

PALO VERDE NUCLEAR GENERATING STATION

Mechanical Maintenance Training

Classroom Lesson



Mechanical Maintenance Training	Date: 7/23/2010 7:04:12 AM
LP Number: NMC61C000902	Rev Author: LEE BAKER
Title: Auxiliary Drive and Camshaft	Technical Review:
Duration : 3 HOURS	Teaching Approval:

INITIATING DOCUMENTS

Task Analysis of Tasks

REQUIRED TOPICS

None

CONTENT REFERENCES

South Texas Project Significant Problem Investigation Report #H880200: Cracked Heads on ESF Diesel Generator #23

VTM-C628-001: Diesel Generator Tech Manual

VTM-C628-002: Diesel Generator Auxiliaries

LESSON PLAN REVISION DATA

Jul 23, 2010 Lee Baker

Revised Lesson Plan to:

Incorporate Human Performance and Prevent Events strategies [TCSAI 3478459]

Add systems training tie-in of the Class Electrical systems [TCSAI 3260637]

Include OE from IN 07-27 [TCSAI 3319710]

Tasks and Topics Covered

The following tasks are covered in Auxiliary Drive and Camshaft :

Task or Topic Number*	Task Statement
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Lesson: Auxiliary Drive and Camshaft

EDG004	Perform routine maintenance on emergency diesel engine
EDG010	Troubleshoot emergency diesel engine

Total task or topics: 2

TERMINAL OBJECTIVE:

- 1 Given applicable maintenance instructions the Maintenance Mechanic will, state the function and explain the preventive maintenance associated with the EDG Auxiliary Drive and Camshaft controlled components, demonstrated by passing a written exam with a score of 80% or better.
 - 1.1 Describe the EDG Auxiliary Drive and Camshaft controlled components giving location, function, basic operation and construction.
 - 1.2 Explain the routine preventive maintenance performed on EDG Auxiliary Drive & Camshaft controlled components.

CONTENT**METHODS AND ACTIVITIES**

I. Motivation	Focus student attention on “What’s In It For Me”.
II. Pre-Job Brief A. Pre-job briefing on the day’s activities modeling the use of the Palo Verde Standards & Expectations, Preventing Events B. Focus On Five (Task Preview)	
Familiarize worker with the scope of work, task sequence, and critical steps.	
1. Critical Steps (Terminal Objectives) Given applicable maintenance instructions the Maintenance Mechanic will, state the function and explain the preventive maintenance associated with the EDG Auxiliary Drive and Camshaft controlled components, demonstrated by passing a written exam with a score of 80% or better	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) a. 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.
C. Break policy 1. Two Minute Drill – After lunch at a minimum	At Instructor’s discretion, not to interrupt class flow.

CONTENT

METHODS AND ACTIVITIES

III. Lesson Enabling Objectives

Read and/or discuss the lesson objectives

E001 Describe the EDG Auxiliary Drive and Camshaft controlled components giving location, function, basic operation and construction

E002 Explain the routine preventive maintenance performed on EDG Auxiliary Drive & Camshaft controlled components

TO: 1 Given applicable maintenance instructions the Maintenance Mechanic will, state the function and explain the preventive maintenance associated with the EDG Auxiliary Drive and Camshaft controlled components, demonstrated by passing a written exam with a score of 80% or better.

EO: 1.1 Describe the EDG Auxiliary Drive and Camshaft controlled components giving location, function, basic operation and construction.

CONTENT

METHODS AND ACTIVITIES

- I. Auxiliary Drive and Camshaft Components
 - A. Camshaft and Governor Drive
 1. Location
 - a. On aft end of engine (generator end)
 2. Function
 - a. Drives the camshaft and the control and over-speed governors in timed relation to crankshaft
 3. Operation & Construction
 - a. Split type drive sprocket is mounted and keyed on aft end of crankshaft
 - b. Two camshaft drive sprockets, mounted on a shaft with the camshaft drive gear, are driven by the main drive chain
 - c. Camshaft drive gear mates with gears mounted on ends of the camshafts
 - d. Two adjustable chain tightener and sprocket assemblies are mounted one on each side of the centerframe, so that chain tension can be adjusted
 - e. Lubrication of sprocket bearings and chain is from the engine lube oil system
 - B. Control and Over-speed Governor Drives

NOTE: Already discussed under Control System lesson
 - C. Air Start Distributor Drive
 1. Location
 - a. One on each camshaft forward end (2 ea.)

CONTENT	METHODS AND ACTIVITIES
2. Function a. Drive Air Start Distributor in timed relation to engine firing order	
3. Operation and Construction a. Driven by splined shafts which fit into forward end of camshafts	
D. Tachometer Pickup	
1. Function a. Provide indication of engine speed. (does not supply any information for control system)	
2. Location a. Two each, mounted in close proximity to camshaft drive gears in aft end of engine	
3. Operation and Construction a. Impulses caused by gear teeth passing the detector are converted to engine rpm and fed to a read-out	
E. Oil, Jacket Water and Fuel Pump Drives	
1. Location a. Forward end of engine	
2. Function a. Provide prime mover to operate Oil, Jacket Water and Fuel Pumps	
3. Operation and Construction a. Oil Pump is driven off of the forward end of the crankshaft via an adapter, vibration damper and spacer b. Jacket Water Pump is chain driven from Oil Pump drive c. Fuel Pump is driven off the back of the Jacket Water Pump drive shaft	

CONTENT**METHODS AND ACTIVITIES**

F. Camshaft

1. Location

- a. One camshaft is in the outer top corner of each cylinder block. (2 ea.)

2. Function

- a. Operate the fuel injection pumps and main valves to admit fuel and air into the cylinders and to discharge exhaust gases

3. Operation and Construction

- a. Driven at one-half engine speed and rotation is opposite of crankshaft rotation
- b. Bearings
 - 1) Babbitt-lined, precision split shells without shim adjustment
 - 2) Bearing shells are retained in split carriers that are bolted to cylinder block
- c. Lubrication is from engine pressure system through a header located in camshaft trough
- d. Cams are interference fit onto shaft
 - 1) Cams are heated to expand them sufficiently to permit installation
 - 2) Can be positioned on shaft or removed using hydraulic pressure
 - a) Drilled passage leads to a channel machined into the cam to permit hydraulic expansion for removal from the shaft

EO: 1.2 Explain the routine preventive maintenance performed on EDG Auxiliary Drive & Camshaft controlled components.

CONTENT

METHODS AND ACTIVITIES

I. South Texas Project Significant Problem Investigation Report #H880200--Cracked Heads on ESF Diesel Generator #23

A. Cracked Heads

1. From Dec 10, 1987 through June 30, 1988, the diesel generator was being tested for startup. Timing chain oil supply hoses were replaced and hose clips had been added by removing both timing chain covers
2. It was noticed that start times for the diesel were slower than normal and slower than the others. The vendor found the timing was off and adjusted the timing by **2 LINKS**
3. The start times came in spec, but were still slow
4. During a subsequent test, water was observed coming out of the test cocks in cylinders 2L and 7L. These cylinder heads were removed and found to be cracked, allowing jacket water into the cylinder

What Happend

Emphasize the criticality of proper timing and the precaution of NOT removing the timing chain covers for routine maintenance. Emphasize using this event

B. Further testing was halted until all the cylinders could be checked. **18 OF THE 20 CYLINDER HEADS WERE FOUND TO BE CRACKED**

1. The cause was determined to be the 19 hours of run time with the timing out of spec

What Caused This To Happen

C. **DO NOT REMOVE THE TIMING CHAIN COVERS WITHOUT RETIMING THE ENGINE--** Or, do not remove them

What is the Lesson Learned From this event

II. Surveillance

CONTENT**METHODS AND ACTIVITIES**

- A. Check camshaft timing using Protractor
1. Determine TDC on compression stroke for a selected cylinder
 2. Lay a precision machinist bevel protractor across the valve spring keeper of one exhaust valve and one intake valve and center the bubble
 - a. Bubble should center at approximately 22.5 degrees on bevel protractor since this is the cylinder bank angle
 3. While holding the bevel protractor in contact with both spring keepers, have the engine rotated in the normal direction of rotation, using the turning gear, until the bubble again centers
 - a. This should occur at 16 degrees Before Top Center (BTC) on the exhaust stroke
 - b. Acceptance criteria is +/- 3 degrees
 4. If timing is off, initiate corrective action to have the timing chain tension checked and have the engine retimed
- B. Perform Auxiliary Drive Inspections
1. Remove inspection cover on forward end of engine, and jacket water/ fuel pump drive cover
 - a. Inspect for damage, failures, cracks, or defects of all visible components
 - b. Check for damaged gears, roller bearings, and drive chain condition
 - c. Check vibration damper for dents
 - d. Check mounting for vibration damper, to ensure damper is secure
 2. Replace inspection cover gaskets and cover

Emphasize Peer Check

CONTENT**METHODS AND ACTIVITIES**

3. Remove camshaft housing covers left and right on the AFT end of the engine, to facilitate camshaft auxiliary drive inspections. Ensure **FME** is maintained with covers removed
 - a. Visually inspect condition of the camshaft gears, note any unusual gear wear patterns
 - b. Check idler gear end play
 - c. Check idler gear bearing condition
 - d. Check left and right camshaft thrust clearance
 - 1) If clearance is outside of tolerance (0.006" to 0.010"), initiate corrective action to have thrust clearance adjusted
 - 2) Thrust clearance is adjusted by adding or removing shims at camshaft bushing cover
4. Replace AFT end inspection cover gaskets and covers
5. Remove camshaft bearing access covers as necessary on both sides of engine
 - a. Visually inspect camshaft and cams for scoring or cracking
6. Replace camshaft bearing access cover gaskets and covers

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.