

PALO VERDE NUCLEAR GENERATING STATION

Mechanical Maintenance Training

Classroom Lesson



Mechanical Maintenance Training	Date: 7/23/2010 5:42:15 AM
LP Number: NMC61C000202	Rev Author: LEE BAKER
Title: Lubrication System	Technical Review:
Duration : 6 HOURS	Teaching Approval:

INITIATING DOCUMENTS

Task Analysis of Tasks

REQUIRED TOPICS

None

CONTENT REFERENCES

PM Task # 029899, 025388

VTM-C628-002: Diesel Generator Auxiliaries

Lubrication of plant equipment.

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 Lubrication System :

Task or Topic Number*	Task Statement
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Lesson: Lubrication System

EDG003	Locate a tripped main or connecting rod bearing temperature shutdown detector
EDG004	Perform routine maintenance on emergency diesel engine
EDG010	Troubleshoot emergency diesel engine

Total task or topics: 3

TERMINAL OBJECTIVE:

- 1 Given applicable maintenance instructions the Maintenance Mechanic will , state the function of and explain maintenance performed on the EDG Lubrication System, demonstrated by passing a written exam with a score of 80% or better.
 - 1.1 State the function of the EDG Lubrication System
 - 1.2 Describe the EDG Lubrication System components
 - 1.3 Describe the EDG Lubrication System Flowpath
 - 1.4 Discuss the routine preventive maintenance performed on the EDG Lubrication System
 - 1.5 Explain addition of lube oil including verification that proper oil is added and that oil is at the proper level.

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 of and explain maintenance performed on the EDG Lubrication System, 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

EO01 State the Functions of the EDG Lubrication System

EO02 Describe the EDG Lubrication System Components

EO03 Describe the EDG Lubrication System Flowpath

EO04 Discuss the routine preventive maintenance performed on the EDG Lubrication System

EO05 Explain addition of lube oil including verification that proper oil is added and that oil is at the proper level

TO: 1 Given applicable maintenance instructions the Maintenance Mechanic will , state the function of and explain maintenance performed on the EDG Lubrication System,
demonstrated by passing a written exam with a score of 80% or better.

EO: 1.1 State the function of the EDG Lubrication System

CONTENT

METHODS AND ACTIVITIES

- I. Functions
 - A. Lubricate bearings and other moving parts
 - B. Keep engine warm to enhance immediate startup
 - C. Provide cooling to pistons
 - D. Keep inside of engine clean by preventing rust and corrosion

EO: 1.2 Describe the EDG Lubrication System components

I. Components

A. Circulating Oil Pump and Heaters

1. Functions

- a. Pump and heater are used to circulate warm oil through the engine when it is not operating
- b. Provides pre-lubrication for bearings and moving parts.
- c. Pump operates anytime engine rpm is below 280 rpm

2. Location

- a. Front of engine on auxiliary skid
- b. One heater located in line between pump and pump discharge valve
- c. Unused heater located in crankcase lube oil sump

3. Construction and Operation

- a. Motor - 20 HP at 3500 rpm
- b. Pump - Horizontally mounted, positive displacement, gear-type pump, 112 gpm at 50 psig
- c. Heaters - Controlled by a temperature switch to come on at 120 degrees falling and off at 130 degrees rising
- d. Relief Valve – (Set at 50 psig); Bypasses excess oil back to suction of pump as necessary

B. Main Oil Pump

1. Function

- a. Circulates oil through the lubrication system during engine operation above 280 rpm
 2. Location
 - a. Forward end of engine
 3. Construction and Operation
 - a. Horizontally mounted, positive displacement, engine driven, gear type pump
 - b. Engine driven off of the crankshaft via a flexible coupling
 - c. Capacity - 670 gpm at 90 psig at rated engine speed
 - d. Pump has combination check and relief valve on the suction side
 - e. Pump has discharge relief valve set 45 psi above pressure downstream of the filters and strainers
- C. Thermostatic Valve
1. Function
 - a. Three-way valve controls engine oil inlet temperature by directing oil through oil cooler or bypassing it
 2. Location
 - a. Above Lube Oil Cooler on the Auxiliary Skid
 3. Construction and Operation

- a. Valve is set at 165 degrees –
 - 1) Oil entering port A at 160 degrees or lower goes out port B to bypass the cooler –
 - 2) At 170 degrees and above, the oil goes out port C to the cooler
- b. Thermostatic elements can be removed from valve, but the temperature setting cannot be changed in the field
 - 1) Elements must be replaced if proper temperature is not maintained

D. Lube Oil Cooler

1. Function

- a. Remove excess heat from the lube oil absorbed during engine operation

2. Location

- a. On Auxiliary Skid

3. Construction and Operation

- a. Shell and tube, cross-flow type with a removable bundle
- b. Oil passes through the shell and over the tubes
- c. Cooled by Spray Ponds

E. Full-Flow Oil Filter

1. Function

- a. Filters (10 microns) lube oil to the engine and turbocharger to minimize wear due to dirty lube oil

2. Location

- a. Forward end of the Auxiliary Skid

3. Construction and Operation

- a. A shell that contains 146 replaceable elements (2-11/16" dia. x 27" long) which operate in parallel to give proper capacity and filtration
- b. Internal Automatic By-pass
 - 1) Valve which will open automatically when the differential pressure across the filter exceeds 40 psi to by-pass the filter in the event the elements become clogged
- c. Filter cartridges must be replaced when differential pressure reaches 20 psi

F. Lube Oil Strainer

- 1. Function
 - a. Prevent any foreign particles such as debris from a ruptured oil filter from getting into the engine
- 2. Location
 - a. Mounted on auxiliary skid downstream of the Lube Oil Full Flow Filter
- 3. Construction and Operation
 - a. Two strainers mounted in parallel
 - b. Each strainer consists of a single case with a cover held down by studs and nuts.
 - c. An eyebolt in the cover is used for removing the cover and a drain plug in the case permits draining the oil
 - d. An eyebolt in the cover is used for removing the cover and a drain plug in the case permits draining the oil

G. Turbocharger Oil Filter

- 1. Function
 - a. Provide level of filtration necessary for proper operation of the Turbocharger

2. Location

- a. Mounted on right side of EDG towards the forward end.

3. Construction and Operation

a. Duplex filter

- 1) A three way valve directs oil through either or both sides of the filter
- 2) Normal operation of the filter is one side open to flow while the other side is clean and standing by
- 3) If turbocharger lube oil pressure falls to 34 psig the three way valve must be positioned to allow oil to flow through the clean half of the filter
 - a) Clean the dirty half of the filter immediately

EO: 1.3 Describe the EDG Lubrication System Flowpath**CONTENT****METHODS AND ACTIVITIES**

- I. Oil flow from main pump to Engine
 - A. Thermostatic valve directs oil through and/or around the oil cooler as the temperature of the oil dictates
 - B. Check valves prevent oil from flowing back through the circulating pump
 - C. After leaving the thermostatic valve and/or cooler, the oil flows through a filter, strainers and to the engine main header
- II. Oil flow through the Engine
 - A. Main internal oil header runs the length of the engine. From this header flexible lines supply oil to
 1. Main bearing caps
 2. From main bearings oil flows through drilled passages in the crankshaft to Connecting rod bearings
 3. Through drilled connecting rods and pins into: Piston crowns for cooling
 4. Oil drains from the pistons into the sump
 - B. A small header, off the inlet end of the main header (at the forward end of the engine) supplies oil to:
 1. Turbocharger
 2. Rocker arm headers
 3. Camshaft bearing headers
 4. Air distributors

CONTENT

METHODS AND ACTIVITIES

- 5. Forward camshaft bearing on the right bank
 - a. Camshaft drive gears on both banks receive oil from camshaft bearing headers at the drive end
- C. At drive end of main header a flexible line carries oil to
 - 1. Chain tightener sprockets (both banks)
 - 2. An oil gallery cast into the centerframe
- D. A flexible oil line carries oil to an external header which feeds
 - 1. Both camshaft drive sprockets and gear oilers
 - 2. Governor drives and drive shafts
- E. Rocker shaft headers run the length of the engine and have individual leads which direct oil to:
 - 1. Valve rocker arm push rods of each cylinder head to lubricate main valve mechanism
 - 2. From rocker arm oil is directed to Each fuel injection pump pedestal to lubricate the pump drive
 - 3. Excess oil drains by gravity into the main valve push rod compartment to Lubricate the crosshead guide, bearings, roller and cam
 - 4. From the camshaft trough, oil flows by gravity to the sump
- F. Cylinders and pistons are lubricated by oil thrown off the crankpins and by oil vapor in the crankcase

EO: 1.4 Discuss the routine preventive maintenance performed on the EDG Lubrication System**CONTENT****METHODS AND ACTIVITIES**

- I. Preventive Maintenance
 - A. Replace Flexible Lubrication Hoses
 - 1. These are the hoses that carry oil from the main oil header to the main bearing caps
 - 2. Since these are flexible hoses they "age-harden". Ensure **safety glasses** are worn at all times when replacing these hoses to reduce the risk of injuring your eyes
 - B. Lubricate Pre-Lube Pump Bearings
 - C. Clean and Inspect Lube Oil Cooler
 - 1. Inspect epoxy coating of water boxes for
 - a. Cracks, chips, missing portions of coating
 - 2. Mechanically clean bores of tubes
 - D. Replace Lube Oil Temperature Control Valve
 - 1. Remove three-way temperature control valve from system and replace with new valve
 - 2. The new valves thermostat are checked for operability
 - 3. Use a dip tank for this check
 - E. Replace Turbocharger Bearing Lube Oil Filter Elements
 - F. Take Lube Oil Sample from EDG Crankcase

CONTENT

METHODS AND ACTIVITIES

1. Analysis of an oil sample can reveal many operating parameters including leaking piston rings, fuel content in the lube oil, or wiped or worn bearings, etc
2. Verify the engine has been running for at least 30 minutes

EO: 1.5 Explain addition of lube oil including verification that proper oil is added and that oil is at the proper level.

CONTENT	METHODS AND ACTIVITIES
I. Brunswick Steam Electric Plant Unit 1	From IN 2007-07
A. During a Loss of Offsite Power EDG tripped and wiped a bearing due to Loss of Lubrication	What Happened
1. EDG experienced a high lubricating oil strainer differential pressure alarm	
2. The EDG later tripped due to a momentary drop in lube oil header pressure that occurred while plant personnel refilled the cleaned lube oil duplex strainer.	
3. The alarm condition was caused by the presence of fibrous lint material in the strainer, the remnants of a cleaning towel that was inadvertently left in the EDG lube oil sump during a previous maintenance activity.	Why Did This Happen
4. It was subsequently learned that the licensee had failed to take effective corrective action after similar high differential pressure alarms were received during two prior post maintenance testing runs	
5. During the event follow-up it was discovered that the EDG #9 crankshaft bearing was wiped	
B. Can this happen at PVNGS	<i>Discuss with the class the significance of the event to our plant (related maintenance practices)</i>
C. What can we do to mitigate this event	<i>What preventative measures or barriers are in place (HU Tools, ect..)</i>

CONTENT**METHODS AND ACTIVITIES**

II. Lube Oil Addition

NOTE: Oil can be added when the unit is shutdown or operating

A. Lubricating oil must be added at the lubricating oil fill connection

1. This connection is located at the 103' elevation at about the midpoint of the engine on the right side of the engine

2. The fill connection is marked as such

B. The type of oil to be used is Rotella T 40.

Peer Check to verify that the proper oil is about to be added

C. Each 55 gallon drum of oil added to the sump will have a resultant increase of 1/2 inch in the sightglass

D. Final oil level should be at the blue band +0.5"/-0.5" on sightglass if L.O. system is operating and +2.0" above blue band if L.O. system is secured

E. The above instructions for addition of L.O. to the EDG's will be attached to the L.O. fill connection of each EDG

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.