PALO VERDE
NUCLEAR GENERATING STATION

Mechanical Maintenance

Classroom Lesson

Mechanical Maintenance Training	**Date: February 13, 2007**
LP Number: NME15C000107	**Rev Author: Curt Cluff**
Title: Basic M.S.T. Construction	**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 14:49:03 -07'00'
Duration : 5 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 05:10:20 -07'00'

INITIATING DOCUMENTS:

Task Analysis of Tasks

REQUIRED TOPICS

NONE

CONTENT REFERENCES

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

N001-3.01-131-5: (MST Technical Manual - original used in development)

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	Eliminated references to "old" equipment and respective terms and rephrased parts for clarity. [Reference TCSAI 2970213].

Tasks and Topics Covered

The following tasks are covered in Basic M.S.T. Construction:

Task or Topic Number*	Task Statement
Lesson:	Basic M.S.T. Construction
MST001	Operate Reactor Head M.S.T.
MST002	Troubleshoot and repair 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, identify, list the functions of, and explain the operation of each major component of the Reactor Vessel Multiple Stud Tensioner as demonstrated on the final written examination with a grade of 80% or better.

1.1.1 Identify and list the functions of the major parts of the MST used in the tensioning process.

1.1.2 Identify and list the functions of the major parts of the MST used in the removal of the studs and nuts.

1.1.3 Identify and list the functions of the major parts of the MST used in the Lifting System.

1.1.4 Identify the functions of the switches on the Control Panel for the Hydraulic Unit.

1.1.5 Identify the functions of the switches on the Control Panel for the Lifting System.

1.1.6 Identify the parts of the Hydraulic Unit

1.1.7 Identify the parts of the Double Stud Turning Tools

Lesson Introduction: Basic M.S.T. Construction

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. With the potential to produce over 54,000,000 pounds of force, knowing how to safely control it is required	
B. Many times this equipment must be operated or repaired on critical path during an outage	
C. Knowledge of its construction, operation, and maintenance will improve performance	
II. Course Introduction	
A. Course Objective Given the task to tension/detension the Rx Vessel Head with the MST the Maintenance Mechanic will operate the MST per the procedure and describe the operation, maintenance, and troubleshooting of the MST as demonstrated by passing a written exam with a minimum grade of 80% and a Lab Practical Evaluation.	Read and/or discuss the course terminal objective
B. Schedule	Lay out the schedule and expectations for schedule adherence
1. 2 full days	
a. In the classroom learning how it is built	
b. Operate the MST	
c. Learn minor problems and how to identify and correct them	
d. Practice operation	
e. Evaluation 2nd day in the afternoon	
2. Break policy	Identify your individual break policy for this course
3. Evaluation	
a. Written exam on construction and maintenance	
b. Practical evaluation on operation and troubleshooting	

CONTENT	METHODS & ACTIVITIES
C. Qualification Qualified to operation and maintain the MST including the DSTT upon completion of this course.	Identify what they will be qualified to do upon completion of the course
D. Prevent Events	Pre-job briefing on the day's activities modeling prevent event tools – examples are listed here
1. What is our task?	Learn to operate and maintain the MST and actually operate it
2. What's the worst that could happen and how do we prevent it?	Injury while operating the MST. 3-leg communication and follow safety precautions
3. What else could go wrong?	Break equipment – follow procedures and training instructions during the course
4. What safety equipment is required?	Safety glasses and chains on the MST platform
5. Am I qualified to take this training?	No prerequisites required – Conduct of Maintenance to be qualified
III. Lesson Introduction	Introduce the lesson material
A. Lesson Terminal Objective Given applicable diagrams and drawings, the maintenance mechanic will identify, list the functions of, and explain the operation of each major component of the Reactor Vessel Multiple Stud Tensioner as demonstrated on the final written examination with a grade of 80% or better	Read and/or discuss the lesson objectives

CONTENT	METHODS & ACTIVITIES

B. Lesson Enabling Objectives

EO01 Identify and list the functions of the major parts of the MST used in the tensioning process.

EO02 Identify and list the functions of the major parts of the MST used in the removal of the studs and nuts.

EO03 Identify and list the functions of the major parts of the MST used in the Lifting System.

EO04 Identify the functions of the switches on the Control Panel for the Hydraulic Unit.

EO05 Identify the functions of the switches on the Control Panel for the Lifting System.

EO06 Identify the parts of the hydraulic unit

EO07 Identify the parts of the Double Stud Turning Tools

T.Obj 1.1	**Given applicable diagrams and drawings, the maintenance mechanic will, identify, list the functions of, and explain the operation of each major component of the Reactor Vessel Multiple Stud Tensioner as demonstrated on the final written examination with a grade of 80% or better.**

EO 1.1.1	**Identify and list the functions of the major parts of the MST used in the tensioning process.**

1.1.1.1 Main Idea

CONTENT	METHODS & ACTIVITIES
I. Function of the MST	Ask the function of the MST, then describe as needed
A. Stretch the Rx Vessel Studs	
1. Tensioning for head closure	
2. Detensioning for head removal	
B. Stretches 27 (50%) at one time	
C. Removes all 54 studs from the Rx Vessel	
1. Holds all 54 studs for transporting to an area for cleaning the studs	
2. Reinstalls all 54 studs into the Rx Vessel	
	If desired, go to the MST in the lab at this time. Have the participants refer to the handout and identify the component parts on the actual MST

CONTENT	METHODS & ACTIVITIES
II. MST Support Ring	Use **T003** and show the location of the support ring
A. Support Ring Functions	**T004**, "Support Ring" Point out how functions are accomplished
1. Supports the individual tensioning segments	
2. Transfers tensioning forces of the ring piston cylinders to Rx vessel head flange	
3. Supplies hydraulic oil to individual ring cylinders.	
B. Operation of Support Ring	Point out locations of hydraulic lines for these purposes
1. Supplies hydraulic oil to Ring Cylinders via an integral ring line.	
2. This ring line eliminates the need for external hydraulic connections and the associated leakage problems	
III. Single Stage Ring Cylinder	Using **T005**, point out the single stage ring cylinder location
A. Single Stage Ring Cylinder Functions	Use **T006** to show the functions and operation of the single stage ring cylinder
1. Converts the high pressure hydraulic energy to the pulling force used to tension and detension Rx vessel studs.	
2. Allows for venting of high and low pressure hydraulic systems	
3. Having a vent on each cylinder allows us to identify if a cylinder is leaking	

CONTENT	METHODS & ACTIVITIES
B. Operation of Single Stage Ring Cylinder	Use **T005** & **T006** to show how Single Stage Ring Cylinder operates
1. Hydraulic oil is ported under Ring Cylinder Piston from the Support Ring through the Piston Travel Limitation Device.	Show oil flow on **T005**
2. Hydraulic oil pressure forces piston upwards until it contacts split coupling. Force of piston is transferred to Rx Vessel Stud via the Split Coupling.	
3. Oil leak-by path	
a. Oil leaking through the inner high-pressure seal of the piston is collected in a ring groove	
b. From the ring groove it then passes through a bore to an outer channel connected to the piston return line	
c. Through the piston return line the oil returns to the reservoir	
d. This design will prevent oil leakage to the outside of the MST.	
IV. Piston Travel Limitation	Show location on **T007**
A. Piston Travel Limitation Functions to prevent piston over-travel	Ask the purpose
B. Operation of Piston Travel Limitation	**T008** shows the closeup to describe the operation. Also, demonstrate using TA01
1. Hydraulic oil enters via "high-pressure inlet"	
2. Oil is directed up around "ball"	
3. Oil flows through "follower tube"	

CONTENT	METHODS & ACTIVITIES
4. Oil fills area under "pistons"	
a. Piston begins upwards travel	
b. "Spring" forces "ball" & "follower tube" to follow "piston" travel	
5. "Ball" contacts the "Seat" and oil pressure builds up in area underneath "ball" causing even tighter seating	
6. Oil flow stops and piston travel stops	
7. If pistons extend without stopping (limitation device failed)	ASK:What are the consequences if the limitation device malfunctions?
a. Damage to the seals	
b. Hydraulic leakage requiring maintenance	
c. Sticking of piston more than fully extended	
V. Split Coupling System	Show location on T009
A. Functions of Split Coupling System	Use T009 and T010 to show function
1. Transfers tensioning forces from Ring Cylinder Pistons to the Rx vessel studs.	
2. Locks studs into MST for transport and storage of Rx vessel studs, nuts and washers.	Point out locking plate on top, T011
B. Engaging Split Coupling on Rx vessel studs	Use T009, 10, & 11 as appropriate to describe Split Coupling operation
1. Pressurized air is lined up to the closing (outer) air cylinders	
2. The couplings close around the vessel studs	
3. Split Coupling machined grooves line up with and engage the Rx vessel stud machined grooves.	

CONTENT	METHODS & ACTIVITIES
4. The locking lever system locks the split coupling into the engaged (closed) position.	
C. Performing tension/detension operations	
1. Start high-pressure hydraulic pumps	
a. Single Stage Ring Cylinder Piston moves up and contacts the bottom of the split coupling	
b. Upward force is transferred to Rx vessel stud	
c. Force is proportional to amount of hydraulic pressure exerted under piston	
2. Nuts are ready to be turned	
D. Disengaging split coupling	
1. Place locking lever locks in the open position.	
2. Pressurized air is lined up to the opening (inboard) air cylinders.	
E. Transportation and storage of the Rx vessel studs, nuts & washers.	Explain the use of the locking plate on top of the split coupling assembly
1. Spring-actuated pin locks the “locking plate” in position. It must be released prior to moving the “locking plate”	
2. A combination wrench is used on the "locking plate", Turn counter clock wise to stop to engage the stud	
3. Stud is then lowered into a recess in the locking plate	**Emphasize that this is critical to verify prior to transporting to ensure stud is not dropped**
4. Rx vessel stud is now held in place integrally with MST	

CONTENT	METHODS & ACTIVITIES
VI. Nut Rotating Device	
A. Function of Nut Rotating Device is to turn the stud nuts during tensioning/detensioning operations	
B. Operation of Nut Rotating Device	Using **Slide**, "Nut Rotating Device", Describe the operation
1. Drive gear is inserted through the support ring and engages with the Rx vessel stud nut	
2. Rx vessel stud nut has gear teeth machined into it	Warn of the severe "glove grabber" capabilities of the teeth
3. Drive gear is turned in the forward or reverse (tighten or loosen) direction by the pneumatically operated angle drive	Identify the two directions and how the nut rotating device is operated to change directions
a. Can turn reversing sleeve under the handle	
b. Can turn the nut rotating device upside down	
VII. Hydraulic Unit (Aggregate)	Using **Slide,** show location – can go to MST and show also
A. Contain the hydraulic fluid sump	
1. Supplies hydraulic oil to the suction of the low pressure pumps	
2. Receives hydraulic oil from the piston return oil line	
B. Contain the low pressure hydraulic pumps	
1. Pre-fills the tensioning cylinders	
2. Provides hydraulic fluid to the suction of the high pressure pumps	
3. Provide piston return hydraulic pressure	

CONTENT	METHODS & ACTIVITIES
C. Contain the high-pressure hydraulic pumps	
1. Provide tensioning pressure to the ring cylinder through the ring line	
D. Contains related piping and control valves	
1. Direct and control hydraulics and pneumatics for MST operations	
2. Controlled by the hydraulic unit control panel	Will be described later
VIII. High Pressure Interconnect	Using **Slide**, point out the location of the interconnects
A. Functions of High Pressure Interconnect	
1. Provides for connection of High Pressure hydraulics from one section of the Support Ring to an adjacent section	
2. Provides high pressure hydraulic connection from the Hydraulic Unit to the Support Ring	
3. Design allows for opening or closing of this connection with no leakage	
B. Operation of High Pressure Interconnect	Using **Slide**, describe operation
1. Remove the capscrew from the top and thread it into the bottom	
2. Capscrew pushes the connecting piston and the blind plug against the upper stop	
3. Unbolt the flange to disassemble – the capscrews are retained by the ring on the lower valve body	These are metric allen screws, but a standard equivalent can work if not tightened too tight – they do not perform a sealing function, only a positional function

EO 1.1.2	Identify and list the functions of the major parts of the MST used in the removal of the studs and nuts.

1.1.2.1 Main Idea

CONTENT	METHODS & ACTIVITIES
I. Working Platform	
A. Functions of the working platform	**T026** Describe functions of Working Platform
1. Provides track for DSTTs to travel along	
2. Absorbs torque generated by the DSTTs during stud turning operations	
3. Allows operating personnel access to DSTTs to perform required operations	
B. Operation of Working Platform	
1. Working Platform is a stationary unit and does not operate	
2. Must be aligned properly with the studs for DSTT operations	
II. Track Interface with Double Stud Turning Tool (DSTT)	Note that the remaining DSTT parts will be described in EO07
A. 8 supporting wheels	
B. 4 horizontal aligning wheels	
1. Handles to extend the wheels out against the track under spring tension	
2. **Locking pins** hold in position	

C. **Pins** between tracks

1. Limit side travel to ¼" maximum off of centerline

2. Are a base to set the DSTT down on a flat surface

D. Rail Lock

1. Prevent tipping the DSTT in the event of a fault

2. Locking pin holds it <u>open</u> for <u>removal</u> from the track

E. Positioning Device

1. Sets the position of the DSTT based on other stud positions

2. Use the device to line up by sighting over another stud

3. Ensure positioning device is not down when lowering the MST to the head Note how it can bend horizontal wheels

F. Interface when removing DSTT

1. Rigging for lifting the DSTT Note rigging on top and accessibility

2. Locking pins to hold rail lock open

3. Retracting horizontal wheels and locking pins to hold in

G. X-Y table

1. Allows the **Tool shaft** to align with the stud

   a. Has sliding assemblies in the "X" dimension and in the "Y" dimension

   b. Air to the Centering cylinder releases the table to self-align when **sensor rod** contacts the stud

2. Aligned to the center when not on the stud

    a. Air released from the Centering cylinder allows the spring to hold the table in place

    b. Should allow the tool shaft to be close to center for the next stud

EO 1.1.3	Identify and list the functions of the major parts of the MST used in the Lifting System.

1.1.3.1 Main Idea

CONTENT	METHODS & ACTIVITIES
I. Functions of the Lift System	Describe the functions of the Lift System
A. Allows lifting and lowering of MST without a crane	
1. This provides better control of the MST when lifting and lowering	
2. Minimize chances of damaging studs	
B. Sets position for stud withdrawal and insertion	
II. Component Parts	
A. Outriggers	**Slide** shows the outriggers
1. Perform the actual lifting operations	
2. Three of them	
B. Reaction Bridges	Point out on Slide
1. Located over Rx vessel annulus	
2. Support MST when not resting on the vessel flange	

3. Provides for indexing MST to proper location (odd or even) — Show using **Slide**

4. They are <u>not</u> interchangeable

III. Operation of the Lift System — Explain the operation of the Lift System

A. Outriggers retracted — **Slide**

"Outrigger in Down Position"

1. This is the position for tensioning and detensioning

2. MST rests on the closure head flange

3. The outriggers should "NOT" be in contact with the support plates on the reaction bridges — **<u>NOTE:</u>**

Verify they understand that any tensioning performed with outriggers resting on the reaction bridges would transfer all forces to reaction bridges via outriggers causing equipment damage and possible personnel injury.

4. Also in this position in storage for stud removal for cleaning

B. Outriggers are partially extended — Show intermediate position on **T032**

1. This is the position for threading the studs into or out of the vessel flange

2. MST is high enough to allow the stud to unthread from vessel, but bottom of stud will still be inside the head — About 14” from the head flange

C. Outriggers are completely extended **T033**

"Outrigger in up position"

1. High enough to clear the studs from the vessel head flange
2. In this position during:
   a. Transport from storage to the head and from the head to storage
   b. Reindexing of the MST during de-tensioning or tensioning operations

EO 1.1.4	Identify the functions of the switches on the Control Panel for the Hydraulic Unit.

1.1.4.1 Main Idea

CONTENT **METHODS & ACTIVITIES**

I. LP Pump selection

A. Select which of the 2 LP pump starts

1. Either one
2. Both

B. Lighted button indicates pump is selected

C. Will not start until action is indicated

1. Pressure Buildup
2. Piston Return

II. HP pump selection

A. Selects which intensifier (HP Pump) is used

B. Could be either one or both

III. Air release

A. Press to bleed off air

B. Lights up when air pressure is high enough

IV. Close coupling

A. Closes split couplings

B. Interlock with pumps starting

C. Air bleeds off after 5 seconds

V. High Pressure Release

A. Press to bleed of pressure from high pressure header

B. When pressure drops fully:

1. Pressure buildup light comes on indicating pumps are ready to start — Actually comes on when 2nd unloader opens

2. High pressure release light stops blinking and stays off

C. Stays open to allow flow back to reservoir for returning the pistons

VI. Piston Return

A. Aligns LP pumps to return header

B. Starts low pressure pump for piston return

C. Pump shuts off and system realigns 3 seconds after pressure switch (33) actuates

VII. Open coupling

A. Opens couplings when pressed if locking levers are up first

B. Only keeps the solenoid energized for about 5 seconds

C. Interlock with high pressure release is based on the 294 psi setpoint

VIII. Aggregate Ready, LampTest

A. Light on indicates panel ready for operation

B. Push button and all lamps come on – verifies bulbs working properly

C. Helps ensure you know what pumps are selected

IX. Main *Switch #2*

A. To have power to this switch, the *Main Switch #1* on the right side of the control panel must be in position 1.

B. Position 0--Hydraulic Unit "Off"

C. Position 1--Hydraulic Unit "On"

1. Position 1 also supplies power to the old SHV plug

2. Used for operating the DSTTs in the test stand

D. Position 2--Stud Handling Vehicle "On"

EO 1.1.5	Identify the functions of the switches on the Control Panel for the Lifting System.

1.1.5.1 Main Idea

CONTENT	METHODS & ACTIVITIES
I. Purpose of Control Panel for the Lifting System	Using **Slide**, point out each of the following control devices on the control panel and describe their functions
A. Remotely control the outriggers extending and retracting to control MST elevation	
B. Operates electric motors on the outriggers	
C. Outriggers can operate individually or together	
II. Functions of Control Devices of the Lifting System Control Panel	
A. Main Switch #1	
1. Position 0: Control panel off	
2. Position 1: Hydraulic Unit Energized through *Main Switch #2*	
3. Position 2: Lifting System Energized	
B. *Individual Lower* push buttons	
1. When button is held down the individual outrigger #1, #2, or #3 retracts	
2. Lowers the MST	
C. *Individual Raise* push buttons	
1. When button is held down, the individual outrigger extends	
2. Raises the MST	

D. *Joint Lower* Rotary Switch

1. The 3 outriggers retract simultaneously
2. Not synchronized, but will be close

E. *Joint Raise* Rotary Switch

1. The 3 outriggers extend simultaneously
2. Not synchronized, but will be close

F. Indicating Lights

1. Indicate when an outrigger motor is energized
2. May be helpful during troubleshooting

G. *Intermediate Position Bypass* button

1. Out Position
    a. Lifting system stops at pre-set (intermediate) position
    b. Pre-setting of the position is done by adjustment of the limit switches in each outrigger
    c. When operating outriggers jointly, the first outrigger to hit its limit switch will stop <u>all</u> outriggers
2. In Position
    a. Pre-set intermediate position is bypassed
    b. Allows movement to final (completely extended or retracted) position.
    c. Should stop automatically – activated by limit switch
    d. Again, when operating outriggers jointly, the first outrigger to hit its limit switch (up or down) will stop <u>all</u> outriggers

H. *Trouble* Indicating Light

1. Comes on when the control circuit is interrupted
2. Indicates a thermal relay of a motor has tripped
3. Resets inside the control panel

Prevent Events – ensure the panel is unplugged or precautions for entering an energized panel are reviewed before entering to reset the thermal relays

I. *Emergency Stop* push button

1. Depressing the push button stops any evolution on the lifting system
2. Button locks and must be manually released to allow operation
3. Additional stop buttons on each outrigger
    a. Slightly different operation
    b. Knurled ring must be turned to release the button

J. *Joint Lift Power Available* indicating light

1. Light on indicates power is lined up to operate the outrigger motors
2. If switch is turned and light is not lit, one of the individual outrigger emergency stop buttons is likely pushed in

EO 1.1.6	Identify the parts of the Hydraulic Unit

1.1.6.1 Main Idea

CONTENT	Method and Activities
I. Cabinet	Point out parts as they are described – MST de-energized
A. High enough for access to locking latches behind the aggregate	
1. Plates be operated from above	
2. Allows access for verifications prior to performing steps that could drop the stud	
B. Hookups to the hydraulic unit and panel	
1. High Pressure Interconnect	
2. A single cable between the cabinet and hydraulic unit for both the hydraulic unit and the DSTTs	
3. Identify what stays in the Containment Building with the MST and what goes with the panel	
a. Hydraulic unit disconnected from MST at quick disconnects	
b. All parts connecting aggregate to panel go out with them	
c. 60 to 100 amp adapter goes out	
d. Aggregate legs stay and removed bolts are stored in the blocks on the bottom of the hydraulic unit – go out	

CONTENT	Method and Activities
C. Computer (PLC) sets up the parameters – should not need setting up after the initial setup	Show location but avoid resetting as it requires entering the panel while energized Note training panel set at 8,000 psi and 10,000 psi. We are limited by the capacity of the test stand
II. Low Pressure Pumps	
A. Electrical pumps	
1. 2 pumps	
2. Capable of over 3,000 psi discharge pressure	
B. Purpose	
1. Fill cylinders	
2. Return pistons	
3. Operate the high pressure pumps	
C. LP Header Pressure Control	
1. Unloaders (called relief valves in the tech manual) protect system	
a. 2,900 psi to the high-pressure header	
b. 1,200 psi to the return header	
2. Single pump when returning pistons	Emphasize this – though not a safety concern, it places added wear on components which has caused premature failure
a. The unloader allows too much backpressure during piston return with 2 pumps running	
b. Won't damage the equipment, but the pump will trip out regularly on high pressure	

CONTENT	Method and Activities
III. Intensifiers	Reference the picture in the handout to describe the operation of the pump
A. Are the high pressure pumps (Identified as such on the control panel)	
B. The discharge of the low pressure pumps both operates the high pressure pumps and provides suction fluid	
1. Solenoid valve shifts to shift the LP supply to the operating piston	
2. A spring returns the spool when the solenoid is de-energized	
3. This action moves the piston back and forth	
4. Actuation of solenoids by proximity probes on the side of the pump motor	
IV. High Pressure Release Valves	
A. 2 separate valves	
B. Operate by air pressure to open	
1. Larger one is spring return to close	
2. Smaller one is air return to close	
C. Must be open to return the pistons	
D. Can be bypassed with manual valve to perform their function	
V. Piston Return Pressure Control	
A. The low pressure unloader keeps the pressure below 1,200 psi	
B. Needle valve about ¾ turn open	

CONTENT	Method and Activities
C. Pressure switch downstream of needle valve to turn off LP pumps	
VI. Identify the Parts on the Schematic	Using the schematic, identify all the same parts just described and point them out again on the hydraulic unit itself
A. Reservoir	
B. LP Pumps (1), (P1 & P2)	
C. Intensifiers (HP Pumps) (29.1 & 29.2)	
D. 4-way valves (18) & (19)	
1. (19) lines up the pump discharge to the high or low pressure header (piston return)	
2. (18) depressurizes the header and must be energized (closed) to build up pressure for any evolution	
E. Unloader (Relief) valves (17) & (20)	
1. (17) is for low pressure control during tensioning	
2. (20) is for low pressure control during piston return operations	
F. High Pressure Release Valves (23) & (24)	
1. Large one (23) spring return to close releases pressure down to 294 psi.	
2. Small one (24) air operated both directions releases pressure down to less than 74 psi when lamp goes out	
3. Operated by solenoid valves (40.1), (40.2), and (40.3)	

CONTENT	Method and Activities
G. High Pressure Relief Valve (25) is overpressure protection for the entire system	
H. High Pressure header bypass valve (26.2) can manually release the pressure off the high pressure header	
I. Piston Return pressure control components	
1. Needle valve (36)	
a. Throttles the pump discharge to the MST LP header	
b. Unloader (20) required to keep pressure down	
2. Pressure Switch (33)	
a. Is set to turn off the pumps at a pressure slightly lower than the unloader (20) setpoint	
b. Turns off the pumps 3 seconds after reaching its setpoint	
J. Filter/Moisture separator, pressure regulator, lubricator (34)	
1. Notice it lubricates <u>all</u> air being use by <u>all</u> the components	
2. Bypass check valve should never function	This comment can be omitted
3. Pressure switch (35) for air pressure indication on the panel	
K. 5-way valve for split couplings (38)	
L. Needle Valves (41.1) & (41.2) for throttling air to split coupling system – they are open considerably	
M. Air Release Valve (42) for depressurizing system	

EO 1.1.7	Identify the parts of the Double Stud Turning Tools

1.1.7.1 Main Idea

CONTENT **Method and Activities**

I. Stud Engagement Device

A. Pneumatic cylinders (2) turn lower triangle to engage the stud

B. Same pneumatic cylinders (2) return the triangles to align with each other when disengaging

C. Solenoid to operate the cylinder partially controlled by the sensor rod position

D. Provides positive indication of tool being engaged (or coupled) to the stud

E. Lights on the externals of the switches provide visual indication of the position

II. Sensor Rod Position Indication

A. Rod extends through the tool shaft

B. Top of rod is monitored by two ring-shaped proximity switches

1. When the tool is down on the stud, the rod is up - both switches are activated and the tool can engage/disengage the stud

2. When the tool is free of the stud, the rod is down and neither switch is activated

3. When the sensor rods touches the stud, the lower switch is activated, telling the computer the tool has reached the stud

CONTENT	Method and Activities
4. If the proximity switches are not set properly, the DSTT will not properly latch to the stud	Note that it probably will not latch at all – fail safe
III. Weight Compensation Device	
A. Is a double-acting, pneumatic piston/cylinder	
B. A manually set pressure goes to the top of the piston for lowering the tool to the stud	
C. Pressure below the piston is set in the computer for the operation being performed	Overview only here – will cover more thoroughly after buttons are described
1. Lowering without stud	
2. Raising without stud	
3. Lowering with stud	
4. Raising with stud	
5. Threading the stud in or out – no motion up or down	
D. A holding pin on the tool must be released to allow movement of the cylinders	Emphasize pin – especially during this course
IV. Sensors	Point out location of sensors on the machine
A. Position Indication	
1. Cable attached to tool shaft	
2. Monitors amount the cable has gone down	
3. Used for distance (depth) setpoints	
B. Sensor Rod, Stud position	
1. Rod touches the top of the stud	

CONTENT	Method and Activities
2. Proximity switches on top of the rod indicate when touching the stud and when fully set down on the stud	
C. Stud engaged/disengaged	
1. Proximity switches on one (1) cylinder indicate whether the stud is engaged or disengaged	
2. Prevents an operation of the tool shaft that might drop the stud – provides positive indication of tool engaged with stud	
3. Light on sensor shows when piston is on that end	
D. X-Y disengage cylinder energized	
1. Proximity switch on cylinder	
2. Light shows piston is down to center the X-Y slide – light is off when slide is released	
V. Pneumatic Control Cabinet	
A. Contains all the components for the pneumatic control system in the DSTT	Can show internals if desired
B. Includes	Use diagram of parts and identify their functions and manual actuations
1. Pressure regulators	
a. One main regulator – manually set	
b. Two regulators for the top of the pistons – manually set	
c. Two solenoid controlled regulators (Y01) for the bottom of the piston	

CONTENT	Method and Activities
2. 3-way solenoid valves	No expectation to remember this information. It is an overview for information only
a. For the X-Y table release (Y05)	
b. For the stud engage/disengagement (Y06)	Note manual actuation for recovery if power is cut off
c. For sending air to the top of the pistons (Y02)	Ditto
d. For sending air to the bottom to the pistons (HV)	Ditto
e. For releasing air from the bottom of the pistons (Y03)	Ditto
f. Keep stud from dropping on loss of power (Y04)	
g. One (1) of each for the near tool and one of each for the far tool.	
h. Each has manual actuation possible to recover in the event of a solenoid failure or a loss of electric power	
3. Pressure Switch	
a. Indicates when air pressure is low	
b. Motor will not be allowed to start if pressure is too low	
c. Setpoint is adjustable	
4. Moisture separator/filter is part of the main pressure regulator assembly	
C. Pressure gages	
1. One shows pressure from main regulator to the cabinet	

CONTENT	Method and Activities
2. One each indicates pressure to the top of the specific tool's compensation cylinder (when lined up through Y02)	
3. One each (on HV) indicates pressure to the bottom of the specific tool's compensation cylinder	
VI. Power Control Cabinet	
A. On-Off switch (Outside the cabinet)	
B. Frequency converter inside (controls motor speed and torque)	
1. Slow near the end of stud turning	
2. Fast in the middle	
VII. PLC Control Cabinet	Leave de-energized and simply point out the buttons
A. Operator Interface Panel	
B. Panel from which DSTT is operated	
1. Near tool and Far tool controls are separate	**Prevent Events** – Self checking every time you push a button
2. Operator Panel is the computer screen and keys where the setpoints are adjusted	
3. Divided into 3 sections: **General, Automatic, and Manual** controls	Point out where these three sections are
C. General control buttons	
1. **Control On/Off** activates the buttons to allow control of the DSTT	
2. **LampTest** tests the lamps for the entire board	

CONTENT **Method and Activities**

3. **Fault** buttons

    a. Identify that a fault exists (Computer screen tells which fault)

    b. General **Fault** button identifies a fault common to both tools (Low air pressure e.g.)

    c. **Fault Near Tool** and **Fault Far Tool** buttons identify faults specific to one tool (timeout e.g.)

    d. Respective button must be pressed to clear the fault

4. **Emergency Stop** stops all operation of the DSTT

D. Automatic Control Buttons

1. Separate controls for the near and far units

2. **Select Auto** or **Manual**

3. **Select Insert** or **Remove** – the operation to be performed

4. **Start** initiates or restarts the auto function

    a. Must restart at programmed locations

    b. Must restart when an error occurs

    c. Restart after a pause is initiated

5. **Pause** stops the auto function but allows restart where it left off

6. **Stop/Reset** stops the auto function

    a. Will not allow restart in auto until returned to “Home” position

CONTENT	Method and Activities
b. Must use the manual mode to return the tool back to its "Home" position	
7. **Manual** indicating light is illuminated when the Manual mode is selected	
E. Manual Control Buttons	
1. The buttons are also indicating lights and will light in auto at the time the evolution is active	Emphasize this point
2. **Weight Comp On/Off**	
a. With Comp on, should hold the stud in position, not moving, without pressing a lift or lower button	
3. Lift tool	
a. Press and release, the tool is raised slowly	
4. **Lift tool** with **Weight Comp On**	
a. Tool lifts with stud	
5. Lower tool	
a. Press and release, the tool lowers slowly	
6. **Lower tool** with **Weight Comp On**	
a. Tool lowers with stud	
7. **Insert Right**	
a. Turns tool clockwise	
b. Speed and torque depend on the depth position of the tool	
c. Slow speed area	
1) Top ¼" of travel	
2) Bottom ¼" of travel	

CONTENT **Method and Activities**

d. Operation in Fast and Slow areas, **Inserting**

1) Must hold pushbutton down to keep it turning in upper slow region

2) When in the fast area, can push and release the button

3) After button is released, turning continues through the slow area and stops when fully inserted

4) Can go lower by holding the button down

8. **Remove Left**

a. Turns tool counterclockwise

b. Speed and torque depend on the depth position of the tool

c. Slow speed area

1) Top ¼" of travel

2) Bottom ¼" of travel

d. Operation in Fast and Slow areas, **Removing**

1) Depress pushbutton and it will begin turning out in slow

2) When in the fast area, can release the button

3) Turning will stop when it reaches upper slow area

a) Waiting for you to turn on the lift function

CONTENT	Method and Activities
b) To continue in upper slow area, must hold pushbutton down to keep it turning	
4) Hold button until stud is lifted free of threads	
9. **Disengage Stud**	**Prevent Events**: Self Checking - Ensure no weight on the stud How?
a. Coupling device disengages	
b. Light blinks until the proximity switches indicate the stud is disengaged	
c. Light stays on when proximity switches indicate disengaged	
d. Tool will not disengage until the *Lower Tool* button is depressed with *Weight Compensation* off	
10. **Engage Stud**	
a. Coupling device engages	
b. Light blinks until the proximity switches indicate the stud is engaged	
c. Light stays on when proximity switches indicate engaged	
11. Stop Manual	
a. Stops the operation of the tool when in manual	
b. Can restart with any operation in manual if conditions are right	

CONTENT	Method and Activities
VIII. Motor	
A. Mounted on a gearbox	
B. Variable speed controlled by frequency inverter	
C. Can be manually operated on handwheel	

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.