

LESSON TITLE: AND SEAL FAILURE
PROGRAM: 326\506
REV 0

AUTHOR: T. L. BELL
APPROVED BY: 
DATE: 3-9-89

1.0 TRAINING AIDS

1.1 LESSON PACKAGE #13

1.2 TRANSPARENCY PACKAGE #13

2.0 REFERENCES

2.1 B&W ADVANCED COURSE MANUAL -CHAPTER 5

A-16

3.0 LEARNING OBJECTIVES

3.1 COVER LEARNING OBJECTIVES ON PAGE 5-1

4.0 PRESENTATION

THIS PRESENTATION COVERS THE SEQUENCE OF EVENTS OF THE AND DURING THE SEAL FAILURE EVENT.

- 4.1 t=0145 - the Reactor Operator discovers that a seal failure is in progress.
 - 4.1.1 A leak rate calculation is in progress, and he observes a step decrease in Makeup Tank Level
 - 4.1.2 RCP seal pressures and seal return flow changes confirms leakage.
 - 4.1.2.1 Cover seal pressure changes
 - 4.1.2.2 Seal return flow increases are caused by an increase in the differential pressure.
- 4.2 Seal Leakage Limits are in excess of Technical Specifications and an orderly shutdown is ordered by the Shift Supervisor.
 - 4.2.1 Initial Rate of power reduction is 5% per minute
 - 4.2.2 177 FA ICS is designed to maneuver at 10% per minute
 - 4.2.3 The initial seal leak rate was 10 to 20 GPM
- 4.3 t=0214 (+19 min) - Unit electrical loads are transferred from the unit auxiliary transformer to the startup transformer in preparation for plant shutdown.
- 4.4 t=0220 (+25 min) - RCS Letdown is isolated to minimize the loss of pressurizer level
- 4.5 t=0227 (+37 min) - During the load decrease, the rate of seal leakage increased, and the operators increase the rate of load decrease to 20 to 30% per minute.
 - 4.5.1 Student Question - How can the rate of load decrease be increased above 10% per minute?
 - 4.5.2 Answer - In track, the rate of load change is 20 percent per minute.
- 4.6 t=0247 (+62 minutes) - Generator off line.
- 4.7 t=0248 (+63 minutes) - "C" RCP is stopped.
 - 4.7.1 Pump is stopped after the unit is off line to prevent the rationing of feedwater and the upset condition that this transient causes.
 - 4.7.2 t=0250 (+65 min) - manual reactor trip
 - 4.7.3 Four actions are taken ^{in response to increased} to minimize seal leakage that is in the range of 250 to 300 GPM

- 4.7.3.1 HPI is manually initiated by:
 - 4.7.3.1.1 Starting a second Makeup pump
 - 4.7.3.1.2 Opening the suction valves from the BWST
 - 4.7.3.1.3 Opening the HPI motor operated valves
 - 4.7.3.2 RCP Lift pumps are started and stopped in an effort to change the seal package location
 - 4.7.3.3 The Seal Return Isolation valve is closed.
 - 4.7.3.4 Seal injection is increased to quench the steam and water mixture from the pump
- 4.8 t=0256 (+71 min) - RB coolers are placed in service
- 4.8.1 Reactor building pressure is increasing because of steam leakage from the seal.
 - 4.8.2 Prevents high building pressure ESF
- 4.9 t=0301 (+76 min) - Stopped "A" RCP in preparation for a cooldown of the RCS.
- 4.10 t=0305 (+80 min) - A cooldown rate of 75 degrees per hour is established
- 4.10.1 "C" makeup pump is stopped, and all HPI MOVs are closed. Normal Makeup with the exception of the suction source which is the BWST.
 - 4.10.2 Due to the High cooldown rate, the operator did not bypass SLBIC system soon enough to prevent actuation.
 - 4.10.2.1 Steam driven EFW starts
 - 4.10.2.2 Raised header pressure to >600
 - 4.10.2.3 Bypassed SLBIC
 - 4.10.2.4 SLBIC auto resets when pressure is >650.
 - 4.10.2.5 "A" DTSG pressure actuates SLBIC
 - 4.10.2.6 Header pressure raised above 600 psig
 - 4.10.2.7 SLBIC successfully bypassed
- 4.11 Steam driven EFW pump stopped. Auxiliary Feedwater placed in service
- 4.12 t=0800 (+375 min) - Containment entry to power up and close CFT outlet valves
- 4.12.1 Valves were powered from switchboard on the 375' elevation of containment. One floor above ground level.
 - 4.12.2 The CFTs inject some water prior to isolation.
- 4.13 t=0900 (+435 min) - Unit in cold shutdown.
- 4.14 Failure Analysis
- 4.14.1 All three seals had failed
 - 4.14.2 The upper seal had the most damage
 - 4.14.3 The stationary carbon seal had disintegrated. It is believed that this was the initial failure. The other two seals failed due to upward movement.
 - 4.14.4 Upper seal failed due to excessive wear or fatigue
- 4.15 Plant Fixes

- 4.15.1 All four RCP seal packages replaced
- 4.15.2 CFT breakers are relocated outside of containment
- 4.15.3 60,000 gallons of radioactive water that had collected in the RB was totally reprocessed without any release to the environment.

5.0 Dcone Unit 2 Seal Failure.

5.1 Initial problem

- 5.1.1 A leak is discovered on the seal supply line to one of the four reactor coolant pumps
- 5.1.2 Three and a half hours later, seal inject is isolated to the affected pump to facilitate repairs.
- 5.1.3 Leakage continued
- 5.1.4 All seal injection is isolated by closing the total seal flow control valve for the repair, but again, leakage continued.

5.2 After 9 hours, a manual isolation valve is closed to stop seal injection leakage.

- 5.2.1 Plant Computer Alarms during next 16 minutes
 - 5.2.1.1 High seal inlet temperature
 - 5.2.1.2 Quench Tank Pressure High
 - 5.2.1.3 RCP seal leakoff flow High
 - 5.2.1.4 Affected RCP Off
 - 5.2.1.5 Affected RCP seal return isolated
 - 5.2.1.6 Unaffected RCP seal inlet temp high
 - 5.2.1.7 RCP Motor temperature alarms
 - 5.2.1.8 High Quench tank level
 - 5.2.1.9 Reactor Trip
- 5.2.2 3 Minutes after the seal was manually isolated, the following operator actions were performed.
 - 5.2.2.1 Manual load reduction to 22%
 - 5.2.2.2 Turbine removed from service
 - 5.2.2.3 Manual reactor trip from 15%
 - 5.2.2.4 RCS cooldown commenced

5.3 Fourteen minutes following the reactor trip

- 5.3.1 RB entry to investigate fire alarms and oil catch tank alarms
- 5.3.2 Steam blowing from failed seal is causing alarms .

5.4 Cooldown events fourteen hours after the seal leak was discovered

- 5.4.1 The core flood tanks are vented to the Quench Tank
 - 5.4.1.1 Normally vented to vent header
 - 5.4.1.2 Can shut CFT isolation valve and avoid venting
- 5.4.2 Quench Tank is overpressurized
- 5.4.3 Rupture disk blows
 - 5.4.3.1 Pressurizer level sensing line is severed
 - 5.4.3.2 Insulation on the bottom of the pressurizer is damaged

5.5 Summary

- 5.5.1 Seal leakage estimated to be 90 GPM

5.5.2 50000 gallons total is collected
5.5.3 12 inches deep in RB