PALO VERDE
NUCLEAR GENERATING STATION

Mechanical Maintenance Training
Turbine Rotor Removal
Classroom Lesson

Mechanical Maintenance Training	**Date: 5/25/2010 10:53:12 AM**
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Title: Turbine Rotor Removal	**Technical Review:** Holladay, James A(Z49490) Digitally signed by Holladay, James A (Z49490) DN: cn=Holladay, James A(Z49490) Reason: I have reviewed this document Date: 2010.06.17 17:23:30 -07'00'
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INITIATING DOCUMENTS

Task Analysis of Tasks

REQUIRED TOPICS

None

CONTENT REFERENCES

G E Preventive Maintenance Training Manual

M400-0301-00044 & 00045: INSTRUCTION MANUAL-STEAM TURBINE GENERATOR

TCS #99-0031 Revise LSTG Turbine course

TCSAI 2856141 Include standards and expectation into lesson plan.

LESSON PLAN REVISION DATA

May 25, 2010	Mark Tague	TCSAI 3478460 Incorporate Human Performance and Prevent Events strategies

Tasks and Topics Covered

The following tasks are covered in Turbine Rotor Removal :

Task or Topic Number*	**Task Statement**
Lesson:	Turbine Rotor Removal
LSTG017	Remove and install turbine rotors (e.g. for cleaning or blade inspection)
LSTG018	Remove inner and outer turbine shells
LSTG025	Rework or replace governor on LSTG
LSTG004	Remove, inspect, and install LSTG couplings

Total task or topics: 4

TERMINAL OBJECTIVE:

1 Given a maintenance operation, the plant mechanic will, state the procedure for turbine disassembly

as demonstrated by passing a written examination with a minimum score of 80% using classroom reference materials.

1.1 Discuss PVNGS Standards and Expectations and Prevent Event Strategies Applicable to Turbine Maintenance.

1.2 State the procedure for disassembly of the thrust bearing

1.3 State the procedure for disassembly of the couplings

1.4 State the steps necessary to disassemble the high pressure turbine

1.5 State the steps necessary to disassemble the low pressure turbine.

Introduction

CONTENT	METHODS & ACTIVITIES
I. Motivation	Focus student attention on "What's In It For Me".
II. Pre-Job Brief	Pre-job briefing on the day's activities modeling the use of the ***Palo Verde Standards & Expectations, Preventing Events***
A. Focus On Five (Task Preview)	Familiarize worker with the scope of work, task sequence, and critical steps.
1. Critical Steps (Course Terminal Objective) Given a maintenance operation, the plant mechanic will, state the procedure for turbine disassembly as demonstrated by passing a written examination with a minimum score of 80% using classroom reference materials.	PVNGS Standards & Expectation book (Focus on five) Highlight the critical steps (Terminal Objectives) on the power point presentation.
2. Identify error likely situations (error traps)	Discuss at least one specific error likely situation. (Look at Error Precursors in S&E book)
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.	What defenses can we employ to prevent the "Worst thing that could happen"
5. Identify actions to assure proper configuration control.	This may not be applicable in every training setting.
B. Two Minute Drill	At Instructor's discretion, not to interrupt class flow. (Expected after lunch at a minimum)
III. Lesson Introduction	
A. Lesson Enabling Objectives	
EO01 Discuss PVNGS Standards and Expectations and Prevent Event Strategies Applicable to Turbine Maintenance.	
EO02 State the procedure for disassembly of the thrust bearing.	
EO03 State the procedure for disassembly of the couplings.	

	CONTENT	METHODS & ACTIVITIES
EO04	State the steps necessary to disassemble the high pressure turbine.	
EO05	State the steps necessary to disassemble the low pressure turbine.	

TO: 1 Given a maintenance operation, the plant mechanic will, state the procedure for turbine disassembly

as demonstrated by passing a written examination with a minimum score of 80% using classroom reference materials.

EO: 1.1 Discuss PVNGS Standards and Expectations and Prevent Event Strategies Applicable to Turbine Maintenance.

Main Idea

CONTENT	METHODS & ACTIVITIES

I. Standards and Expectations

It is vital that all personnel, APS and Contract, have a clear understanding of the Site Expectations and Standards for Prevent Events.

These Expectations and Standards provide a set of common behaviors to improve our performance.

A. Nuclear Safety

1. Everyone's priority

B. Industrial Safety

1. Ensure your safety and the safety of others

C. Radiological Safety

1. Maintain your exposure ALARA
2. Minimize the spread of contamination
3. Prevent the release of radioactive material

D. Emergency Response

1. Personnel participate and respond effectively to emergency situations and drills

E. Pre-job Brief

1. Every job begins with a pre-job brief
2. Focus on Five

F. Procedure Use and Adherence

CONTENT

METHODS & ACTIVITIES

1. Follow procedures and instructions as they are written.

2. Understand the procedure and written instruction level of use, when to STOP for resolution and use of sign-offs and place keepers.

3. Actively participate in procedure and written instruction improvement.

4. Ensure activities are completed as provided for in procedures or written instructions, regardless of level of use.

G. Self-Checking

1. Personnel self-check at every critical step of task.

H. Peer-Checking

1. Peer-Checking will be used when performing steps or actions that are irreversible. The peer checker must always assume the performer is about to make a mistake.

I. Two-Minute Drill

1. Every task utilizes a two-minute drill to verify conditions, job hazards and assumptions discussed during the pre-job brief.

J. Three-Way Communication/Phonetic Alphabet

1. Three-way (3-legged) communication and phonetic alphabet will be used at critical steps.

K. Questioning Attitude/Stop when Unsure

1. Use questioning attitude when information received does not seem Consistent with your knowledge and training or when things “don’t seem right.”

CONTENT	METHODS & ACTIVITIES
L. Personal Accountabilities and Responsibilities	
1. Personnel report all conditions adverse or potentially adverse to nuclear, industrial or radiological safety.	
2. Create success by developing clear goals and expectations, effectively interacting, taking ownership, treating each other with respect and being accountable.	

EO: 1.2 State the procedure for disassembly of the thrust bearing

Main Idea

CONTENT	METHODS & ACTIVITIES
I. Thrust Bearing bump check	The following information has been reviewed by the team responsible for specific turbine component maintenance at Palo Verde. The information is not intended to be used as a repair guide nor does it replace in any way the applicable written procedures. It is intended as an overview of the steps and methods used at Palo Verde to perform inspections on the High Pressure and Low Pressure turbines at our site. Due to the schedule requirements for the overhead crane, the following may or may not be performed in this specific order – it is only a guide.
A. The thrust bearing is located on the generator end of the High Pressure rotor at the mid-standard. The mid-standard also includes the number 2 bearing.	Power Point Slide 39
1. **NOTE** for this work a SOD permit will be hung on the lube oil system that will allow the mechanical team to control the operation of the turning gear oil pump and bearing lift pumps.	

CONTENT	METHODS & ACTIVITIES
a. Anytime work begins on the oil system perform a 2 minute drill to cover the hazards associated with possibly large volumes of residual oil and how to mitigate an oil spill. Workers must be sure of the oil pumping mechanisms being secure before opening the oil system.	PE Tools 2 Minute Drill Questioning Attitude Stop when unsure
B. Shut down the lube oil and install “blanks” in the thrust bearing oil feed lines and the oil feed line for number 3 bearing.	Power Point Slide 40 Power Point Slide 41
C. Unbolt, rig and remove the standard cover over ‘A’ coupling. Also unbolt and remove the generator end oil deflector from the mid-standard cover.	
D. Install the thrust bearing “jacking beam”. Set up 2 special dial indicators on the thrust bearing. 1 goes against the thrust bearing casing, and the other on the thrust runner on the rotor.	Position HP rotor
E. Set up hydraulic rams to jack the rotor in both directions. Rotate the rotor train to get the rotors up on oil	
1. Stop the rotation and quickly jack the rotor in the direction towards the generator.	
2. Zero the indicators and repeat the process but jack the rotor towards the front standard.	
3. The indicator reading on the thrust runner minus the indicator reading on the thrust bearing casing equals the T. Brg. Clearance.	
4. It should be .012” to .014”. Repeat the process to insure the readings were accurate.	

CONTENT	METHODS & ACTIVITIES
5. Leave the rotors thrusted towards the front standard for axial clearance readings UNLESS the thrust bearing is going to be disassembled. a. If the thrust bearing is going to be disassembled leave the thrust at mid-float to allow a gap for removing thrust bearing parts. b. Disassembly of the thrust bearings is not always required during an outage. c. It is scheduled for every other outage, or when the HP is being worked, or if the bump check is bad. d. Disassembly and inspection will be covered in more detail later.	

EO: 1.3 State the procedure for disassembly of the couplings

Main Idea

CONTENT	METHODS & ACTIVITIES
I Coupling Disassembly	
A. **NOTE** coupling disassembly can proceed under the SOD permit and be performed prior to the turbine master clearance being in place.	PE Tools Pre-Job Brief 2 Minute Drill
1. Disassembly of the couplings requires some rigging. Ensure that the 2 minute Drill includes discussion of weights, proper rigging techniques, pinch points and body positioning. Remember that with coupling disassembly there will be drops of oil occasionally so there could be slip hazards. Watch for oil and clean as you go.	Self Checking Error precursors like inaccurate risk perception and complacency.
B. Shut down the lube oil.	
1. Have I&C remove the vibration probes from the standard covers being removed.	
2. Install blanks in the oil feed lines to the appropriate bearings.	
C. Unbolt and remove the upper oil deflectors and standard covers as required.	
D. Unbolt and remove the coupling guards.	
1. Couplings B, C, and D are oil cooled.	
2. Be sure to recover the oil line orifice from the piping to the guard.	
3. The lower half of the guard will be rolled out around the coupling.	

CONTENT	METHODS & ACTIVITIES
4. Make sure the 4 shims for the guard are match marked as to their location.	PE Tool- Procedure adherence Ensure any shims removed are bagged and clearly tagged as to where they came from so they can be put back in the same place.
II **Coupling bolts**	
A. All of the couplings on our turbines have tapered sleeve hydraulic bolts.	
1. The sleeves have 2 to 3 mils clearance to the coupling bolt holes and are easy to remove once disassembled.	
III **Hydraulic bolts**	
A. Special tooling provided with the bolts is required to de-tension and remove the bolts.	
1. Very high hydraulic pressures are used, and care must be taken to not be in line with the bolt or tooling while working with them.	PE Tool 2 Minute Drill
2. The ram used for de-tensioning the coupling bolts can also create a hazard. When the ram is extended about ¾" to 1" a red stripe will appear. When the red stripe appears all jacking must stop. The ram must be collapsed and repositioned so jacking can begin again.	PE tools: Questioning attitude After several of these bolts are done the job can become routine. Don't let Error precursors like complacency catch you off guard.
3. Loosen generator end nut in order to eject hydraulic bolts.	
B. Prior to removing the coupling bolts, take as-found coupling run-out readings.	Don't forget to do.
1. The general method for removing the coupling bolts is to first de-tension and remove 2 bolts 180 degrees from each other.	Power Point Slide 42
2. Replace these bolts with adjustable expanding mandrels.	

CONTENT	METHODS & ACTIVITIES
3. De-tension the remaining studs. Rotate the turbine rotors a few revolutions.	
4. This may help relieve any torsional stresses on the body fit studs or the sleeves of the hydraulic bolts.	
5. Remove all of the studs, and then remove the expanding mandrels.	
C. Couplings A, B, and C have a spacer between the coupling faces. D coupling at the generator does not have a spacer.	
1. D coupling has a rabbet fit that must be separated. In any case, the rotors must be thrusted to separate the couplings.	
a. New Mono block rotors have a .060" clearance on rabbit fit.	
2. When thrusting the turbine rotors, consideration must be give to the close tolerances internal to the machine	PE Tools: Questioning attitude Record how much the rotor has moved in order to eliminate the possibility of moving it too far and causing damage.
3. If the rotors are thrusted too far, a rotor could be pushed up against the stationary diaphragms inside.	
4. Thrust brackets can be installed in various places to control the movement of the rotor.	
5. To separate the couplings to remove a spacer, the generator half of the coupling needs to be thrusted towards the generator.	
6. It only needs to be moved about .030". To separate the rabbet fit on D coupling the generator field rotor is jacked towards the collector end.	
7. Once the rabbet fit is apart, do not jack the field rotor more than ¼".	

CONTENT

METHODS & ACTIVITIES

8. This is to provide room to remove the number 9 bearing from the generator.

9. The generator half of the couplings have jack bolt holes to allow separating the coupling faces.

D. On couplings A, B & C the spacers are held to the generator half of the coupling with 4 socket head cap screws.

1. Attach rigging, remove the cap screws, and rig the spacer out of the coupling.

E. Store the spacer by suspending it from rigging.

1. If it is laid down, make sure it is on a flat surface to prevent it from warping.

2. **NOTE**: GE uses the following terminology for lactations on the turbine. Left and right are determined when looking from the front standard towards the generator. Numbering is with odd numbers on the left and even on the right. Numbers are sequential from front (or turbine end) to the rear (or generator end). All keys, bolts, dowels, etc., are numbered in this fashion.

EO: 1.4 State the steps necessary to disassemble the high pressure turbine

Main Idea

	CONTENT	METHODS & ACTIVITIES
I	Disassembly of the High Pressure Turbine	PE Tool Pre-Job Brief
	A. Ensure that the Pre-Job brief and 2 Minute Drill include discussion about rigging hazards and general hazards associated with disassembly of these large parts. There are numerous pinch points and workers need to be aware of them. Use of Effective communication when one of these large parts is being moved will ensure that all workers are aware of load movement and can position themselves in a safe place. Sign the steps in the work order as you go.	Effective Communication Procedure use & Adherence
	B. Disassemble and remove the HP turbine appearance lagging.	2 Minute Drill
	1. Remove the front standard “dog-house”.	
	C. Unbolt and remove the front standard cover.	
	1. The cover has close tolerance fits to both the number 1 bearing and the oil seal around the PMG and must be lifted level.	
	2. Use jack-bolts to raise the cover to break the horizontal joint loose, and then rig and remove. The center of gravity is almost directly over the T-1 bearing location so the rigging needs adjusted.	
	3. Install “rabbits” around the oil drain openings for FME. “Rabbits” are FME bags stuffed with rags used to stuff around the pipe in the drain opening. (You must record the number of rags in each bag for F.M.E. accountability)	Stress the importance of FME use and documentation.

CONTENT	METHODS & ACTIVITIES
D. Unbolt and remove the mid-standard cover.	
1. The cover has a tight fit to the thrust bearing and must be raised using jack bolts to prevent galling.	
2. Once clear of the fit, rig and remove. Install rabbits in the oil drain opening.	
E. Disassemble and remove the upper half of the numbers 1 and 2 bearings, and the thrust bearing	
1. Cover the journal areas of the rotor with clean sheet rubber for protection.	
2. Unbolt and roll out the lower oil deflectors by the packing casings.	Only if work is being done on the oil deflectors.
3. This is to provide room to take rotor position readings.	
F. Unbolt and remove the steam packing casings from both the turbine and generator end of the HP shell.	
1. These are numbered the N1 and N2 packing casings.	
2. From the outboard lower packing groove remove the packing segments.	
3. Take rotor position readings between the rotor and the packing groove at the left, right, and bottom positions.	
G. The steam piping connecting to the upper shell is supported by spring cans.	
1. The spring cans need to be pinned prior to unbolting the flanges.	

CONTENT	METHODS & ACTIVITIES
H. The studs for the inlet flanges are stretched and heat will need to be applied to de-tension the studs.	
1. The inlet flanges go to the center of the shell. The outlet piping flange studs are torqued and may be removed with Hy-torq equipment.	
a. Outlet piping flange studs torqued to 2000 ft/lbs.	
2. De-tension and remove all flange studs. The pipes have “ears” on them to allow them to be pulled back from the shell.	
3. Using either come-alongs, or turn-buckles, pull the pipes away from the HP shell.	
4. Install FME devices over both halves of each flange.	
I. The HP shell is supported at both the front and mid standards by sitting on “running” keys, or operating shims.	
1. It is imperative that the “tops off” keys be installed before the running keys are pulled out. If this step is missed there is a good chance of rotor blade or packing damage.	PE Tools Procedure use and Adherence Questioning Attitude
2. These keys are under the shell arms which are part of the upper shell.	
3. Prior to de-tensioning the horizontal joint studs for the shell, the “tops off” or alignment shims keys must be installed.	
4. These transfer the load of the HP shell to the lower half.	
5. The shell must be raised approx .015” to install the tops-off keys.	
6. This is done by using 75 ton jacks in pockets provided at the standards.	

CONTENT	METHODS & ACTIVITIES
7. Due to stresses from piping to the lower shell, sometimes the jacks will not lift the shell.	
8. In this case, help from the overhead crane is needed.	
9. If the crane is needed to help lift the turbine shell; conduct a 2 minute Drill with the crane operator so that he is aware to be watching the load cell numbers in the cab. The signalman needs constant contact with the crane operator to ensure rigging working load limits are not exceeded.	PE Tool: Questioning Attitude 2 Minute Drill Effective communication
10. Use extreme caution when using the crane to help lift the shell. Use 2 of the HP shell chokers on 1 corner of the shell and the 50 Ton hook.	
J. Once the HP shell is supported by the tops-off keys the horizontal joint studs can be removed.	Power Point Slide 43
1. These studs are stretched using super bolt technology.	
2. Follow the de-tensioning instructions in the work order for the proper order.	
3. Once the studs are de-tensioned, remove all of the lower nuts.	
4. The studs and top nuts will stay with the upper half shell while it is rigged from the turbine.	
5. The process of de-tensioning the studs takes about 2 hours.	
K. Due to the tight tolerances between the shell and the diaphragms and packing heads internal to the turbine, it must be jacked up level until the fits are cleared.	
1. The shell has 4 pockets on each side to accept 50 ton jacks.	

CONTENT	METHODS & ACTIVITIES
L. Attach the rigging to the HP shell I.A.W. the rigging diagram in the tech manual.	PE Tool Procedure use and adherence
1. Adjust the rigging to obtain equal tension on all 4 legs.	
2. Take a strain on the rigging, and using the 8 hydraulic jacks, raise the shell approx. 10 inches to clear the fits.	
3. Maintain tension on the rigging while raising the shell.	
4. Once clear of the fits, use the crane to finish the lift and transport the shell to its storage area.	
M. At each end of the HP shell are located packing heads (internal to the shell).	
1. De-tension the studs and bolts and rig off the packing heads.	
N. Loosen and remove the diaphragm horizontal joint bolts.	Power Point Slide 44
1. Guide pins are used when rigging the diaphragms from the machine.	
2. Rig off the upper diaphragms. Maintenance racks are used for cleaning, inspecting, and reworking of the diaphragms.	
3. The uppers must be laid down on the floor and then flipped to install in the racks.	
4. Use caution when performing the flipping operation with the crane.	
O. The HP rotor is connected to the control rotor in the front standard by the quill shaft.	
1. Unbolt and remove the quill shaft connecting the two rotors.	

CONTENT	METHODS & ACTIVITIES
P. Prior to removing the HP rotor, wheel and diaphragm clearance readings are taken. Turbine rotor is thrusted toward the turbine end.	
1. These as-found readings provide us with information as to the axial positioning of the rotor in the turbine, radial clearances to the diaphragms, and would show any “dishing” that may have occurred to a diaphragm.	
2. These readings are time consuming, taking almost a shift.	
3. They are taken using tapered slip gages, adjustable parallels, feeler gages, and micrometers.	
4. Be sure to attach lanyards to the tools being used to prevent them being dropped into the turbine.	
5. At this stage of the work the extraction lines for the turbine are not covered with FME	
Q. Once the as-found readings have been accepted, the rotor can be rigged from the machine.	Power Point Slide 45
1. The maintenance stands for the rotor need to be set in the correct position BEFORE the rotor is lifted.	
2. Any rigging operation involving the rotor is a critical task and a detailed pre-job briefing must be held.	PE Tools
3. The HP rotor weighs 72 tons and the rigging beam weighs 17 tons, for a total of 89 tons.	
R. Lifting u-straps need to be installed at each end of the rotor.	Power Point Slide 46
1. They are rolled in around the rotor at the oil deflector journal area.	
2. A thin layer of copper softening material is placed between the u-strap and the rotor.	

CONTENT

METHODS & ACTIVITIES

3. Attach the rigging to the beam as shown in the tech manual.

4. We now have high performance slings to be used in place of the 2” wire rope used in the past.

5. Center the crane over the rotor and attach the rigging to the u-straps.

6. Due to the close tolerance between the rotor and the diaphragms, the rotor must be lifted level and movement of the rotor must be controlled.

7. Wooden wedges can be used between the coupling halves as the lift is made to control movement.

8. Station workers along the turbine on both sides to monitor the numerous points of possible interference.

9. Using caution, raise the rotor slowly until clear of the turbine and transport to the stands.

S. Rig and remove the lower diaphragms from the turbine.

1. Cover the extraction lines with FME covers as the diaphragms are removed.

2. Place the lower diaphragms in the maintenance racks.

T. Rig and remove the lower bearings and the lower thrust bearing pieces.

U. Unbolt and remove the lower oil deflectors. The HP turbine shell is now disassembled and the components are ready for cleaning and inspection.

EO: 1.5 State the steps necessary to disassemble the low pressure turbine.

Main Idea

CONTENT	METHODS & ACTIVITIES
I. Disassembly of the Low Pressure Turbine	This guideline picks up with the rotors uncoupled and the coupling spacers removed.
A. Perform Pre-Job Brief	PE Tools
B. Disassemble and remove the upper half journal bearing pieces from both ends of the rotor	2 Minute Drill Power Point Slide 47
1. Cover the journal area with clean sheet rubber for protection.	
C. Unbolt and roll out the lower oil deflectors by the packing casings to provide room for taking rotor position readings.	
D. Unbolt and remove the upper half packing casings from each end of the exhaust hood.	
1. Remove the packing segments from the outboard packing groove in the lower half.	PE Tool: Questioning Attitude These packing segments are very sharp. Insure gloves are in good shape as this packing can cut right through them.
2. Using adjustable parallels, take rotor position readings at both ends of the rotor.	
E. Disconnect the fire protection brackets from the exhaust hoods on both ends.	
F. On top of the exhaust hood are hand hole covers to access the circular gib keys (commonly called dog-bone keys).	Power Point Slide 48
1. These keys help maintain alignment between the exhaust hood and the inner casing	

CONTENT	METHODS & ACTIVITIES
2. Remove the L-shaped keys from the two positions on the inner two sides of the circular gib key.	
a. The circular Gib key can now be removed.	
3. The exhaust hood can be removed without removing the dog-bones, but by removing them the hood does not need to be jacked up as high prior to rigging.	
G. Remove all of the exhaust hood horizontal joint dowel pins.	
1. Ensure these dowel pins are properly bagged and tagged to ensure they can be installed in the proper location on assembly.	PE Tool: Self Checking
2. They are stamped as to their location.	
3. After removing the dowels, remove all of the horizontal joint bolting.	
4. Install the exhaust hood guide pins on both ends of the shell on either the left or right side.	
5. Install jack bolts evenly spaced around the exhaust hood.	
H. The weight of the exhaust hood is 89 tons.	Power Point Slide 49
1. After holding a pre-job briefing, attach rigging as outlined in the tech manual.	PE TOOL Pre-Job Brief
2. Be careful to not damage the blow-out diaphragms located on top of the exhaust hood when attaching the rigging.	
3. Adjust the rigging for equal tension on all 4 pick points.	
4. Using the jack bolts, break the upper half of the hood free from the lower.	

CONTENT	METHODS & ACTIVITIES
5. Once raised approx 1”, take the load with the crane.	
6. The main points of interference are between the hood and the cone extensions inside the hood on either end, so the levelness of the load is more important in the front to rear direction.	
7. Place observers to monitor the gap between the hood and the cone extensions and remove the hood	
8. It will either be placed on a rail car in the crane bay or placed in a storage location on the turbine deck.	
9. In either case this is a large component that does not have much clearance to other turbine shells, valves, piping, etc.	
10. Station observers along the travel route and proceed cautiously.	
11. Rope off the area around the turbine lower shell as there is now an open hole to the condenser.	
I. Install the inner casing work platform.	Power Point Slide 50 Stress the importance of having fall protection on.
1. Unbolt and remove the cone extensions.	
J. After installing the work platform, unbolt and remove the steam shielding from over the horizontal joint bolts.	
1. Cut the lock tabs and break the unions on the hood spray piping located on each end of the inner casing on the right side.	
2. Open the lower inner casing manways to access the inner horizontal joint bolts.	

CONTENT	METHODS & ACTIVITIES
3. There are 5 manways on each side of the inner casing.	
4. Working inside these manways can be extremely hot especially if it hasn't been many days since the turbine was shut down. Perform a heat stress test to determine what stay times will be. If you get warm and you aren't even approaching your stay time yet, STOP and exit the manway. Get to an area where you can cool off.	Operating Experience PE Tool: 2 Minute Drill Stop when unsure.
5. After opening the manways, install the FME covers inside the casing pockets.	Stress the importance of FME
6. Use Hy-torq equipment to de-tension the inner horizontal bolts and remove the nuts	
7. The outer studs will need to be heated to be de-tensioned.	
8. The majority of the studs are threaded into tapped holes, but there are 4 body-fit studs and 2 other through-studs that have nuts and washers on the bottom.	
9. The nuts are accessed through doors in the work platform.	
a. A small rope must be dropped down through the through hole on the bolt so the rope comes out the bottom. Tie the two ends together with a good bowline knot. Now if the nut and washer comes off by accident the rope will catch both of them.	PE Tool: 2 Minute Drill and explain how to catch the nut and washer.
10. Use caution not to drop them into the condenser.	Stress how to report dropped items for retrieval and why.
11. Install the 2 guide pins in the holes that the through studs were located at.	

CONTENT	METHODS & ACTIVITIES
12. The body-fit studs can be left in and removed along with the upper half casing as it is jacked up.	
K. After holding a pre-job briefing, attach rigging as outlined in the tech manual.	PE Tool Pre-Job Briefing
1. Set up 4 ea. 75 ton long stroke porta-powers and shims for jacking the upper half casing up.	Power Point Slide 51
2. Adjust the rigging to obtain equal tension and begin jacking up the inner casing.	
3. Maintain some tension on the rigging with the crane as the jacking operation is in progress.	
4. The inner casing is jacked up about 9 inches to clear the fits on the upper diaphragms.	
5. Maintain a level condition as it is jacked up	
6. Once clear of the fits, travel with the crane to its storage location on the turbine deck.	
7. The weight of the inner casing is 55 tons.	
L. Unbolt the upper diaphragms and install the guide pins. Rig and remove the diaphragms.	Power Point Slide 52
1. Rigging drawings are in the tech manual.	Power Point Slide 53
2. With the larger diaphragms, they must be rigged to equalize the load between the inner and outer ring.	
M. As-found wheel and diaphragm clearance readings need to be taken prior to removing the rotor.	
1. Insure the rotor is in the proper axial position based on the coupling gap on the turbine end (should equal the spacer thickness).	
2. Due to the thermal expansion of the long rotors, these readings are more for info only.	

CONTENT	METHODS & ACTIVITIES
3. They could indicate something drastically wrong, but any alignment moves would be based on readings taken at reassembly, when components are at ambient temperature.	
N. Insure the rotor maintenance stands are set.	
1. They must be precision leveled and aligned.	
O. The procedure for removing the LP rotors is the same as with the HP rotor.	
1. Adjust the rigging beam for the rotor being removed.	
2. The beam is stamped as to how it is to be set up.	
3. The LP rotors average 160 tons not including the weight of the rigging beam.	
4. The clearances inside the turbine are close, and if the load drifts it can't be held back.	
5. Caution must be used to control the movement of the rotor with wooden wedges between the coupling faces.	
6. The rotor must be leveled and adjustments may need to be made to the beam once the operation has started.	
7. Once the rotor is clear of the turbine and the crane has started to travel it is critical that observers be stationed along the path to look for interferences.	
8. The rigging team has to remember that any damage to the rotor has the potential to hold up an outage for weeks or months possibly, and it is impossible to use too much caution.	PE Tool Stop when unsure

CONTENT	METHODS & ACTIVITIES
P. After removing the rotor, place it in the maintenance stands and disconnect the rigging beam Return it to its storage area on the turbine deck.	
Q. Rig and remove the lower diaphragms, utilizing the rigging drawings in the tech manual. 1. Place them in the maintenance stands. 2. Remove the packing segments from the lower diaphragms. 3. The packing can remain in the upper halves, but the lower needs removed for diaphragm wire alignment at installation.	
R. Disconnect the bearing lift pump oil lines and remove the lower bearing components.	Power point slide 54
S. Remove the lower oil deflectors.	
T. The LP turbine is now disassembled for cleaning and inspection.	

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.