

PALO VERDE NUCLEAR GENERATING STATION

Mechanical Maintenance

Classroom Lesson



Mechanical Maintenance Training	Date: February 13, 2007
LP Number: NME15C000204	Rev Author: Curt Cluff
Title: Maintenance of M.S.T.	Technical Review:
Duration : 1 Hour	Teaching Approval:

Title: Maintenance of M.S.T.

Lesson Plan #: NME15C000204

INITIATING DOCUMENTS:

Task Analysis of Tasks

REQUIRED TOPICS

NONE

CONTENT REFERENCES

31MT-9RC30: Reactor Vessel Head Removal and Installation

VTM-C490-0028, Stud Tensioner

Maintenance and Operating Manual: Modification of Multi-Stud Tensioning System, Wenutec, BA 823 039

Lesson Plan Revision Data

Feb 13, 2007 Curt Cluff Rephrased portions for clarity. Modified enabling objectives slightly to agree with and support terminal objective. [Reference TCSAI 2970213]

Tasks and Topics Covered

The following tasks are covered in Maintenance of M.S.T.:

Task or Topic Number*	Task Statement
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Lesson: [Maintenance of M.S.T.](#)

MST002	Troubleshoot and repair M.S.T.
MST001	Operate Reactor Head M.S.T.

Total tasks or topics: 2

TERMINAL OBJECTIVE:

- 1.1 Given applicable diagrams the Maintenance Mechanic will, describe the steps necessary to replace the seals in the components, and then vent a Reactor Vessel Multiple Stud Tensioner demonstrated by passing a written exam with a score of 80% or better.
 - 1.1.1 Describe the steps necessary to replace seals in split coupling system air cylinders
 - 1.1.2 Describe the steps necessary to replace Ring Piston Cylinder seals
 - 1.1.3 Describe the steps necessary to replace Piston Travel Limitation Device seals
 - 1.1.4 Describe the steps necessary to replace seals in High Pressure Interconnects
 - 1.1.5 Describe the steps necessary to vent a Reactor Vessel Multiple Stud Tensioner

Lesson Introduction: Maintenance of M.S.T.

The following items are things to consider in your Lesson Introduction. They are not mandatory. You should develop your own introduction and place that material in the Program Hierarchy in the Lesson Introduction Tab or appropriate Training Unit.

CLASSROOM GUIDELINES

- If applicable, remind students of class guidelines as posted in the classroom.
- Pass the attendance sheet around and have it signed in Dark ink.
- Ensure that student materials needed for the class are available for each student.
- Emphasize student participation and remind them of your philosophy on asking and answering questions, if applicable.

ATTENTION STEP

- Give a brief statement or story to get student concentration focused on the lesson subject matter.

LESSON INTRODUCTION

- Give a brief statement that introduces the specific lesson topic. Should be limited to a single statement.

MOTIVATION

- Focus student's attention on the benefits they derive from the training. At Instructor's discretion. The need for motivation in each succeeding lesson must be analyzed by the Instructor and presented as necessary.
- Instructor should include how the STAR process can be used to improve or enhance Operator Performance, if applicable.
- Read and discuss lesson terminal objective and review lesson enabling objectives, if desired.
- If applicable, briefly preview the lesson topic outline and introduce the major points to be covered. The objective review may have been sufficient.
- REINFORCE the following PVNGS management expectations as opportunities become available:

- Nuclear Safety
- Industrial Safety Practices
- STAR and Self-Checking
- Procedure Compliance
- Communication Standards
- ALARA
- Prevent Events

CONTENT	METHODS & ACTIVITIES
I. Motivation	Focus student attention on “What’s In It For Me”.
A. Help us understand how it works	
B. Improve equipment reliability to:	
1. Support ALARA concepts by not performing maintenance in the Cavity	
2. Shorten outage time by not requiring maintenance during critical path work	
C. Safety	Prevent Events Tools
1. Rigging – qualifications required	For actual performance, not for this class
2. Heavy components – keep hands safe and watch pinch points	
II. Lesson Introduction	Introduce the lesson material
A. Lesson Terminal Objective	Read and/or discuss the lesson objectives
Given applicable diagrams the Maintenance Mechanic will describe the steps necessary to replace the seals in the components, and then vent a Reactor Vessel Multiple Stud Tensioner, demonstrated by passing a written exam with a score of 80% or better.	
B. Lesson Enabling Objectives	
EO01 Describe the steps necessary to replace seals in split coupling system air cylinders	
EO02 Describe the steps necessary to replace Ring Piston Cylinder seals	
EO03 Describe the steps necessary to replace Piston Travel Limitation Device seals	
EO04 Describe the steps necessary to replace seals in High Pressure Interconnects	
EO05 Describe the steps necessary to vent a Reactor Vessel Multiple Stud Tensioner	

T.Obj 1.1	Given applicable diagrams the Maintenance Mechanic will, describe the steps necessary to replace the seals in the components, and then vent a Reactor Vessel Multiple Stud Tensioner demonstrated by passing a written exam with a score of 80% or better.
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EO 1.1.1	Describe the steps necessary to replace seals in split coupling system air cylinders
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1.1.1.1 Main Idea

CONTENT

METHODS & ACTIVITIES

I. Removing the Split Coupling Assembly

After explaining each section, move to the MST, and identify the parts described in the discussion

A. Access the split coupling system to be worked on

T002 "Working Platform"

Point out location of platform to be removed

1. Any studs hanging will have to be removed from the MST at the split coupling and the attached "H"-brackets
2. The rail hoist will need to be installed on the MST to remove the studs

B. Remove split coupling system to be worked on

T003 [Use MST to show parts during removal of assy]

"Top view of MST" Point out split coupling and air lines to students

1. Tag air lines to split coupling air cylinders that are to be removed to identify:

Prevent Events self check to ensure hoses are reinstalled where they belong

- a. Cylinder number
- b. If air line is from open or close header

2. Disconnect air lines to split coupling system air cylinder to be removed

3. Remove "H"-brackets on both sides of the split coupling to be removed by lifting off from its pins

4. Tag split coupling system to be removed

5. Rig to split coupling system and remove

Go to MST and show students that split coupling is not fastened to the ring piston cylinder.

- a. Ensure lift is straight up
- b. Lower split coupling assembly to deck or scaffolding
- c. If lifting through the working platform, use the chain guide to minimize interference between the chain and the platform
- d. Place coupling system in a clean dry place

II. Replace seals in air cylinders

Use split coupling assy. liberally along with the TPs

A. Remove seals

1. Remove upper support plate

Slide "Split Coupling Cutaway"

- a. Remove 4 bolts (11)

- b. Remove upper support plate (4)
- 2. Remove cross connect air line for engaging split coupling
- 3. Loosen cylinder screws (11)
- 4. Pull off cylinder base (2)
- 5. Pull off cylinder tube (4)
- 6. Pull piston rod (3) out of cylinder head (1)
 - a. Lift the split coupling half so lip (3) of piston rod will clear holding plate bolted on split coupling half

Slide "Air Cylinder Cutaway"
Point out part numbers

B. Replace seals

NOTE: Lubricate seals with hydraulic oil

- 1. All seals inside cylinder assembly
- 2. **NOTE**
Manufacturer recommends replacement of complete piston

C. Reassembly is basically the reverse of disassembly

EO 1.1.2 Describe the steps necessary to replace Ring Piston Cylinder seals

1.1.2.1 Main Idea

CONTENT

METHODS & ACTIVITIES

- | | |
|---|--|
| <p>I. Replace ring piston cylinder seals</p> <p style="padding-left: 20px;">A. Removal of ring piston cylinder</p> <p style="padding-left: 40px;">1. Disconnect the piston return hydraulic line from piston cylinder</p> <p style="padding-left: 60px;">a. If not already done use a magic marker and match mark ring piston cylinder and the support ring.</p> <p style="padding-left: 60px;">b. Orientation does not have to be exact, but should be close</p> <p style="padding-left: 40px;">2. Loosen the hold down bolts and turn the hold down rings out of the way.</p> <p style="padding-left: 40px;">3. Remove the hold down bolts</p> <p style="padding-left: 40px;">4. Rig to and lift out the ring piston cylinder</p> <p style="padding-left: 60px;">a. Be careful to lift it straight out</p> <p style="padding-left: 60px;">b. If not, could damage the Piston Travel Limitation Device</p> <p style="padding-left: 60px;">c. When clear of the piston travel limitation rod, move to the side and lower to the deck or scaffolding</p> | <p>Go to M.S.T. and point out the location of parts for removal process</p> <p>Slide "MST Cutaway (side view)"
Point out components to be removed</p> <p>Use Piston Travel Limitation Training Aid and point out the position of the rod and how it could be damaged</p> |
|---|--|

5. Place cylinder on cribbing in a clean, dry location where it can be worked on

- B. Remove seals from ring piston cylinder

Use Ring cylinder along with the TPs to illustrate

NOTE

When replacing ring piston cylinder seals, the piston travel limitation seals should be replaced also.

CAUTION

BE CAREFUL NOT TO ALLOW ANY DAMAGE TO THE CYLINDER WALLS OR PISTON SEALING GROOVES

1. Matchmark components prior to disassembly for ease in reassembly

Prevent Events – Self check and procedure compliance to ensure proper alignment of component parts of the ring cylinder

2. Bolt cylinder to table

3. Loosen but **do not** remove venting screw (12) and ball (14)

T010 "Piston Ring Cylinder Cutaway (side view)"

- a. Removal increases the chance of losing the ball
- b. Loosening is required to vent the cylinder during removal

4. Apply just enough force to the flange to move it in slightly.

T011 "Piston Ring Cylinder with clamp force shown"

- a. Can use C-clamp or tap with soft stock like aluminum or brass bar
- b. This will relieve force on groove wire to facilitate removal

Point out where clamp force should be

5. Remove groove wire

- a. Tap groove wire (4) back with a punch until the end is visible. (end is marked with a center punch)

T012 "Piston Ring Cylinder Cutaway (side view)"

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- b. Press groove wire end out of groove with screwdriver T011
 - c. Pull groove wire out. T011
 - 6. Install strongback to piston with jack between table and strongback in the center of the cylinder
 - 7. Remove the cylinder
 - a. Jack the piston out of the cylinder – the cover will come with it
 - b. A significant amount of hydraulic fluid may come out
 - c. Remove strongback and attach eyebolts and remove the piston & cover
 - d. Unbolt the cylinder from the table and slide hole over the edge of the table to discard the hydraulic fluid into a waiting bucket
 - 8. Remove venting screw (12) and ball (14) T010 "Piston Ring Cylinder Cutaway (side view)"
 - 9. Replace all seals (items 5 through 11 and item 15) T012 – Point out all seals
 - a. Clean seal seating surfaces as necessary and coat with hydraulic oil (Tellus 32)
 - b. Locate the backup rings per the drawing **Prevent Events** – self check and following Work Order
- C. Assemble ring piston cylinder
 - 1. Rig to piston and lower straight into the cylinder T012
 - a. Locate piston over cylinder and line up match-marks T012
 - b. If no matchmarks, align vents and LP ports as identified in the procedure **Prevent Events** – self check and following Work Order
 - c. Carefully lower piston into cylinder. (must be lowered straight in to prevent cutting seals) T012

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- d. May need to tap with a mallet to get the piston started into the cylinder fit
 - e. Remove lifting eyes from top of piston T012
 2. Press piston into cylinder T012
 - a. Bar attached to table using allthread
 - b. Strongback bolted to piston
 - c. Jack between the two to press the piston into the cylinder
 3. Locate cover flange over piston cylinder and line up match marks T012
 - a. Lower cover flange into place
 - b. Install clamp or tap down using aluminum bar to remove upward force **Slide**
 4. Push groove wire in.
 - a. Push groove wire end into groove until end is just left visible (end is marked with a center punch) **Slide**
 - b. Tap remainder of groove wire in with a punch
 5. Install vents
 - a. Install ball (14) and venting screw (12) in piston T014
 - b. Lightly set ball against the seat with a punch to establish seal
 - c. Install vent (13) into the cover

EO 1.1.3	Describe the steps necessary to replace Piston Travel Limitation Device seals
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1.1.3.1 Main Idea

CONTENT

METHODS & ACTIVITIES

I. Replace piston limitation device seals

A. Remove piston limitation device

T015 & Training Aid "Piston Limitation Device Cutaway (side view)"

NOTE

Ensure that each piston travel limitation device with its individual parts is re-installed into the same cylinder.

Point out parts as described

CAUTION

ALLOW NO FOREIGN MATERIAL TO ENTER RING GROOVE VIA PISTON LIMITATION PORT

1. Pull spacer tube (2) out of travel limitation
2. Remove threaded bushing (1)
3. Inspect spherical seat for any signs of damage
4. Remove ball (3) and spring (4)
5. Inspect ball and spring for any signs of damage

B. Replace seals in piston travel limitation device

T015 & TA, "Piston Limitation Device Cutaway (side view)"

Point out parts as described

1. Remove old seals (items 5 through 8)
2. Install new gaskets (items 5 through 8) (lubricate new seals with hydraulic oil prior to installation)

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|--|--|
| <p>C. Assemble piston travel limitation device</p> <ol style="list-style-type: none"> 1. Insert ball (3) and spring (4) 2. Screw threaded bushing (1) back into support ring 3. Install spacer tube (2) <ol style="list-style-type: none"> a. Verify proper operation of spring (4) and ball (3) by pressing and releasing spacer tube (2) several times. | <p>T015 & TA, "Piston Limitation Device"</p> <p>Point out parts as described</p> |
| <p>D. Install ring piston cylinder</p> <ol style="list-style-type: none"> 1. Rig to and lift ring piston cylinder assembly (ensure assembly is lifted straight) 2. Locate ring piston cylinder over its designated spot on support ring 3. Line up match marks and lower ring piston cylinder onto support ring <u>using extreme care not to bump piston travel limitation.</u> 4. Align on ring the reinstall and tighten the hold down bolts 5. Connect piston return hydraulic line to ring piston cylinder. | <p>T016 "MST Cutaway (side view)" Point out components as described</p> <p>To review, ask <u>why</u> it should be lifted straight (not bend the Piston Travel Limitation rod)</p> <p>Show how the spacer tube can be damaged by the ring cylinder during installation.</p> <p>Prevent Events – Self-check to ensure proper alignment of vent and hydraulic ports for the installation location & centered in the hole</p> |
| <p>E. Install split coupling system</p> <ol style="list-style-type: none"> 1. Rig to and lift split coupling system | <p>T016 "MST cutaway (side view)" Point out components as described</p> |

- 2. Locate split coupling system over designated ring piston cylinder
- 3. Line up and lower split coupling system onto ring piston cylinder over thread protector screws.
- 4. Reconnect air lines to split coupling system air cylinders

F. Installation of work platform (if removed)

T016 "MST cutaway (side view)"
Point out components as described

- 1. Install removed section of working platform with shims
- 2. Align over the split couplings then install and tighten working platform screws

Prevent Events – Self-checking to ensure alignment will allow grappling the studs with the DSTT

EO 1.1.4	Describe the steps necessary to replace seals in High Pressure Interconnects
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1.1.4.1 Main Idea

CONTENT

METHODS & ACTIVITIES

I. Replace seals in high pressure interconnect

T017 "High pressure interconnect cutaway (side view)" Point out parts as described

A. Disassemble and replace seals in high pressure interconnect

Details will not be tested

- 1. Loosen cylinder bolts (15)
- 2. Remove high pressure interconnect (6 & 7) from support ring

3. Plug connection holes in support ring for FME control
4. Remove retaining ring (22) and pull piece (6) out of piece (7).
5. Screw bolt (9) with ratchet (28 & 29) into lower cover (5) until plug (4) and valve element (3) hit against upper cover (5).
6. Loosen cylinder bolts (16)
7. Separate connecting pieces (1 & 2)
8. Remove plug (4) and valve element (3)
 - a. Press out using a pin through cover (5)

NOTE

Lubricate seals with hydraulic oil

9. Replace seals (24 & 25) located on piece (6)
 10. Replace seals (26 & 27)
 - a. Four seals on valve element (3)
 - b. Two seals on plug (4)
 - c. Two seals on connecting piece (6)
- B. Re-assemble high pressure interconnect
1. Install valve element (3) then plug (4)
 2. Assemble connecting pieces (1 & 2)
 3. Tighten cylinder bolts (16)
 4. Screw bolt (9) with ratchet (28), out of lower cover.
 5. Insert screw bolt (9) into upper cover (5) and turn in with ratchet until plug (4) and valve element (3) make contact with lower cover.
 6. Install piece (6) into piece (7)

- 7. Install retaining ring (22)
- 8. Install high pressure interconnect (6 & 7) into support ring.
- 9. Install and tighten cylinder bolts (15).

EO 1.1.5	Describe the steps necessary to vent a Reactor Vessel Multiple Stud Tensioner
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1.1.5.1 Main Idea

CONTENT

METHODS & ACTIVITIES

I. Venting of the MST

Perform venting on MST, simultaneous with or following the discussion by performing the steps listed to demonstrate the venting process

A. General

- 1. MST's should be vented:
 - a. After initial assembly
 - b. After five opening and closing cycles of the reactor vessel
 - c. After any preventive or corrective maintenance that opened the hydraulic system.
- 2. MST General Pre-operational Test will be performed before venting

B. Vent ring piston cylinder piston area and high pressure interconnects

- 1. Energize the hydraulic aggregate control panel

2. Pre-fill tensioning cylinders (use only 1 low pressure pump)

Prevent Events: self and peer check to ensure LP pump discharge pressure only when opening the vents

NOTE

Check oil level in oil reservoir frequently during venting. If oil level in oil reservoir drops below hydraulic pump suction connection venting will have to be performed again.

NOTE

The piston area must be vented as the pistons extend. When the piston travel limitation device stops piston travel, the oil supply is stopped and cylinders can no longer be vented.

3. With pumps running, vent piston area of ring piston cylinder
 - a. Remove dust cap from large vent screw (horizontal vent off the side of the piston)
 - b. Connect one end of vent hose to the vent screw and put the other end into a clean container
 - c. Open the vent screw (~½ turn CCW) until oil exits bubble-free, then close the vent screw
 - d. Remove the hose and replace the dust cap.
 - e. Proceed with venting of all remaining cylinders in the same manner

T028 "Vent line connected to ring piston cylinder"
Show students how vent rig is set up

Dust caps can be left until completely done – many are now missing

4. Vent high pressure interconnects using vent screws provided
 - a. Remove dust cap from large vent screw
 - b. Connect one end of vent hose to vent screw and put other end into a clean container

T029 "Vent line connected to high pressure interconnect"
Show students how vent rig is set up

- c. Open vent screw (~½ turns CCW) until oil exits bubble free then close vent screw
 - d. Remove hose and replace dust cap
 - e. Press "Stop" push button – Ensure pumps turn off
 - f. Return the pistons to the bottom when complete
- C. Steps after venting
- 1. Shut off plant air supply
 - 2. Press push button "air pressure release" at control panel to depressurize the system
 - 3. De-energize the hydraulic aggregate control panel

SUMMARY OF MAIN PRINCIPLES

The following items are things to consider in your lesson summary. They are not mandatory. You should develop your own summary.,

Objectives Review

Review the Lesson Objectives

Topic 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

Oral questioning

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. If applicable, end with a statement leading to the next lesson.

You may also use this opportunity to address an impending exam or practical exercise.

Should be used as a transitional function to tie the relationship of this lesson to the next lesson. Should provide a note of finality.