PDR 05-19-90

Georgia Power

POWER GENERATION DEPARTMENT

VOGTLE ELECTRIC GENERATING P

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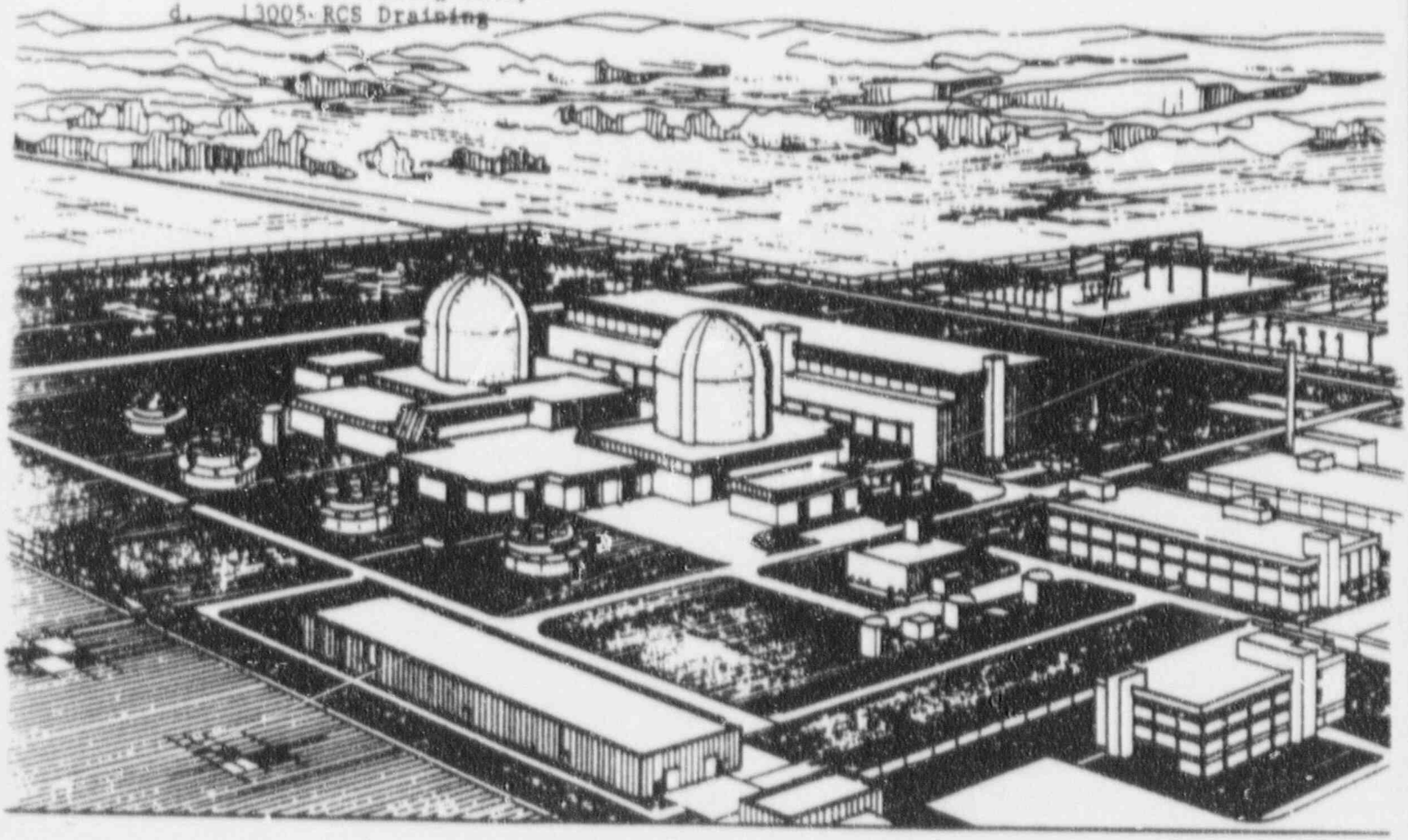
TRAINING STUDENT HANDOUT

TITLE:	CONTINUING TRAINING--RHR MID-LOOP OPER.	NUMBER:	GE-HO-88002-00-001-C
PROGRAM:	MAINTENANCE / QC	REVISION:	0
AUTHOR:	G.R. BATE	DATE:	8/8/88
APPROVED:	M. T. Stark	DATE:	8/9/88

REFERENCES:

1. NRC Generic Letter 87-12: "Loss of RHR While RCS Partially Filled"
2. GPC Response to NRC Generic Letter 87-12
3. NOP-464
4. LO-LP-60990-00-C: "Case Study on Loss of RHR at Diablo Canyon"
5. GPC Standing Order 1-87-48: "RHR Operation with RCS Partially Filled"
6. Procedures:
   a. 12000-Refueling Recovery
   b. 12006-Unit Cooldown to Cold Shutdown
   c. 12007-Refueling Entry
   d. 13005-RCS Draining



STUDENT _____ DATE _____

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LIST OF OBJECTIVES

1. State the initial conditions at Diablo Canyon prior to the loss of RHR cooling.

2. Describe the events that led to the loss of RHR cooling at Diablo Canyon.

3. Describe the possible consequences that could have resulted from a sustained loss of RHR cooling.

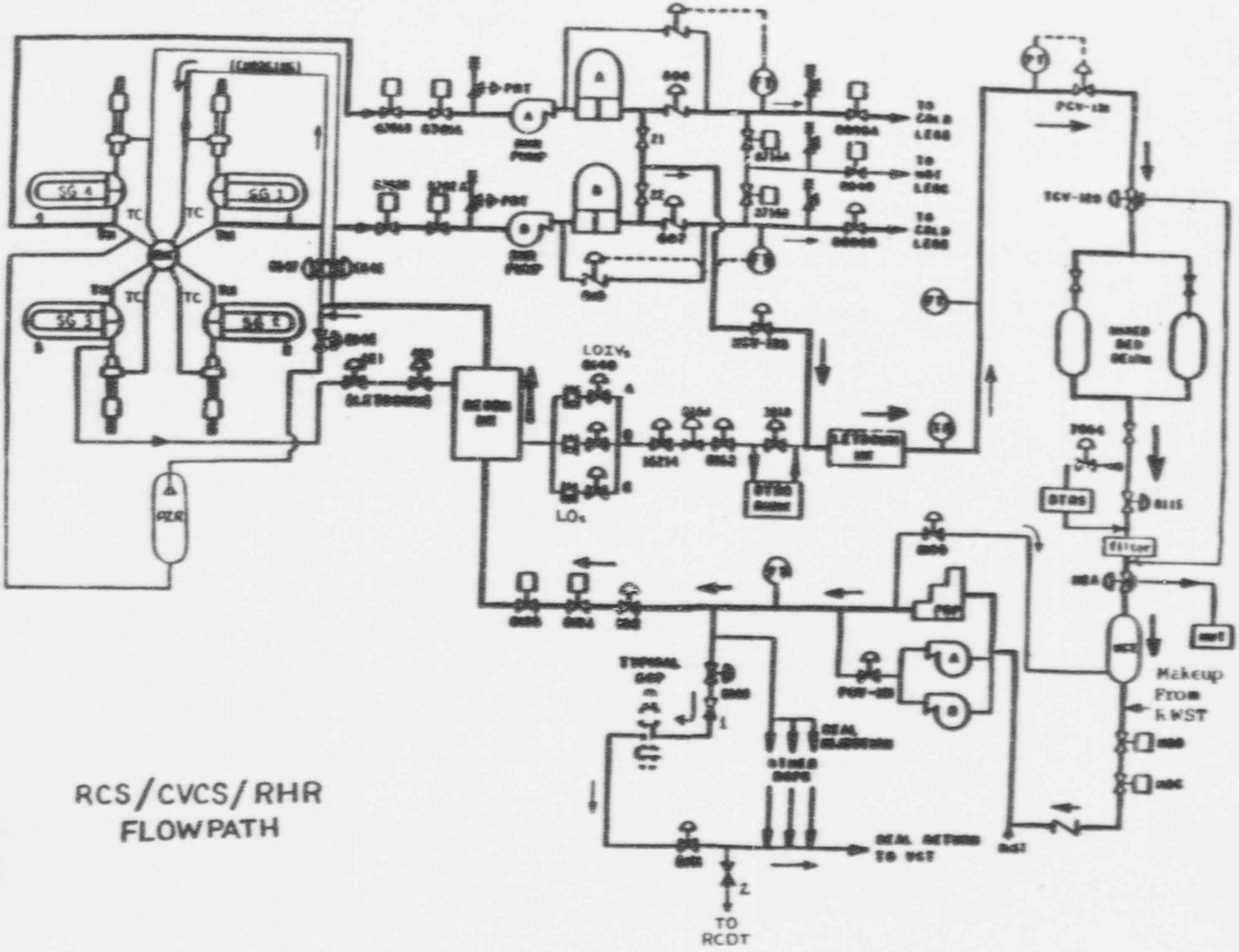
4. List the instrumentation utilized at Diablo Canyon for monitoring reactor vessel level.

5. List the instrumentation utilized at Diablo Canyon for monitoring core temperature.

6. Describe actions taken at Diablo Canyon which had adverse affects on the loss of cooling event.

7. Describe the actions to be taken by GPC to reduce the probability of a similar event occurring at Plant Vogtle.

8. List precautions which maintenance personnel must take while working on MWOs during drain-down conditions.



RCS/CVCS/RHR
FLOWPATH

Initial conditions at Diablo Canyon

1. Mode 5 in preparation for first refueling
2. Plant shutdown for 7 days
3. Containment equipment hatch open
4. Personnel air lock open
5. Containment purge in progress
6. Incore thermocouples disconnected in preparation for reactor vessel head removal
7. LLRT of containment penetrations in progress
8. RVLIS out of service due to work on PAM sytems
9. Train B RHR pump operating with both heat exchangers in service and both trains cross-connected at 87 F
10. No charging pumps running (Diablo Canyon's system of normal charging somewhat different than Vogtle's)
11. RCS drained down to mid-loop in preparation for SG manway cover removal and channel head entry.
12. Reactor vessel vented to pressurizer
13. Reactor vessel level monitored by:
    a. Tygon tube (one inch) manometer connected to intermediate leg of loop 1
    b. Two electrical systems (wide and narrow range)
14. Level controlled by balancing letdown and charging
15. Temperature monitored by temperature elements in the RHR loop

NORMALLY EXPECTED INITIAL CONDITIONS

1. The temperature of the RCS is less than 200 degrees Fahrenheit.
2. A steam bubble is in the Pressurizer and level is maintained between 17 percent and 80 percent using the cold calibrated level channel.
3. Pressurizer pressure is 250 ± 25 psig.
4. One or two RCP's are in operation to equalize temperatures.
5. One or both trains of RHR are in operation maintaining RCS temperature. Flow in each operating RHR loop is 3000 gpm.
6. Charging and letdown are in operation and one train of RHR is cross connected to the letdown system.
7. Both trains of the COPS are armed.
8. SG's are at their normal level (45-55% narrow range) with a nitrogen blanket at 2 to 5 psig.
9. Safety injection signals from low steam line pressure and low pressurizer pressure are blocked.
10. Both Safety Injection Pumps have their power removed and all Safety Injection accumulators are isolated.
11. Both motor driven Auxiliary Feedwater Pumps have their control switches in PULL-TO-LOCK.

POTENTIAL DISTURBANCES TO THE DRAIN-DOWN PROCESS

System	Potential Cause
1. Automatic closure of RHR suction valves from RCS hot legs	Instrument failure, error during maintenance or testing
2. Automatic opening of Pressurizer PORV's from COPS	Instrument failure, error during maintenance or testing
3. Automatic initiation of Emergency Core Cooling System	Instrument failure, error during maintenance or testing
4. Automatic initiation of Auxiliary Feedwater System	Error during maintenance or testing
5. Automatic energization of Pressurizer heaters	Error during maintenance or testing
6. Closure or opening of letdown pressure control valve	Instrument failure, loss of instrument air, error during maintenance or testing
7. Closure or opening of RHR heat exchanger outlet valves	Control failure, loss of instrument air, error during maintenance or testing
8. Closure or opening of RHR heat exchanger bypass valves	Instrument failure, loss of instrument air, error during maintenance or testing
9. Change in charging flow	Instrument failure, loss of instrument air, error during maintenance or testing

PERMANENT PLANT INSTRUMENTATION AVAILABLE DURING PARTIAL FILL

#	TRAIN A	TRAIN B	DESCRIPTION	LOCATION	RANGE
1	PI-0601	PI-0602	RHR pump suction pressure	Local	0- 800 psig
2	PI-10614		RHR pump discharge pressure	Local	0-1000 psig
3		PI-10615	RHR pump discharge pressure	Local	0- 800 psig
4	FIS-0610	FIS-0611	RHR pump discharge flow	Local	0-1500 gpm
5	PI-403	PI-405	RCS wide range pressure	QMCB	0-3000 psig
6	PI-408	PI-418	Reactor vessel pressure	QMCB	0-3000 psig
7	PI-438	PI-428	Reactor vessel pressure	QMCB	0-3000 psig
8	PI-0614	PI-0615	RHR pump discharge pressure	QMCB	0- 800 psig
9	FI-618A	FI-619A	RHR to RCS cold leg flow	QMCB	0-5000 gpm
10	FIC-618A	FIC-619A	M/A station for RHR heat	QMCB	0- 100 %
			exchanger bypass valve		
11	HIC-606A	HIC-607A	M/A station for RHR heat	QMCB	0- 100 %
			exchanger outlet valve		
12	TR-0612	TR-0613	Pen recorder for RHR heat	QMCB	0- 400 degF
			exchanger inlet & outlet		
			temperatures		
13	FI-618B	FI-619B	same as 3	PSDA,PSDB	0-5000 gpm
14	FIC-618B	FIC-619B	same as 6	PSDA,PSDB	0- 100 %
15	HIC-606B	HIC-607B	same as 7	PSDA,PSDB	0- 100 %
16	TI-604B	TI-605B	RHR heat exchanger outlet	PSDA,PSDB	50-400 degF
			temperature		
17	LT-1311	LT-1321	Reactor vessel level	QMCB	0- 120 %
18	(various)	(various)	Core Exit Thermocouples	ERF	0-2300 degF
			28 per train - 30 total	computer	
19	LI-0462		Pressurizer level (cold)	QMCB	0- 100%
20	PI-0469		PRT pressure	QMCB	0- 100 psig

ELEVATION	COMPONENT
281'	MINIMUM RWST LEVEL
223'	RWST OUTLET NOZZLE LEVEL
221'	TOP OF STEAM GENERATOR U-TUBES
196'	PRESSURIZER SURGE LINE NOZZLE LEVEL
194'	RV FLANGE
193'	TOP OF RCP SEAL PACKAGE
190'	BOTTOM OF RCP SEAL PACKAGE
188'	NORMAL RCS LEVEL (1/2 LOOP FULL)
187'	CENTERLINE OF RCP DISCHARGE PIPING
184'	PRT INLET PIPING
124'	CENTERLINE RHR PUMP DISCHARGE PIPING

05-20-A-90
PROC

Georgia Power

POWER GENERATION DEPARTMENT

VOGTLE ELECTRIC GENERATING PLANT

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TRAINING LESSON PLAN

TITLE: CONTINUING TRAINING--RHR MID-LOOP OPER.	NUMBER: GE-LP-88002-00-C
PROGRAM: MAINTENANCE/QC	REVISION: 00
AUTHOR: G.R. BATE	DATE: 8/8/88
APPROVED: M. I. Stark	DATE: 8/9/88

INSTRUCTOR GUIDELINES:

1. LESSON PRESENTATION FORMAT--Lecture

2. LIST OF EQUIPMENT/MATERIALS REQUIRED--Overhead Projector, Transparencies, Student Handout

3. STUDENT EVALUATION METHOD--Quiz

MASTER COPY

REFERENCES:

1. NRC Generic Letter 87-12: "Loss of RHR while RCS Partially Filled"

2. GPC Response to NRC Generic Letter 87-12

3. NOP-464

4. LO-LP-60990-00-C: "Case Study for the Loss of RHR Cooling at Diablo Canyon"

5. GPC Standing Order 1-87-48: "RHR Operation with RCS Partially Filled"

6. Procedures:

   a. 12000--Refueling Recovery
   b. 12006--Unit Cooldown to Cold Shutdown
   c. 12007--Refueling Entry
   d. 13005--RCS Draining

I. PURPOSE STATEMENT:

The purpose of this lesson is to provide the student with an understanding of the events leading up to, during, and corrective actions taken for the loss of RHR at Diablo Canyon Unit 2 nuclear Power Plant and applicable actions taken or to be taken to reduce the possibility of a similar event occurring at Plant Vogtle.

II. LIST OF OBJECTIVES:

1. State the initial conditions at Diablo Canyon prior to the loss of RHR cooling.
2. Describe the events that led to the loss of RHR cooling at Diablo Canyon.
3. Describe the possible consequences that could have resulted from a sustained loss of RHR cooling.
4. List the instrumentation utilized at Diablo Canyon for monitoring reactor vessel level.
5. List the instrumentation utilized at Diablo Canyon for monitoring core temperature.
6. Describe actions taken at Diablo Canyon which had adverse affects on the loss of cooling event.
7. Describe the actions to be taken by GPC to reduce the probability of a similar event occurring at Plant Vogtle.
8. List precautions which maintenance personnel must take while working on MWOs during drain-down conditions.

III. LESSON OUTLINE:

NOTES

I. INTRODUCTION

A. Lesson covers following:

1. Case study on loss of RHR cooling at Diablo Canyon while the RCS was partially filled (27 additional events have occurred in the industry due to inadequate RCS water level).

2. Actions taken by GPC in response to the NRC's generic letter 87-12 which questioned utilities to assess the safe operation of PWRs when RCS water level is drained down below the top of the reactor pressure vessel head.

3. Precautions maintenance personnel should take when performing MWOs during drained-down conditions.

B. Discuss Lesson Objectives — GE-TP-88002-00-001

II. PRESENTATION

A. Review of RCS/RHR/CVCS operation during cold shutdown condition (mode 5) just prior to refueling (mode 6).

1. Mode 5--Cold Shutdown

a. Reactor shutdown with Keff less than 0.99.

b. Tavg less than or equal to 200 F.

2. Mode 6--Refueling

a. Reactor shutdown with Keff less than or equal to 0.95.

b. Tavg less than or equal to 140 F.

3. RCS — GE-TP-88002-00-002

a. All four RCPs off.

b. PZR empty.

c. RCS drained to a level that has the hot leg piping of the reactor half filled (mid-loop).

4. RHR

a. Both trains operable with at least one train operating.

III. LESSON OUTLINE:

NOTES

b. RHR inlet via at least one hot leg and returned to all four cold legs.

c. Minimum flow requirement of 3000 gpm.

d. Small amount of flow (75 t 120 gpm) sent into CVCS just upstream of letdown heat exchanger for continuous cleanup of reactor coolant.

5. CVCS

a. Normal inlet to CVCS from loop 3 cold leg.

b. Three letdown orifices in service with isolation valves (LOIVs) open.

c. Only a small trickle of flow exists through the letdown orifices since flow is dependent on differential pressure and the dp is very low in mode 5.

d. PCV-131 controlled by PT for desired pressure.

e. PDP operating to maintain level by balancing letdown and charging.

f. Seal injection to RCPs injected into No. 1 seal and thermal barrier.

B. Initial Conditions at Diablo Canyon prior to loss of RHR cooling.

GE-TP-88002-00-003
Obj. 1

1. Mode 5 in preparation for first refueling.

2. Plant shutdown for 7 days.

3. Containment equipment hatch open.

4. Personnal air lock open.

5. Containment purge in progress.

6. Incore thermocouples disconnected in preparation for reactor vessel head removal.

7. LLRT of containment penetrations in progress.

8. RVLIS out of service due to work on PAM systems.

9. Train B RHR pump operating with both heat exchangers in service and both trains cross-connected at 87 F.

III. LESSON OUTLINE:

NOTES

10. No charging pumps running (Diablo Canyon's system of normal charging somewhat different than Vogtle's).

11. RCS drained down to mid-loop in preparation for SG manway cover removal and channel head entry.

12. Reactor vessel vented to pressurizer.

13. Reactor vessel level monitored by: Obj. 4

    a. Tygon tube (one inch) manometer connected to intermediate leg of loop 1.

    b. Two electrical systems (wide and narrow range).

14. Level controlled by balancing letdown and charging.

15. Temperature monitored by temperature elements in the RHR loop. Obj. 5

C. Event Initiation Obj. 2

1. Plant operator isolated portion of RCP seal water return line to VCT in preparation for testing penetration for air leaks.

2. All valves necessary for system isolation were independently verified to be closed.

3. One of the valves labeled "Valve 1" on the TP was improperly seated (operated by a reach rod).

4. At 2043, a plant engineer opened a valve (valve 2 on TP) to drain the seal water return line to the RCDT in preparation for LLRT (without notifying the control room of the test start) then left the area.

5. With valve 1 improperly seated, water from CVCS and RCS was draining into RCDT.

6. Control room operator immediately notices a decrease in VCT level.

7. ABO notices and reported increased level in RCDT.

8. Operators attempted to restore VCT level by increasing letdown flow from RHR into CVCS.

9. Reactor vessel level started slowly decreasing as indicated.

III. LESSON OUTLINE:

NOTES

10. Operators isolated charging and letdown in an attempt to stop the leak.

11. With the loss of flow into the VCT, water level in VCT decreased rapidly since water was still draining from VCT into RCDT at a rate of 30 gpm.

12. Reactor vessel level indicator in control room indicated level had stopped decreasing.

D. Loss of RHR cooling

1. At 2125 (42 minutes after engineer opened drain valve for his LLRT), control room operators noticed fluctuating amperage on running RHR pump.

2. No. 2 RHR pump secured, then No. 1 pump started but was immediately secured due to fluctuating amps as well.

3. RHR was lost at this point.

4. Decay heat now began heating reactor coolant from 87 F.

5. With loss of RHR, temperature indication of core was also lost since all incore thermocouples were disconnected.

6. Vortexing and cavitation was suspected as the cause of RHR motor amp fluctuation due to low level in the hot leg piping.

7. Validity of electric reactor vessel indicators was suspect due to vortexing so ABO dispatched to check on tygon tube level inside containment.

8. Operators had intention of opening RHR valves aligned to RWST to allow gravity fill to RCS, however, they requested a status of SG manway cover removal to see if any personnel was in area of manway or inside of channel head.

9. At 2138, VCT outlet valve was closed to stop VCT inventory loss.

10. At 2200, plant engineer opened vent valves associated with his LLRT penetration being drained and left the area to find HP technician to assist in LLRT.

11. At 2203, RHR pumps vented.

III. LESSON OUTLINE:

NOTES

12. At 2221, No. 1 RHR pump started but still had fluctuating amps so pump was again stopped.

13. At 2227, NOUE declared since RHR lost for more than one hour.

14. Plant engineer noticed large amount of water associated with his draining evolution.

15. At 2230, containment activity levels increasing and air samples ordered.

E. Restoration of RHR cooling

1. At 2241, operators informed that SG manways not removed but some bolts had been detensioned.

2. RWST to RHR valves were immediately opened for gravity fill into RCS.

3. At 2250, leak path to RCDT isolated.

4. At 2254, No. 2 RHR pump started and RHR cooling flow established.

5. Pump discharge temperatures rose to approximately 220 F and within 5 minutes temperatures dropped to less than 200 F.

6. At 2258, personnel in containment reported steam venting from ruptured tygon tube on reactor vessel head vent and was then isolated.

7. Containment evacuation was ordered.

8. Steam leakage reported from SG manways.

9. Decay heat had increased temperature of core from 87 F to boiling during loss of RHR.

10. Operators now restored plant to normal operation.

F. Potential consequences due to loss of RHR cooling.

Obj. 3

1. Boiling was occurring in reactor core.

2. Reactor vessel water level could have boiled dry and caused core damage with possible fission product release to containment atmosphere.

3. Since air lock and equipment hatch open, fission products could have reached the environment.

III. LESSON OUTLINE:

NOTES

G. Detrimental Effects During Event

1. Outage activities not coordinated with mid-loop operation planned for a lengthy period of time.

2. Equipment hatch open during mid-loop operation.

3. Only core temperature indication was from RHR loop.

4. Operators estimated heatup rate at 1 F/min but was actually 2.7 F/min.

5. Procedural deficiencies were discovered.

6. Shift briefing did not mention LLRT started, however, it was approved.

7. Plant engineer did not inform control room of LLRT start.

8. Work orders that have a potential of draining RCS should not be performed when operating at mid-loop.

9. Poor communications existed.

10. Poor design of reach rod for improper seated valve.

11. An ALERT should have been declared instead of NOUE.

H. Plant Vogtle's action to reduce possibility of similar event as Diablo Canyon loss of RHR. Obj. 7

1. Generic letter 87-12 from NRC asked utilities various questions on how they planned to ensure safe operation of PWR plant during mid-loop operation.

2. GPC's response to NRC--not all items discussed, only those that are of interest to maintenance personnel.

a. QUESTION 1: Circumstances when plant would enter into drain-down condition?

b. RESPONSE 1:

1) Refueling operations for head removal.

2) Maintenance activities for various components such as RCP seal replacement, SG tube inspections/replacement, repair of RCS boundary valves, etc.

III. LESSON OUTLINE:

NOTES

c. QUESTION 2: Conditions which plant would be in just prior to drain-down?

d. RESPONSE 2: Discuss initial conditions briefly which are listed as appendix A of response letter. GE-TP-88002-00-004

e. QUESTION 3: Control systems and interlocks that could disturb the drain-down process?

f. RESPONSE 3: Discuss control systems and interlocks which are listed as appendix C of response letter. GE-TP-88002-00-005

1) If MWO issued for those listed systems, ensure supervision is aware of the consequences at mid-loop.

2) If work has to be performed on any of these systems during mid-loop, care should be exercised to ensure procedural compliance is followed and a questioning attitude maintained throughout as any error could have an affect on reactor vessel level.

3) If possible, no work should be performed which could affect reactor vessel level during mid-loop.

g. QUESTION 4: Equipment status change coordination?

h. RESPONSE 4:

1) Changes to status of equipment for maintenance, testing, or operations which affect plant conditions must be authorized by the shift supervisor.

2) The above statement is true for all modes.

i. QUESTION 5: RCS overpressure protection?

j. RESPONSE 5:

1) Protection from overpressure when reactor vessel head is in place during modes 4, 5, and 6 is provided by the COPS.

2) If pressure is too great for the existing temperature, power operated relief valve (PORV) lifts to PRT.

III. LESSON OUTLINE:

NOTES

k. QUESTION 6: Time required to replace containment equipment hatch if open?

l. RESPONSE 6: Replacement takes three to four hours and an additional 11 hours FOR LLRT.

m. QUESTION 7: Instrumentation and alarms provided during RCS partial fill?

n. RESPONSE 7:

1) Permanent plant instrumentation

a) Discuss instruments listed in Table 2 of GPC response letter. GE-TP-88002-00-006

(1) New procedure will require a minimum of two incore thermocouples operable any time head installed and level below top head flange.

(2) If head is to be removed, disconnection of thermocouples is to be delayed until last possible moment and reinstalled at first opportunity after head replaced.

b) Alarms

(1) "RHR Pump Motor Overload" annun.

(2) "RHR Pump Discharge High Pressure" annun.

(3) No temperature alarms annunciated in control room for use during mid-loop operation.

2) Temporary connections, piping, and instrumentation.

a) One inch tygon tube connected to RCS at loop 1 intermediate leg and pressurizer steam space.

(1) Care should be taken not to step on tygon tubing run and report any defects, kinks, twists, or air binding to supervision.

III. LESSON OUTLINE:

NOTES

(2) Tubing will have continuous slope to minimize air entrapment.

(3) Tubing will be protected by physical barriers when routed through traffic areas.

(4) Tubing will be positively identified along route.

(5) Tubing will run upward along containment wall adjacent to elevation marks.

(6) Discuss elevation marks and associated RCS component descriptions. GE-TP-88002-00-007

(7) Operations will assign a continuous watch station at tubing during mid-loop operation and will walkdown tubing every four hours to ensure tube is free of kinks, etc.

b) RVLIS is available but not accurate enough for controlling level within a tight band of 6 to 12 inches.

c) Additional instrumentation planned but not part of letter to NRC.

(1) Level instrument connected to one of RCS flow taps beneath SG and to RTD bypass manifold then wired to SI Accumulator Tank level channel indicator in control room (channel L-952).

(2) Level instrument connected across hot leg pipe with a 30 inch span.

d) Installations will be part of MWO process.

o. QUESTION 8: Pumps required to be operable to control RCS inventory?

III. LESSON OUTLINE:

NOTES

p. RESPONSE 8:

1) A minimum of one of three CVCS charging pumps is required to be operable, therefore, two pumps can be removed from service for maintenance.

2) Both RHR pumps required to be operable in mode 6 with water level less than 23 feet above the RV flange or in mode 5 with the RCS loops not completely filled.

a) One train may be inoperable for up to two hours for surveillance testing.

b) One train may be deenergized for one hour provided dilution of RCS is not permitted and core outlet temperature is at least 10 F below saturation.

q. QUESTION 9: Training provided to affected personnel during RCS partial fill?

r. RESPONSE 9:

1) Maintenance Operation Quality Assurance Program/MWO lesson details use of MWOs.

2) Safety and Admin Controls lesson details proper use of admin, maintenance, and HP procedures.

3) Equipment Clearance and Tagging lesson details personnel's responsibility according to clearance and tagging procedure.

s. QUESTION 10: What are planned changes and when are they scheduled to be incorporated?

t. RESPONSE 10:

1) Minimum level during mid-loop will be 188 ft. instead of 187 ft. 6 inches to give a one foot margin to mid-loop (short term).

2) If RHR is lost for more than one hour or temperatures are greater than 200 F, an ALERT will be declared and containment closure verified (short term).

III. LESSON OUTLINE:

NOTES

3) Work will be limited that has potential to decrease RCS inventory when level below top head flange (short term).

4) Evaluation to be made to install structure around equipment hatch to allow placement of polyethylene curtain over opening (long term).

3. Precautions for maintenance personnel during mid-loop operations. Obj. 8

a. Maintain questioning attitude toward MWOs.

b. Any unusual or suspicious evolutions should be reported to supervision, such as:

1) Unexpected sound of water flow.

2) Steam leaks.

3) Air hisses.

c. WATCH OUT for tygon tube.

III. SUMMARY

A. Review lesson objectives in preparation for quiz.

LIST OF OBJECTIVES

1. State the initial conditions at Diablo Canyon prior to the loss of RHR cooling.

2. Describe the events that led to the loss of RHR cooling at Diablo Canyon.

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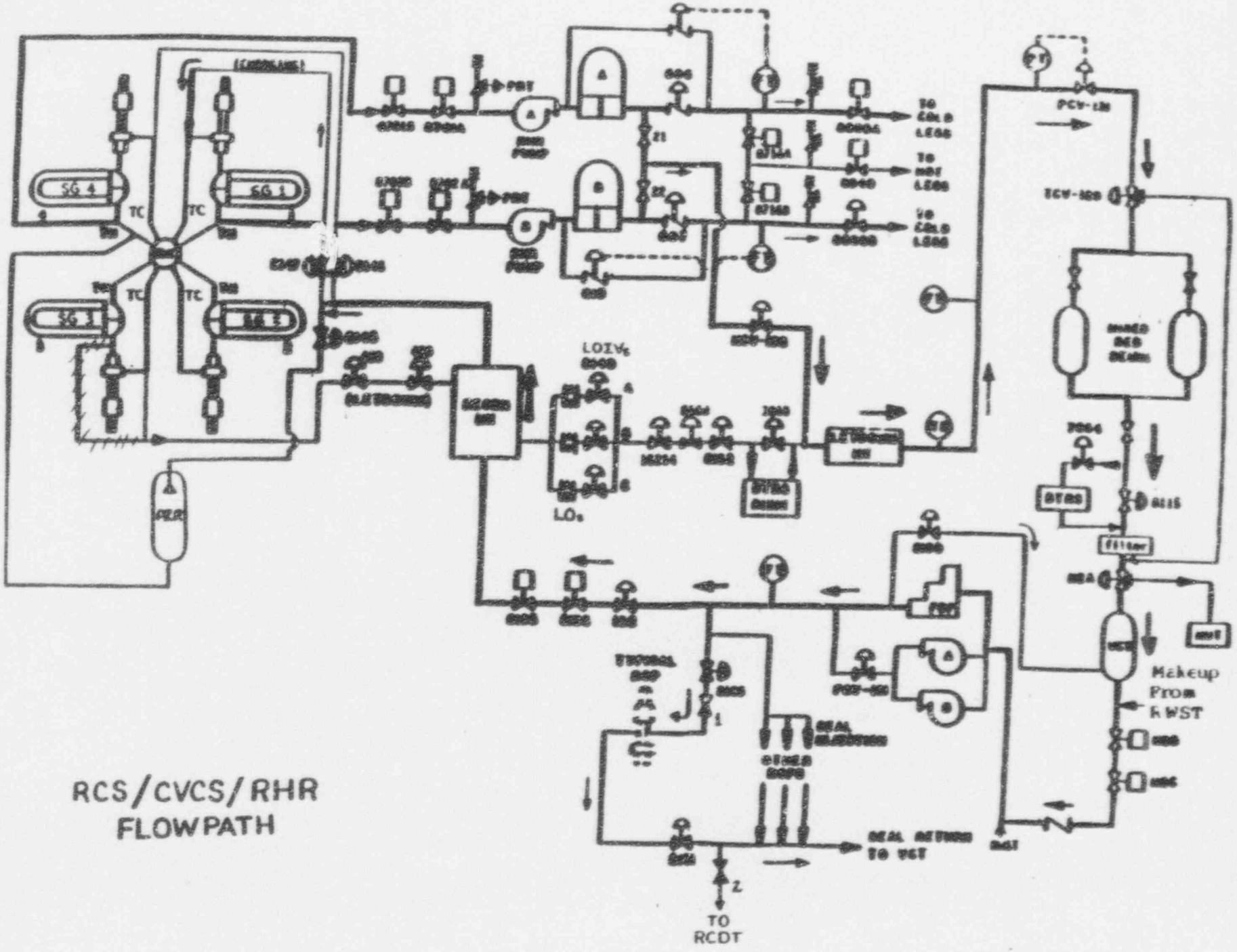

RCS/CVCS/RHR
FLOWPATH

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    b. Two electrical systems (wide and narrow range)
14. Level controlled by balancing letdown and charging
15. Temperature monitored by temperature elements in the RHR loop

NORMALLY EXPECTED INITIAL CONDITIONS

1. The temperature of the RCS is less than 200 degrees Fahrenheit.
2. A steam bubble is in the Pressurizer and level is maintained between 17 percent and 80 percent using the cold calibrated level channel.
3. Pressurizer pressure is 250 ± 25 psig.
4. One or two RCP's are in operation to equalize temperatures.
5. One or both trains of RHR are in operation maintaining RCS temperature. Flow in each operating RHR loop is 3000 gpm.
6. Charging and letdown are in operation and one train of RHR is cross connected to the letdown system.
7. Both trains of the COPS are armed.
8. SG's are at their normal level (45-55% narrow range) with a nitrogen blanket at 2 to 5 psig.
9. Safety injection signals from low steam line pressure and low pressurizer pressure are blocked.
10. Both Safety Injection Pumps have their power removed and all Safety Injection accumulators are isolated.
11. Both motor driven Auxiliary Feedwater Pumps have their control switches in PULL-TO-LOCK.

POTENTIAL DISTURBANCES TO THE DRAIN-DOWN PROCESS

System	Potential Cause
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2. Automatic opening of Pressurizer PORV's from COPS	Instrument failure, error during maintenance or testing
3. Automatic initiation of Emergency Core Cooling System	Instrument failure, error during maintenance or testing
4. Automatic initiation of Auxiliary Feedwater System	Error during maintenance or testing
5. Automatic energization of Pressurizer heaters	Error during maintenance or testing
6. Closure or opening of letdown pressure control valve	Instrument failure, loss of instrument air, error during maintenance or testing
7. Closure or opening of RHR heat exchanger outlet valves	Control failure, loss of instrument air, error during maintenance or testing
8. Closure or opening of RHR heat exchanger bypass valves	Instrument failure, loss of instrument air, error during maintenance or testing
9. Change in charging flow	Instrument failure, loss of instrument air, error during maintenance or testing

PERMANENT PLANT INSTRUMENTATION AVAILABLE DURING PARTIAL FILL

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3		PI-10615	RHR pump discharge pressure	Local	0- 800 psig
4	FIS-0610	FIS-0611	RHR pump discharge flow	Local	0-1500 gpm
5	PI-403	PI-405	RCS wide range pressure	QMCB	0-3000 psig
6	PI-408	PI-418	Reactor vessel pressure	QMCB	0-3000 psig
7	PI-438	PI-428	Reactor vessel pressure	QMCB	0-3000 psig
8	PI-0614	PI-0615	RHR pump discharge pressure	QMCB	0- 800 psig
9	FI-618A	FI-619A	RHR to RCS cold leg flow	QMCB	0-5000 gpm
10	FIC-618A	FIC-619A	M/A station for RHR heat exchanger bypass valve	QMCB	0- 100 %
11	HIC-606A	HIC-607A	M/A station for RHR heat exchanger outlet valve	QMCB	0- 100 %
12	TR-0612	TR-0613	Pen recorder for RHR heat exchanger inlet & outlet temperatures	QMCB	0- 400 degF
13	FI-618B	FI-619B	same as 5	PSDA,PSDB	0-5000 gpm
14	FIC-618B	FIC-619B	same as 6	PSDA,PSDB	0- 100 %
15	HIC-606B	HIC-607B	same as 7	PSDA,PSDB	0- 100 %
16	TI-6048	TI-6058	RHR heat exchanger outlet temperature	PSDA,PSDB	50-400 degF
17	LT-1311	LT-1321	Reactor vessel level	QMCB	0- 120 %
18	(various)	(various)	Core Exit Thermocouples 28 per train - 30 total	ERF computer	0-2300 degF
19	LI-0462		Pressurizer level (cold)	QMCB	0- 100%
20	PI-0469		PRT pressure	QMCB	0- 100 psig

ELEVATION	COMPONENT
281'	MINIMUM RWST LEVEL
223'	RWST OUTLET NOZZLE LEVEL
221'	TOP OF STEAM GENERATOR U-TUBES
196'	PRESSURIZER SURGE LINE NOZZLE LEVEL
194'	RV FLANGE
193'	TOP OF RCP SEAL PACKAGE
190'	BOTTOM OF RCP SEAL PACKAGE
188'	NORMAL RCS LEVEL (1/2 LOOP FULL)
187'	CENTERLINE OF RCP DISCHARGE PIPING
184'	PRT INLET PIPING
124'	CENTERLINE RHR PUMP DISCHARGE PIPING