

05-49-90

GEORGIA POWER
POWER GENERATION DEPARTMENT
VOGTLE ELECTRIC GENERATING PLANT

TRAINING LESSON PLAN

TITLE:	EMERGENCY DIESEL GENERATOR AUXILIARIES LUBE OIL AND CRANK CASE VENTILATION	NUMBER:	LO-LP-11104-04-C
PROGRAM:	LICENSED OPERATOR	REVISION:	4
SME:	C. BREWER	DATE:	12/6/89
APPROVED:	<i>[Signature]</i>	DATE:	12/8/89

INSTRUCTOR GUIDELINES:

- I. FORMAT
 - A. Lecture with visual aids
- II. MATERIALS
 - A. Overhead projector
 - B. Transparencies
 - C. White board with markers
- III. EVALUATION
 - A. Written or oral exam in conjunction with other lesson plans
- IV. REMARKS
 - A. A performance-based instructional unit (IU) is attached to the lesson plan as a student handout. After the lecture, instruction should be provided for the attached instructional unit. The instructor should be available to answer any questions that may arise concerning the IU material. After instruction on the IU, the student will perform, simulate, observe or discuss (as identified on the cluster signoff criteria list) the task covered in the instructional unit in the presence of an evaluator.

FOR INFORMATION ONLY

MASTER COPY

I PURPOSE STATEMENT

Following completion of this lesson, the student will possess those knowledges systematically identified for the performance of the DE AUX - LUBE OIL AND CRANK CASE VENT tasks.

II LIST OF OBJECTIVES

1. Describe the lube oil keep warm circuit.
2. Describe the engine lube oil pump circuit.
3. Determine the power supplies for the following components:
 - a. Main oil pump
 - b. Keepwarm circulating oil pump
 - c. Lube oil keepwarm heater
4. Describe the permissives associated with the lube oil keepwarm system.
5. Explain how lube oil temperature is controlled when the Emergency Diesel Generator is in standby, and when running.
(KSA numbers: 064000A101)
6. Identify the diesel generator trips associated with the Lube Oil System, including the setpoints.
(KSA numbers: 064000K402)
7. Explain why the keep-warm oil is not circulated through the rocker arms or turbocharger when in standby.
8. Explain how the following situations affect EDG operation:
 - a. Failure of engine-driven main oil pump
 - b. Failure of cooling system
 - c. Inoperable lube oil keep warm pump
 - d. Inoperable lube oil keep warm heater
9. Describe the permissives associated with the crankcase fan.
10. Explain how the EDG is protected from an overpressure condition in the crankcase.
(KSA numbers: 064000A104)

Licensed Operator Objectives for this lesson plan can be found in the Licensed Operator System Master Plan Section 2.3 (Qualification Signoff Criteria)

Rev 5 Cluster 11 DIESEL GENERATOR

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REFERENCES:

1. Plant Vogtle Procedures:
 - 13145 "Diesel Generator"
 - 13146 "Diesel Generator Fuel Oil Transfer System"
 - 14980 "Diesel Generator Operability Test"
 - 13427 "4160 VAC 1E Electrical Distribution System"
 - 17035 Annunciator Response Procedures
 - 17038 Annunciator Response Procedures
2. Technical Specifications:
 - 3.8.1 Electrical Power Systems, AC sources
3. "Standby (Emergency) Diesel Generator," Vogtle Training Text: Chapter 16C, VEGP
4. Plant Manual Chapter 23
5. P&IDs, Logics and Other Drawings
 - Piping and Instrument Diagrams
 - 1X4DB170-1
 - 1X4DB170-2
 - Vendor Drawings
 - AX4AK01-27 (Lube Oil)
 - AX4AK01-26 (Jacket Water)
 - AX4AK01-29 (Starting Air)
 - AX4AK01-28 (Fuel Oil)
 - Control Logic Diagrams
 - 1X5DN107-1 (DG Fuel Oil System)
 - 1X5DN107-2 (DG Unit Engine)
 - 1X5DN107-3 (Generator)
 - Elementary Diagrams
 - 1X3D-BH-G03C
 - 1X3D-BH-G03D
 - 1X3D-BH-G03E
 - 1X3D-BH-G03F
 - 1X3D-BH-G03G
 - 1X3D-BH-G03H
 - 1X3D-BH-G03I
 - 1X3D-BH-G03J
 - One Line Diagrams
 - 1X3D-AA-A01A
 - 1X3D-AA-K01A
6. Vendor Manuals
 - AX4AK01-509
 - AX4AK01-510
 - AX4AK01-563

REFERENCES:

7. FSAR: 8.3, 9.5.4, 9.5.5, 9.5.6, 9.5.7, 9.5.8
8. OAP Commitments: None
9. Instructional Units:
LO-IU-11104-C-001 Respond to Lube Oil System Alarms
10. Transparencies:
LO-TP-11104-001 Lesson Objectives
LO-TP-11104-002 Lube Oil Piping Schematic
LO-TP-11104-003 Turbocharger Lubrication Conceptual Drawing

III. LESSON OUTLINE:

NOTES

I. INTRODUCTION

A. Overview

1. This lesson describes the distribution, filtering, temperature and pressure control of the diesel engine, both when the engine is running, and when in standby.
2. The lesson also presents a separate, but related auxiliary system, the engine's crankcase ventilation system.
3. Present Lesson Objectives

LO-TP-11104-001

B. This lesson will be presented in the following sequence:

Write on board

1. General Overview
 - a. Functions
 - b. Flowpaths
2. Component Description
3. Controls
4. Instrumentation and Alarms
5. Operations
6. Summary

II. PRESENTATION

A. General Overview

1. Functions
 - a. Provide lubrication when engine is running
 - 1) Prevents metal-to-metal contact at bearings, gears, and turbocharger bearings, by lube oil pumped from a reservoir to engine components
 - 2) Remove heat and transfer it to the jacket water system
 - 3) Remove contaminants from engine oil by straining and filtration

III. LESSON OUTLINE:

NOTES

b. Provide lubrication when engine is shutdown

- 1) To main lube oil header in engine for pre-lubrication of bearings, gears, by an electric motor driven pump
- 2) To turbocharger thrust bearings, only at a drip (<.35 gal/hr)
- 3) Provide NO engine rocker lube due to possibility of hydraulic lock if oil got into combustion chamber
- 4) Warm the oil being supplied, with electric immersion heater
- 5) Warmed lube oil prevents extreme viscosities on start and allows quick starts

c. Crankcase Ventilation Function

- 1) Remove vapors with 2 electrically driven fans
- 2) Maintain negative crankcase pressure to reduce oil seepage
- 3) Relieve gases in event of a crankcase vapor explosion

2. Flowpaths

LO-TP-11104-002

a. Engine-driven lube oil circuit

Objective 2

- 1) Lube oil sump tank - two connected reservoirs
- 2) Pump suction foot valve closed when engine off - allows engine LO pump suction to be kept full by keep-warm circuit
- 3) Engine L.O. Pump
 - a) Gear driven by engine when engine is running
 - b) At engine front, 500 gpm
- 4) Lube oil cooler

Objective 3a

III. LESSON OUTLINE:

NOTES

- a) Shell side, oil
- b) Tube side, jacket water
- c) Jacket water removes lube oil heat, NSCW removes JW heat
- 5) Duplex oil filter selected can be changed with engine running
- 6) Selectable lube oil strainers
- 7) Main header to distribute oil to engine internals
- 8) Turbocharger and Rocker Lube
- 9) Pressure regulators
 - a) 2 parallel regulators main header pressure sensed
 - b) Regulated to hold header pressure at 55 psig
- b. Lube oil keep-warm circuit
 - 1) Lube oil sump tank
 - 2) Keep warm heater is thermostatically controlled
 - 3) Keep warm suction isolation valve
 - 4) Keep warm pump
 - a) Running when engine is in standby, stops when engine starts
 - b) Powered by 480 VAC
 - c) 50 psi relief on discharge
 - 5) Keep warm filter
 - 6) Keep warm strainer collects particles, including filter element pieces, should the filter deteriorate
 - 7) Main header
- c. Crankcase Ventilation

Objective 1

III. LESSON OUTLINE:

NOTES

- 1) Two motor-driven blowers
- 2) Expel vapors when engine is running
- 3) Discharge through an oil separator
- 4) Crankcase air discharged outside DG bldg
- 5) Oil separated flows back to crankcase

B. Component Description

1. Main Oil Pump
 - a. Positive displacement, rotary, engine driven
 - b. Capacity - 500 gpm
2. Keep-Warm Circulating Pump
 - a. Positive displacement, rotary, motor driven pump
 - b. Capacity: 99 gpm
 - c. Rating: 15 HP
 - d. Powered from 1NBI/1NBO
 - e. Controls located at local MCC
3. Lube Oil Cooler
 - a. Cooled by jacket water cooling system
 - b. Flow rates (and temperatures)
 - 1) Tube side - 900 gpm (154°F outlet)
 - 2) Shell side - 500 gpm (152°F outlet)
4. Lube Oil Sump
 - a. 2 interconnected, vertical 350 gallon sumps
 - b. Located on the auxiliary skid on either side of the jacket water standpipe
 - c. Normal level - 31"
Low level alarm - 26"

Objective 3b

III. LESSON OUTLINE:

NOTES

Pump suction line - 14"

5. Keep Warm Heater
 - a. Electric immersion heater - 45 KW
 - b. Power Supply - MCC 1NBI/1NBO
 - c. Located in Lube oil sump
 - d. Maintains oil temperature above 150°F
 - e. De-energized when diesel is started

Objective 3c

6. Main Oil Filter
 - a. Full flow duplex cartridge filter
 - b. 10 micron capability
7. Strainers (3)
 - a. Full flow single stage
 - b. 80 micron capability
 - c. Protects engine against solids if a filter cartridge disintegrates
8. Crankcase Fans (2)
 - a. 1/3 hp
 - b. 120 V panel 1NYI1, 1NYO2

C. Controls

1. Lube Oil Keep-Warm Pump
 - a. START/STOP/AUTO handswitch on 480 V MCC 1NBI/1NBO
 - b. Auto STOP on engine start and run
 - c. Auto START when engine is not running if power available to 1NBI/1NBO (Non-1E 480V)
2. Lube Oil Keep-Warm Heater
 - a. AUTO/OFF handswitch on 480 V MCC 1NBI/1NBO

"Engine Running" signal, 200 rpm

Objective 4 (partial)

III. LESSON OUTLINE:

NOTES

- | | |
|--|--------------------------|
| <ul style="list-style-type: none"> b. Heater energizes if in AUTO and: <ul style="list-style-type: none"> 1) L.O. keep-warm pump running, and 2) Thermostat detects low temp 3) Power available to 1NBI/1NBO (Non-1E 480 V) | Objective 4
(partial) |
| <ul style="list-style-type: none"> 3. Diesel Generator Trips <ul style="list-style-type: none"> a. Turbocharger Oil Pressure Low <ul style="list-style-type: none"> 1) ≤ 15 psig 2) Alarm, no trip, on emerg. start b. Lube oil temp high <ul style="list-style-type: none"> 1) 200^oF lube oil temp return from engine 2) Alarm, no trip, on emerg. start c. Low Pressure Lube Oil Trip <ul style="list-style-type: none"> 1) 2/3 engine header pressure sensors < 30 psig 2) Shuts down DG if normal started <u>or</u> emergency started 3) "Low Oil Pressure Sensor Malfunction" alarm if 1/3 sensor malfunctions 4) Bypassed during startup to allow engine operation | Objective 6 |
| <ul style="list-style-type: none"> D. Instrumentation and Alarms <ul style="list-style-type: none"> 1. Panel at Engine Skid Front <ul style="list-style-type: none"> a. L.O. pressure, keep-warm pump (in or out) <ul style="list-style-type: none"> 1) Normally aligned to show disch. pressure 2) Can be aligned to show suction pressure 3) - 30 to 0 in Hg vacuum, 0-60 psig pressure | Objective 8
(partial) |

III. LESSON OUTLINE:

NOTES

- b. L.O. pressure, KW filter diff. 0-60 psid
- c. L.O. pressure, KW strainer diff. 0-60 psid
- d. L.O. pressure, engine pump - IN/OUT
 - 1) Normally aligned to indicate disch. pressure
 - 2) Can be aligned to show suction pressure
 - 3) - 30 to 0 in Hg vacuum, 0-100 psig disch
- e. L.O. pressure, filter diff 0-60 psid
- f. L.O. pressure RB strainer diff 0 - 60 psid
- g. L.O. pressure LB strainer diff 0-60 psid
- 2. Indications on Engine Control Panel PDG 2/4
 - a. Turbo oil pressure right/left
 - b. Lube oil pressure
 - c. Diff. pressure lube oil filter
 - d. Lube tank level
 - 1) Push to read
 - 2) "Bubbler" instrument
- 3. Alarms (both PDG2/PDG4 and QEAB)
 - a. Low temp. lube oil - in
 - b. Low temp. lube oil - out
 - c. High temp. lube oil - in
 - d. High temp. lube oil - out
 - e. Trip - high temp. lube oil
 - f. Low level lube oil
 - g. Low pressure lube oil
 - h. Trip, low pressure lube oil

III. LESSON OUTLINE:

NOTES

- i. Low pressure turbo oil - right
 - j. Low pressure turbo oil - left
 - k. Trip low pressure turbo oil
 - l. Hi dp lube oil filter
 - m. Low oil pressure sensor malfunction
 - n. Switch not in AUTO
4. Crankcase Ventilation Instrumentation and Alarms
- a. Crankcase fan permissives Objective 9
 - 1) Start on engine start
 - 2) Stop on engine stop
 - b. Instrumentation
 - 1) Liquid filled manometer
 - a) U-tube
 - b) Right side connected to engine crankcase
 - c. Annunciator, PDG2/d and QEAB
 - 1) DG trip, high crankcase pressure
 - a) Engine trips at 3 psig crankcase pressure
 - b) Indicative of an explosion inside the crankcase
- E. System Operations
- 1. Lube Oil Temperature Control Objective 5
 - a. Engine running
 - 1) Lube oil temperature will vary with engine load.
 - 2) Normal range 142°F to 170°F Procedure 13145-1
 - 3) 500 gpm lube oil flows through L.O.

III. LESSON OUTLINE:

NOTES

- cooler
- 4) Lube oil temp increase
 - a) JW temp increase
 - b) JW temp control valve increases NSCW flow
 - b. Engine in standby
 - 1) L.O. keep warm pump running
 - 2) Thermostat causes KW heater to energize/de-energize.
 - 3) Normal range 142^oF to 170^oF
 2. Lube Oil Pressure Control
 - a. Two parallel pressure regulators
 - b. Bypasses part of main pump discharge
 - c. Relieves to oil sump
 - d. Main header pressure sensed, regulated to 55 psig
 - e. Protects engine from oil over-pressurization, especially if cold
 3. Loss of Heater:
 - a. Large engine mass retains heat for long time
 - b. DG HVAC keeps room >50^oF
 - c. Start DG and warm as needed until heater restored
 - d. Detected by alarms
 - 1) Low temp lube oil - in
 - 2) Low temp lube oil - out
 4. Loss of KW Pump
 - a. Detected by low lube oil temp alarms

Objective 8
(partial)

ARP 17035-1

Objective 8
(partial)

III. LESSON OUTLINE:

NOTES

- b. DG inoperable
 - c. Engine placed in maintenance mode to prevent start
 - d. Potential to damage engine bearings otherwise
5. Prelube of Turbocharger Bearings LO-TP-11104-003
- a. Drip lube - orificed oil to turbocharger bearings
 - 1) Present when KW pump running
 - 2) Supplied after KW strainer
 - b. Prelubrication:
 - 1) Done for planned engine starts
 - 2) PEO opens prelube valve 1 to 2 minutes prior to engine start. Recloses it after start Valve
1-2403-64-130
(131)
 - 3) Supplies lube oil to turbocharger thrust bearings
 - 4) Bypasses turbocharger drip orifices - supply comes off prior to KW oil strainer
 - c. Keep warm oil is not circulated through the rocker arms or turbocharger during standby operation FSAR Q430.34
Objective 7
 - 1) Could result in hydraulic cylinder lock due to leaking guides
 - 2) Could cause fires due to leakage through turbocharger bearing seal to the exhaust gas chambers
 - 3) Check valves prevent flow to rocker arms; drip system lubrication is provided to turbocharger bearings
 - d. Shift supv. notified of all diesel starts - specify whether DG start included prelubrication
6. Failure of Cooling System Objective 8

III. LESSON OUTLINE:

NOTES

- (partial)
- a. High lube oil temperature
 - b. Engine trip on high jacket water temp
7. Lube Oil Makeup
- a. Makeup oil usually added directly to sump via:
 - 1) Dipstick tube
 - 2) Electric or hand-driven pump
 - b. Estimated consumption rate 1 gallon per 7000 KW/hour
 - 1) 6000 KW is maximum safety related post-LOCA load
 - 2) Results in 144 gallon consumption in 7 days
 - i.e., no makeup required for 7 days following LOCA
 - 3) DG will run unattended as long as sufficient lube oil exists to maintain lube oil pressure greater than 30 psig or jacket water temp less than 200 F
 - c. Sump level approx. 1" for every 55 gal. lube oil
9. Crankcase Ventilation System
- a. Normal manometer Reading
 - 1) Slight negative
 - a) - 2" to 2.5" H₂O unloaded
 - b) - 1.5" to 2" loaded
 - 2) Less, with leaky valve covers or side covers
 - c. Manometer reading expected with fans off

Manometer right side connected to crankcase

Readings differ engine to engine, but vacuum will be greater unloaded than loaded, due to blow-by

III. LESSON OUTLINE:

NOTES

- and engine running
- 1) Slight positive pressure, 1/2 to 1 inch H₂O
 - 2) Occurs on safety injection, since CC fans are Non-IE and de-energized
- d. Relief doors open at approx. 1 1/2 psig positive to relieve smoke/vapors to diesel room
- e. Engine Trip - crankcase overpressure
- 1) Explosion of vapors inside crankcase
 - 2) Detector near right - side crankcase fan
 - 3) Occurs at 3 psig positive CC pressure
 - 4) Smoke, possible explosive vapors in DG room
 - 5) If doubted about whether trip was real or not, on an actual 3 psig over-pressurization, fluid will be blown out of manometer
 - 6) Personnel should stay away from the sides of the engine should internal engine noises appear
 - 7) Failed bearings, piston seizure can cause hot spots to ignite vapors
- From FSAR Q430.38
Objective 10
(partial)
- Objective 10
(partial)

III. SUMMARY

A. Review Lesson Plan Objectives

1. DESCRIBE THE LUBE OIL KEEP WARM CIRCUIT
See Section II.A.2.b
2. DESCRIBE THE ENGINE LUBE OIL PUMP CIRCUIT
See Section II.A.2.a
3. DETERMINE THE POWER SUPPLIES FOR THE FOLLOWING COMPONENTS:
 - a. MAIN OIL PUMP

Engine-driven

b. KEEP WARM CIRCULATING OIL PUMP

INBI/INBO

c. LUBE OIL KEEP WARM HEATER

INBI/INBO

4. DESCRIBE THE PERMISSIVES ASSOCIATED WITH THE LUBE OIL KEEP WARM SYSTEM

Pump - Start when engine stopped and stop when engine > 200 rpm

Heater - Energizes if pump running and thermostat detects low temp

5. EXPLAIN HOW LUBE OIL TEMPERATURE IS CONTROLLED WHEN THE EDG IS IN STANDBY, AND WHEN RUNNING

See Section II.E.1.a and b

6. IDENTIFY THE DIESEL GENERATOR TRIPS ASSOCIATED WITH THE LUBE OIL SYSTEM, INCLUDING THE SETPOINTS

Turbocharger Oil Pressure Low; ≤ 15 psig; trip on normal start only

Lube Oil High Temp; $\geq 200^{\circ}\text{F}$; trip on normal start only

Low pressure Lube Oil Trip; $2/3 < 30$ psig; trip on normal or emergency start

7. EXPLAIN WHY THE KEEP WARM OIL IS NOT CIRCULATED THROUGH THE ROCKER ARMS OR TURBOCHARGER WHEN IN STANDBY

See Section II.E.5.c

8. EXPLAIN HOW THE FOLLOWING SITUATIONS AFFECT EDG OPERATION:

a. FAILURE OF ENGINE-DRIVEN MAIN OIL PUMP

b. FAILURE OF COOLING SYSTEM

c. INOPERABLE LUBE OIL KEEP WARM PUMP

III. LESSON OUTLINE:**NOTES**

d. INOPERABLE LUBE OIL KEEP WARM HEATER

See Section II.E.3, 4, and 6

9. DESCRIBE THE PERMISSIVES ASSOCIATED WITH THE CRANKCASE FAN

Starts and stops with engine

10. EXPLAIN HOW THE EDG IS PROTECTED FROM AN OVER-PRESSURE CONDITION IN THE CRANKCASE

See Section II.E.9.d and e