PALO VERDE
NUCLEAR GENERATING STATION

Mechanical Maintenance Training
Turbine Rotor Reinstallation
Classroom Lesson

Mechanical Maintenance Training	**Date: 5/25/2010 9:13:51 AM**
LP Number: NMT75C000503	**Rev Author: MARK TAGUE**
Title: Turbine Rotor Reinstallation	**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 17:24:36 -07'00'
Duration : 5 HOURS	**Teaching Approval:** Steinmetz, Tim P(Z99348) Digitally signed by Steinmetz, Tim P(Z99348) DN: cn=Steinmetz, Tim P(Z99348) Reason: I am approving this document Date: 2010.06.25 10:41:09 -07'00'

INITIATING DOCUMENTS

Task Analysis of Tasks

REQUIRED TOPICS

None

CONTENT REFERENCES

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 Reinstallation :

Task or Topic Number*	Task Statement
Lesson:	Turbine Rotor Reinstallation
LSTG017	Remove and install turbine rotors (e.g. for cleaning or blade inspection)
LSTG003	Realign turbine
LSTG004	Remove, inspect, and install LSTG couplings

Total task or topics: 3

TERMINAL OBJECTIVE:

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

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

1.1 State the procedure for reinstalling the turbine bearings and rotors.

1.2 List the steps required for reinstallation of the inner (shell) casing

1.3 List the steps required for reinstallation of the exhaust hood

1.4 State the procedure for realigning the 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 (Terminal Objectives) Given a maintenance operation, the plant mechanic will, state the procedure for reinstalling turbine rotor 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 State the procedure for reinstalling the turbine bearings and rotors.	
EO02 List the steps required for reinstallation of the inner (shell) casing.	
EO03 List the steps required for reinstallation of the exhaust hood.	

CONTENT	METHODS & ACTIVITIES
EO04 State the procedure for realigning the turbine.	

TO: 1	**Given a maintenance operation, the plant mechanic will, state the procedure for reinstalling turbine rotor** **as demonstrated by passing a written examination with a minimum score of 80% using classroom reference materials.**

EO: 1.1 State the procedure for reinstalling the turbine bearings and rotors.

Main Idea

CONTENT	METHODS & ACTIVITIES
I. **Turbine Reassembly**	The following guideline will describe the assembly of both the LP and HP turbine as they are similar. Differences between the two processes will be covered as they arise. One important item to remember during assembly of the turbine is the need for FME. Make sure all tools have lanyards, and all badges are secured. An item dropped into the turbine once it is almost assembled could cause a delay of days to recover it.
A. Prior to reassembly, insure all inspections have been completed. Make sure that all NDE indications have been corrected or accepted by engineering.	PE Tool: Self Check Peer Check
B. Begin the assembly of the turbine by installing the lower diaphragms for alignment.	PE Tool: Procedure Use and Adherence
1. Lubricate the seal strips and crush pins and rig per the tech manual drawings.	
2. Insure the diaphragms are seated and pushed to the left side of the shell.	
3. The diaphragms are aligned to a tight wire that represents the center of the rotor.	
4. Since the wire alignment is a task covered by its own job-qual card, it will be performed by selected individuals.	

CONTENT	METHODS & ACTIVITIES
5. Diaphragm alignment can also be performed by specialized laser equipment, usually by an outside vendor.	
6. Once the alignment has been accepted by either engineering or supervision, assembly can proceed.	
7. Install the lower diaphragm packing segments.	
C. Install the lower oil deflectors, except for the ones next to the packing casings. Leave the bolts loose as the deflector will need to be set once the rotor is installed.	
D. Install the packing segments in the lower packing casings, except for the outboard ring. It needs to be left out for rotor position readings.	
E. Install the lower half of the journal bearings.	
F. Install the lower half of the thrust bearing strong back and casing. Do not install the thrust plates or shims at this time.	
G. Install the v-block rotor stands in the proper location on the turbine deck. The rotor will be brought up to the v-block stands and temporarily supported there for final cleaning.	
H. After holding a pre-job briefing, attach the rigging beam to the crane.	PE Tool: Pre-Job Brief
1. Hook up the beam to the rotor lifting saddles and level.	PE Tool: 2 Minute Drill
2. Transport the rotor to the v-block stands and partially rest the weight on the stands, but keep tension on the rigging.	
3. Strap lap the journal areas of the rotor using fine grit emery.	
4. Final, check the level of the rotor, and if good, transport to the shell.	

CONTENT	METHODS & ACTIVITIES
5. Station observers along the way.	
6. Watching for interference as the rotor is lowered into the shell is even more important than when it is being removed.	
7. The weight of the rotor could crush diaphragm components without the riggers even noticing, so extreme care must be taken.	PE Tool: Maintain a Questioning Attitude during Rotor Installation as clearances are very tight.
I. Apply heavy oil to the lower bearings and set the rotor in place.	
1. Remove the rigging beam and then roll out the u-straps from the rotor.	
J. Once the rotor is installed it will be rolled numerous times for checking fits, wheel readings and alignment readings. An Anti-rotation plate must be installed on every bearing that has the upper components removed. If this plate is not installed the possibility of the lower bearing component rolling out of the fit is possible and could result in injury to personnel and serious damage to equipment.	Operating Experience Error Precursor: Assumption Don’t assume some one has installed the anti-rotation plate. Perform a Self Check and go insure the plate is installed.
1. Install anti-rotation plates on the lower bearing halves.	
2. The rotor will need to be rotated and the anti-rotation plates keep the bearings from rolling out.	
3. They are installed on the right side horizontal joint.	
K. Prior to further assembly, the wheel and diaphragm clearance readings need to be taken.	
1. Now that the components are at ambient temperature the readings will give an accurate indication of the axial alignment of the turbine.	

CONTENT	METHODS & ACTIVITIES

2. If working on a LP turbine set the rotor in its proper axial position by measuring the coupling gap on the turbine end of the rotor.
3. The gap should be equal to the coupling spacer thickness.
4. All axial measurements are taken with the rotor train thrusted towards the turbine end.
5. Therefore you must insure the upstream rotors have been left thrusted that direction.
6. When working on the HP rotor, axial position can be determined by measuring the gap between the thrust collar and the thrust bearing casing on the generator side of the casing.
7. The gap should equal the thickness of the thrust plate and shim on that side.
8. The rotor is thrusted by using thrust brackets on each end of the rotor that are bolted to the horizontal joint.
9. Jack bolts on the brackets push against the back-side of the coupling hubs.
10. Once the rotor is turning and up on oil it moves easily.

L. Once the rotor is positioned, take the wheel and diaphragm clearance readings.

1. They are compared to the actual as-built readings and the deviations will show whether an axial alignment move needs to be made.
2. On the HP rotor axial adjustments would be made by changing the thickness of the thrust bearing shims.

CONTENT	METHODS & ACTIVITIES
3. It would be unusual to have to do this as the HP shell and mid-standard are keyed together and the relationship between the 2 should remain constant.	
4. An axial move on a LP turbine is not so unusual.	
5. We have had to do this numerous times at Palo Verde due to settlement of the foundation pedestals (we think).	
6. The inner casing is keyed to the lower exhaust hood.	
7. By changing the thickness of the keys, the inner casing can be moved relative to the rotor to reestablish the proper clearances.	
M. Once the wheel and diaphragm clearances are accepted, assembly can continue with installation of the upper diaphragms.	
1. Rig the diaphragm halves according to the tech manual. Install the guidepins into the lower half.	PE Tool: Procedure use and adherence.
2. Apply anti-seize to the seal strip and crush pin on the upper and install.	
3. Install and torque the horizontal joint bolts. Continue until all diaphragms are installed.	
4. Once all are installed, rotate the rotor to make sure there is no binding.	
N. On the HP turbine, install the packing heads and tension the bolts.	
1. The packing heads are internal to the shell.	
O. Horizontal joint studs on the turbine are tensioned.	

CONTENT | **METHODS & ACTIVITIES**

1. Readings need to be taken on the studs in their relaxed state and it is easiest to measure the LP studs before proceeding.

2. We normally measure the studs during the inspection process just to speed things up.

3. It is also easier to lubricate the threads of the LP studs at this time.

4. The studs for the HP will be installed with the upper shell, so it is best to have them lubricated and suspended in the shell from the upper nuts.

EO: 1.2 List the steps required for reinstallation of the inner (shell) casing

Main Idea

CONTENT	METHODS & ACTIVITIES
I. Installation of the LP inner casing	
A. Inspect the upper half casing for any loose items.	Self Check
1. Make sure the FME devices are in place in the pockets.	
B. Install the guide pins into the lower half inner casing.	
C. After holding the pre-job briefing, attach the rigging to the upper half according to the tech manual.	PE Tool: Pre-Job Brief and 2 Minute Drill
1. Level the upper half.	
D. Apply Alinco (Triple boiled linseed oil) to the horizontal joint of the lower half.	Power Point Slide 90
1. Transport the upper half to the turbine and center over the guide pins.	
2. While observing for obstructions, slowly lower the upper half.	
3. As the upper is being lowered, have I&C install the thermo-couple on the left side.	
4. Just prior to landing the upper half, install the body fit studs into their appropriate holes and drive them in.	
5. Complete the lowering process and remove the rigging.	
E. Install all of the nuts onto their respective studs.	
1. They are numbered as to location.	

CONTENT	METHODS & ACTIVITIES
F. Begin the tensioning process with the inner studs in the center pocket.	
1. Hy-torq equipment can be used.	
2. Set the hydraulic pressure to achieve the desired elongation.	
3. Numerous passes will need to be made to get all of the inner studs elongated properly.	
4. Once the inner studs are tightened, begin on the outer studs.	
5. They are slugged up tight (called cold-stretched) and measured to determine how much more elongation is required.	
6. Using a special protractor the nuts are laid out for degrees of rotation needed to obtain the proper stretch.	
7. Using the cowl rods, heat the studs until the nuts can be turned the desired amount.	
8. Work from the center out.	
9. Once all of the studs are tightened, allow them to cool and measure them again.	
10. Adjustments may need to be made.	PE Tool: Self check Double check to ensure elongation for each bolt is correct.
11. After all of the studs are in tolerance, torque the hex bolts for the casing extensions.	
12. Feeler check the joint to insure it is closed.	PE Tool: Stop when unsure If a gap is found let the turbine leader know right away. An obstruction here could cause steam cutting of the joint.
G. Make up the hood spray piping connections and have the lock tabs welded.	

CONTENT	METHODS & ACTIVITIES
H. Remove all of the FME devices and close up the inner casing manways.	
I. Install the cone extensions.	
J. Rope off the area around the turbine and remove the inner casing work platform.	

EO: 1.3 List the steps required for reinstallation of the exhaust hood

Main Idea

CONTENT	METHODS & ACTIVITIES
I. **Installation of the HP upper shell**	PE Tool: Pre-Job Brief
A. Thoroughly clean and inspect both the upper and lower half shells.	
B. Stage 8ea. 50 ton hydraulic rams and shims at the lower half shell.	
C. After holding the pre-job briefing, attach rigging to the upper half shell according to the tech manual.	PE Tool; Procedure Use and Adherence. The Shell must be rigged in accordance with the technical manual as it is heavy and the weight needs to be distributed evenly over the four legs.
1. Raise the shell and check its level condition.	
2. Adjust the rigging so that the upper shell is level.	
3. Apply Alinco (Triple boiled linseed oil) to the lower half horizontal joint and transport the upper into position and lower until it is ready to engage the fit areas on the diaphragms (approx. 10 ").	
D. Install the jacks and shims and adjust them to the same height.	
1. Begin lowering the shell, and by using the jacks and the crane together to maintain even lowering, set it down.	
2. Use of the jacks is not <u>required</u>, but it is a recommendation as it helps keep from galling a fit.	

CONTENT

3. Installing the upper shell level is very critical. The clearance between the shell fits and the upper diaphragms is so tight that if the upper shell isn't level the two parts will begin to rub together which causes galling (pulled metal). If the pulled metal is bad enough it can cause the shell to stick and make it very difficult to get back off to repair. During U3R3 the shell had to be removed again to weld repair some galled areas.

E. After removing the rigging, lubricate and install the stud bottom nuts in their respective locations.

1. Using the stud stretch sheet and the datum rods, take the relaxed readings on the studs.

2. Beginning in the middle and working outward, cold stretch the studs to close the joint and take the "slop" out of the threads.

3. Feeler check the joint to make sure it is closed.

4. Again measure the studs to determine the amount of elongation still required.

5. Stretch the studs in accordance with the super bolt technical manual.

6. There are 84 studs ranging from 4 1/2 to 6 inches in diameter.

7. Some of the 6 inch studs get stretched 50 to 65 mils.

F. After the horizontal joint bolting is completed, the steam pipes may be made up.

1. The flanges are a tongue and groove joint with gaskets.

2. Install the gasket.

3. Using the overhead crane taking a strain on the pipe may help in aligning the flange.

METHODS & ACTIVITIES

Operating Experience

PE Tool Questioning Attitude
While the upper shell is traveling downward be watching for the slightest hesitation of the shell to travel. This could indicate galling and an un-level condition.

CONTENT	METHODS & ACTIVITIES
4. Release the come-along or turnbuckle on the ears of the pipe and pull it into the shell flange.	
5. Lubricate and install the studs and nuts.	
G. The center pipes, the main steam leads, have the studs tensioned using heating rods.	
1. The outlet pipes on the 4 corners have the studs torqued to 2200 ft.lbs.	
H. After tightening the studs, unpin the spring can supports for the piping.	
I. Now that the upper shell is installed, the "tops-off" or alignment keys, need removed and the "tops-on", or running keys, installed.	
1. Using 75 ton jacks, and maybe assistance from the overhead crane, raise the turbine shell and install the running keys.	
2. Remove the alignment keys and lower the shell.	
II. **Installation of the LP Exhaust hood**	
A. On the lower half, clean the horizontal joint and stone the surface.	
1. Chase the threads in the horizontal joint bolt holes.	Power Point Slide 91
B. After holding the pre-job briefing, attach the rigging to the exhaust hood.	PE Tool: Pre-Job Brief
1. Raise and level. Install the guide-pins in either the left or right side lower half.	
2. Apply Alinco to the lower horizontal joint.	
3. Apply RTV 60 in the cone area only.	
C. Transport the exhaust hood to the machine and center over the guide pins.	

CONTENT	METHODS & ACTIVITIES
1. Begin lowering while watching for interference with the cone extensions inside.	
2. Just as the hood begins to make contact with the lower half, install and drive home the horizontal joint dowels.	
3. After the dowels are in, relax the tension on the crane and remove the rigging.	
4. Install the horizontal joint bolts and torque.	
D. Lubricate and install the circular gib keys on top of the exhaust hood to the inner casing. Install new gaskets and the covers and torque the bolts.	

EO: 1.4 State the procedure for realigning the turbine

Main Idea

CONTENT	**METHODS & ACTIVITIES**

I. **Coupling Alignment**

A. Alignment of turbine rotors and couplings is quite a bit different than a normal coupling alignment.

1. On our units we are dealing with 5 rotors in a line, having 4 couplings.
2. Only the 'D' coupling is aligned in what is called a fair condition with the face and rim in alignment.
3. The 'A' coupling is intentionally offset .028" on the rim and .002" on the face. 'B' and 'C' couplings are set with the rims in alignment and the face open .007” to .008” at the top.
4. This may seem strange, but the machine is designed such that at temperature and rated speed, the shafts will come into alignment.
5. The turbine rotors are moved by making shim changes to the contact pads of the lower bearing rings.
6. The generator rotor and bearings are not moved relative to the stator.
7. So if the generator rotor needs moved, the entire generator gets moved.
8. Since the generator weighs over 900 tons when assembled and has feet that run almost the entire length, a shim change is a big job.
9. The low pressure exhaust hoods and inner casing cannot be moved once assembled.

CONTENT	METHODS & ACTIVITIES

10. If a LP rotor needs moved, you have to consider the internal clearances of the turbine before making the move.
11. The HP turbine is a different story.
12. The shell can be moved as it sits on the running keys for elevation, and is also keyed horizontally to the front and mid-standard.
13. The clearances internal to the HP are closer than on the LP turbines.
14. So if the HP rotor is moved, the shell may need moved to realign it to the rotor.
15. The other consideration with the HP rotor is that it is coupled to the control rotor in the front standard, and all of the other components in the front standard are daisy-chained to the control rotor.
16. The alignment tolerance for the front standard components is .002", so if the HP rotor is moved, all of the front standard components may need realigned.
17. At Palo Verde all of our alignment decisions are based on readings taken when the components have cooled down to ambient.
18. With the LP turbines the readings are taken at reassembly,
19. The HP turbine is built differently, with the bearings being in the front and mid-standard.
20. Alignment readings can be taken with the shell disassembled and the rotor sitting in the bearings.

CONTENT	METHODS & ACTIVITIES
B. As an example, during U2R7 the turbine was taken apart.	Operating Experience
1. By the time all of the components were removed the shell and rotor were basically at ambient temperature.	PE Tool Questioning Attitude by thinking ahead, alignment checks were possible to do with the turbine disassembled saving additional steps at the end of the evolution.
2. The rotor was installed and an alignment check made on 'A' coupling.	
3. The rotor was then removed for cleaning and inspection.	
4. The alignment corrections were then made while inspecting the bearings, and changes made to the running key thickness.	
5. At reassembly, the alignment was checked and found to be good.	
6. Because of all the variables in the process, engineering and supervision make a joint decision on what alignment moves to make.	
7. What we'll cover now is the process of taking the readings and making the shim changes.	
C. Prior to taking the alignment readings the bearings need to be squared up.	PE Tool: Pre-Job Brief
1. This is accomplished by using 2 ea. 75 ton jacks and a v-block to raise the rotor about .030".	
2. Install a piece of gasket material thicker than the bearing clearance on top of the journal. Normally 3/32" is just right.	
3. Install the upper half of the bearing ball and tighten the bolts.	
4. Release the hydraulic pressure and lower the rotor.	

CONTENT | **METHODS & ACTIVITIES**

5. Remove the upper half bearing and the gasket material.

6. Both bearings need squared up so repeat the process on the other bearing(s).

D. Coordinating with operations, run the turning gear oil pump and the required bearing lift oil pumps.

1. Using the turning device, rotate the rotors for approx 15 minutes to take out the sag from the rotor as it has been sitting stationary for some time.

E. The alignment readings taken are 16 point face readings and rim readings taken at 90 degrees.

1. Install a mag-base and indicator on top of the coupling on the rim indicating from turbine to generator half and zero.

2. From this initial position, take gap readings on the face at 90 degrees and record in row of the table.

3. Rotate the rotors 90 degrees and repeat the gap readings and read the indicator.

4. Continue in this manner until the four 90 degree positions have been taken.

5. The face readings at top, left, bottom, and right are averaged.

6. From the averages the face alignment is determined.

7. Be sure that after turning the rotors 90 degrees that the pin used to turn the rotors is free in the hole.

8. If it is bound up the readings could be in error.

9. The set of readings should add up to be valid.

CONTENT **METHODS & ACTIVITIES**

10. Take a second set to see if the readings repeat.

11. Perform the process on the coupling at the other end of the rotor, if necessary.

F. The readings will be evaluated by supervision and engineering and determine what move to make with the bearing.

1. The bearings have 5 pads located on the bottom ring.

2. Shim changes are made at these pads to shift the position of the bearing in the pedestal.

3. There are 2 methods available to calculate the shim change.

4. The first is calculating the change by adding the following 2 calculations together for each pad.

   a. Shim= vertical shift x cosine of the pad angle

   b. Shim= horizontal shift x sine of the pad angle

5. The pad angles are: bottom pad is zero, the adjacent pads are 30 degrees, and the oil hole pads are 75 degrees.

6. The second method is to use the data sheet in EXCEL that will calculate the shim changes for you.

   a. All that is needed to be entered is the desired shift horizontally and vertically.

   b. The sheet is found in the H drive, RAMS, common, MT, forms.

G. To make a shim change on the pads the bearing will need to be rolled out.

CONTENT	METHODS & ACTIVITIES
1. Raise the shaft using the 75 ton jacks and the v-block. Lock the collar on the jacks - do not rely on the hydraulics to hold up the rotor.	PE Tool Pre-Job Brief 2 Minute drill
2. Attach rigging to one side of the bearing liner and oil the journal.	
3. Use caution to not damage the bearing pieces or the journal during this process.	
4. As the bearing is being rolled out, utilize a "anti-rotation device" to keep the bearing ring from rolling out with the bearing.	
5. Once the liner is sitting on top of the journal, rig it off with the crane.	
6. To roll out the lower ring, attach chain falls to both sides of the ring.	
7. Place sheet rubber around the journal for protection.	
8. Raise the ring up from the pedestal fit.	
9. Using the falls, raise one side while lowering the other until the ring can be removed from around the rotor	
10. Transport to a work area off the machine and make the desired shim change.	
11. While making the shim change, keep accurate records of what shims were found and what was left in place.	PE Tool: Self Check and Peer Check
12. Also use care in insuring that left is left, and right is right.	
13. As long as the shim change is under .010", the bearing can just be installed.	
14. If the change is over.010", the bearing contact to the pedestal must be blue checked again.	

CONTENT **METHODS & ACTIVITIES**

a. This is a time consuming process, as the bearing has to be rolled in and out each blue check.

15. At the installation of the bearing, it has to be squared up to the rotor again before taking another set of alignment readings.

H. If the alignment is acceptable, take rotor position readings between the packing groove and the rotor.

1. These readings give an indication as to the internal clearances for the turbine.

2. If the HP rotor was moved, the rotor position readings will determine if the shell needs to be moved to reestablish proper clearance.

I. Vertical moves on the shell are made by adjusting the thickness of the running keys.

1. Whatever adjustment made to the running keys must be made to the alignment keys also.

2. There is a third set of keys called the safety keys.

a. The thickness of these keys must be changed also.

b. The safety keys, commonly called idiot keys, are permanently installed and are used in case the alignment keys are forgotten to be installed before de-tensioning the horizontal joint.

3. The upper and lower halves of the shell are keyed horizontally to the front and mid-standards.

a. These keys are adjusted to move the shell sideways.

CONTENT	METHODS & ACTIVITIES
J. If the HP rotor was moved, the alignments in the front standard must be checked.	
1. The control rotor is aligned to the HP rotor.	
2. The shaft driven oil pump casing is aligned to the pump impeller.	
3. The PMG is aligned to the oil pump shaft.	
4. The clearances for the differential expansion detector are re-established, as are the speed probe and emergency trip mechanism.	
5. All of these alignments and clearances are controlled by the Front Standard Clearance Diagram in the tech manual.	
II. **Final Assembly and Coupling Up**	
C. Install the packing segments in the outboard groove of the packing casing.	
1. Using the "Johnson bar" and attachment, rig and install the packing casing.	
2. Use care not to damage the packing teeth when sliding the casing into position.	
3. Apply RTV-60 to the vertical and horizontal joint of the casing and torque.	
D. Roll in the lower oil deflectors next to the packing casings.	
1. The oil deflectors use Tite-seal on the joints.	
2. Set the clearance on all of the oil deflectors in accordance with the tech manual.	M400-0303-01033 Dwg.
a. This clearance may vary between oil deflectors as it is based on journal size.	
3. Torque the bolts.	

CONTENT	**METHODS & ACTIVITIES**
E. Set the upper half of the oil deflectors next to the packing casings in place.	
F. During final assembly of the bearings, the following measurements need to be taken: tilt, twist, and pinch.	Power Point Slide 92
1. Tilt is the relationship of the bearing to the axis of the rotor in the vertical direction.	
2. Twist is the relationship of the bearing to the axis in the horizontal direction.	
a. Twist is measured with feeler gages at the horizontal joint of the bearing.	
3. Measurements are taken on both inboard and outboard, and on the left and right.	
4. The twist is calculated by using the equation on the bearing alignment sheet.	
5. Tilt is measured by placing a lead wire which is thicker than the bearing clearance on top of the rotor.	
a. The upper half of the bearing liner is installed and the bolts tightened.	
b. Remove the upper half and measure the wire.	
c. Using the equation on the bearing alignment sheet, the tilt is calculated.	
6. Pinch is determined by placing a lead wire (which is thicker than the shims that will be used) on top of the bearing liner and installing the strong back.	Power Point Slide 93
a. Shims of a known thickness are placed under the strong back at the horizontal joint and the bolts tightened.	
b. Remove the strong back and measure the wire.	

CONTENT	METHODS & ACTIVITIES

c. The thickness of the shims minus the thickness of the crushed wire is the pinch.

d. With our turbine bearings the pinch should be zero to one mil pinch.

G. If the tilt, twist, and pinch are acceptable, final assemble the bearings.

1. The bearing bolts are torqued, with the exception of the large hex bolts for the ears.

a. They are tightened to deflect the ears 1 to 2 mils.

b. Set up dial indicators and tighten the bolts to obtain the proper deflection, and then bend the lock tabs over the bolt heads.

H. Install the bearing lift pump oil line and have the lock straps welded.

I. Have the bearing thermocouples installed.

J. Position the couplings so that the assembly match marks are in line.

1. Rig and install the coupling spacer

a. Do not use any lubricant on the spacer.

b. Attach the spacer to the turbine half of the coupling with the 4 socket head cap screws, but do not torque at this time.

K. Install 4 clearance studs in the coupling.

1. Back off of any thrust brackets and install a turning pin in the coupling.

2. While rotating the rotors, tighten the studs to pull the rotors together.

3. As the faces are almost touching, install 2 expanding mandrel pins into their respective holes.

CONTENT	METHODS & ACTIVITIES

4. Complete tightening the 4 clearance studs.

L. At this point a preliminary check is made on the coupling run out and recorded.

M. Installation of the hydraulic coupling bolts is a 2 stage process.

1. The tapered studs and sleeves are installed and the sleeves expanded.
2. They are then tensioned.
3. Use the tooling for the particular coupling bolts as specified by the vendor drawings.
4. The studs and sleeves are lubricated by wiping them with a rag lightly oiled.
5. The tooling to install the studs will locate them axially in the hole so that proper thread engagement occurs with both nuts.
6. The studs are tensioned to the prescribed hydraulic pressure to insure that they are elongated properly.
7. Insure the holes are clean and free of any burrs or raised metal.
8. The normal method is to install all of the studs and expand the sleeves with the exception of the holes with the 4 clearance studs and the 2 alignment pins.
9. Take another info run-out check.
10. Begin tensioning the studs in a cross pattern and every so often check the run-out.
11. Continue in this manner until all studs are tensioned, and then remove the expandable pins and clearance studs.
12. Install, expand, and tension the studs in those holes.

CONTENT	METHODS & ACTIVITIES

13. If during the process the run-out turns bad, studs may need to be relaxed and tightened in a different sequence.

14. It is important to maintain the run-out as it could have an effect on the vibration levels when the turbine is started up and running.

N. If the final run-out is acceptable, torque and stake the 4 socket head cap screws securing the coupling spacer.

O. Roll in the lower half of the coupling guard and install with the 4 match marked shims.

1. Install the upper half of the guard insuring that the lube oil orifice is installed in the union (B, C, and D couplings).

2. With feeler gages check the clearance of the guard to the coupling hub.

3. If necessary, adjust the clearance using the jack bolts on the feet.

4. If adjustments are made, make new captive shims for the feet that incorporate the change made.

P. Verify FME and install the coupling and standard covers.

1. Tite-seal is applied to the metal to metal joints.

2. Have I&C install the instrumentation that was removed.

Q. The final item prior to releasing the Turbine back to operations is to perform a flush on the lube-oil system.

1. Throughout the outage blanks have been installed in oil feed lines to various bearings that were disassembled or uncovered.

CONTENT	METHODS & ACTIVITIES

2. In areas that were not disturbed, 100 mesh screens will have been installed in the feed lines.
3. By doing this throughout the outage the flushing process is speeded up.
4. The lines that were blanked off will have the blanks removed and screens installed.
5. The lube oil system will be ran and monitored for an increase in pressure.
6. When the pressure builds up it indicates the screens are dirty and need cleaned.
7. The process is repeated until the screens are "clean" after running 24 hours.
8. Maintenance engineering will buy off the oil flush after inspecting what is collected on the screens.
9. All of the feed lines have orifices that are sized for their location.
10. The orifices are all match marked as to their size and location.
11. It is important that they are installed in the proper place.
12. Restoration of the system includes verifying that all blanks are removed, all 100 mesh screens are removed, and that the orifices are installed in their proper location.

CONTENT

R. At PVNGS we had a near miss with 100 mesh screen in the past. The turn over log indicated that the 100 mesh screens had been removed from all bearing orifices. The turbine was just about ready to turn over to operations. One of the turbine workers noticed a tag on one of the bearing orifices that stated “100 mesh screen was installed”. The worker notified management of the tag and consulted the log. It was believed that all mesh screen had been removed because of what was recorded in the log. The worker insisted the screen must still be in or the tag would have been removed. The oil was shut down and the orifice was pulled out. There was still 100 mesh screen installed on the orifice. The worker started with a Questioning attitude and then had to move to challenging assumptions and finished with a peer check to find that the screen was still installed. This is an example of using the PE tools to insure we don’t miss opportunities to fix problems.

1. Some utilities have left 100 mesh screens in a feed line.
2. After a period of time the mesh becomes clogged and shuts off the oil flow to a bearing.
3. The bearing gets "wiped" and also the rotor journal can be damaged, causing an extended outage to repair.

METHODS & ACTIVITIES

Operating Experience

PE Tools

Questioning Attitude

Challenge Assumptions and Self Check

Peer Check

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.

Post Training (Job) Critique

Use Standards & Expectations Book Why, When, & How (page 74)