PALO VERDE
NUCLEAR GENERATING STATION

Mechanical Maintenance

Classroom Lesson

Mechanical Maintenance Training	**Date: February 13, 2007**
LP Number: NME15C000306	**Rev Author: Curt Cluff**
Title: M.S.T. Operation and Troubleshooting	**Technical Review:** Cluff, Curt D (Z25211) Digitally signed by Cluff, Curt D(Z25211) DN: cn=Cluff, Curt D (Z25211) Reason: Per Telecon, Tech review by Michael Chastain, 2/08/2007 Date: 2007.02.13 15:04:54 -07'00'
Duration : 4 hours	**Teaching Approval:** Freitas, Jeffrey (Z36100) Digitally signed by Freitas, Jeffrey (Z36100) DN: cn=Freitas, Jeffrey (Z36100), email=Jeffrey.Freitas@aps.com Reason: I am approving this document Date: 2007.11.01 05:11:55 -07'00'

INITIATING DOCUMENTS:

Task Analysis of Tasks

REQUIRED TOPICS

NONE

CONTENT REFERENCES

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

VTM-C490-0028, Stud Tensioner

NATM 31MT-9RC30, Reactor Vessel Head Removal and Installation

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

OE 16463, Reactor Pressure Vessel Stud Tensioner Failure results in spraying hydraulic fluid in the reactor cavity

OE 11946, Failure of Test Stud for Reactor Vessel Stud

Lesson Plan Revision Data

Feb 13, 2007	Curt Cluff	Minor rewording for clarification and removal of specific details not relevant to this level of understanding. [Reference TCSAI 2970213]

Tasks and Topics Covered

The following tasks are covered in M.S.T. Operation and Troubleshooting:

Task or Topic Number*	Task Statement
Lesson:	M.S.T. Operation and Troubleshooting
MST002	Troubleshoot and repair M.S.T.
MST001	Operate Reactor Head M.S.T.
MST003	Set up and adjust Double Stud Turning Tool

Total tasks or topics: 3

TERMINAL OBJECTIVE:

1.1 Given applicable diagrams and drawings, the maintenance mechanic will, operate the MST and troubleshoot the hydraulic and pneumatic system as demonstrated by passing a written exam with a minimum grade of 80% and a Lab Practical Evaluation.

1.1.1 State the steps to tension/detension the studs

1.1.2 Using the schematic drawing, identify the operation of the hydraulic aggregate during a tensioning/detensioning evolution

1.1.3 Identify basic troubleshooting techniques

1.1.4 Analyze a basic set of symptoms and determine the components which could have caused the symptoms

1.1.5 Describe the basic operation of the Lift System and identify faults that have occurred and their corrections.

Lesson Introduction: M.S.T. Operation and Troubleshooting

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. Review the physical parts of the control circuitry	
B. Practice troubleshooting activities	
C. Incident in Spring 1996 outage as example of why	
1. Tensioned the studs for 1st pass and relaxed. Needed to adjust 7 of the studs, but pressure would not build up	
2. Troubleshooting and repair took 2 hours	
3. **THIS WAS CRITICAL PATH TIME**	
II. Prevent Events	Pre-job briefing on the day's activities modeling prevent event tools
A. Potential dangers	Discuss OEs and the dangers they emphasize
1. OE 16463: A fitting on the hydraulic system blew due to improper PMs. The potential was there for serious injury. Resulted in hydraulic fluid cleanup and evaluation of its potential effect on the primary system	PPE use and hazard assessment for where to stand during tensioning
2. OE 11946: A test stud was fabricated and broke, launching the tensioner which fell to the floor and broke. The potential was there for serious injury – could be replicated by damaged stud	Hazard assessment and where to stand during tensioning operations
B. Preventive tools	
1. Hazard assessment during pre-job brief and 2-minute drills	
2. Standing clear of the MST during tensioning operation when not required to be checking the machine	

CONTENT	METHODS & ACTIVITIES
III. Lesson Introduction	Introduce the lesson material
A. Lesson Terminal Objective Given applicable diagrams and drawings, the maintenance mechanic will operate the MST and troubleshoot the hydraulic and pneumatic system as demonstrated by passing the final exam with a grade of 80% and a Lab Practical Evaluation.	Read and/or discuss the lesson objectives
B. Lesson Enabling Objectives	
EO01 State the steps to tension/detension the studs	
EO02 Using the Schematic drawing, identify the operation of the hydraulic aggregate during a tensioning/detensioning evolution	
EO03 Identify basic troubleshooting techniques	
EO04 Analyze a basic set of symptoms and determine the components which could have caused the symptoms.	
EO05 Describe the basic operation of the Lift System and identify faults that have occurred and their corrections.	

T.Obj 1.1	**Given applicable diagrams and drawings, the maintenance mechanic will, operate the MST and troubleshoot the hydraulic and pneumatic system as demonstrated by passing a written exam with a minimum grade of 80% and a Lab Practical Evaluation.**

EO 1.1.1	**State the steps to tension/detension the studs**

1.1.1.1 Main Idea

CONTENT	Method and Activities
I. First Time Setup, Prior To Use Of New Equipment	Briefly describe the actions to be taken the first time we use the new equipment this upcoming outage
A. Alignment of the MST to the Studs	
1. Set cones on top of the 3 studs near the outriggers	
2. MST lowered onto the cones using the crane with the outriggers retracted	
a. MST will set down on the cones	
b. Will center the holes in the MST around the studs	
3. Plates on the reaction bridges will be loosened	
4. Outrigger legs are lowered until they contact the plates	
5. Plate capscrews are tightened with the proper alignment	
B. Reindex the MST to the second set of plates	
1. Cones do not have to be removed	

CONTENT	Method and Activities
2. Procedure repeated for the second set of plates	
C. Purpose	
1. Studs have rubbed the side of the MST due to the MST holes not being centered around the studs	
2. Has happened at least 3 times in Unit 2 alone	
3. With the new DSTTs, this could create problems that may not be recognized since the equipment is new	
II. Set Up For Tensioning	Select a volunteer and direct the operations – describing them
A. Permission signature from Shift Manager	
B. Setting on flange	
1. Outriggers up at least an inch	Note that in the MUF, the full inch is not necessary because the "head" does not move down
2. All Split Coupling assemblies resting on studs	
C. Verify the panel is ready for operation	
1. **Power Switch #1** and **Power Switch #2** are both set to position 1	
2. Wait for the Computer (PLC) to boot up (about 10 seconds)	New item – patience
3. Press the **LampTest** button	
4. Verify air pressure light indicates pressure is high enough	
D. Press **Close couplings** button	
1. Air shuts off after about 5 seconds	
2. Must verify coupling are closed	

CONTENT	Method and Activities
3. Latch handle is the only indication the coupling is closed	**Prevent Events** Use self and peer check to ensure couplings are latched
III. Tension the Studs	Set up with dial indicator on stud to show elongation during tensioning
A. Select both **Low Pressure Pumps**	
B. Press **Pressure Buildup**	**Prevent Events**: Pre-job and 2-minute drills to ensure who is responsible for pressure gauge and when to stop the tensioning operation
1. Both low pressure pumps should start	
2. Cylinders will fill and extend to the split couplings	
3. When full, pressure will build up to 2,900 psi	Note sound change and that the unloader is lifting – need to start the intensifiers quickly
C. Start **High Pressure Pumps**	
1. Press **High Pressure Pump** buttons #1 & #2	
a. Intensifiers will both start	
b. LP pump discharge pressure (31) will drop	
2. When preset pressure is reached (about 20,000 psi) intensifier #2 will shut down	Note at about 8,000 psi here that one pump shuts off
3. When sufficiently elongated, press **Stop** button	
a. .135” on first pass, .115” second pass	Have designated person signal to stop at proper elongation or 9,000 psi if dial indicator not available
b. Stop when nuts are loose for de-tensioning	

CONTENT	Method and Activities
4. Have pressure limits that cannot be exceeded without engineering approval	**Prevent Events:** pre-job and 2-minute with peer check – Procedure compliance – ensure someone is verifying limits are not exceeded
a. Should not need to be exceeded	Test stand value is different (10,000 psi)
b. 26,500 1st pass tensioning	
c. 22,000 2nd pass tensioning	
d. 24,181 1st pass detensioning	
e. 26,500 2nd pass detensioning	
IV. Returning the Pistons	
A. Press **High Pressure Release**	
1. Pressure drops off	
2. Pressure Buildup light blinks, then stays on when second unloader opens	
3. HP release light stops blinking and turns off when pressure is low enough	
B. Deselect pumps not needed for pressure return	**Prevent Events**: Self check and procedure
1. **One LP pump selected**	
a. One LP pump has more than adequate capacity to achieve maximum pressure	
b. 2nd LP pump only recirculates oil back to the reservoir, increasing oil temperature	
2. Both HP pumps deselected	
C. Press **Piston Return**	
1. LP pump starts	

CONTENT	Method and Activities
2. Stops when pistons fully return	
3. Verify pistons have returned	**PE**: Use peer check to ensure all pistons are down
a. May require extra push of the piston return button	**PE** 3-leg communication for verification
b. Very important for final pass of de-tensioning or DSTTs may not work properly	Emphasize the need for returning the pistons fully
4. Pumps turn off 3 seconds after pressure switch setpoint is reached	
D. Deselect all Pumps	
V. Open Split Couplings	
A. Raise locking levers	
B. Press **Open Coupling** button	
C. Verify they opened	**PE**: Peer check to prevent damage to the MST
1. Air shuts off after about 5 seconds	
2. May require an additional push of the button	

EO 1.1.2	Using the schematic drawing, identify the operation of the hydraulic aggregate during a tensioning/detensioning evolution

1.1.2.1 Main Idea

CONTENT	Method and Activities
I. Close Split Coupling	Use the schematic to identify for each evolution which components operate – can either simulate or perform the evolution again
A. Energizes (Y10) on (38) – Air goes through needle valve (41.1) to close the couplings	Note the lights on the solenoids
B. (Y10) de-energizes after about 5 seconds – Air pressure bleeds off through check valve/needle valve (41.1) and (38)	
II. Start Low Pressure Pumps	
A. Must select both pumps <u>and</u> press Pressure Buildup	
1. Solenoid (Y2) on 4-way (19) energizes	
2. Solenoid (Y1) on (18) energizes	
3. LP Pumps (1) start	
B. Oil discharges from LP pumps	
1. Goes through filter	
2. Goes through 4-way valve (19)	
3. Goes through check valve, isolation valve, and HP Interconnect to the high pressure header and the ring cylinders	
C. Oil above the cylinder returns to the reservoir through	
1. Hose and check valve (36)	

CONTENT	Method and Activities
2. 4-way valve (19)	
3. Check valve	
4. Return filter	
D. Overpressure protection – Relief Valve (17) (Unloader) limits pressure to 2,900 psi	
III. Start HP Pumps (Intensifiers)	Describe operation
A. Solenoids (Y7) & (Y8) at the intensifiers align the pressure from 4-way valve (19) to the power piston on the intensifier (29.1) & (29.2)	Could relate to the A/O pumps that used to be in the old aggregate – these are powered by hydraulics instead of air
B. Piston assembly slides to the opposite side	
1. Pushes fluid out the HP pump discharge	
2. When piston assembly reaches travel limit, the solenoid (Y7) & (Y8) shifts and the assembly reverses direction	
3. Travel limit sensed by proximity switches (B6 – B9)	
4. Check valve closes with the higher pressure on the downstream side	
C. When **stop** is pushed, motors on LP pumps stop and no further pumping occurs	
D. Overpressure protection	
1. Transducer (32) shuts off pumps at the value set in the computer	
2. Relief Valve (25) relieves pressure at the adjusted setpoint	

CONTENT **Method and Activities**

IV. Return Pistons

A. Press High Pressure Release

1. De-energizes solenoid (40.2) and energizes solenoids (40.1) and (40.3) (at 294 psi)

2. Opens high pressure release valves (23) and (24) (at 294 psi)

B. Press Piston Return

1. Energizes solenoid (Y3) on 4-way valve (19)

2. Starts selected LP pump

C. Fluid flowpath

1. Oil travels through the needle valve (36) to the top of the pistons

2. Fluid under the piston returns to the reservoir

a. Through HP Interconnect and shutoff valve

b. Through HP Release valves (23) & (24)

c. Through Check Valve

d. Through the filter

D. Pressure control

1. Relief Valve (20) (Unloader) controls operating pressure at 1,200 psi

2. Pressure Switch (33) shuts down pumps when header pressure approaches 1,200 psi

V. Open Split Couplings

A. Energizes solenoid (Y11) on 5-way (38), sending air through needle valve (41.2) to the split coupling

CONTENT	Method and Activities
B. De-energizes after about 5 seconds, bleeding the air off through (41.2) and 5-way (38)	
VI. Review Operation	Have one of the students walk through the evolution to ensure the new panel can be operated for a tensioning evolution following the procedure steps – stop and teach as needed
A. Pre-job brief	
1. Responsible person to monitor pressure	
2. Responsible person to monitor elongation for final shutoff	
3. Safety for pressing buttons when assistants are on the other side	
B. 3-leg communication	
1. Hands clear when closing and opening couplings	
2. Starting pumps with personnel on opposite side	
C. Perform post operation feedback session with participants and observers	
D. Repeat as necessary	

EO 1.1.3	Identify basic troubleshooting techniques

1.1.3.1 Main Idea

CONTENT	METHODS & ACTIVITIES
I. Helpful hints	These are a composite of information gleaned from the Mechanics who have been involved in operation of the MST. They may assist in helping with the overall job of using the tensioner to avoid problems with the Critical Path of an outage.
A. Allow for spare fuses to be stored in the cabinet	
1. Fuses are easily replaced	
2. Saves lost time in tracking down electrician and then tracking down fuses	
B. Minimizing Stud handling vehicles failures	
1. Test them on the Test Stand between outages to make sure they operate properly	
2. Ensure the initial conditions are set prior to attempting to operate the DSTT	
3. Take care not to cut the hoses or chords when rolling the DSTTs or screwing the studs in/out	
4. Take care not to damage the “stand-still supervisor” when raising and lowering the cylinder/coupling device on the DSTT	

II. General rules

Verify they can agree with these general troubleshooting rules or discuss the disagreements

A. Evaluate all symptoms together

B. Determine which components could cause the symptoms

C. Check any simple possibilities

D. Check the most likely (from past experience)

E. Systematic elimination

III. Ways to use these rules

A. Symptoms

1. Check all problems and pressures thoroughly

2. Try different evolutions to obtain more symptoms and information

B. Determining components

1. Need to evaluate symptoms

2. Look at schematic and determine proper lineup for the evolution

3. Determine which components could possibly have caused these symptoms

C. Simple possibilities

1. Levels

2. Valve positions

3. Visible leaks

4. Venting

5. Isolating sections or components

D. Most likely

1. This would be evaluated on past experience and history
2. Recent evolution done to the MST
3. Cause of same or similar problems in the past

E. Systematic elimination

1. Troubleshooting guide in the tech manual
2. Checking and replacing of components which may possibly cause the problem
3. Example: Remove check valves or control valves and inspect

EO 1.1.4	Analyze a basic set of symptoms and determine the components which could have caused the symptoms

1.1.4.1 Main Idea

CONTENT	METHODS & ACTIVITIES
	Prevent Events: Pre-job brief and 2-minute drills – Since much of this objective identifies working without written instructions, the potential for error is greater These are examples, not an exhaustive evaluation of all faults

I. Pistons Will Not Extend

A. Which components

1. Prevent pressure from reaching the cylinders

2. Include

   a. 4-way valve *18*

   b. Unloader valve *17*

   c. Intensifier seal failure in power piston

   d. Manual valve *26.2* open

   e. HP Release valves *23* or *24*

   f. Relief valve *25* leaking by

   g. HP piston seal failure

B. How to correct

1. Determine which it is

   a. Shutting High Pressure Interconnect will eliminate/identify piston seal

   b. If pistons return, not *17* or *18*

   c. Can manually operate suspect solenoids and 4-ways

   d. Check/flush manual valve and HP release valves

   e. Separate return lines to see where leaking by

      Note: Have a plan to recover/reattach fitting without pressurizing the open line

Prevent Events – Self and/or peer checking

Prevent Events – Pre-job brief/2-minute drill to evaluate the hazards involved

2. Use only one train if possible

3. Replace failed component – this will require a work order

II. Pistons Will Not Return

A. Which components

Prevent Events – Self and/or peer checking

1. Prevents pressure from rising in the return header <u>after</u> pressurizing the supply header
2. Includes
    a. 4-way valve *19* did not shift properly
    b. Unloader valve *20* leaking by
    c. Needle valve *36* adjustment along with pressure switch *33*
    d. Piston seal

B. How to correct

1. Symptoms – if shutting off 3 seconds after pressure increases, the needle valve and pressure switch are the problem
2. If pressure never increases, check leak paths
3. Can manually operate suspect solenoids and 4-ways
4. Replace failed component – this will require a work order

III. Split Couplings Will Not Close

A. Which components

Prevent Events – Self and/or peer checking

1. Prevent air pressure from increasing at the split coupling assemblies
2. Includes
    a. 4-way valve *38*
    b. Needle valve *41.1*

3. If partially opening then stops, adjust needle valve setting

B. How to correct

1. Manually operate solenoid valve
2. Verify air pressure on gage
3. Cycle needle valve to ensure it is opened and clear

IV. Nut Will Not Come Loose

A. What could cause this

1. Not fully stretched
   a. Insufficient pressure
   b. Piston on its limiter
2. Imperfection imbedded between nut and head
3. Corrosion

B. How to correct

1. Raise pressure within procedure limitations

Prevent Events – Procedure adherence

2. Raise pressure per Engineering approval
3. Add shims under the split coupling assembly

EO 1.1.5	Describe the basic operation of the Lift System and identify faults that have occurred and their corrections.

1.1.5.1 Main Idea

CONTENT	METHODS & ACTIVITIES
I. Basic Operations	
A. Raise MST (extend outriggers)	
B. Lower MST (retract outriggers)	
C. Stop in intermediate position	
D. Bypass the intermediate position	
II. Operation of the Limit Switches	Show slide show on limit switch operation and show the limit switches on the MST.
A. General operation of the switches	Slides S007 & S008 can illustrate
1. Contacts are closed (electricity goes through them) when rollers are not on the cam	
2. When rollers are lifted by the cam, the contacts open (circuit is broken)	
3. Spins clockwise during upward motion, counterclockwise during downward motion	
4. There are 3 functional limit switches	S007
a. Arbitrarily name them #1 through #3, outside to inside	
b. #1 limits upward movement	
c. #2 stops movement in the intermediate position	
d. #3 limits downward movement	

B. To allow raising — S008 through S011 Shows fully down through almost at the intermediate

1. Contact #1 must be closed
2. If any contact #2 is open, intermediate position must be bypassed

C. To stop in intermediate — S012 through S015 shows intermediate through almost up

1. Bypass of intermediate button must not be pushed
2. Any contact #2 opens to stop when going up
3. All 3 contacts #2 must be closed to stop going down

D. To allow lowering — S016 shows fully up

1. Contact #3 must be closed
2. If all 3 contacts #2 are closed, intermediate position must be bypassed

Show slide show S017 through S025 to review the limit switch operation.

III. Faults That Have Occurred — Can refer back to any slides or go down to the MST and show the parts (preferred)

A. Will not raise or lower

1. Power light not lit
   a. Verify all of the four (4) Emergency Stop Buttons are pulled out
   b. Power switch in proper position (position 2)
   c. Panel is plugged in and hooked up to the MST & all outriggers are hooked up

d. Thermal Overload condition

1) Trouble light would be illuminated

2) Reset by pushing button in cabinet

e. Fuse (7th from the top on bank of 10) blown

Emphasize here and in the fuse check how important proper safety is by **<u>demonstrating</u>** that before opening the cabinet you:

- ✍ Turn off the power
- ✍ Unplug the chord

2. With power light on

a. MST raised beyond limit and activating fully down limit switch

b. Outrigger motor brake fault (affects one outrigger only)

c. If only one is not operating, could be one of the fuses in that one (especially if it hums only)

1) Top 3 fuses are outrigger #1

2) Next 3 fuses are outrigger #2

3) Last 3 fuses are outrigger #3

B. MST will not raise

1. With power light not lit – same as the previous

2. Power light on – same as the previous plus:

a. MST down and electrical plug is phased backwards

b. Limit switch out of adjustment opening contact #1

c. If the MST is at or above the intermediate position, is the intermediate bypass button pushed?

C. Will not lower

1. Power light not lit – same as previous

2. Power light on – same as with neither up nor down plus:

    a. Limit switch out of adjustment opening contact #3

    b. MST was raised beyond its upper limit and the fully down limit switch cam opened contact #3

    c. If the MST is at or below the intermediate position, is the intermediate bypass button pushed?

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.