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Georgia Power

POWER GENERATION DEPARTMENT

VOGTLE ELECTRIC GENERATING PLANT

1 of 2

TRAINING LESSON PLAN

TITLE:	CASE STUDY FOR THE LOSS OF RHR COOLING EVENT AT DIABLO CANYON	NUMBER:	LO-LP-60990-02-C
PROGRAM:	LICENSED OPERATOR	REVISION:	2
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INSTRUCTOR GUIDELINES:

I. LESSON FORMAT

A. Lecture with Visual Aids

II. MATERIALS

A. Overhead Projector

B. Student Handout

C. Dry Erase Board and Markers

III. EVALUATION

A. Written or oral exam in conjunction with other lesson plans

IV. REMARKS

A. This LP satisfies the requirements of the commitments listed on the Reference Page of this LP.

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I. PURPOSE STATEMENT:

This case study is designed to provide understanding of the events leading up to, during, and the corrective actions associated with the loss of RHR cooling at Diablo Canyon. Included in the case study are the actions taken at Plant Vogtle to reduce the possibility of a similar event occurring.

II. LIST OF OBJECTIVES:

1. Describe briefly the initial conditions for operating with the RCS at mid-loop.
2. List the instrumentation used to monitor RCS level when operating at mid-loop.
3. List the instrumentation used to monitor RCS temperature when operating at mid-loop.
4. Discuss the events that led to the loss of RHR cooling at Diablo Canyon.
5. Describe the actions that the operators took to mitigate the loss of RHR cooling.
6. Describe the possible consequences that could result from a loss of RHR cooling.
7. Describe actions taken to reduce the probability of a similar event from occurring at Plant Vogtle.

REFERENCES:

1. NUREG 1269 LOSS OF RHR SYSTEM

2. IEN 87-23 LOSS OF DECAY HEAT REMOVAL DURING LOW REACTOR COOLANT LEVEL OPERATION

3. GENERIC LETTER 87-12 LOSS OF RHR WHILE THE RCS IS PARTIALLY FILLED

4. PROCEDURES

   12000 - REFUELING RECOVERY
   12006 - UNIT COOLDOWN TO COLD SHUTDOWN
   12007 - REFUELING ENTRY
   13002 - REACTOR COOLANT SYSTEM DRAINING

5. GENERIC LETTER 88.017 NRC CONCERNS AND ACTION ON LOSS OF RHR

6. GENERIC LETTER 87.012 VEGP RESPONSE TO GL-87-12

7. SOER 88.003 LOSSES OF RHR WITH REDUCED VESSEL WATER LEVEL AT PWRs

III. LESSON OUTLINE:

NOTES

I. INTRODUCTION

A. This case study material covers a loss of residual heat removal during mid-loop operation nd the phenomena influencing that buhavior at PG&E's Diablo Canyon Unit #2.

1. 37 additional events have occurred that are attributed to inadequate RCS water level.

2. Core damage or a release to the environment could have occurred.

II. SUMMARY

A. PG&E's Diablo Canyon Unic #2

1. Four loop Westinghouse 1119 MWe PWR - same as Vogtle

2. Good initial operating history

B. Reactor in Mode 5

1. 7 days after shutdown for its first refueling outage

2. A loss of both RHR trains occurred for approximately 1.5 hours

C. Complications affecting the loss of RHR cooling

1. Removal of the containment equipment hatch (release path to the environment)

2. RCS hot leg mid-loop level operation

3. Steam generator manway removal in progress during the event

4. The reactor coolant heated from 87^{0} F to boiling

5. Steam was vented from the RV head

6. Water spilled from the partially unsealed SG manways

7. Containment radiogas activity was observed to increase

III. LESSON OUTLINE:

NOTES

III. DETAILED EVENT DESCRIPTION

A. Initial Conditions

1. Mode 5

2. The containment building equipment hatch was removed

3. The personnel airlock was open

4. Containment purge was in progress

5. Removal of steam generator manways was in progress

6. Local leak rate testing of containment penetrations was in progress

7. The RHR pump 2-1 was operating through both RHR heat exchangers, both trains were cross connected

8. The RCS was drained down to the mid-loop level

9. RV level was being monitored by:

a. A tygon tube manometer inside containment

b. 2 electrical systems (a wide and narrow range)

c. Normal RVLIS was out of service

10. The RV was vented to the pressurizer

11. The SI pumps circuit breakers were racked out

12. RV level maintained by:

a. Sending excess water to the RWST

b. Makeup from the RWST

IV. EVENT INITIATION

A. A plant engineer opened a valve to perform a local leak rate test, creating a leak from the RCS

B. Loss of RHR cooling

1. RHR pump began cavitating

III. LESSON OUTLINE:

NOTES

2. Operator shutdown the running pump

3. Operator started and then shutdown the standby pump

   a. It also cavitated

4. RHR cooling capability lost

   a. No method of monitoring incore temperatures

   b. Validity of the temporary RV level indication suspected

      1) Operator dispatched to check local RV tygon tube indication

5. Operator attempted to verify RCS integrity

6. Operators attempted to stop leak

7. NOUE declared

C. Leak stopped after approximately 1.5 hours by engineer

   1. Operators refilled the system from the RWST via a RHR pump

V. FUNDAMENTAL CAUSES AND DISCUSSION TOPICS

A. RV level indication system problems

B. Improperly seated valve

C. Operator awareness of evolutions in progress

D. Containment integrity problems

E. Mid-loop operation

F. Instrumentation

G. Communications

H. Event Classification

VI. POST-EVENT TECHNICAL AND ADMINISTRATIVE INVESTIGATIVE ACTIONS TAKEN AT PLANT VOGTLE

A. Several procedure-related deficiencies were identified and corrected

III. LESSON OUTLINE:

NOTES

B. Hardware Changes

VII. PROBLEM UPDATES

A. GL-88.014 Loss of Decay Heat Removal

1. Significant new information has been generated since the Diablo Canyon event, April 10, 1987

a. Several previously unrecognized phenomena need to be addressed.

1) Some of these realistically can cause core uncovery or complete core voiding in less than half an hour (previously believed that 4 hours would be required).

2) New phenomena not previously understood

a) Pressurization

(1) Caused by steam formation in unvented reactor vessel

(2) Inappropriate use of SG nozzle dam can lead to core voiding within 15-20 minutes following loss of RHR

(3) Cold leg opening can allow water to be ejected from vessel following loss of RHR until sufficient water is lost that steam is relieved by clearing the crossover pipes

(4) Pressure difference within RCS may prevent water from reaching the RV

(5) Rapid RCS pressurization may prevent gravity feed from tanks anticipated to be available

(6) Rapid pressurization may cause instruments to malfunction or provide misleading indications

III. LESSON OUTLINE:

NOTES

(7) Rapid pressurization may cause the RCS to respond in unanticipated ways

(8) Small RCS openings (vents and drains) may lead to instrument malfunctions or unanticipated RCS responses

(9) Large RCS pressure boundary openings (SG manway RCP seals, pressurizer manways) may lead to instrument malfunction or unanticipated RCS responses

(10) SG secondary side inventory and opening may influence RCS behavior

b) Vortexing

(1) Small amount of air into RHR pump suction may lead to subtle changes that occur over a time of minutes to an hour or more

(2) Large amounts of air may cause immediate loss of RHR

(3) Vortexing may occur at levels higher than anticipated

(4) Vortexing may not be reflected by pump current and flow rate instruments until it is sufficiently severe to cause a loss of RHR

(5) Vortexing may cause RCS level indication errors

c) SG tube draining

(1) Draining SG U-tube is frequently done by draining the RCS to point where vortexing could occur

d) RCS level differences

III. LESSON OUTLINE:

NOTES

(1) Critical level parameters is in hot leg where RHR takes suction

(2) Level instruments connected at other points

(3) Level difference exists between level indicator and hot leg RHR connection point (may be several inches difference)

e) RHR system effects

(1) Shifting from one train to another may cause level changed due to differences in actual size, etc.

(2) Starting one system while another is running can increase total flow thus increase vortexing

(3) Operator response to a loss of one RHR pump by starting the second pump may result in the loss of the second pump also if started without correcting the cause of the loss of the first pump

(4) Stopping or starting RHR may cause RCS level changes due to partially filled system or air induction into the RHR system

f) Instrumentation

(1) May be in error by half a foot or more without detection of inaccuracies

(2) Flow dynamics, entrapped air, and pressurization may affect level indication individually or RV indicators simultaneously

III. LESSON OUTLINE:

NOTES

(3) Many normal instruments disconnected during RV head removal etc.

(4) Remaining instruments may be inadequate

B. SOER 88.003

1. This document addresses the following specific training concerns associated with this problem

   a. Response to discrepancies in or loss of indicated level

   b. Methods to determine decay heatup rates

   c. Indications of pump cavitation and actions needed to restore core cooling flow

   d. Response to a loss-of-core cooling flow with no indication of core coolant temperature

2. Review this SOER with the class

   a. A detailed study of the SOER and associated concerns is covered in LO-LP-12101 and associated handouts and instructional units