PALO VERDE
NUCLEAR GENERATING STATION

Mechanical Maintenance Training
Turbine Rework
Classroom Lesson

Mechanical Maintenance Training	**Date: 5/25/2010 8:44:21 AM**
LP Number: NMT75C000403	**Rev Author: MARK TAGUE**
Title: Turbine Rework	**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 17:24:15 -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 10:40:43 -07'00'

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

TCS #99-0606 Add task 8170460208 Rework steam nozzles to lesson plan.

TurboCare Retractable Packing - LGGETRPBS9/99

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 Rework :

Task or Topic Number*	Task Statement
Lesson:	Turbine Rework
LSTG021	Rework or replace steam seals on turbine shell
LSTG022	Rework diaphragms on turbine shell
LSTG002	Rework turbine bearings
LSTG025	Rework or replace governor on LSTG

Total task or topics: 4

TERMINAL OBJECTIVE:

1 Given a maintenance operation, the plant mechanic will, explain the procedure for reworking turbine components

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

1.1 Describe the rework or replacement of the turbine steam seals

1.2 State the procedure for replacing the turbine shell diaphragms

1.3 Explain the procedure for reworking the turbine bearings

1.4 List the steps necessary for replacing the turbine governor

1.5 Describe the rework process for steam nozzles

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 explain the procedure for reworking turbine components 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 Describe the rework or replacement of the turbine steam seals.	
EO02 State the procedure for replacing the turbine shell diaphragms.	
EO03 Explain the procedure for reworking the turbine bearings.	

CONTENT	METHODS & ACTIVITIES
EO04 List the steps necessary for replacing the turbine governor.	
EO05 Describe the rework process for steam nozzles.	

TO: 1 Given a maintenance operation, the plant mechanic will, explain the procedure for reworking turbine components

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

EO: 1.1 Describe the rework or replacement of the turbine steam seals

Main Idea

CONTENT	METHODS & ACTIVITIES
I Shaft Seal Packing	Power Point Slide 75 Use packing set and tools to demonstrate
A. Packing rework	
1. Machine or hand scrape using tool contoured to maintain tooth profile and sharpness.	Explain to the student that care must be taken to avoid gouging the teeth when scraping.
a. Take care to avoid gouging the teeth when scraping	
b. Sharp edges can easily cut fingers - take care to avoid this	PE Tool: 2 Minute Drill Packing is sharp and will cut easily. Where a good set of gloves along with other required PPE.
2. If teeth are gouged or severely damaged, replace the packing.	
3. If new packing is not available and the damage is limited to severe denting and small gouges, the following procedure may be used to reconstruct the packing edges.	
4. *****WARNING*****Do NOT attempt to use this procedure on carbon shaft packing. This procedure is only for use on metallic packings. **NOTE:** There are special hand tools available for straightening packing that General Electric deems repairable.	PE Tool: Stop when unsure

CONTENT	METHODS & ACTIVITIES
5. *******NOTE******* This is a laborious and time consuming procedure. It should be used only as a last resort if new packing is not available and repairs must be made immediately to resume turbine operation.	
B. Packing replacement	Power Point Slide 76 Diaphragm section.
1. Packing segments	
a. Packing segments are rabbetted on both sides and slide into the diaphragm.	
b. Slide the packing segments out of the diaphragm and install the new segments.	
2. Packing springs	Power Point Slide 77 Packing springs
a. Replace any broken, damaged, or bent springs and retaining rings.	
II RETRACTABLE PACKING	Power Point Slide 78 Cross-section of retractable packing in open position.
A. Since rubbing creates excessive clearance and increased steam flow through the packing, resulting in large loss in efficiency, a retractable packing design was developed which provides a large clearance during the critical periods and design operating clearance during operation.	Currently in U1 and U3 HP Turbine diaphragms.
B. The flat spring normally located behind the packing ring has been removed and replaced with a coil spring located in a hole machined in the butt of the ring segment.	Modified Packing Ring
1. The coil spring causes the packing ring segments to move radially away from the shaft and take up the amount of space between the back side of the packing and the packing ring holder.	

CONTENT	METHODS & ACTIVITIES
2. This distance is normally .125” and does not include design radial clearance (normally an additional .015” to .025”).	
C. The segments have moved radially away from the shaft, allowing a total radial clearance of .150”.	
1. The packing is designed to close beyond the point where thermal gradients occur and well above the critical speed range.	
D. As steam flow increases through the turbine, steam pressure behind the packing ring will overcome the spring and friction forces, thus causing the packing ring to close to the desired operating clearance.	Power Point Slide 79 Cross-section of retractable packing in open position.

EO: 1.2 State the procedure for replacing the turbine shell diaphragms

Main Idea

	CONTENT	METHODS & ACTIVITIES
I	Diaphragm Replacement	PE Tool: 2 Minute Drill Rigging hazards, pinch points and minimal clearances.
	A. Slowly lift diaphragm clear of shell half. Avoid damaging the crush pins on the high pressure side rim or the machined facing on the low pressure side rim.	Power Point Slide 80 Explain to the student that because the low pressure side rim forms a metal-to-metal joint, damage to this area must be avoided.
	B. Insert reworked diaphragms into the shell half. Maintain clearances in accordance with the appropriate clearance diagrams.	Power Point Slide 49

EO: 1.3 Explain the procedure for reworking the turbine bearings

Main Idea

CONTENT	METHODS & ACTIVITIES
I Bearing Rework	PE Tool: 2 Minute Drill
A. Journal Bearing Rework	Power Point Slide 82
1. Babbitted surfaces	
a. Lightly hand scrape raised lips around scoring, being careful not to remove any babbitt from the bearing surface.	PE Tool: Stop when unsure While performing bearing scraping, scrape lightly to remove high spots. If your not sure what exactly to look for STOP and get the turbine leader to show you.
b. If cracking in babbitt is found, re-babbitt the area and rebore the bearing; or, replace the bearing.	Explain to the student that babbitt is very soft material and that a very light touch during scraping is required.
1) Re-babbitting involves melting a rod of babbitt material onto the bearing shell	
2) Will have to be re-bored to proper size	
c. Fitting of replacement journal bearings	Replacement should have fitting checks performed to verify the true bore characteristics.
1) Acquire a check sheet from General Electric	
2) Using inside micrometers measure bearing I.D. at various points.	

CONTENT	METHODS & ACTIVITIES
2. Alignment pads	Power Point Slide 83
a. In the past at PVNGS we have had a situation where the alignment pad(s) on a bearing had some small high spots left over from filing to shape, or debris left in between the shims underneath the pads. The pads must be stoned smooth and inspected for any high spots, and all shim changes must include a thorough inspection and cleaning before being installed and the bearing rolled back into the machine. These types of obstructions get found usually one of two ways. On the final feeler check of the pads, or at alignment reading time. These obstructions cost a great deal of lost time as the bearing components must all be rolled out and inspected and installed again. This is unacceptable.	Operating Experience
b. Lap alignment pads, if necessary, to achieve 75% overall contact with 100% contact around oil feed and drain holes.	PE Tool; Questioning Attitude Ensuring the proper contact area is critical. Sometimes debris can cause minimal contact. Be sure no debris is present between shims or after shaping alignment pads.
3. Bearing re-alignment	Power Point Slide 84
a. Measure TILT and correct if necessary.	
b. Measure TWIST and correct if necessary.	
B. Thrust Bearing Rework	
1. Babbitted surfaces	Repeat the previous warning about scraping babbitted surfaces.
a. Thrust plates	

CONTENT	METHODS & ACTIVITIES
1) Lightly hand scrape to remove any lips from scored areas.	
2) *******WARNING******* Do NOT attempt to re-taper the thrust plate lands by scraping. Special equipment is required to duplicate the 3-dimensional geometry of the 6 x 9 taper.	Ensure the student understands that re-tapering the thrust plate lands is a specialized repair procedure.
3) Re-taper lands as required.	
b. Tilting pads.	
1) Lightly hand scrape surfaces to remove lips around scoring.	
2) Replace pads if mechanically damaged.	
2. Thrust Collar Rework.	
a. Use FINE CROCUS cloth to remove any rust or scaling that is present on thrust collar.	Q. Why do we want these deposits removed? A. They prohibit oil wedge formation.
b. If deep rusting or pitting is evident, the thrust collar must be reworked.	Part of rotor forging
3. Shim adjustments	Ensure the student understands when thrust bearing shims adjustments are necessary.
a. *******CAUTION******* Thrust bearing shim adjustments must be made if thrust bearing parts are replaced OR if rotor repositioning is required.	
b. Position rotor to achieve bucket clearances in accordance with the clearance diagrams.	

CONTENT	METHODS & ACTIVITIES
c. Adjust shims to maintain this rotor position.	
d. Check the setting of the thrust bearing wear detector and reset if required.	Power Point Slide 85

EO: 1.4 List the steps necessary for replacing the turbine governor

Main Idea

	CONTENT	METHODS & ACTIVITIES
I	Turbine Governor Replacement	PE Tool; 2 Minute Drill Explain to the student that the governor is replaced rather than reworked. After rework the governor has an unknown set point that could allow the turbine to over speed.
	A. Remove front standard cover	
	B. Disconnect and remove the Quill shaft from between the control rotor and the HP turbine rotor.	
	C. Unbolt the governor from the control rotor and replace.	
	D. Install Front Standard Covers.	
	1. *******WARNING*******The newly installed Emergency Governor MUST be tested upon turbine startup to ensure proper protection from turbine overspeeding.	

EO: 1.5 Describe the rework process for steam nozzles

Main Idea

CONTENT	METHODS & ACTIVITIES
I NOZZLES	Power Point Slide 86, 87 & 88
A. A diaphragm is a stationary part of each stage in the turbine.	
1. Its purposes are to accelerate the steam in order to produce mechanical energy at the buckets and to direct the steam at the proper angle into the buckets	
2. The acceleration of the steam is accomplished by precise control of the nozzle area of each stage.	
3. This control of the area distributes the total pressure drop in the turbine in the most efficient proportions among the various stages.	
4. The area of the first stage is the most critical because it controls the total amount of steam that passes through the turbine and, hence, controls the capacity of the turbine.	
B. Steam arriving at the turbine passes through the steam chest and is admitted into the turbine in the required amounts by the steam control valves.	
1. Angular nozzles, or ports, in the nozzle blocks, organize and distribute the steam so that it flows in the proper directions in well-formed high-speed jets.	
2. These jets of steam strike the buckets of the first-stage wheel at the optimum angle, imparting rotational energy to the rotor.	
II NOZZLE BLOCK	

CONTENT

METHODS & ACTIVITIES

A. The design of nozzle parts depends on factors such as the entering steam conditions, exhaust steam pressure, shaft speed, rated capacity, steam flow, and their location in the machine

B. Nozzles may be either “converging” or “converging-diverging” type, relative to how they shape the steam, with the selection depending on the pressure ratio of steam across the nozzle.

    1. In cross section, however, the steam passage essentially remains rectangular.

    2. The nozzle openings are usually grouped so that each group can be controlled by a given control valve.

C. First-stage nozzles and diaphragm partitions essentially perform the same function, differing only in terminology and the temperature and pressure of operation.

D. The nozzle block, or plate, containing individual directing vanes and is arranged in segments which are bolted and keyed to the shell face just ahead of the first-stage wheel.

    1. The service experienced by the nozzle block is most severe at start-up time, when temperature differentials and stresses are greatest and freedom of movement is somewhat restricted.

    2. In turbines, which are continually being cycled on, and off, therefore, heat chamber design and operating practices become very important.

        a. In many feed pump turbines, the low-pressure nozzle assembly is welded directly to the head.

        b. High-pressure admission utilizes a separate lower half assembly in which the nozzles are of the reamer type.

CONTENT	METHODS & ACTIVITIES
III METHODS OF SUPPORT	
A. First stage nozzles are held in the shell by a ring of pre-stressed bolts at the inner diameter and by closely fitted holding keys and/or austenitic ring at the outer diameter.	
1. This austenitic ring is designed with a small clearance, which will close tight at normal operating temperature due to a higher coefficient of expansion than the shell material.	
2. These parts must restrain a force applied on the admission face of the nozzle by the pressure drop across the nozzle.	
IV MAINTENANCE – Could include the following	
A. First stage nozzles	
1. Visually examine in place discharge edges of partitions, spill strips, holders, bolting, and keys.	PE Tool: Questioning Attitude during any inspection.
2. Examine ahead of the nozzle using boroscope.	
3. Remove for detailed examination – partition keys, shims, and bridges – determine erosion pattern.	
4. Magnaflux or dye check nozzles and bolts.	
5. Clean joints of oxide compounds.	
6. Blue check fit areas.	
7. Replace nozzle, re-stressing bolts to proper tolerance.	
8. Area check nozzle openings.	

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.