# Mechanical Maintenance Training

**Date:** 10/26/2010  
**Rev Author:** CURT CLUFF  
**Title:** Mechanical Seal Assemblies  
**Duration:** 5 HOURS  
**Technical Review:**  
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Date: 2011.03.04 14:33:41 -07'00'
INITIATING DOCUMENTS
Task Analysis of Tasks

REQUIRED TOPICS
None

CONTENT REFERENCES
31MT-9RC26: Reactor Coolant Pump Sulzer Bingham Seal Disassembly and Assembly
31MT-9RC22: Reactor Coolant Pump Seal Housing Disassembly, Examination, and Assembly (Sulzer Bingham)
31MT-9RC23: Reactor Coolant Pump Sulzer Bingham Seal Replacement
N001-0602-00644 - Sulzer-Bingham Seals
DMWO 2774550, Addition of backup ring [also DMDI 2911439]

LESSON PLAN REVISION DATA
Oct 26, 2010 Curt Cluff Minor rewording and refining for clarification and incorporation of DMWO 2774550 [TCSAI 3277044]

Tasks and Topics Covered
The following tasks are covered in Mechanical Seal Assemblies:

<table>
<thead>
<tr>
<th>Task or Topic Number*</th>
<th>Task Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCP001</td>
<td>Maintain mechanical seals (Reactor Cooling Pump)</td>
</tr>
</tbody>
</table>

Total task or topics: 1
TERMINAL OBJECTIVE:

1. Given tech manual and maintenance procedures, the maintenance mechanic will, identify components in the Reactor Coolant Pump seal and state steps to disassemble, inspect, repair, and reassemble Reactor Coolant Pump seal assemblies in accordance with maintenance procedures 31MT9RC26 AND 31MT9RC22. as demonstrated by passing the final written exam with a minimum grade of 80%.

1.1 Explain the Principles of Operation of the Mechanical Seal Assembly.

1.2 Identify components in Seal I, II, and III and their functions.

1.3 State the steps necessary to disassemble seals I, II, and III.

1.4 State the steps needed to assemble seal assemblies I, II, and III.
CONTENT

I. Motivation

A. Seal maintenance is the most common mechanical task on the RCPs

B. A seal failure at PVNGS caused leakage into the pump bowl
   1. Resulted in damage to several RCP nuts and studs.
   2. Some had to be replaced prior to pressurizing the reactor

C. High frequency of RCP seal failures has prompted utilities and vendor reps to review the subject in detail. Some of the major causes were identified as follows:
   1. Improper maintenance—errors in installation and refurbishing of seals, such as placing them in the wrong orientation, failure to vent them properly, or omitting the placement of O-rings, have resulted in failures.
   2. Foreign material present
   3. Human errors
   4. Excessive Vibrations

D. Recommendation: Plant personnel should be trained and qualified for RCP seal maintenance to ensure quality work and minimize radiation exposure per ALARA program requirements. Consider using seal mockups, vendor training or job performance aids to improve expertise.

METHODS AND ACTIVITIES

Focus student attention on “What’s In It For Me”.

II. Pre-Job Brief

A. Focus On Five (Task Preview)

Familiarize worker with the scope of work, task sequence, and critical steps.

1. Critical Steps (Terminal Objectives)

   Given tech manual and maintenance procedures, the maintenance mechanic will identify components in the Reactor Coolant Pump seal and state steps to disassemble, inspect, repair, and reassemble Reactor Coolant Pump seal assemblies in accordance with maintenance procedures 31MT9RC26 and 31MT9RC22 as demonstrated by passing the final written exam with a minimum grade of 80%.

2. Identify error likely situations (error traps)
   a. Discuss at least one specific error likely situation.

3. Identify the Worst thing that can happen. Apply to the setting you’re in. (Lab versus Classroom)

4. Identify specific error prevention defenses to be used.

5. Identify actions to assure proper configuration control.

B. Two Minute Drill – After lunch at a minimum

At Instructor’s discretion, not to interrupt class flow.
III. Lesson Introduction

A. Lesson Enabling Objectives

EO01 Explain the Principles of Operation of the Mechanical Seal Assembly.
EO02 Identify components in Seal I, II, and III and their functions.
EO03 State the steps necessary to disassemble seals I, II, and III.
EO04 Define acceptable/unacceptable flaws on seal assembly components.
EO05 State the steps needed to assemble seal assemblies I, II, and III.

METHODS AND ACTIVITIES

Read and/or discuss the lesson objectives
TO: 1  Given tech manual and maintenance procedures, the maintenance mechanic will, identify components in the Reactor Coolant Pump seal and state steps to disassemble, inspect, repair, and reassemble Reactor Coolant Pump seal assemblies in accordance with maintenance procedures 31MT9RC26 AND 31MT9RC22. as demonstrated by passing the final written exam with a minimum grade of 80%.

EO: 1.1  Explain the Principles of Operation of the Mechanical Seal Assembly.

CONTENTS

I. Basic Seal Description

A. Three sets of rotating and stationary surfaces in close contact
B. Fluid between them is enough for lubrication and cooling
C. The spring is for proper face loading to determine proper leakoff amount
D. Static seals to prevent bypassing the dynamic seal, rendering them virtually ineffective.

II. Operation of RCP Seals

A. Three single seals in series
B. Entire seal arrangement has clean fluid entering under the first stage
   1. Some of the water goes down through the bearing, keeping out the fluid directly from the reactor coolant system
   2. Remaining water goes either through the seal or bypasses the seal to be cooled and minimize the heat to the second stage seal

METHODS & ACTIVITIES

Slide – Picture of a Seal to guide through this discussion

Slide – Picture of an individual seal--point out the relative parts described in the basic seal

Slide – Picture of entire seal arrangement
CONTENTS

I. Seal Retainer
   A. The exterior boundary of the seal assembly
   B. Housing for the stationary parts of the seal assembly.

II. Shaft Protection Sleeve
    A. Interior boundary of the seal assembly
    B. Holds the rotating elements of the seal assembly

III. Carrier Ring
     A. Holds the stationary seal face—the stationary half of the sealing surface
     B. Springs between the carrier and the seal retainer push the sealing faces against each other to establish the desired leakoff rate

EO: 1.2 Identify components in Seal I, II, and III and their functions.
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>METHODS &amp; ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV. Rotating Seal Ring</td>
<td>Click</td>
</tr>
<tr>
<td>A. Attached to the flange of the shaft protection sleeve</td>
<td></td>
</tr>
<tr>
<td>B. Rotating face of the seal assembly—contains the rotating half of the actual sealing surface</td>
<td></td>
</tr>
<tr>
<td>V. Drive Pins</td>
<td>Click</td>
</tr>
<tr>
<td>A. Hold seal assemblies to each other</td>
<td></td>
</tr>
<tr>
<td>1. Inner ones hold shaft protection sleeves together</td>
<td></td>
</tr>
<tr>
<td>2. Outer ones hold seal retainers together</td>
<td></td>
</tr>
<tr>
<td>B. Must be pulled to separate seal assemblies</td>
<td></td>
</tr>
<tr>
<td>VI. Seal Cover</td>
<td>Slide</td>
</tr>
<tr>
<td>A. On the bottom of the Seal I assembly, surrounding the seal retainer</td>
<td></td>
</tr>
<tr>
<td>B. Keeps the shaft protection sleeve assembly captured inside the seal retainer assembly</td>
<td></td>
</tr>
<tr>
<td>VII. Items which can be used to distinguish the different seals</td>
<td>Slide</td>
</tr>
<tr>
<td>A. Top of Seal III assembly is relatively flat</td>
<td>Click</td>
</tr>
<tr>
<td>1. Does not need to be pinned to an assembly above it</td>
<td></td>
</tr>
<tr>
<td>2. Has a leakoff port for water that leaks past the seals</td>
<td></td>
</tr>
<tr>
<td>B. Bottom of Seal I</td>
<td>Click</td>
</tr>
<tr>
<td>1. Includes a Seal Cover</td>
<td></td>
</tr>
<tr>
<td>2. Has a pin that needs to align with the feed screw</td>
<td></td>
</tr>
</tbody>
</table>
CONTENTS

C. Diameters

1. Seal III is the largest outside diameter, the smallest inside diameter

2. Seal II is about .080” smaller on the OD and .080” larger on the ID

3. Seal I is about .080” smaller than II on the OD and .080” larger on the ID

EO: 1.3 State the steps necessary to disassemble seals I, II, and III.

CONTENTS

I. Seal Cartridge Disassembly

This assumes the seal assemblies went to the rebuild area as a single cartridge

A. Install the sleeve jacking tool on the Seal III if not installed

1. Ensure the “halo” is locked in place

2. Tighten the jacking screw until the drive pins between Seal III and Seal II seal retainers are loose

B. Remove Seal III

1. Back off the jacking screws and remove the 2 inner drive pins

2. Remove Seal III and put in storage container

C. Repeat with Seal II assembly

D. Place Seal I in a storage container also
CONTENTS

II. Seal I disassembly

A. Preparation
   1. Record pump ID number and seal serial number
   2. Set Seal I assembly on blocks to protect the dowel pin in the shaft protection sleeve

B. Separate rotating and stationary subassemblies
   1. Tighten jacking screws enough to insert carrier retainers
   2. Spring gap should be about 1/8” when able to install carrier retainers
   3. Back off jacking screws until carrier is held by retainers
   4. Remove the drive pins, then lift the seal retainer and shaft protection sleeve assemblies off the seal cover
   5. Remove seal cover and lower the Seal I assembly back onto the ¾” blocks
   6. Remove the sleeve jacking tool
   7. Hold shaft protection sleeve subassembly in place and lift the seal retainer/carrier subassembly off

C. Disassemble shaft protection sleeve subassembly
   1. Remove O-ring from ID
   2. Lift rotating seal ring straight up and off the shaft protection sleeve
      a. Set face up on a soft, clean surface

METHODS & ACTIVITIES

Slide

Show on slide

Click

Point out gap on slide

Prevent Events: Self-check/STAR. Ensure the retainers are holding before removing the jacking tool

Slide

Slide show resting on blocks to protect pin

Click

Mention, then New Slide, show parts

Click
CONTENTS

b. Remove the centering O-rings

c. Remove the rotating seal support ring and the “face” O-ring

d. Remove the anti-rotation pin from the shaft protection sleeve

D. Seal Retainer/Carrier Disassembly

1. Remove the 2 O-rings from the OD

2. Set in Spring Compression tool

   a. Place the spring compression tool on the work table and disassemble

   b. Attach seal retainer holder to the retainer

      1) with the proper alignment

         Again note holder and position of markings

      2) Anti-rotation lug lined up with punch marks on seal retainer holder

      Note holder, seal retainer, then change slide

   c. Place seal retainer/carrier assembly in carrier holder

      1) Punch marks on carrier holder show location of anti-rotation lug

         Slide Note pin position

      2) Allows pins in carrier holder to align with holes in carrier face

   d. Install handwheel on each of the 3 threaded rods

3. Separate carrier assembly from retainer assembly

   a. Turn down handwheels until the carrier retainers can be removed

      Click

   b. Back off the handwheels evenly until spring support the seal retainer

Show parts being operated
c. Remove the handwheels and lift the seal retainer subassembly off the carrier

d. Remove springs, O-rings and backup ring from the carrier and remove the carrier/stationary seal ring subassembly form the carrier holder

4. Seal Retainer disassembly
   a. Remove Spirolox retaining ring
   b. Turn over on 2” blocks and install installation tool
   c. Using a soft hammer, tap the secondary seal sleeve out
   d. Remove O-ring

5. Carrier/Stationary Seal Ring disassembly
   a. Remove Spirolox retaining ring and the retainer ring
   b. Remove O-ring and backup ring by poking with sharp awl or equivalent
      Prevent Events: 2-minute drill care not to scratch seating surfaces
   c. Lift stationary seal ring out of carrier

E. Seal II and III assemblies
   1. Do not have the covers on the bottom
   2. Essentially the same process for the remaining steps
EO: 1.4 State the steps needed to assemble seal assemblies I, II, and III.

CONTENTS

I. Inspection

A. Comprehensive inspection criteria is contained in the procedure

B. O-rings and springs are also inspected

1. Not reused

2. Inspection is for potential failure analysis

C. Several dimensions taken that are critical to seal operation

II. Assemble Seal Retainer Subassembly

A. Seal Sleeve Installation

1. Dow Corning 55 O-ring lubricant

2. Install O-ring

3. Carefully guide seal sleeve into seal retainer

4. Using installation tool and soft mallet, tap the sleeve into the retainer until it bottoms

5. Install the Spirolox retaining ring

METHODS & ACTIVITIES

Slide of partially disassembled seal assembly, can point to parts as desired

Use procedure pictures to illustrate

New slide, show sleeve installation
CONTENTS

B. Reassemble Carrier subassembly

1. Determine which carrier and stationary seal go together based on critical dimensions

2. Install O-ring on Stationary Seal Ring
   a. Set Seal Ring on a soft cloth face down (chamfer side up)
   b. Lightly lubricate O-ring
   c. Slide down until about 1/8” from the front edge
   d. Repeat with the backup ring with the concave side facing the O-ring until it touches the O-ring
   e. Clean backside surface with lint-free cloth to remove any excess lubricant from the OD

3. Install Stationary Seal Ring into carrier
   a. Orient the Stationary seal ring face up over the carrier
   b. Set the ring down into the carrier – the O-ring will hold the seal ring up
   c. Carefully place the O-ring installation tool over the stationary seal ring and press the O-ring into the carrier O-ring groove
   d. The stationary seal ring should be seated against the carrier at this time

4. Place the retainer ring over the O-ring and secure with the Spirolox retaining ring

5. Wipe the seal ring with a clean, lint-free cloth

METHODS & ACTIVITIES

Prevent Events: self-checking to ensure the proper parts are assembled

New slide, show parts during assembly

Show location on next slide

Show this installation on the next slide

Prevent Events: The tolerance is close, so 2 minute drill to evaluate how to not chip the seal

Next slide

Next slide
CONTENTS

6. Turn the carrier over and install O-ring and backup ring

III. Assemble Shaft Protection Sleeve Subassembly

A. Place shaft protection sleeve on the Sleeve Compression tool baseplate

1. If Seal I assembly, a minimum ¼” keystock will be required to protect the pin

2. Insure the anti-rotation pin is installed in the shaft protection sleeve

3. Determine which protection sleeve and associated parts go together based on critical dimensions
   a. The thickest stationary seal ring [Dimension T] is assigned to Seal I, the thinnest to Seal III
   b. The thickest carrier is assigned to Seal I, the thinnest to Seal III

4. Calculate the clearance between the end of the anti-rotation pin and the bottom of the hole in the rotating seal ring (.005” min)

B. Assemble rotating seal to the shaft protection sleeve

1. Install O-rings and support ring
   a. Install one “centering” O-ring in groove
   b. Install a dry (no lube) “face” O-ring
   c. Press the support ring by hand over the “centering” O-ring
   d. Lightly lubricate other “centering” O-ring and install it in the upper “centering” O-ring groove

METHODS & ACTIVITIES

Next slide

Prevent Events: self-checking to ensure the proper parts are assembled

Next slide, click again to show which dimension

Next slide, click again to show which dimension

Next slide and follow the identified measurements
CONTENTS

e. Install dry “face” O-ring to the backside O-ring groove of the rotating seal ring

METHODS & ACTIVITIES

Slide

2. Install the rotating seal ring

a. Press down by hand

b. Visually check that all O-rings are still in their grooves, not slipped off

IV. Assemble Carrier Subassembly to the Seal Retainer Subassembly

A. Prepare Spring Compression tool

1. Remove handwheels

2. Set adjusting nuts to approximately height “H” for installing springs

B. Set carrier subassembly on the carrier holder

1. Aligning the pins

2. The anti-rotation lug aligned with the punchmark

C. Set seal retainer subassembly into the spring compression tool

1. Attach seal retainer holder to the seal retainer, aligning the anti-rotation slot with the punch marks

2. Position the seal retainer over the carrier holder and align the slot with the lug on the carrier

3. Lower the retainer over the threaded rods until the seal retainer holder rests on the nuts

Next slide
CONTENTS

D. Connect the two assemblies

1. Install the 30 springs between the seal retainer and carrier
   a. Into seal retainer first
   b. Compress slightly and guide into the corresponding hole in the carrier
   c. Use a mirror and verify all springs are installed correctly

2. Lower the retainer assembly until the weight is supported by the springs

3. Using handwheels, lower the seal retainer until the anti-rotation lug and slot are ready to engage
   a. Verify they are aligned
   b. Rotate as necessary to align

4. Use handwheels and lower the Seal Retainer subassembly over the carrier subassembly
   a. Handwheels should turn easily – they should not have to be forced
   b. Verify O-rings are not being pinched/damaged
   c. Use a mirror to ensure proper engagement while aligning

5. Install carrier retainers

6. Remove handwheels

7. Lift seal retainer/carryer subassembly and set it on the assembly bench

8. Remove the eyebolts and seal retainer holder
CONTENTS

V. Complete assembly

A. Seal I

1. Set seal retainer cover on the baseplate with 1/4" keystock

2. Set the Seal I shaft protection sleeve subassembly on the baseplate

3. Install Seal Retainer assembly
   a. Wipe rotating and stationary seal faces with lint-free cloth
   b. Align the 4 drive-pin holes and lower the Seal I retainer/carrier onto the seal cover
   c. Install 4 drive-pins

4. Lubricate and install O-ring on inside of shaft protection sleeve

5. Lubricate and install O-rings on the outside of the seal retainer

B. Seal II final assembly/installation

1. Set the Seal II shaft protection sleeve subassembly on the Seal I assembly

2. Install 2 drive pins

3. Install seal retainer and O-rings the same as with Seal I

C. Seal III final assembly/installation

1. Set the Seal III shaft protection sleeve subassembly on the Seal II assembly

2. Install 2 drive pins

3. Install seal retainer and O-rings the same as with Seal I
CONTENTS

D. Install shaft jacking tool
   1. Tighten the jacking screws
   2. Remove the nine carrier retainers

VI. Seal Setting Measurement
   A. Install sleeve compression tool
      1. Install tool plate, washer, and nut on threaded rod
      2. Tighten to clamp the shaft protection sleeves together
   B. Back off the jacking screws
      1. Read 0.250" ± 0.005" seal setting gap
      2. All three should read 0.240" to 0.300".
      3. Measure the "K" dimension to determine the seal setting gap when installed
   C. Seals can now be fitness tested and installed
      1. Installation must be within 120 days of fitness test
      2. Fitness test verifies all three seals are installed correctly
SUMMARY OF MAIN PRINCIPLES

The following items are things to consider in your lesson summary. They are not mandatory.

Objectives Review

Restate the main principles or ideas covered in the lesson. Relate key points to the objectives. Use a question and answer session with the objectives.

Questions and Answers

Ask questions that implement the objectives. Discuss students’ answers as needed to ensure the objectives are being met.

Problem Areas

Review any problem areas discovered during the oral questioning, quiz, or previous tests, if applicable. Use this opportunity to solicit final questions from the students.

Concluding Statement

If not done in the previous step, review the motivational points that apply this lesson to students’ needs. End with a statement leading to the next lesson. Use as a transitional function to tie the relationship of this lesson to the next lesson.