (a) by an operator in the CR, or
>
> (b) from a location other than the CR with provision for providing immediate water level values to an operator in the CR if significant changes occur. Observations should be recorded at an interval no greater than 15 minutes during normal conditions.**
>
> ---
>
> ** Guidance should be developed and provided to operators that covers evacuation of the monitoring post. The guidance should properly balance reactor and personnel safety.

Response to Item 4

To supplement the information provided by RCS temperature indication at least two independent, continuous RCS water level indications are provided through the reactor vessel refueling level indication system (RVRLIS). These indications consist of:

1. Wide Range (WR) RVRLIS tapping off the Loop No. 2 cold leg.

2. Narrow Range (NR) RVRLIS tapping off the Loop No. 3 hot leg.

3. A tygon stand pipe tapping off the Loop No. 4 crossover leg.

These water level indications, coupled with RCS temperature indications, are instrumental in providing vital information to operators for early alert of potential RHR suction loss, indication of core coverage, and input for estimating time to uncover the core.

As a prerequisite to draining for reduced inventory operation, OP A-2:II, "Reactor Vessel-Draining the RCS to the Vessel Flange," requires the installation of independent NR and WR level indication in accordance with Instrumentation and Control (I&C) procedure MP 2.28-2, "Activation of the RVRLIS System." This I&C procedure also requires the installation of a multipoint recorder in the control room. The recorder also indicates pressurizer relief tank pressure.

The control room level indicators for the NR and WR RVRLIS are normally used to monitor ECCS accumulators associated with RCS loops 2 and 3, respectively. When used for NR and WR RVRLIS, these level indicators are relabeled and rescaled for reduced inventory conditions. In addition, these level indications are administratively controlled using a keylock switch.

In addition to RVRLIS indication, OP A:2-III requires an operator be stationed inside containment and in communication with the control room at all times when the RCS level is less than 111 feet. The auxiliary operator stationed in the containment is capable of being quickly dispatched to monitor the tygon tube level whenever the need arises.

To assist operators in the use of the RVRLIS as well as assuring reliable indication, the following precautions and limitations are procedurally identified in OP A-2:III:

1. When the head is on the reactor vessel and T/C conoseals are installed, the WR RVRLIS can be expected to indicate slightly higher than the NR RVRLIS if air entrainment or vortexing is present in the RHR suction piping. If a discrepancy between the NR and WR indication occurs, the NR RVRLIS is to be used.

2. When the head is on the reactor vessel with the T/C conoseals installed, rapid changes in reactor vessel level can create unequal pressures between the gas spaces in the pressurizer and the reactor vessel head area due to restriction of the vent crosstie line. By procedural controls, level changes are made slowly (letdown may not exceed 75 gpm) to minimize the effects on the WR and NR RVRLIS indications. If a difference exists between WR and NR RVRLIS indications, the NR level is to be used.

3. When the head is on the reactor vessel with the T/C conoseals installed and the RVRLIS vent system routed to the plant vent, pressure differences may be created between the gas spaces in the pressurizer and the reactor vessel head area which could cause discrepancies between WR and NR RVRLIS indications. The RVRLIS vent system will normally be isolated from the plant vent and will only be placed in service by direction of the Shift Foreman.

4. The WR and NR RVRLIS, the RVRLIS vent and the standpipe will be walked down on a daily basis while in service. The completion of the walkdown will be documented in the Control Operator's log and the walkdown will ensure:

   - No kinked or collapsed tubing.
   - No loop seals exist and that gradual slopes are maintained in tubing runs.
   - No condensation in level transmitter reference legs. I&C will blowdown the NR RVRLIS reference leg with nitrogen once per day when referenced to the reactor vessel head.

5. A daily channel check will be performed between the standpipe, and wide and narrow range RVRLIS. Agreement should be within ± 2 inches (narrow range) and ± 7 inches (wide range) after level has been allowed to stabilize.

Item 5

> Implement procedures and administrative controls that generally avoid operations that deliberately or knowingly lead to perturbations to the RCS and/or to systems that are necessary to maintain the RCS in a stable and controlled condition while the RCS is in a reduced inventory condition.
>
> If operations that could perturb the RCS or systems supporting the RCS must be conducted while in a reduced inventory condition, then additional measures should be taken to assure that the RCS will remain in a stable and controlled condition. Such additional measures include both prevention of a loss of DHR and enhanced monitoring requirements to ensure timely response to a loss of DHR should such a loss occur.

Response to Item 5

The April 10, 1987, event at Diablo Canyon was initiated by activities which impacted the RCS inventory but were not related to mid-loop operation. In recognition of this, PG&E established administrative controls in OP A-2:III to

ensure licensed operators awareness of any activities which may affect the RCS. Operators are also cautioned to minimize any conditions which can cause transients (i.e., RHR pump changes, flow rate changes). OP A-2:III also contains measures to prevent a loss of RHR. One such measure, for example, is the revision to the DCPP Technical Specifications to allow a lowered RHR flow rate (1300 gpm rather than the previous 3000 gpm). Lower flow results in a lower probability of vortexing, air entrainment, and pump cavitation. OP A-2:III, Attachment 8.5, gives the control operators quantitative guidance in maintaining level. Operators are instructed to keep the RCS level at or above 107 feet 6 inches and are provided with a table estimating the level where vortexing and air entrainment will begin as a function of RHR flow rate. RCS level can only be reduced below 107 feet 6 inches with prior DCPP management approval.

In light of the guidance contained in Generic Letter 88-17, PG&E reviewed the operating procedures controlling activities that could result in adverse RCS perturbations. It was determined that the procedures could be further strengthened and will be revised before the next entry into mid-loop.

OP A-2:III instructs the operators to inject nitrogen into the RCS flow instrumentation taps in order to drain the steam generator U-tubes. This reduces perturbations in RCS level that can occur when level has to be lowered below the top of the hot leg in order to drain the steam generator U-tubes. Steam generator U-tube draining can now be accomplished at a level above the top of the hot leg thus avoiding level perturbations when operating in the critical level band when the level is below the top of the hot leg.

Item 6

> Provide at least two available* or operable means of adding inventory to the RCS that are in addition to pumps that are a part of the normal DHR systems. These should include at least one high pressure injection pump. The water addition rate capable of being provided by each of the means should be at least sufficient to keep the core covered. Procedures for use of these systems during loss of DHR events should be provided. The path of water addition must be specified to assure the flow does not bypass the reactor vessel before exiting any opening in the RCS.
>
> ---
>
> * Available means ready for use quickly enough to meet the intended functional need.

Response to Item 6

Subsequent to the April 10, 1987, loss of RHR event, PG&E analyzed the amount of water required for continued core coverage. This analysis estimated that

approximately 125 gpm is required assuming a 20 Mw decay heat load. This heat load corresponds to the decay heat from the core after two days of shutdown from full power operation and provides a conservative value as mid-loop operation will not occur prior to this time. To ensure this flow rate is available, PG&E enhanced OP A-2:III to provide at least two available means, different from the normal RHR system, of adding inventory to the RCS in the event of failures of the RHR pumps.

Specifically, OP A-2:III stipulates, prior to draining to mid-loop, that one charging pump be available, gravity fill makeup from the Refueling Water Storage Tank be available, and a Safety Injection (SI) Pump and an associated hot leg flow path to the RCS (available through valve 8802A or B) also be available.

With the above pumps available core coverage can be maintained. The expected flow at mid-loop operation for a centrifugal charging pump is approximately 550 gpm and the expected flow for a safety injection pump is approximately 650 gpm. These pumping rates exceed that required to make up losses due to boiling and are adequate to keep the core covered.

PG&E has developed operating procedure OP AP-16, Section C, to use these systems should loss of RHR occur. This procedure instructs the operators to:

1. Stop RHR pump to prevent damage and dispatch operators to vent RHR pump seal water cooler.

2. Isolate RHR letdown.

3. If the RCS level is less than 108 feet, restore the RCS level to greater than 108 feet by initiating makeup to the RCS by:

   - Opening the Refueling Water Storage Tank (RWST) isolation valve to the RHR to provide cold water to the RHR Pump suction as well as add inventory to the RCS through all four cold legs; or

   - Opening the valves which admit RWST water to the charging system. Start a centrifugal charging pump to overcome system pressure if required and makeup to the Loop No. 4 cold leg; or,

   - Opening the RHR to RWST isolation valve to allow gravity induced back flow from the RWST to the RCS in all four cold legs and hot legs No. 1 and No. 2.

4. If RHR has not been restored, then one of the following two recovery actions to achieve a feed and bleed cooling mode will be taken before the RCS reaches 200°F.

   - If all steam generator nozzle dams or manways are installed, the RCS level will be raised to the 125 foot elevation using a centrifugal charging pump which will provide makeup to cold leg No. 4 and restore RHR letdown by directing coolant into the Liquid Hold-Up Tank; or,

- When manways and nozzle dams are not installed, gravity will be used to bring the RCS level up to the 110 foot level and water will flow from the primary manways.

Before PG&E's next entry into mid-loop, procedure OP AP-16 will be further enhanced to include hot leg injection using a Safety Injection Pump.

Item 7

(Applicable to Westinghouse and Combustion Engineering nuclear steam supply system (NSSS) designs). Implement procedures and administrative controls that reasonably assure that all hot legs are not blocked simultaneously by nozzle dams unless a vent path is provided that is large enough to prevent pressurization of the upper plenum of the RV.

Response to Item 7

In recognition of the importance of assuming that loss of RHR does not result in forcing water out of the reactor vessel (via a cold leg), PG&E has implemented procedures and administrative controls that will reasonably assure a sufficient size vent path exists prior to blocking all hot legs with nozzle dams. This vent path is provided by two different means:

1. Sequencing the steam generator nozzle dam installation so that at least one hot leg nozzle dam is the last to be installed and upon removal a hot leg nozzle dam is removed prior to removal of any cold leg nozzle dams.

2. Assuring the reactor vessel is detensioned thus providing an annular gap at the vessel head.

Specifically, Attachment A to Operating Procedure L-6, "Refueling," provides the following guidance on the installation of the steam generator nozzle dams and requires the following sequence of steps:

(a) Fill or verify that at least two steam generator secondary sides are filled to greater than 15 percent narrow range level.

(b) Remove the manways from steam generators (SG) No. 1, No. 2, No. 3 and No. 4, hot leg first. Install nozzle dams (hot and cold legs) in the No. 1, No. 2 and No. 3 steam generators.

(c) Install the cold leg nozzle dam in the No. 4 steam generator.

(d) Verify that the reactor head is fully detensioned with studs removed and conoseals removed. This provides a RCS vent path before the next step is performed.

(e) Install the No. 4 steam generator hot leg nozzle dam.

(f) Refill the reactor vessel to the approximate level of the flange.

Attachment B to OP L-6 gives guidance in the removal of steam generator nozzle dams and requires that the following steps shall be performed in sequence.

(a) Fill or verify that at least two steam generator secondary sides are filled to greater than 15 percent narrow range level.

(b) Verify that the reactor head is fully detensioned and that the conoseals are removed.

(c) Remove the steam generator No. 1 hot leg nozzle dam.

(d) Remove the remaining nozzle dams and install all but the steam generator No. 4 hot leg manway.

(e) Install the steam generator No. 4 hot leg manway.

(f) Refill the reactor vessel to the approximate level at the flange.

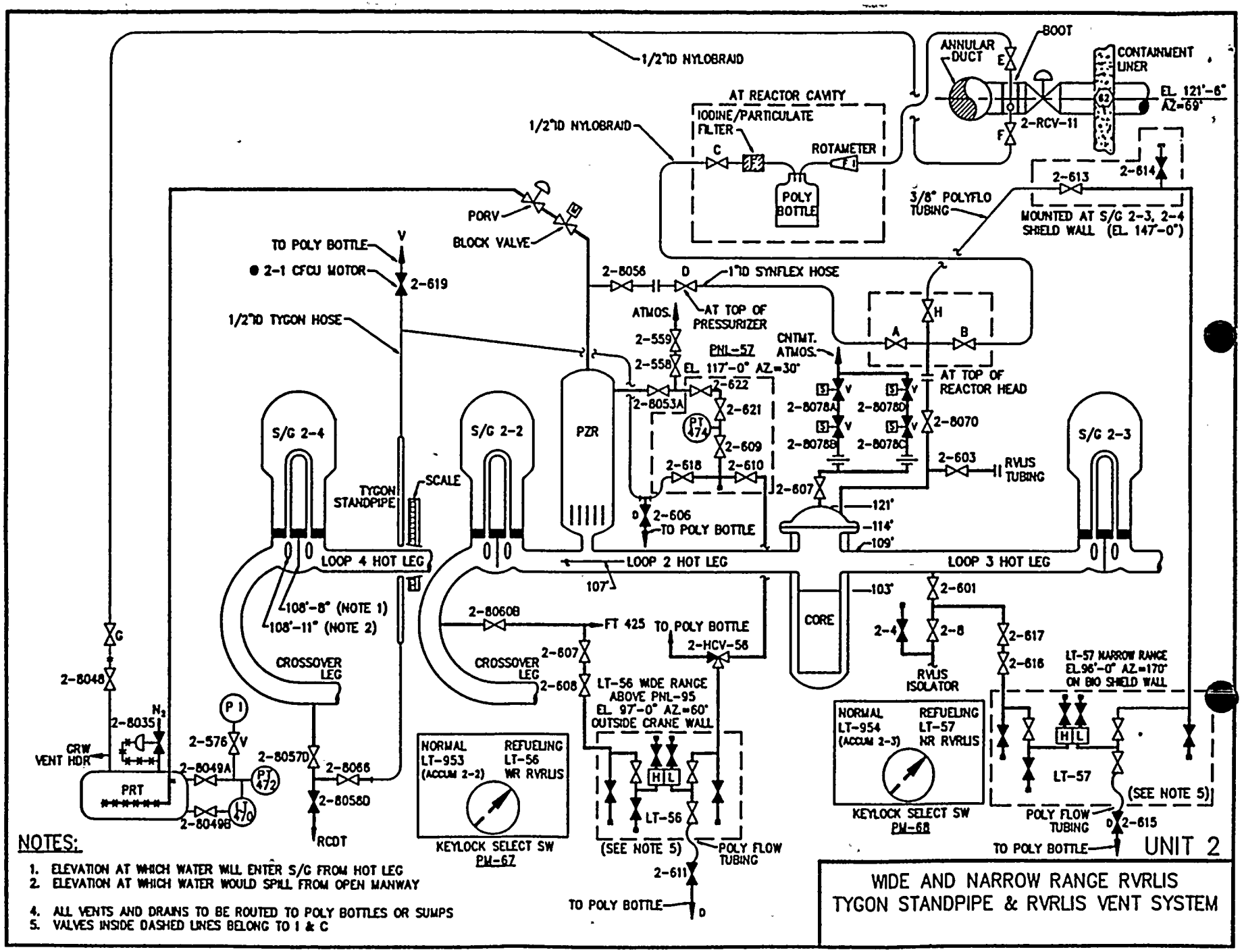
These procedures take into consideration NRC Information Notice No. 88-36, "Possible Sudden Loss of RCS Inventory During Low Coolant Level Operation." The recent Westinghouse Owners Group Report WCAP-11916, "Loss of RHRS Cooling While the RCS is Partially Filled," has been used to generate Diablo Canyon specific estimates of the time to core uncovery if there are large cold leg vents but no hot leg vents. These estimates considered various times after shutdown and are being used in operator training to emphasize the rationale behind opening a hot leg first and closing one last.

Item 8

> (Applicable to NSSSs with loop stop valves) Implement procedures and administrative controls that reasonably assure that all hot legs are not blocked simultaneously by closed stop valves unless a vent path is provided that is large enough to prevent pressurization of the RV upper plenum or unless the RCS configuration prevents RV water loss if RV pressurization should occur. Closing cold legs by nozzle dams does not meet this condition.

Response to Item 8

Not applicable to DCPP: No loop stop valves are used at DCPP.


1/2"ID NYLOBRAID
ANNULAR DUCT
BOOT
CONTAINMENT LINER
EL 121'-6" AZ=69°
AT REACTOR CAVITY
IODINE/PARTICULATE FILTER
ROTAMETER
POLY BOTTLE
2-RCV-11
2-613
2-614
3/8" POLYFLO TUBING
MOUNTED AT S/G 2-3, 2-4 SHIELD WALL (EL. 147'-0")
PORV
BLOCK VALVE
TO POLY BOTTLE
2-1 CFCU MOTOR
2-619
1/2"ID TYGON HOSE
2-8056
1"ID SYNFLEX HOSE
AT TOP OF PRESSURIZER
ATMOS.
2-559
2-558
PNL-57
EL. 117'-0" AZ.=30°
CNTMT. ATMOS.
AT TOP OF REACTOR HEAD
2-622
2-621
2-609
2-610
2-8053A
PT 474
2-8078A
2-8078B
2-8078C
2-8078D
2-8070
2-603
RVLIS TUBING
2-618
2-607
2-606
TO POLY BOTTLE
121'
114'
109'
S/G 2-4
S/G 2-2
PZR
S/G 2-3
TYGON STANDPIPE
SCALE
LOOP 4 HOT LEG
LOOP 2 HOT LEG
LOOP 3 HOT LEG
107'
103'
108'-8" (NOTE 1)
108'-11" (NOTE 2)
CROSSOVER LEG
2-8060B
FT 425
TO POLY BOTTLE
2-HCV-56
CORE
2-601
2-4
2-8
2-617
2-616
RVLIS ISOLATOR
LT-57 NARROW RANGE EL.96'-0" AZ.=170° ON BIO SHIELD WALL
2-8048
2-8035
N2
CRW VENT HDR
PRT
2-576
2-8049A
2-8049B
PT 472
LT 470
2-8057D
2-8066
2-8058D
RCDT
LT-56 WIDE RANGE ABOVE PNL-95 EL. 97'-0" AZ.=60° OUTSIDE CRANE WALL
NORMAL LT-953 (ACCUM 2-2)
REFUELING LT-56 WR RVRLIS
KEYLOCK SELECT SW PM-67
NORMAL LT-954 (ACCUM 2-3)
REFUELING LT-57 NR RVRLIS
KEYLOCK SELECT SW PM-68
LT-57
LT-56
(SEE NOTE 5)
POLY FLOW TUBING
2-615
2-611
TO POLY BOTTLE
UNIT 2
NOTES:
1. ELEVATION AT WHICH WATER WILL ENTER S/G FROM HOT LEG
2. ELEVATION AT WHICH WATER WOULD SPILL FROM OPEN MANWAY
4. ALL VENTS AND DRAINS TO BE ROUTED TO POLY BOTTLES OR SUMPS
5. VALVES INSIDE DASHED LINES BELONG TO I & C
WIDE AND NARROW RANGE RVRLIS
TYGON STANDPIPE & RVRLIS VENT SYSTEM