Reactor Coolant Pumps and Motors

Chapters 2.3
B&W Cross-training Course
R-326C
OBJECTIVES

1. Explain how the plant operator can determine a seal failure using seal pressure indications.

2. Explain the purposes of the protection provided by the following reactor coolant pump start interlocks:
   a. Low oil pressure interlock.
   b. Minimum seal injection water & CCW flow interlock.
   c. Cold water interlock.
   d. Core lift interlock.
Reactors

Coolant Pump and Motor Assembly

Fig. 2.3-1
Reactor
Coolant Pump
Cross Section
Fig. 2.3-2
Pressure is dropped by staging coils & clearances of the seals.

1.5 gpm passes through seal package.

9.5 gpm per RCP supplied from M/U & Purification.

8 gpm into pump casing & down past radial bearing into RCS.

Fig. 2.3-3

NOTES:
P3 = 750 PSIG
P2 = 1480 PSIG
P1 = 2210 PSIG
Most of the 1.5 gpm flow passes through 3 staging coils and to Seal Return HX (to M/U & Purification system makeup tank).

Seal leakage chamber alarmed & drains to RCDT.

0.01 gpm past seal faces & into the seal leakage chamber.

Shaft-mounted recirculation impeller maintains 40 gpm flow through integral seal water HX mounted on motor stand. Cooled by CCW.

Shaft Seal Arrangement
Fig. 2.3-3
Loss of CCW:
As long as normal seal injection is maintained, no operational restrictions on RCP.

0.01 gpm still flows past seal faces.

1.5 gpm passes through seal package.

8 gpm into pump casing & down past radial bearing into RCS still occurs.

Shaft-mounted recirculation impeller still maintains 40 gpm flow through integral seal water HX mounted on motor stand.
Loss of seal injection: As long as CCW is maintained to seal water HX, no operational restrictions on RCP.

1.5 gpm still passes through staging coils.

0.01 gpm still flows past seal faces.

Recirculation flow is cooled sufficiently in HX to maintain acceptable radial bearing & seal temps.

Recirculation flow cooled by CCW in seal water HX.

Coolant flows up shaft and is combined w/ recirculation flow.

Shaft Seal Arrangement (Fig. 2.3-3)
If RCS > 200°F, shut down RCP immediately.

Loss of CCW and seal injection to RCP

Shaft Seal Arrangement (Fig. 2.3-3)
Table 2.3-1 lists the expected pressure for various seal failure conditions.

<table>
<thead>
<tr>
<th>Seal Failure</th>
<th>Seal #1</th>
<th>Seal #2</th>
<th>Seal #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>P3*</td>
<td>1115</td>
<td>1115</td>
<td>20</td>
</tr>
<tr>
<td>P2*</td>
<td>2210</td>
<td>1115</td>
<td>1115</td>
</tr>
<tr>
<td>P1*</td>
<td>2210</td>
<td>2210</td>
<td>2210</td>
</tr>
</tbody>
</table>

*Refer to Figure 2.3-3 for location of pressure detectors. P1 is always 2210 psig.
Reactor Coolant Pump Motor
Cross Section
Fig. 2.3-4
RCP Motor

• **Anti-rotation device**
  - Prevents reverse rotation to reduce starting current.

• **Oil lift pumps**
  - Provide oil pressure to thrust bearing before pump start to minimize starting torque.
  - As RCP speed increases, oil pump auto stops.
  - When RCP stopped, oil pump auto starts.
  - Thrust bearing oil pressure interlocked w/ RCP starting circuit.

• **Flywheel**
  - Provides coastdown flow following loss of power.
  - This allows Rx power reduction before flow through core is reduced.
  - Ensures localized boiling & DNB do not occur.
RCP Start Logic

• Cold Water Interlock
  – Must be < 22% power to start RCP.
  – Starting an idle pump will increase core flow & decrease average moderator temperature.
  – Positive reactivity added by pump start.
  – Ensures high pressure trip setpoint (2370#) will NOT be reached before power equilibrium is restored after RCP start.

• Core lift interlock
  – When starting 4th RCP:
    • Cold leg temp. must be > 500°F.
    • Prevents high density coolant from lifting fuel assemblies.
    • Prevents spacer grids from rubbing fuel rod cladding.
Reactor Coolant Pump Start Logic (Fig. 2.3-5)
RCP Motor Stator and Bearing Temperatures indicated on Plant Computer.

- Pressure Transmitters provide seal pressure at each stage
- Upper and Middle Seal Pressures on Panel NSP
- Lower Seal Pressure Read on Plant Comp.
Reactor Coolant Flow vs. Number of Pumps Operating
Fig. 2.3-6
Reactor Coolant Pump Head Capacity Curve
Fig. 2.3-7