PALO VERDE
NUCLEAR GENERATING STATION

Mechanical Maintenance Training
Turbine Inspections
Classroom Lesson

Mechanical Maintenance Training	**Date: 5/25/2010 7:43:47 AM**
LP Number: NMT75C000303	**Rev Author: MARK TAGUE**
Title: Turbine Inspections	**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 12:31:28 -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 10:43:02 -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

TCSAI 2781091 SEN252 Unplanned outage because of turbine blade failure

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 Inspections :

Task or Topic Number*	Task Statement
Lesson:	Turbine Inspections
LSTG023	Inspect turbine governor on LSTG
LSTG024	Clean turbine governor on LSTG
LSTG019	Inspect inner and outer turbine shells
LSTG001	Inspect turbine bearings
LSTG004	Remove, inspect, and install LSTG couplings

Total task or topics: 5

TERMINAL OBJECTIVE:

1 Given a maintenance operation, the plant mechanic will, explain the procedure for inspecting turbine components as demonstrated by passing a written examination with a minimum score of 80% using classroom reference materials.

1.1 State the inspection criteria for the shaft seal packing

1.2 State the inspection criteria for the turbine casings

1.3 Explain the inspection criteria for the turbine rotors

1.4 State the inspection criteria for the turbine bearings

1.5 State the inspection criteria for the turbine emergency governor

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 inspecting 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 State the inspection criteria for the shaft seal packing.	
EO02 State the inspection criteria for the turbine casings.	
EO03 Explain the inspection criteria for the turbine rotors.	
EO04 State the inspection criteria for the turbine bearings.	

CONTENT	METHODS & ACTIVITIES
EO05 State the inspection criteria for the turbine emergency governor.	

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

EO: 1.1 State the inspection criteria for the shaft seal packing

Main Idea

	CONTENT	METHODS & ACTIVITIES
I	Shaft Seal Packing Inspections	Ensure the student understands the need for detailed inspections on close tolerance equipment.
	A. Packing teeth	
	1. Record any rubbing patterns found.	
	2. Check the teeth for sharpness. Sharpen as required.	PE Tools: Stop when unsure & Questioning Attitude During these inspections question anything that appears abnormal and if there is any uncertainty; STOP and ask the turbine leader to clarify.
	3. Check for cracking or chipping. Replace segments as necessary.	
	B. Packing	
	1. Springs Record all spring breakage locations.	
	2. Check springs for relaxation. Replace springs as necessary.	
	3. Check springs for cracking. Replace as required.	
	C. Packing Housings	
	1. Check for signs of wear within the casing.	
	2. Check housing for signs of erosion, corrosion, pitting, or scoring.	Ensure student knows the difference between erosion and corrosion.
	3. Check mating surfaces for proper fit.	

EO: 1.2 State the inspection criteria for the turbine casings

Main Idea

	CONTENT	METHODS & ACTIVITIES
I	Turbine Casing Inspections	Power Point Slide 56
	A. Inspections on the shells and hoods involve looking closely at the horizontal joint surfaces of these components. The two biggest hazards are trip and fall hazards. Workers will need to be tied off when working inside the fall zone. The casing studs stick up 12 inches or so on the inner casing so workers will need to maintain a keen awareness of where they are standing and where they are proceeding to, because it is easy to trip over these studs or have your fall protection device snag on these studs and cause a fall.	PE Tool: 2 Minute Drill
	1. Distortion-caused by thermal stresses, creep, or quenching from water intrusion.	
	a. First signs usually occur during horizontal joint bolt disassembly	Ensure the student can recognize distortion during the disassembly process.
	b. Sometimes disassembly can only be accomplished by a judicious sequence of loosening and retightening of bolts from the center and working out.	
	c. Other signs may include binding between casing and inner shell requiring hydraulic jacking to separate them.	
	2. Cracking-caused by thermal stresses.	Ensure the student understands how cracks start and propagate.
	a. Check all weld areas especially if distortion is found.	

CONTENT	METHODS & ACTIVITIES
b. Check the structural plates and ribbing especially if distortion is found.	
c. Check the LP inlet bowl area, axial pipe struts, and the diaphragm ledge rings.	
d. Newer turbine units have an inlet turning vane, check carefully if installed. Since there is limited service experience on the turning vanes, all inspection data should be reported to the General Electric Technical Representative.	Ensure the students know to report ALL inspection data to the General Electric Technical Representative. PE Tool: Effectively Communicate data to ensure nothing is missed especially if the items identified require rework.
3. Erosion-caused by the introduction of water or solid particles.	
a. Check all horizontal joint surfaces for signs of leakage.	
b. Check inner surfaces on shells and hoods.	
4. Galling-caused by heavy oxide buildup, shells not at equal temperatures during disassembly, tight clearances, or interference at rabbet fits.	Ensure student understands difference between galling and distortion.
a. Clean up affected areas by filing or stoning any burrs or rolled edges.	
B. Nozzle bores, bridges, and port areas	Power Point Slide 57 Explain to the student that the port area is the area between the valve seat and the nozzle face.
1. Check for cracking on either side of bore radii, and along relief grooves on bridges.	
2. Check for cracking between bore and the adjacent horizontal joint bolt holes, and between bore and port area.	Ensure the student knows each of the inspection points.

CONTENT	METHODS & ACTIVITIES
3. Check for cracks in radii between bores, faces, and in line with the bridges.	
4. Check for the presence of chaplets and chills in nozzle bores and faces.	Explain to the student the difference between a chaplet and a chill.
a. A chaplet is a support which is placed in a mold to position a mold core.	
b. A chill is a piece placed in a mold to direct and enhance the solidification of molten metal.	
c. Because chaplets and chills never fully fuse with the molten metal, they are usually identified by a black oxide layer surrounding them.	Ask the students if anyone has seen indications like this. If so, have them explain the distinguishing characteristics.
d. Chaplets and chills can be the source of pinpoint leaks, and cyclical stress cracking.	Ensure the student understands the importance of identifying chaplets and chills.
5. Check for signs of erosion of the nozzle bores, faces, and port areas.	
C. Pipe Connections	
1. Check for cracks at wall thickness changes	
2. Check for chaplets and chills in shells.	
3. Check for cracks in weld areas.	
D. Valve chests, Bypass and Overload Chambers	
1. Check for thermal stress cracking.	
2. Check for chaplets and chills.	
3. Check for cracking in previous repair areas especially weld areas.	

EO: 1.3 Explain the inspection criteria for the turbine rotors

Main Idea

CONTENT	METHODS & ACTIVITIES
I Turbine Rotor Inspections:	Power Point Slide 58
These inspection need to be thorough since the rotor is a large spinning mass when in service. Any problems found need to be addressed while the rotor is out of the machine as it will not be out again for about 6 years. The trailing edges of turbine buckets will be very rough as a result of moisture and can cut gloves easily. Use extreme care when touching these surfaces.	PE Tools: 2 Minute Drill and Questioning Attitude
A. Turbine Rotor	
1. Check for scoring or scratching on the bearing journals and the thrust plate (HP Rotor).	
2. Check for cracks along the rotor shaft, at fillets of shoulders, and any other rotor diameter changes.	
a. Mechanics will measure the journal diameters	PE Tool: Self Checking
b. ISI & GE perform the NDE rotor inspections	
3. Check for wear, erosion, and corrosion at shaft seal packing areas.	
4. For any cracking found, it is a good practice to perform Magnetic Particle and/or Dye Penetrant testing to identify actual size of flaws.	
a. Magnetic Particle (MT) testing	Ensure the student understands the basic use and theory of Magnetic Particle testing.

CONTENT	METHODS & ACTIVITIES
1) Magnetic Particle tests are used to identify surface cracks or flaws. 2) Basic principles a) Magnetic fields are distorted by irregular surfaces. b) By wrapping current-carrying cables around the magnetic material to be tested, magnetic fields are induced into the material. c) Once the magnetic field is induced, spray finely powdered iron over the surface. d) The iron powder will be evenly distributed over the surface except at areas containing flaws where a high concentrations of powder will be found.	
b. Dye Penetrant (PT) testing	Ensure the student understands the use and basic principles of Dye Penetrant testing.
1) Dye Penetrant testing is used to identify small surface flaws. 2) Basic principles a) Since small surface cracks are not easily seen, some method of high-lighting them is required. b) The piece to be tested is sprayed with dye and the dye is wiped off the surface (but not from the crack). c) The piece is then sprayed with developer and the developer is then wiped off.	

CONTENT	METHODS & ACTIVITIES
d) The developer causes the dye to turn a bright orange in color allowing cracks to be found with or without the aid of a magnifying glass.	
B. Rotor Wheels	Ensure the student understands the inspections to be performed on the rotor wheels.
1. Check rim dovetail areas for signs of cracking, wear, and erosion.	
2. Check steam equalizing holes for cracking, and erosion.	
NOTE: General Electric will also perform an Ultrasonic examination of the wheels.	
C. Buckets (or blades)	Power Point Slide 59 Explain to the student that the buckets are most likely to be damaged by turbine operations, and careful inspections are required.
1. Check the vanes for wear,erosion, and cracking.	
2. Check the bucket roots for corrosion, erosion, pitting, cracking, and mechanical damage.	
3. Check bucket covers for looseness, and cracking at tenon joints.	
4. Check bucket covers for evidence of dislocation.	
5. Check bucket tenons for cracking or corrosion.	
6. Check bucket dovetails for cracking, corrosion, and mechanical damage.	

CONTENT	METHODS & ACTIVITIES
D. **SEN 252 Unplanned Outage Because of Turbine Blade Failure**	Operating Experience
1. On October 18, 2004, Cooper Nuclear Station entered a forced outage because of a sudden increase in turbine bearing vibration.	Power Point Slide 60-63
a. A turbine blade in the number 2 low pressure turbine (row L-2) was found separated at the top of the blade root, along with collateral damage.	
b. A high-cycle fatigue fracture was also noted in another blade in the same row.	
c. The crack was fully propagated through the blade root, but the blade had not ejected before the unit was taken off line.	
d. The significant aspects of this event are as follows:	
1) A malfunction resulted in damage to major plant equipment.	
2) An unplanned plant outage of 20 days resulted from the event.	
2. **Summary of Damage**	
a. Collateral missile damage within the affected turbine was found on adjacent rotating and stationary blades.	
b. Seventeen turbine blades in row L-2 were replaced, either because of consequential impact damage or because they were grouped with damaged blades.	
c. Fourteen additional blades were replaced in row L-2 because indications of cracks were identified during nondestructive examination.	

	CONTENT	METHODS & ACTIVITIES
	d. Nine of these blades were identified using eddy-current examination and four others using magnetic particle examination. e. The rows downstream of the failure (L-1 and L-0) experienced minor impact damage. f. The majority of this damage was blended out to remove any stress concentration sites. Seven impact sites in the L-0 row were in an unfavorable area for blending repairs. g. Tips were removed from these blades, along with three others, to achieve proper balancing. h. Three airfoils were repaired on the stationary blades downstream of the failed rotating row. No other stationary blade repairs were required.	
3.	This Event stresses the importance of doing thorough inspections so that any abnormality is discovered and can be repaired while the turbine is apart for service. Un-discovered cracks, erosion or other abnormality can be costly later.	PE Tools: Questioning Attitude Self Checking and Stopping when unsure.

EO: 1.4 State the inspection criteria for the turbine bearings

Main Idea

	CONTENT	METHODS & ACTIVITIES
I	Bearing Inspections	Power Point Slide 64-67 Explain to the student that babbitt is very soft material and is easily damaged.
	A. Journal Bearings	PE Tool: Questioning Attitude
	1. Check babbitt surfaces for wear, embedded particles, scoring, denting, and cracking.	
	2. Check inside bore for even distribution of wear.	
	3. Perform UT on bearing babbitt	
	B. Thrust Bearing	Power Point Slide 68-72
	1. Check thrust plate babbitt for even wear, embedded particles, scoring, denting, and cracking.	
	2. If cracks in babbitt are suspected or found, a Dye Penetrant test is required.	
	3. Check bearing base ring for distortion, corrosion, and signs of discoloration due to high bearing temperatures.	
	4. Check bearing casing for distortion, cracking, and corrosion.	

EO: 1.5 State the inspection criteria for the turbine emergency governor

Main Idea

CONTENT	METHODS & ACTIVITIES
I Emergency Governor Inspections	Power Point Slide 73 PE Tool: Questioning Attitude Ensure the student understands the need for careful inspection of the emergency governor as it is the last line of defense against turbine damage from overspeed conditions.
A. Adjusting Spring	
1. Check for cracking, corrosion, erosion, and mechanical damage.	
B. Governing Ring	
1. Check for cracking, corrosion, erosion, distortion, and mechanical damage.	
C. Guide Bushing	
1. Check for cracking, corrosion, erosion, distortion, and mechanical damage.	
D. Guide Bolt Assembly	
1. Check for cracking, corrosion, erosion, distortion, and mechanical damage.	
2. Check for signs of galling.	

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.