<table>
<thead>
<tr>
<th><strong>Mechanical Maintenance Training</strong></th>
<th><strong>Date:</strong> 10/26/2010 4:07:39 AM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LP Number:</strong> NME30C000402</td>
<td><strong>Rev Author:</strong> CURT CLUFF</td>
</tr>
<tr>
<td><strong>Title:</strong> Seal Replacement</td>
<td><strong>Technical Review:</strong></td>
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<tr>
<td></td>
<td>Kleinman, Dean</td>
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<td></td>
<td>W(Z56639)</td>
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<tr>
<td><strong>Duration:</strong> 6 HOURS</td>
<td><strong>Teaching Approval:</strong></td>
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<tr>
<td></td>
<td>Baker Sr, Lee</td>
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<td>E(Z07641)</td>
</tr>
</tbody>
</table>
The following tasks are covered in Seal Replacement:

<table>
<thead>
<tr>
<th>Task or Topic Number*</th>
<th>Task Statement</th>
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<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 major components of the Reactor Coolant Pump Seal assembly and state the steps to replace seals in Reactor Coolant Pump in accordance with maintenance procedure 31MT9RC23 as demonstrated on the final written exam with a minimum grade of 80%.

   1.1 Identify major components of the Reactor Coolant Pump seal assemblies.

   1.2 State the steps to raise thrust bearing for seal replacement.

   1.3 State the steps to remove seals (I, II, & III).

   1.4 State the steps to disassemble and reassemble seal housing internals.

   1.5 State the steps to install new seals.

   1.6 State the steps to seat thrust bearing.

   1.7 State the steps to couple the shafts.
CONTENT

I. Motivation
   A. Look at replacement of the seal without removing the motor or thrust bearing
   B. Requires some steps unique to this task

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 major components of the Reactor Coolant Pump Seal assembly and state the steps to replace seals in the Reactor Coolant Pump in accordance with maintenance procedure 31MT9RC23 as demonstrated on 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

METHODS AND ACTIVITIES

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

PVNGS Standards & Expectation book (Focus on five) Highlight the critical steps (Terminal Objectives) on the power point presentation.

Look at Error Precursors in S&E book

Apply to the setting you’re in.

What defenses can we employ to prevent the “Worst thing that could happen”

This may not be applicable in every training setting.

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

A. Lesson Enabling Objectives

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>METHODS AND ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>EO01 Identify major components of the Reactor Coolant Pump seal assemblies.</td>
<td>Read and/or discuss the lesson objectives</td>
</tr>
<tr>
<td>EO02 State the steps to raise thrust bearing for seal replacement.</td>
<td></td>
</tr>
<tr>
<td>EO03 State the steps to remove seals (I, II, &amp; III).</td>
<td></td>
</tr>
<tr>
<td>EO04 State the steps to disassemble and reassemble seal housing internals.</td>
<td></td>
</tr>
<tr>
<td>EO05 State the steps to install new seals.</td>
<td></td>
</tr>
<tr>
<td>EO06 State the steps to seat thrust bearing.</td>
<td></td>
</tr>
<tr>
<td>EO07 State the steps to couple the shafts.</td>
<td></td>
</tr>
</tbody>
</table>
TO: 1

Given tech manual and maintenance procedures, the maintenance mechanic will, identify major components of the Reactor Coolant Pump Seal assembly and state the steps to replace seals in Reactor Coolant Pump in accordance with maintenance procedure 31MT9RC23 as demonstrated on the final written exam with a minimum grade of 80%.

EO: 1.1

Identify major components of the Reactor Coolant Pump seal assemblies.

CONTENT

METHODS & ACTIVITIES

I. Seal Assembly Parts

A. Rigid Coupling

1. Located between the thrust bearing and the seal housing assembly

2. Connects the shaft of the thrust bearing with the shaft of the pump

B. Seal Housing

1. Surrounds the seal assemblies and the pump shaft

2. Pressure boundary for the pump

3. Holds the seals between the rotating and stationary components of the RCP

C. Thrust Ring Retainer

1. Located at the extreme upper portion of the seal housing

2. Directs any leakage through the seals to the leakoff lines to prevent potentially contaminated liquid from entering the environment
## CONTENT

### D. Seal Assemblies I, II, and III
1. Between the housing and the shaft
2. Seal I on bottom, III on top
3. Seals the clearances between the rotating parts (shaft) and the stationary parts (housing)

### E. Feed bushing
1. Below the seal I assembly, surrounding the feed screw
2. In conjunction with the feed screw, it minimizes the possibility of potentially contaminated liquid entering the seal system

### F. Feed ring
1. Below the seal I assembly, surrounding the shaft, inside the feed bushing
2. Directs the flow of seal water towards the impeller to cool the water lubricated journal bearing

### G. Water lubricated journal bearing
1. Located between the impeller and the feed ring
2. Maintains the positional relationship (alignment) between the rotating and stationary parts of the pump

### H. Seal robot
1. Attached over the RCP seal housing retainer ring bolts and nuts off to one side
2. Lifts and lowers the parts of the seal assembly evenly and controllably
EO: 1.2 State the steps to raise thrust bearing for seal replacement.

CONTENT

I. Prerequisites

A. Area must be cleaned and FME measures established (covers ready) to preclude the introduction of foreign material into the system.

B. Wear cotton gloves when handling bearings or seals on their mating surfaces.

C. Match mark parts for easy reassembly.

D. Take the necessary precautions for working around inhibited/borated systems.

E. All parts to be removed should be bagged and tagged.

II. Remove oil and water lines

A. This was previously described in lesson 1.

B. Since the thrust bearing will still have to be lifted considerably, the lines will still have to be removed.
   1. Hanger bracket shims must all be reinstalled in the same location.
   2. Ensure bolting and shims are bagged and tagged for easy identification.

METHODS & ACTIVITIES

Prevent Events: These items should be covered in pre-job brief and 2-minute drills to emphasize importance. Add peer checking also.

Change slide, then change again: Only need to remind them – review material.

Change slides (next 3) to show photos of the connections.

Prevent Event: pre-job and 2-minute drill – procedure requirement.

Change slide to illustrate the need to raise the Thrust Bearing.
### CONTENT

#### III. Uncouple/remove flexible coupling

- **A.** Locate or make match mark for diaphragm packs and coupling halves to aid in reassembly
  - Change slide to show match marks

- **B.** Remove coupling bolts and nuts securing diaphragm and adapter assembly to coupling halves.
  - Change slide to show removing bolting

- **C.** Remove diaphragm packs and adapters and set on top of thrust bearing
  - Change slide to show removed section on top of thrust bearing

#### IV. Raise the thrust bearing

- **A.** Disconnect rigid coupling (covered in lesson 1)
  - Click to highlight
    - 1. Shift Supervisor permission/signature is required
    - 2. Note conditions may not allow lowering onto the stop seal yet
    - 3. Can still proceed by installing mechanical jacks to hold the shaft off the stop seal
  - Change slide to show mechanical jacks

- **B.** Remove bolts and keyed washers holding thrust bearing to motor support stand.
  - Change slide, then change slide again for photo

- **C.** Install four lifting eyes into thrust bearing support flange
  - Change slide

- **D.** Attach four, 3-ton come-a-longs through lower motor frame holes with straps
  - Change slide

- **E.** Install 3 alignment pins
  - Change slide
    - 1. They install in the threaded holes for the hold-down bolts
    - NOTE: although not identified in the procedure, they should be used to more easily align the dowel pin upon reinstallation
CONTENT

2. Cannot be installed in the same holes as the eyebolts

F. Raise the thrust bearing high enough to allow installation of seal crane robot (about 13 inches)

G. Install four safety stops and relax come-a-longs until most of the weight is on the safety stops

H. Examine mating surfaces of coupling halves for spline wear or misalignment

I. Install cover on splines to protect them from damage

EO: 1.3 State the steps to remove seals (I, II, & III).

CONTENT

I. Install crane

A. Remove seal sensing lines as necessary

1. Seal sensing line brackets may need to be removed for operation of the seal crane
   a. Procedure identifies removal of all 3 sensing lines
   b. If not required, only have to remove those needed for seal crane operation

2. Must matchmark all locations and the brackets

3. Ensure brackets and any shims are installed exactly as removed

B. Crane is disassembled prior to bringing in and loading into the pump bay

METHODS & ACTIVITIES

Change slide

Click to highlight, then change slide to show closeup

Change slide to identify brackets

Change slide to show procedure picture
CONTENT

C. Install base assembly
   1. Install over 2 RCP studs just to the side of the window
   2. Lock down with base nuts snug tight

D. Install post assembly, hub assembly, and boom assembly onto the base
   1. Ensure pins are tight
   2. Lock boom up with cylinder assembly and pin

E. Install trunnion tool
F. Hook up hoses to the pump
G. Verify operation
   1. Check which knobs control which functions
   2. Practice moving for control and direction before picking the parts
   3. Ensure PSV pressure is set below 800 lbs.

METHODS & ACTIVITIES

Change slide

Crane has been installed on both sides. Fittings may need to be modified to fit on the opposite side from where last used.

Change slide

Show on drawing then click to show assembled crane

Prevent Events: Self-checking and peer verification

Change slide shows coupling removal parts

Prevent Events: Ensures there are matchmarks for reassembly

Prevent Events: Radioactive gases may escape while lowering
CONTENT

2. If leakage is excessive, block shaft back up and notify rad protection before proceeding

C. Remove socket head cap screws
   1. Ensure the pump shaft does not turn during coupling removal

   Prevent Events: 2-minute drill – not damage the stop seal. Remember, there is a special tool for the capscrew removal

   2. 45º 1st pass, then last 45º 2nd pass then remove on 3rd pass

   3. Each pass is done in marked numerical order

D. Remove the coupling half
   1. Install two coupling studs through trunnion assembly inner plate, 180° apart

   2. Assemble inner and outer plates of trunnion assembly and install on trunnion tool of seal robot
      a. Engage two nuts on the bolts, ensuring they are evenly spaced to lift the coupling half evenly
      b. Lift lower coupling until it clears the pump shaft, and then remove the coupling half

   3. Install cover plates, top and bottom, to protect the teeth

   Change slide to note protective cover on the shaft, similar to the two on the coupling half

   CAUTION: Contact radiation protection group before proceeding. Exposure rates and contamination levels may vary considerably.

E. ISI inspection (If required)
   1. If ISI is going to perform NDE on the pump shaft, the hole inside the shaft must be unplugged
### CONTENT

2. Remove the Stopfen (17 mm socket) and Bolzen (special slide hammer allthread) plugs

3. Note if there is any water inside the hole and remove

### METHODS & ACTIVITIES

- Change slide
- Preserving Evidence – if water is found it must be noted to engineering

### III. Remove seals

#### A. Thrust Ring Retainer removal

1. Loosen and remove 12 capscrews (126) from the thrust ring retainer (125)

2. The locking rings (127) will release when capscrews are turned or a punch may be used to release them

3. Attach the trunnion ring to the thrust retainer with ½” –13 UNC studs/nuts

4. Using care not to damage the Carbon throttle bushing, remove the thrust retainer

- Change slide

#### B. Remove segmented thrust ring

1. Install a sleeve jacking tool “Halo” on the Seal III shaft protection sleeve with retaining pins

- Prevent Events: Self and peer checking to ensure tool pins are fully engaged

2. Jack sleeve down until segmented thrust ring is loose

3. Pry the segmented thrust pieces out
   a. Segment with parallel ends comes out first
   b. Other two segments can then be removed

#### C. Seal III removal

1. Fasten trunnion plate to the top of the seal with two ½”-13 UNC studs & 4 nuts

- Change slide
<table>
<thead>
<tr>
<th>CONTENT</th>
<th>METHODS &amp; ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Lift seal until split blocking ring can be installed on the seal II retainer</td>
<td>Prevent Events: STAR and 2-minute drill – What you expect and what to do if you don’t see it</td>
</tr>
<tr>
<td>a. This will require additional force to initially break the assembly loose</td>
<td>Identify ways that have assisted such as 2 – ¾ ton come-a-long attached to the thrust bearing</td>
</tr>
<tr>
<td>1) O-rings bond with the housing and shaft</td>
<td></td>
</tr>
<tr>
<td>2) Come-a-Longs attached between the thrust bearing and the seal are used to initially break the seals loose</td>
<td></td>
</tr>
<tr>
<td>b. If the entire shaft lifts, set back down and may have to jack the seal up against the shaft before removing</td>
<td>Note where and how it has been jacked in the past</td>
</tr>
<tr>
<td>3. Set seal on split blocking ring</td>
<td>Click to highlight</td>
</tr>
<tr>
<td>4. Remove pins</td>
<td>Click to highlight</td>
</tr>
<tr>
<td>a. Outer pins can be removed with the jacking screws pushed down, relieving the spring tension from the seal retainer</td>
<td></td>
</tr>
<tr>
<td>b. Inner pins may require that the jacking screws on the halo be backed off slightly</td>
<td>Click to highlight</td>
</tr>
<tr>
<td>c. Pin removal tool or screw should be used to minimize potential for dropping pins</td>
<td>Click to highlight</td>
</tr>
<tr>
<td>5. Lift and remove the Seal III cartridge – DO NOT remove jacking ring</td>
<td>Change slide (4 times) to show photos of removal</td>
</tr>
<tr>
<td>D. Seal II removal</td>
<td></td>
</tr>
<tr>
<td>1. Attach a 2nd sleeve jacking tool to the Seal II shaft protection sleeve</td>
<td>Prevent Events: Ensure engaged in the sleeve, 700 lbf, Self-peer check, 2-minute drill</td>
</tr>
<tr>
<td>2. Fasten trunnion to seal II retainer</td>
<td>Change slide</td>
</tr>
</tbody>
</table>
### CONTENT

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>3. Lift seal until split blocking ring can be removed from the Seal II assembly</td>
</tr>
<tr>
<td>4. Continue lifting until the split blocking ring can be installed on the Seal I retainer</td>
</tr>
<tr>
<td>5. Set Seal assembly onto split blocking ring</td>
</tr>
</tbody>
</table>
| 6. Remove pins  
  a. Outer and inner as before  
  b. Jacking tool will likely need to be tightened for removal of the outer pins and loosened for removal of the inner pins  |
| 7. Lift and remove the Seal II cartridge – DO NOT remove jacking ring |

#### E. Seal I assembly removal
- Attach trunnion to the seal assembly
- Lift and remove split blocking ring
- Continue lifting and remove Seal I cartridge
- Do NOT remove drive pins in the seal I assembly

### IV. Seal Housing Adapter (Top Hat) Removal

This step is not necessary for normal seal work

<table>
<thead>
<tr>
<th>METHODS &amp; ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Remove ½” blind flange and O-ring on the seal housing adapter</td>
</tr>
<tr>
<td>B. Have engineering take gap measurement</td>
</tr>
</tbody>
</table>

Engineering will direct this and any other measurements they want taken

1. Between housing and adapter
2. For assisting in root cause analysis of leakage
3. Install transfer punch bushings and mark the hole locations sufficient to align the tophat when lowering back down
<table>
<thead>
<tr>
<th>CONTENT</th>
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</thead>
<tbody>
<tr>
<td>4. Loosen the studs in standard sequence but do not remove yet (engineering measurement is required)</td>
<td></td>
</tr>
<tr>
<td>5. Remove the nuts</td>
<td></td>
</tr>
<tr>
<td>6. Remove transfer punch bushings and install lifting hooks in jackscrew holes</td>
<td>Change slide to show hooks</td>
</tr>
<tr>
<td>7. Turn hooks until top hat is clear of rabbit fit</td>
<td></td>
</tr>
<tr>
<td>8. Attach robot to hooks with lifting bar on outer trunnion</td>
<td></td>
</tr>
<tr>
<td>9. Lift and remove top hat</td>
<td>Change slide to show 2nd view</td>
</tr>
</tbody>
</table>

**EO: 1.4** State the steps to disassemble and reassemble seal housing internals.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Note that these steps are not commonly done (reference 31MT-9RC22)</td>
<td></td>
</tr>
<tr>
<td>I. Lower feed screw (feed ring) removal</td>
<td></td>
</tr>
<tr>
<td>A. Lower trunnion down and to align with holes in the feed screw (view A)</td>
<td></td>
</tr>
<tr>
<td>1. Install 575mm (25 in) long bolts into feed screw and raise until U-strap can be placed into position</td>
<td>View B</td>
</tr>
<tr>
<td>2. Replace 575mm bolts with 130mm (5 in) bolts and remove feed screw (view C)</td>
<td>Change slide</td>
</tr>
<tr>
<td>II. Feed bushing removal</td>
<td>Point out view D</td>
</tr>
<tr>
<td>A. Same operation as with the feed screw</td>
<td></td>
</tr>
<tr>
<td>1. Use different bolt holes in the trunnion inner plate</td>
<td></td>
</tr>
<tr>
<td>CONTENT</td>
<td>METHODS &amp; ACTIVITIES</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------</td>
</tr>
<tr>
<td>2. Bolt diameter is smaller</td>
<td></td>
</tr>
<tr>
<td>a. 12mm dia. Compared to 16mm</td>
<td></td>
</tr>
<tr>
<td>b. Long bolt is 560mm (24 1/4 in) long</td>
<td></td>
</tr>
<tr>
<td>c. Short bolt is 40mm (1 5/8 in) long</td>
<td></td>
</tr>
</tbody>
</table>

III. Journal bearing removal

A. Use same bolts as the feed screw removal

1. Same operation as the feed screw except different holes in the trunnion inner plate

2. U-strap cannot be used, and stop pins will have to be used into holes provided in the side of the journal bearing (View B, item 8)

B. Care must be taken to prevent damage to the carbon liner

C. Same bolts and process for the shaft protection sleeve

IV. Internals Reassembly

A. Prerequisites

1. Care must be taken to not rotate the shaft during reassembly or it could cause damage to the pump stop seal

2. Shaft and housing interior must be checked for cleanliness

B. **NOTE:** Reinstallation is basically the reverse of removal.

V. Journal bearing installation

A. If the shaft protection sleeve has been removed, it will be installed first

1. Determine if the interference fit is in tolerance

   a. Shaft OD measured
CONTENT

b. Protection sleeve ID measured
c. .0012” - .0027” interference

2. Wipe clean and heat sleeve to 310 °F

3. Wipe down shaft

4. Remove sleeve from oven and quickly install onto shaft – hold in position until cool

5. Measurements must be taken to ensure the shaft sleeve is seated before installing the journal bearing – if questionable, contact engineering

B. Install 40mm (1 5/8 in) bolt into the top of the journal bearing through the trunnion plate holes

C. Center the journal bearing over the shaft and carefully lower it down to install the stop pins and set onto the seal housing

D. Replace 40mm bolts with 575mm (23 in) bolts

E. Raise the trunnion, equalize the load, and remove the stop pins

F. Carefully lower the journal bearing over the shaft so as not to damage the carbon face
   1. Align the key (1) with the keyway by rotating the trunnion plate
   2. When the journal bearing is seated properly, remove the bolts

VI. Feed bushing installation

A. Record measurement "A1" in the seal housing and "W" on the feed bushing for feed bushing seating checks

B. Reinstall key if removed and verify dowel pin is installed

METHODS & ACTIVITIES

Change slide to show measurement location – click to show W location

Change slide to show feed bushing installation
CONTENT

C. Lubricate O-ring with Molykote 41

NOTE: The use of Molykote 41 for lubricating the O-rings prior to installation applies to all the O-rings installed in this procedure.

D. Reinstall feed bushing similar to the journal bearing with the following exceptions

1. Use the proper size bolts

2. Rest the feed bushing on the U-strap while changing the bolt length to the longer bolts

3. If force is required to overcome resistance from new O-ring use hardwood blocks and levers 180° apart (place eyebolts in place of removed bolts in the seal cover for the fulcrum)

4. NOTE: DO NOT USE FORCE IF IT IS COCKED OR HUNG UP ON KEYWAY

Emphasize that this would possibly damage the machined surfaces on bushing and shaft

5. Take and record feed bushing measurement "A" to within 0.10mm (.004").

a. Compare calculated dimension with actual (Calculated = A1 - W)

VII. Feed screw installation

A. Lubricate and install O-ring in feed screw bore

B. Install 130mm (5 in) bolts with washers and lift feed screw

C. Place on U-strap and change to the 575mm bolts

D. Install the same as with feed bushing

E. Take and record measurement “G”

1. Ensure feed screw is properly seated
CONCEPT

2. Engineering contacted if not within .015” of historical measurement

EO: 1.5 State the steps to install new seals.

CONTENT METHODS & ACTIVITIES

I. General instructions
   A. Check bolt and dowel pin holes for cleanliness
   B. Use Neolube 2 or equivalent for threads unless otherwise specified

II. Bolzen and Stopfen Plug reinstallation
   A. Using new O-ring lubricated with Molykote 41, insert Bolzen plug
      1. Can use the threaded rod from the special slide hammer
      2. Distance (4.7”) is measured to make sure it is fully seated
   B. Lubricate Stopfen plug threads with Molykote 41 and install plug, torquing to 10 ft-lbs

III. Seal Housing Adapter (Top Hat) Installation
   A. Remove plugs (38 – 42) one at a time and replace the O-rings.
      1. Lubricate O-rings with Molykote 55
      2. Reinstall plugs in the same hole they were removed from
         a. The five plugs are each a different length
         b. They must be installed in the proper location

Prevent Events – follow procedure, and do one at a time
CONTENT

B. Prepare for installation

1. Lube and install a minimum of 4 studs on top of seal housing

2. Install 3 small O-rings on the top face of the seal housing

3. Install large O-ring on top face of seal housing
   – lubricate with Molykote 55

4. Install locator jackscrews in Top Hat, protruding about ½”

C. Install Seal Housing Adapter (Top Hat)

1. Do NOT allow stud lube to contact O-rings

2. Ensure dowel pin in the housing is aligned with the hole in the adapter (Top Hat)

3. Jackscrews are seated in their center-punched holes

4. Install 4 nuts on the studs hand tight

D. Seat the Seal Housing Adapter

1. Incrementally lower the adapter using the jackscrews
   Prevent Events: peer checking to ensure remains level so there is no binding and fully seated

2. Keep the four nuts lightly tensioned

3. Ensure it comes down level and all 4 jackscrews remain seated in their punch marks until fully seated

4. Ensure nuts tight enough to prevent lateral movement and remove the lifting/locator jackscrews

5. Install the remaining studs, washers, and nuts into the seal housing
E. Torque the nuts on the Housing Adapter

1. Initial torque is 50 ft-lbs
   a. Ensure the housing is centered first, as defined by engineering
   b. Take it to 50 ft-lbs in as many increments as possible to prevent moving off-center
   c. If the housing moves, re-center using jacking screws again and beginning again
   d. Torque to 100 ft-lbs and reverify centering

2. Fully torque to 1196 ft-lbs in:
   a. Normal sequencing
   b. Five stages, 200, 300, 500, 800, & 1196
   c. Reverify centered after each step

Prevent Events: Peer check to ensure the housing is centered and does not move. 2-minute drill on how to prevent it – these joints have leaked due to not being fully seated (machining interference problem)

F. Reinstall blind flange on seal housing adapter with locking sleeves and new o-ring

IV. Preparing Seals for Installation

A. Separated into transport containers for movement in and out of the Containment Building
   1. Each has a lifting bar on the inside for transporting
   2. Designated for lifting a single cartridge, not the entire set
CONTENT

B. Verify seal cavity is clean

C. Verify half key and flathead screw installed on shaft

D. Install new locking rings on the thrust retainer and stake to the retainer

V. Seal I assembly installation

A. Note that there may be measurements to be taken prior to seal installation
   1. Depends on the work that was performed
   2. $G = \pm .015''$ from the historic values is always taken, even if the feed screw was not removed

B. Prep the seal
   1. Lubricate all O-rings with DC55 grease
   2. Fasten to the trunnion plate
   3. Remove Seal I cartridge from the container
   4. Install one inner and two outer O-rings in their grooves

C. Install the seal assembly
   1. Position over the pump shaft
   2. Rotate seal assembly to align the dowel pin in the shaft protection sleeve with the slot in the lower feed screw
   3. Lower the seal assembly into the pump cavity and install the 2-piece blocking ring in the Seal I retainer
   4. Remove the capscrews and trunnion assembly

METHODS & ACTIVITIES

Change slide

Prevent Events: self and peer check to ensure the O-ring is in the groove
VI. Seal II assembly installation

A. Prepare Seal II assembly the same as the Seal I assembly

B. Position Seal II assembly over the pump shaft and lower over the Seal I assembly

C. Connect the two seal assemblies together
   1. Rotate the Seal II assembly until the indexing pin on the Shaft Protection sleeve is aligned and lower
   2. Install two drive pins on the inside of the shaft protection sleeve
   3. Install 4 drive pins on the outside of the Seal II retainer
   4. Adjustment may be required on the sleeve jacking tool for the outside pins

D. Lower Seal assemblies
   1. Lift the Seal assemblies to remove the 2-piece blocking ring from Seal I
   2. Lower the Seal Assemblies down until the 2-piece blocking ring can be installed on Seal II

NOTE: Pay attention to the drive pins as the assemblies are installed. We have had them fall out in the past during seal installation.

E. Remove capscrews, trunnion, and sleeve jacking tool

VII. Install Seal III assembly

A. Record the 3rd stage retainer serial number for inclusion on ASME Section XI repair/replacement form
CONTENT

B. Prepare Seal III assembly
   1. Lubricate all O-rings with DC55 grease
   2. Fasten to the trunnion plate
   3. Remove Seal III cartridge from the container
   4. Install one inner

   Prevent Events: self and peer check to ensure the O-ring is in the groove

   5. Install two outer O-rings in their grooves with a backing ring on the upper groove
      a. Backup ring on top of the O-ring
      b. Concave surface facing down

C. Position Seal III assembly over the pump shaft and lower over the Seal II assembly

D. Connect the two seal assemblies together
   1. Rotate the Seal III assembly until the indexing pin on the Shaft Protection sleeve is aligned and lower
   2. Install two drive pins on the inside of the shaft protection sleeve
   3. Install 4 drive pins on the outside of the Seal III retainer
   4. Adjustment may be required on the sleeve jacking tool for the outside pins

E. Lower Seal assemblies
   1. Lift the Seal assemblies to remove the 2-piece blocking ring from Seal II
   2. Lower the seal cartridge into the pump cavity
      a. Dowel pin in Seal I shaft protection sleeve must engage with slot in the feed screw
**CONTENT**

b. Mark on the Seal III shaft protection sleeve identifies location of dowel pin if shaft was marked

c. Fully lowered when top of Seal III retainer is even with or slightly below the bottom of the groove for the thrust ring

**METHODS & ACTIVITIES**

Note that a level or plumb bob could have been used to mark the top of the shaft for easier alignment

VIII. Complete reassembly

A. Install segmented thrust ring

1. Remove trunnion and move seal crane out of the way

2. Install 3 segment pieces – segment with parallel ends is installed last

3. Back off the sleeve jacking screws and remove the tool from the Seal III shaft protection sleeve

B. Install thrust ring retainer

1. Use trunnion on seal robot

2. Lower carefully over Seal III shaft protection sleeve and onto the thrust ring

3. Remove trunnion and move crane assembly

4. Align holes and install capscrews

5. Torque to 20 ft-lbs, 3 passes, max of 30% on first pass

6. Stake the locking rings to the capscrews

7. CRITICAL STEP: Take measurement Kf

   a. Compared to Ks to verify running seal clearances

   b. Ks is taken from 31MT-9RC26 when the seal was rebuilt
EO: 1.6  State the steps to seat thrust bearing.

**CONTENT**

**METHODS & ACTIVITIES**

I. Install rigid half-coupling

A. Position rigid coupling half under crane

B. Attach coupling half to crane by installing coupling stud bolts through trunnion inner plate and coupling half and securing with two stud hex nuts

C. Orient coupling match marks with marks on pump shaft

D. Lower coupling half onto pump shaft

1. Align match marks (XXX) prior to meshing teeth

2. Install coupling bolts to secure in place

   a. Holes are numbered to correspond with bolt numbers

   b. Lubricate threads and both sides of hardened washer with Never-Seez

   c. Install lower coupling with socket head cap screws prefixed with a "P" for "pump shaft" hand tight

E. Remove seal crane assembly to provide clearance

F. Torque Lower coupling bolting

   1. Initial torquing

      a. Center capscrew to 649 ft-lbs

      b. Outer capscrews to 167 ft-lbs

   2. Final tightening

      a. Use special coupling bolt wrench to prevent rotation of pump shaft
CONTENT

b. 1\textsuperscript{st} pass is to 1\textsuperscript{st} mark (22.5° & 45°) Click to move

c. 2\textsuperscript{nd} pass is to 2\textsuperscript{nd} mark (45° & 90°) Click to move

G. Dimension E

1. This gap defines the running clearance

2. Engineer will take whatever extra measurements needed to ensure running clearances are correct

3. This dimension (along with the “G” dimension) has been shown to be a precursor to bearing shaft sleeve cracking

   a. Too high a number can indicate this problem

   b. Unit 3, 1B RCP had a cracked shaft sleeve and the only evidence prior to the high vibration was the high ‘E’ dimension Change slide to show cracked shaft sleeve

H. Lower pump shaft back onto the static seal (stop seal)

   1. Remember that each time the shaft is raised or lowered, there is the potential for gas and water to escape

   2. This potential, however, is minimized with the current seals – they never fully separate

II. Lower and reseat thrust bearing

   Generally a repeat of lesson 1

   A. Locate match marks between rigid coupling halves and remove upper and lower coupling protective plates Change slide

   B. Raise thrust bearing and remove safety stops Change slide

   C. Lower thrust bearing

      1. Align dowel pin on thrust bearing flange Change slide for alignment
2. Align rigid coupling match marks – rotate thrust bearing shaft rather than pump shaft to do the alignment

D. Remove lifting equipment

E. Insert keyed washers and bolts, torque

**EO: 1.7** State the steps to couple the shafts.

I. Couple rigid coupling

A. Lubricate two studs and nuts 180° apart
   1. Holes are numbered under the flange for the corresponding numbered nuts and studs
   
   **Prevent Events:** Peer check to ensure all parts are assembled correctly [Click to highlight]

   2. Nuts stamped with the letter "P" are on the bottom (Pump) side of the studs

   3. Nuts stamped with the letter "A" are on the top of the studs

B. Install them hand tight

C. Quickly raise pump shaft by tightening two stud nuts together until coupling halves mate
   
   **Prevent Events:** Procedure compliance. Can prevent damage to the seals

   1. Ops must be contacted 1st

   2. If seal injection is on, reverse flow could occur, pushing internal O-rings out of their grooves This has happened in the past, requiring seal disassembly again
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<tr>
<th>CONTENT</th>
<th>METHODS &amp; ACTIVITIES</th>
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<tbody>
<tr>
<td><strong>D. Install remaining studs</strong></td>
<td></td>
</tr>
<tr>
<td>1. Top of the stud must be adjusted to between 2 7/16&quot; and 2 ½&quot; above the flange</td>
<td>Change slide</td>
</tr>
<tr>
<td>2. Ensure they are in the right holes and the nuts are on the right end</td>
<td>Prevent Events: Peer check to ensure all parts are assembled correctly</td>
</tr>
<tr>
<td>3. Measure and record the no-load stud length to ten-thousandths of an inch</td>
<td></td>
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<tr>
<td><strong>E. Tension studbolts</strong></td>
<td></td>
</tr>
<tr>
<td>1. Tension in 3 steps</td>
<td>Change slide</td>
</tr>
<tr>
<td>2. Use Baby Biachs but can use standard torque wrenches with multipliers</td>
<td>Note why Biach tensioners are preferred – minimize chances for galling</td>
</tr>
<tr>
<td>3. Final elongation is .248±.0008&quot;</td>
<td>Change slide again to show pump</td>
</tr>
<tr>
<td><strong>F. Reset speed sensor</strong></td>
<td></td>
</tr>
<tr>
<td>1. Loosen bolts and slide into approximate position.</td>
<td>Change slide – repeat of lesson 1, so only review if needed</td>
</tr>
<tr>
<td>2. Final alignment is by I &amp; C</td>
<td></td>
</tr>
<tr>
<td><strong>II. Align flexible coupling</strong></td>
<td>Review of lesson 1— Change slide - use slides for illustration</td>
</tr>
<tr>
<td><strong>A. Alignment measurements</strong></td>
<td></td>
</tr>
<tr>
<td>1. Center the shaft with motor centering bolts</td>
<td>Change slide</td>
</tr>
<tr>
<td>2. Measure parallel offset of thrust bearing and motor shafts</td>
<td>Change slide</td>
</tr>
<tr>
<td>3. Check for angular misalignment of thrust bearing and motor shafts</td>
<td>Change slide</td>
</tr>
<tr>
<td><strong>B. Plot both values on graph.</strong></td>
<td></td>
</tr>
<tr>
<td>1. If not satisfactory, move motor to attain alignment</td>
<td>Change slide</td>
</tr>
</tbody>
</table>
CONTENT

2. Reverify readings and adjust until correct

III. Install flexible coupling

A. Align matchmarks on flange of diaphragm pack with those on the coupling half mounted on thrust bearing drive shaft

1. Rotation of motor requires use of Motor Rotor Lifting device

2. Aligning matchmarks on both the motor and thrust bearing portion may not be possible (motor removed and replaced, e.g.)

B. Secure diaphragm pack and adaptor assembly to coupling half mounted on motor shaft with bolts and nuts torqued to 325 ft-lbs in three steps

C. Punch the bolt heads to identify the number of times torqued

IV. Reconnect oil and water lines

A. As per lesson 1

METHODS & ACTIVITIES

Review of lesson 1—use slides for illustration

Change slide – remind them that there were several lines discussed in lesson 1
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 (last chance).

Concluding Statement

If not done in the previous step, review the motivational points that apply this lesson to students’ needs. Use this opportunity to address the impending exam.