05-20C-90

Georgia Power

POWER GENERATION DEPARTMENT

VOGTLE ELECTRIC GENERATING PLANT

TRAINING LESSON PLAN

TITLE:	EMERGENCY DIESEL GENERATOR GENERAL OVERVIEW	NUMBER:	NL-LR-11201-00-C
PROGRAM:	OUTSIDE AREA OPERATOR	REVISION:	0
AUTHOR:	G.D. STONE	DATE:	10/26/87
APPROVED:	TACraig	DATE:	5/11/89

INSTRUCTOR GUIDELINES:

I. LESSON FORMAT

A. Lecture with Visual Aids

II. MATERIALS

A. Transparencies and Overhead Projector

B. Dry Erase Board and Markers

III. EVALUATION

A. Written or Oral Exam in conjunction with other Lesson Plans

IV. REMARKS

A. Performance-based instructional units (IUs) are attached to the lesson plan as student handouts. After the lecture instruction should be provided for the attached instructional units. The instructor should be available to answer 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.

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I. PURPOSE STATEMENT:

UPON COMPLETION OF THIS LESSON, THE STUDENT WILL HAVE THOSE KNOWLEDGES SYSTEMATICALLY REQUIRED FOR THE PERFORMANCE OF EMERGENCY DIESEL GENERATOR TASKS

II. LIST OF OBJECTIVES:

1. State the purpose of the emergency diesel generators.

2. Draw a simple one-line diagram of ESF bus 1AA02 (or 1BA03) indicating normal and alternate supplies.

3. List the four cycles of a four-cycle diesel engine, and state what occurs on each.

4. Given drawings of a basic diesel engine, identify the following internal components:

   a. Cylinders
   b. Pistons and pins
   c. Crankshaft
   d. Camshaft
   e. Valves

5. For the emergency diesel engine, state:

   a. Number of cylinders and arrangement
   b. RPM
   c. Horsepower rating
   d. Number of engines per unit

6. Given drawings of a DSRV-16 diesel engine, identify the following components:

   a. Generator
   b. Generator bearing pillow block
   c. Exciter (brushes)
   d. Flywheel
   e. JW standpipe
   f. Turbochargers
   g. Combustion air coolers
   h. Intake air inlet
   i. Exhaust outlet
   j. Jacket water cooler
   k. NSCW inlet/exit connections on JW cooler
   l. Crankcase vacuum fan

II. LIST OF OBJECTIVES

7. State the purposes of the following emergency diesel generator auxiliary systems:

   a. Fuel oil system
   b. Air start system
   c. Lube oil system
   d. Jacket water system
   e. Combustion air supply and exhaust system
   f. Crankcase ventilation system
   g. Diesel engine control system
   h. Generator control system

8. For the emergency diesel generator, state:

   a. Voltage rating
   b. KVA rat g
   c. Continuous rating in kilowatts
   d. Overload rating in kilowatts per time
   e. Hertz rating
   f. Number of poles
   g. RPM

9. State the functions of the safety sequencer as related to the emergency diesel generators.

10. State the location from which the generator can be paralleled.

11. List the personal protective equipment necessary for monitoring a running diesel generator.

REFERENCES:

1. PLANT VOGTLE PROCEDURES:

   - 13145 DIESEL GENERATOR (REV 8).
   - 13146 DIESEL GENERATOR FUEL OIL TRANSFER SYSTEM (REV 1)
   - 14980 DIESEL GENERATOR OPERABILITY TEST
   - 13427 4160 VAC 1E ELECTRICAL DISTRIBUTION SYSTEM
   - 17035 ANNUNCIATOR RESPONSE PROCEDURES (REV 3)
   - 17038 ANNUNCIATOR RESPONSE PROCEDURES (REV 3)

2. TECHNICAL SPECIFICATIONS:

   - 3.8.1 ELECTRICAL POWER SYSTEM, AC SOURCES

3. VOGTLE TRAINING TEXT, CHAPTER 16C, VEGP

   STANDBY (EMERGENCY) DIESEL GENERATOR

4. PLANT MANUAL, CHAPTER 23, REV 0

5. P&IDS, LOGICS AND OTHER DRAWINGS

   PIPING AND INSTRUMENT DIAGRAMS:

   1X4DB170-1 (REV 21)
   1X4DB170-2 (REV 21)

   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 (REV 2)
   1X3D-BH-G03D (REV 1)
   1X3D-BH-G03E (REV 2)
   1X3D-BH-G03F (REV 2)
   1X3D-BH-G03G (REV 1)
   1X3D-BH-G03H (REV 3)
   1X3D-BH-G03I (REV 2)
   1X3D-BH-G03J (REV 3)

   ONE LINE DIAGRAMS:

   1X3D-AA-A01A (REV 12)
   1X3D-AA-K01A (REV 7)

REFERENCES:

6. VENDOR MANUALS:

AX4AK01-509 (REV 0)
AX4AK01-510 (REV 2)
AX4AK01-563 (REV 6)

7. FSAR:

8.3, 9.5.4, 9.5.5, 9.5.6, 9.5.7, 9.5.8

8. OAP COMMITMENTS:

SOER 83.006	UNAVAILABILITY OF EMERGENCY POWER CAUSED BY DIESEL AND BREAKER UNAVAILABILITY
SOER 83.001	DIESEL GENERATOR FAILURES
SOER 84.042	SYSTEM INTERDEPENDENCY OVERSIGHTS RESULT IN LOSS OF REDUNDANT SAFEGUARDS FUNCTIONS
IEN 85.028	PARTIAL LOSS OF AC POWER AND DIESEL GENERATOR DEGRADATION
IEN 84.069	OPERATION OF EMERGENCY DIESEL GENERATORS
OMR 297	GRID HIGH VOLTAGE AND UNDERVOLTAGE TRIP RELAYS CONTRIBUTE TO EDG OUTPUT BREAKER LOCKOUT
NUREG 1216.000	SAFETY EVALUATION REPORT-RELATED TO OPERABILITY AND RELIABILITY OF EMERGENCY DIESEL GENERATORS MANUFACTURED BY TRANSAMERICA DELAVAL, INC. (NOT AN OAP ACTION ITEM, BUT A TRAINING COMMITMENT)

9. INSTRUCTIONAL UNITS:

NONE

10. TRANSPARENCIES:

NL-TP-11201-001	LESSON OBJECTIVES
NL-TP-11201-002	NORMAL, ALTERNATE AND STANDBY POWER TO 4160V 1E SWGR
NL-TP-11201-003	CROSS SECTION OF RV-16-4 DIESEL ENGINE
NL-TP-11201-004	DIAGRAM OF WORKING PRINCIPLE
NL-TP-11201-005	DG SYSTEM SIMPLIFIED
NL-TP-11201-006	EDG SIDEVIEW
NL-TP-11201-007	EDG TOPVIEW
NL-TP-11201-008	OUTLINE OF SKIDBASE

11. STUDENT HANDOUTS

NL-HO-11201-C-001 EMERGENCY DIESEL GENERATORS GENERAL OVERVIEW

III. LESSON OUTLINE:

NOTES

I. INTRODUCTION

A. This lesson describes the reasons for having emergency diesel generators at Plant Vogtle along with information about the engine, and an introduction to the diesel auxiliary system

B. Review the objectives

NL-TP-11201-001

II. PRESENTATION

A. Purpose and design basis

1. Purpose

Commitment
FSAR Q430.1

The emergency diesel generators provide standby onsite power required by the class 1E AC power systems in the event of a loss of preferred power sources for powering the essential loads necessary to safely shutdown the reactor under any operating and accident conditions

Objective 1

a. Diesel generator - System 2403

1) Diesel engine

2) Generator

3) Fuel systems

4) Engine auxiliary systems

NOTE: "Standby Power System", Syst 1821, is supplied 4160V by Syst 2403

b. The internal combustion diesel engine provides the motive force to drive the generator

2. 4160V Class 1E Bus supplies:

a. 4160V switchgear 1AA02 (Control Bldg) Train A

1) Normal (preferred) supply from "Y"winding of Reserve Aux Transformer 1NXRA, Breaker Closed

RATS step down 230 KV from offsite sources to 13.8 KV (X winding) and 4.16 KV (Y winding)

2) Alternate supply available from "Y" winding of Reserve Aux Transformer 1NXRB. No breaker in cubicle. Would use normal breaker, moved from cubicle 5, but only under administrative controls

Show NL-TP-11201-002 Objective 2

3) Standby (onsite) supply: Emergency diesel generator unit 1, Train A,

III. LESSON OUTLINE:

NOTES

through breaker in Cubicle 19

b. 4160V switchgear 1BA03 (Control Building) Train B

1) Normal (preferred) supply from "Y" winding of Reserve Aux Transformer, INXRB, breaker closed

2) Alternate supply available from "Y" winding of Reserve Aux Transformer INXRA, no breaker in cubicle under administrative controls

3) Standby (onsite) supply: Emergency diesel generator Unit 1, Train B. Breaker racked in, open

3. Safety Design Bases

Commitment: FSARQ 430.1 Include design basis in training

Read to class

a. The diesel generator systems shall be designed to supply power to operate the safety-related equipment to effect a safe shutdown of the reactor in the event offsite power supply is unavailable

b. Each diesel generator shall be sized to meet the power requirements of one train of safety related equipment. Each diesel generator shall have its own independent lubricating, air intake and exhaust, cooling water, air st rt, fuel oil day tank and storage tank systems

c. Each fuel oil storage tank shall be sized for seven days' operation to meet the engineered safety feature load plus an additional amount for periodic testing of the diesel generator (ANSI N195)

d. Two full capacity transfer pumps shall be provided on each fuel oil storage tank for redundancy. Each pump's capacity shall be sized to a minimum of three times the maximum diesel engine consumption

e. The diesel generator systems shall be capable of accomplishing its function in the event of a single failure of any active component

f. The diesel generator and fuel oil storage facilities shall be provided with fire, missile, seismic and tornado protection

III. LESSON OUTLINE:

NOTES

B. General Overview

1. Basic Internal Components

NL-TP-11201-003 Objective 4 (identify)

a. Cylinder

Chamber for the moving piston of an engine

1) Our engine has 16 cylinders

Bore 17", stroke 21"

b. Piston

Moved back and forth in cylinder to increase and decrease volume of cylinder

c. Pin

Transmits forces between piston and rod

d. Crankshaft

Turns the up-and-down motion of the piston to rotary motion

1) Flywheel attached to crankshaft

2) Flywheel (and crankshaft)

Rotate clockwise when you face the flywheel

e. Camshaft

Driven by a crankshaft via gears

1) Lobes (eccentrics) cause up-and-down motion of tappets or pushrods

2) Open intake and exhaust valves

3) Operates fuel injection pumps

f. Valves

1) Two intake valves/cylinder

2) Two exhaust valves/cylinder

3) Closed by springs

4) Opened by pushrod and rockers

2. Basis Four-stroke cycle Diesel Engine

Objective 3 NL-TP-11201-004

III. LESSON OUTLINE:

NOTES

a. Intake Stroke

1) Intake valve open

2) Piston moves down, drawing air into cylinder

3) Intake valve shuts near bottom of stroke

b. Compression stroke

1) Cylinder sealed, air compressed as piston rises

2) Air temperature increases under compression

3) Fuel injected near top of stroke. Fuel ignites from high temperature

c. Power stroke

1) Heat of combustion expands gases, forcing piston downward

2) Exhaust valve opens near bottom of power stroke

d. Exhaust stroke

1) Piston moves upward, pushing gases from cylinder through exhaust valve

2) Air intake valve opens near end of exhaust stroke to aid in purging gases

3) Gas removal and air supply aided by turbocharger

End Objective 3

3. Emergency Diesel Generators at VEGP

a. Engine

1) V-16 cylinder arrangement

Objective 5

2) 450 rpm

3) 9694 horsepower

4) Two engines per nuclear unit

5) Turbocharged

Preread S&K for Qual Book Chapter 11004

III. LESSON OUTLINE:

NOTES

6) Aftercooled

7) Fuel injected directly into cylinder

8) Air started

b. Generator

1) 4160 volts AC, 3 phase — Objective 8

2) 1214.4 amperes

3) 7000 KW continuous

4) 7700 KW for two hours out of 24, overload

5) 8750 KVA

6) 60 HZ

7) Driven direct by engine, 450 rpm

8) 16 poles

C. Component Description Overview — Components described in detail in later lesson plans

1. Basic Auxiliary System Purposes

a. Fuel Oil System — Objective 7 begins

1) Provides onsite storage and delivery of fuel oil for approximately seven days operation of the safety-related loads as required under accident conditions, assuming a loss of all offsite power — NL-TP-11201-005

b. Air Start System

1) Provides a means of starting the engine quickly after receipt of a start signal by injecting stored compressed air into the cylinders

c. Lube Oil System

1) Provides lubricating and cooling of engine bearings and other components during engine operation

2) Provides lube oil for prelubrication and warming of engine bearings and

III. LESSON OUTLINE:

NOTES

other components when engine is in standby

d. Jacket Water System

1) Provides enough cooling to allow continuous operation at maximum load

2) Provides engine warming when engine is shutdown, to promote starting

e. Combustion air supply and exhaust

1) Provides filtered, compressed air for combustion

2) Provides means for removal of exhaust products

f. Crankcase Ventilation System

1) Removes fumes and vapors from the crankcase, and provides partial vacuum

g. Diesel Engine Control System

1) Provides means for starting, loading, running and stopping the diesel engine, and allow for local operations for maintenance purposes

h. Generator and Breaker Control

1) Provides means for controlling the electrical output of the generator, and protection for the generator

End Objective 7

2) General functions of skid components

Objective 6
Students identify components from three drawings:

a) Generator

(1) Power to 4160V Class 1E when connected

b) Generator bearing pillow block

NL-TP-11201-006,

(1) Supports generator shaft bearing

NL-TP-11201-007,

(2) Other end of generator shaft

NL-TP-11201-008

(3) Bolted to flywheel

III. LESSON OUTLINE:

NOTES

(4) Has oil reservoir

c) Exciter - provides current for the rotating DC field of the generator

d) Flywheel - keeps crankshaft turning between power pulses

e) JW standpipe - holds supply of water for the engine cooling system

f) Turbochargers - driven by exhaust gases. Compressed air being supplied for combustion - one each bank

g) Combustion air coolers - remove some heat of compression from turbocharged air. Air density increased

h) Intake air inlet

(1) One for each bank

(2) Silences air sounds

(3) Intake air filter "upstairs" supplies air to inlets

(4) Supplies air to turbocharger

i) Exhaust outlet

(1) One for each bank

(2) Pipes exhaust to exhaust silencer

(3) Exhaust is from turbocharger outlet

j) Jacket water cooler

(1) Removes engine heat (heat exchanger)

(2) NSCW removes heat from JW

k) NSCW inlet/exit connections on JW cooler

(1) JW on shell side

III. LESSON OUTLINE:

NOTES

(2) NSCW on tube side

1) Crankcase vacuum fan

(1) Two fans

(2) At flywheel end — End Objective 6

(3) Vacuum on crankcase keeps oil seepage minimized

3) Basic interrelationships

a) Lube oil system cooled by jacket water system

b) Jacket water system cooled by NSCW system

(1) The EDG will be inoperable if NSCW to the JW cooler is not available — Commitment

c) The Jacket water system removes heat from:

(1) Combustion air supply, at the aftercoolers

(2) Engine jackets

(3) Exhaust manifold jackets

(4) Governor

(5) Turbocharger internals

d) Demineralized water

(1) Makeup to Jacket Water Cooling System

e) Can transfer fuel oil to the Aux Boiler FOST (in unusual circumstances)

f) Starting air system:

(1) Provides supply for engine pneumatic controls

(2) Two redundant systems. Can start on one

III. LESSON OUTLINE:

NOTES

g) Diesel Building HVAC

(1) Ventilation and temperature control

h) Diesel Room Fire Protection and Detection

i) 4160V Class 1E

(1) Provided power from diesel generator when D.G. output breaker is closed

j) 480V AC

(1) Fuel oil transfer pumps (2)

(2) Air compressors and after-cooler fans (2 each)

(3) Jacket Water KW pump and heater

(4) Lube oil KW pump and heater

(5) Generator space heater

k) 125V DC System, Class 1E

(1) DG field flashing

(2) DG control purpose

4) Basic Tech Spec Considerations

a) Fuel Oil Day Tank minimum volume

b) Fuel Oil Storage Tank minimum volume

c) Fuel Oil Transfer Pump — More in later lesson

d) Minimum starting air pressure

e) Many other circumstances can make a diesel generator inoperable - examples

(1) NSCW not available

(2) Control switches misaligned

(3) Certain routine operations — Barring, rolling

III. LESSON OUTLINE:

NOTES

(4) Alarms indicate unusual circumstances

(5) Fuel Oil or Starting Air isolated

f) L.O. must be notified immediately if you suspect problems affecting operability

D. Instrumentation and Control (Overview)

Covered in detail in later lessons

1. Control Room - controls - QEAB

a. Unit/Parallel

Presentation required by FSARQ430.1 commitment

1) Unit position: normal - configures governor and generator voltage regulator to supply the 4160V Class 1E bus alone

2) Parallel: configures governor and regulator to supply the 4160V Class 1E bus PARALLEL to the RAT

b. Start P.B.

1) Starts engine

2) Flashes generator field

3) Local/remote sw in REMOTE

c. Stop P.B.

1) Stops diesel engine

2) Trips DG breaker

3) Shuts down generator

4) Local/remote sw in REMOTE

d. Speed Control

1) Raise P.B., lower P.B.

2) If not paralleled, SPEED (and frequency) would be changed

3) If paralleled, LOAD would be changed

e. Voltage control

III. LESSON OUTLINE:

NOTES

1) Raise P.B., lower P.B.

2) If not paralleled, voltage would change

3) If paralleled, KVARs would change

f. Emergency Stop

1) 2/2 pushbuttons

2) LOCAL/REMOTE sw in REMOTE

g. OPERATION MODE switch

1) Allows alarm to occur if DG circuit breaker becomes inoperable

h. 4160V breaker controls

1) Normal supply

2) Alternate (no breaker)

3) DSLGEN breaker

4) Each has sync switch key

i. Synchronization instr. and controls — None locally

1) Synch mode sel. sw. (MAN/AUTO)

2) Synchroscope, with two sync lights

j. Meters

1) DG ammeters - Phase A, B, C

2) DG voltmeter

3) Frequency meter (Hz)

4) Power

5) Kvars

k. Ammeters, voltmeters frequency meters for paralleling normal source

l. Annunciator alarms — Same as local

m. Diesel fuel oil storage tank level

n. Diesel day tank level

III. LESSON OUTLINE:

NOTES

o. Diesel fuel oil pump controls — None on diesel panel

2. Paralleling (synchronizing)

a. Only done from control room — Objective 10

b. No provisions locally for synchronization

c. To parallel DG

1) Diesel engine running

2) DG sync mode selector sw in AUTO

3) Breaker sync switch ON

4) Unit paralleling switch to PARALLEL

5) Voltage adjusted

6) Speed adjusted - sync scope slowly in "Fast" direction

7) AUTO SYNC PERMISSIVE pressed at 11 o'clock

8) Breaker closes at 12 o'clock

E. Local Controls (Overview) — Presented as FSAR Q 4301 Commitment

1. Local Panels

a. DG1A Generator Panel: PDG-1

b. DG1A Engine Control Panel: PDG-2

c. DG1B Generator Panel: PDG-3 — More detail in later lesson

d. DG1B Engine Control Panel: PDG-4

2. Pneumatic Control Circuits

a. Air from starting air system

b. Regulated to 60 psig

3. Electric Control Circuits

a. 125VDC

b. "A" Circuit - white light

c. "B" Circuit - white light

III. LESSON OUTLINE:

NOTES

d. "C" Circuit - white light

4. Major PDG 1/PDG 3 Controls

a. Generator Control Panels

b. Transfer Switch (LOCAL/REMOTE)

1) REMOTE

- DG control at Control Room
- Normal condition

2) LOCAL

- DG control at DG room panels
- not normal
- DG inoperable - can not auto start

c. Voltage Regulator controls

1) Local voltage control switch (AUTO)

2) Local voltage control switch (MANUAL)

3) AUTO/MANUAL pushbuttons

d. UNIT/PARALLEL switch

e. Engine gov. speed RAISE/LOWER

1) Speed control available in LOCAL mode

f. EXCITER Controls

1) Exciter shutdown P.B.

2) Field flash P.B.

3) Exciter enable P.B.

5. Major PDG-2/PDG-4 Controls

More details in later lesson

a. Start P.B.

1) LOCAL/REMOTE sw in LOCAL

b. Stop P.B.

1) LOCAL/REMOTE sw in LOCAL

III. LESSON OUTLINE:

NOTES

c. Emergency Start

1) Breakglass

2) Backs up Auto Emergency Start (SIAS)

d. Emergency Stop

1) Breakglass, pushbutton

2) DG will not restart unless EMERG TRIP RESET pushed

e. RESET LOCA

1) Makes all trips available

2) Allows normal stop

F. Automatic Features (Overview)

1. DG Start Signals

a. Manual

1) Remote (Control Room)

2) Local (DG Room)

b. Emergency - Manual

1) Breakglass

2) DG starts

3) Running in case needed to power 4160V Class 1E bus

4) Majority of DG trips deactivated

c. Emergency - Auto

1) Safety injection signal

2) DG start

3) Running in case needed to power 4160V Class 1E bus

4) Majority of DG trips deactivated

5) Local/Remote switch in REMOTE

d. Loss of Offsite Power

III. LESSON OUTLINE:

NOTES

1) Local/Remote switch in REMOTE

2) Loads shed, DG starts

3) DG breaker closes

4) Loads sequence back to bus

5) DG alone then supplying bus

e. Testing

1) Provision mode for testing - starting the diesel generator

2) Simulated LOPS, simulated SIAS, or LOPS with SIAS

2. Diesel Start - breaker closure sequence

a. Start signals

1) Safety injection signal - both DGs start

2) Loss of voltage on associated bus, 2/4 detectors (P.T.s) < 70% for 3/4 second — DG starts/loads

3) Degraded voltage: — DG starts/loads

2/4 detectors (PTs) < 88.5% voltage for 20 seconds

4) Testing

b. Output breaker closure permissives: — Commitment SOER 83.006

1) Bus undervoltage (/4 detector)

2) RAT feeder breaker OPEN

3) Diesel at rated speed/voltage

4) No bus faults

5) Breaker handswitch in AUTO

c. Situations which would prevent Auto DG breaker closure when required

1) Engine did not start (no red "running" light)

III. LESSON OUTLINE:

NOTES

2) Speed and voltage low (no blue "Ready to Load" light)

3) Breaker from RAT did not open

4) Breaker handswitches in MAN

5) Transfer control switches not in control room position

6) Generator lockouts

d. Response of Operations to lockouts

1) Lockouts and relay (to right of generator controls)

2) 86A trip

- Trips breaker AND shuts down DG any time

- Caused by differential relay (Phase to phase faults)

3) 86B trip

- Trips breaker and shuts down DG (except SI cond.)

- Caused by:

Overcurrent on any phase

Overcurrnet on neutral transform

Loss of generator field

4) 86C trip

- Trips DG breaker only if DG operating parallel with RAT

- Engine continues to run

- Caused by:

Reverse power

Phase imbalance

End SOER 83.006

G. Sequencer and Paralleling Operations (Overview)

1. Sequencing

FSAR Q.430.1 Commitment

III. LESSON OUTLINE:

	NOTES
a. Sequencer in Control Building	
b. Blackout (loss of offsite power)	Objective 9
1) Start DG	
2) Shed loads (also lockout preferred source)	
3) Connect standby power source to 1E bus	
4) Sequence loads on in a preprogrammed sequence to prevent overloading DG	
c. Safety Injection	
1) Power from RAT	
2) Diesel starts, runs unloaded	
3) SI sequencer loads required equipment	
d. Blackout, then SI, prior to 30.5 sec.	
1) Blackout sequence stopped	DG continues to run
2) SI loads shed	
3) Sequencer resets	
4) SI sequence begins	
e. Blackout - SI occurring after 30.5 sec.	
1) SI loads sequence on as required	
2) Using simulator, demonstrate to students:	FSAR Q.430.1 commitment
a) DG response to SI	
b) DG response to LOSS OF OFFSITE POWER	
c) Starting from C.R.	
d) Synchronizing and paralleling	
e) Loading	
f) Unloading	
g) Shutting down D.G.	

III. LESSON OUTLINE:

NOTES

3) Discuss what would be occurring locally (indications) during the above

End FSAR Q 430.1

H. Preview of [illegible] Operations

1. Procedure for diesel generators: 13iVJ-1
2. Procedure for DG fuel oil Transfer: 13146-1
3. Observe no-smoking areas
4. Investigate strong fuel oil smells in room
5. Make it a habit to check fire protection (water) and detection before doing anything in room
6. Note if ventilation appears normal
   a. ESF fans start and downstairs louvers open when engine runs
7. NSCW - note when in room:
   a. Flow indications - west side, next to sw cooler - slightly above mid-scale
   b. NSCW pressure - on NSCW to JW cooler
   c. Feel pipe for flow
8. Personal protective gear: reminder

Objective 11

   a. Hardhat
   b. Correct shoes
   c. Loose sleeves dangerous
   d. Hearing protection
      1) Sound powered phones
         - When at control panel
         - Communicating with Control Room
      2) Earplugs or muffs
         - When checking DG away from panel
   e. Loose jewelry, rings can cause finger amputations

III. LESSON OUTLINE:

NOTES

I. Industry Significant Operating Experience Report — Begin SOER 83.001

1. Industry Events

a. Plant Hatch EDG engine bearing damage due to inadequate pre-lubrication — Examples of LERs associated with DGs

b. Dresden 3 EDG start failure due to worn cylinder and dirt in the Air Start System

2. Review of Reported Failure Data

a. 40% failed/degraded mechanical components

1) Moisture/corrosion in the Air Start System

2) Pre-lubrication

3) Lube oil quality

b. 42% Failed/degraded electrical/I&C

1) Contacts

2) Relays

3) Cabinets - seals

c. 18% Personnel — 60% of which is operator error

1) Testing conditions

a) Frequency

b) Loading

c) Duration

2) Off-normal operating characteristics

3) Changing parameters

3. VEGP Remedies

a. Operating procedures

b. Air Drying System incorporated in design

c. Frequent inspection of mech and electrical components

d. Frequent sampling and analysis of lube oil

III. LESSON OUTLINE:

NOTES

e. Knowledgeable personnel present during testing

4. Significance - operability of EDG units is important for safe plant shutdown following a loss of off-site power

Georgia Power

POWER GENERATION DEPARTMENT

VOGTLE ELECTRIC GENERATING PLANT

05-20D-90

TRAINING LESSON PLAN

TITLE:	EMERGENCY DIESEL GENERATOR AUXILIARIES	NUMBER:	NL-LP-11203-02-C
PROGRAM:	OUTSIDE AREA OPERATOR	REVISION:	2
AUTHOR:	G.D. STONE	DATE:	12/19/88
APPROVED:	[signature]	DATE:	12-20-88

INSTRUCTOR GUIDELINES:

FOR INFORMATION ONLY

I. LESSON FORMAT

A. Lecture with visual aids

II. MATERIALS

A. Lesson Plan

B. Slides and Slide Projector

C. Transparencies and Overhead Projector

D. Student Handouts

E. Dry Erase Board and Markers

III. REMARKS

Performance-based instructional units (IUs) are attached to the lesson plan as student handouts. After the lecture instruction should be provided for the attached instructional units. The instructor should be available to answer 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.

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I. PURPOSE STATEMENT:

UPON COMPLETION OF THIS LESSON, THE STUDENT WILL HAVE AN UNDERSTANDING OF THE FUNCTIONS AND OPERATIONS OF THE FOLLOWING EMERGENCY DIESEL ENGINE AUXILIARY SYSTEMS: AIR START, LUBE OIL, JACKET WATER COOLING, COMBUSTION AIR SUPPLY AND EXHAUST, AND CRANKCASE VENTILATION

II. LIST OF OBJECTIVES:

1. List the functions of the Air Start System.

2. Make a drawing of one train of the air start system, including the following components as a minimum, and stating the function of each:

   a. Compressor
   b. Aftercooler
   c. Air dryer
   d. Air receiver
   e. Barring device supply
   f. Air supply to engine control panel
   g. Air start solenoid valves (admission valves)
   h. Air start distributor
   i. Air supply manifolds (on engine)
   j. Air start valves (at cylinder heads)

3. Explain the theoretical principle behind the operation of the air dryers.

4. List the power supplies for the:

   a. Air compressors
   b. Air dryers
   c. Air start solenoid valves

5. State the start/stop permissives of the air compressor and aftercooler fans.

6. List the diesel engine permissives associated with the Starting Air System, to include how depletion of the Air Start System is prevented during multiple start sequences.

7. List the locations in the diesel building where Starting Air System pressures can be read.

II. LIST OF OBJECTIVES

8. Describe the response of the Starting Air System on receipt of a DG start signal (emergency or normal).

9. List the points of the Starting Air System which can be "blown down" to check for or remove moisture.

10. State the condition indicated by a hot starting air pipe to a cylinder.

11. State the pump supplying lube oil when the emergency diesel engine is:

    a. Running
    b. In standby

12. State the functions of the Diesel Lube Oil System, including major engine components which are lubricated.

13. Draw a sketch of the lube oil keep warm circuit, including as a minimum the following components:

    a. Lube oil sump tank
    b. Keep warm heater
    c. Keep warm suction isolation valve
    d. Keep warm pump
    e. Keep warm filter
    f. Keep warm strainer

14. Draw a sketch of the engine lube oil pump circuit, including as a minimum the following components:

    a. Pump suction foot valve
    b. Engine L.O. pump
    c. L.O. cooler
    d. Duplex oil filter
    e. Lube oil strainers
    f. Pressure regulators

15. State the type and power supplies for the following lube oil components:

    a. Main oil pump
    b. Keep warm circulating oil pump
    c. Lube oil keep warm heater

16. For the lube oil cooler, state:

    a. How cooled
    b. Type of liquid on tube side
    c. Type of liquid on shell side

II. LIST OF OBJECTIVES

17. For the lube oil sump, state:

    a. Number of tanks
    b. Capacity

18. List the start/stop permissives of the lube oil keep warm pump.

19. State how lube oil temperature is controlled when the diesel generator is in standby, and when running.

20. List the diesel generator trips associated with the Lube Oil System, including the setpoints.

21. List the various methods by which lube oil sump level can be measured.

22. List the pressure (and delta P) instruments for the Diesel Lube Oil System which can be read in the diesel generator building. State what possible problems an abnormal (HI/LOW) reading indicates.

23. State the reason that the turbochargers are prelubricated before a planned engine run.

24. State how and where lube oil is added.

25. State how the diesel engine would respond to:

    a. Failure of engine-driven main oil pump
    b. Inoperable lube oil keep warm pump
    c. Inoperable lube oil keep warm heater

26. State the function of the crankcase ventilation system.

27. State the causes and effects of high crankcase pressure.

28. Give the start/stop permissives of the crankcase fan.

29. State the diesel generator trip associated with the crankcase ventilation system.

30. State which type of instrument is on the engine control panel for the crankcase ventilation system, and how it is correctly read.

31. State the functions of the Jacket Water Cooling System.

II. LIST OF OBJECTIVES

32. Make a drawing of the flow paths of the jacket cooling water, including as a minimum the following major components, and stating the function of each:

    a. Jacket water pump
    b. Jacket water cooler
    c. Thermostatic control valve
    d. Jacket water standpipe
    e. Lube oil cooler
    f. Jacket water keep warm pump
    g. Jacket water keep warm heater

33. List the power supplies for the following:

    a. Jacket water keep warm pump
    b. Jacket water keep warm heater

34. List the start/stop permissives for the jacket water keep warm pump and heater.

35. List the diesel generator trips associated with the Jacket Water System.

36. List the temperature, pressure, and level instrumentation of the Jacket Water System which can be read in the diesel generator room. State what an abnormal (HI/LOW) reading indicates.

37. Describe how jacket water temperature is maintained during standby and during diesel engine running operations.

38. Describe the purpose for which the following systems interface with the emergency diesel generator system:

    a. Demineralized water
    b. NSCW

39. State the functions of the combustion air supply and exhaust systems.

40. State the principle of operation of a turbocharger.

41. Make a simple drawing of the combustion air supply and exhaust system, including as a minimum:

    a. Cycoil air intake filter
    b. Air intake silencers
    c. Turbochargers (air supply blades)
    d. Combustion air coolers
    e. Combustion air supply dampers
    f. Air intake manifolds
    g. Exhaust outlet manifolds
    h. Turbochargers (exhaust blades)
    i. Exhaust muffler

II. LIST OF OBJECTIVES

42. State the response of the combustion air supply dampers to a diesel engine trip.

43. State the maximum cylinder temperature and the reason for that limit.

44. State the consequences of water in the intake manifolds, and how it can be detected.

45. State the principles of operation of the cycoil air intake filter, and indicate the importance of proper filter oil level.

REFERENCES:

1. Plant Vogtle Procedures:

   13145 "Diesel Generator" (Rev 8)
   13146 "Diesel Generator Fuel Oil Transfer System" (Rev 1)
   14980 "Diesel Generator Operability Test"
   13427 "4160 VAC 1E Electrical Distribution System".
   17035, Annunciator Response Procedures (Rev 3)
   17038, Annunciator Response Procedures (Rev 3)

2. Technical Specifications:
   3.8.1 Electrical Power Systems, AC sources

3. "Emergency Diesel Generator" Vogtle Training Text Chapter 16C

4. Plant Manual Chapter 23 (Rev 0)

5. P&IDs, Logics and Other Drawings

   Piping and Instrument Diagrams
   1X4DB170-1 (Rev 21)
   1X4DB170-2 (Rev 21)

   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) (Rev 6)
   1X5DN107-2 (DG Unit Engine) (Rev 3)
   1X5DN107-3 (Generator) (Rev 2)

   Elementary Diagrams

   1X3D-BH-G03C (Rev 2)
   1X3D-BH-G03D (Rev 1)
   1X3D-BH-G03E (Rev 2)
   1X3D-BH-G03F (Rev 2)
   1X3D-BH-G03G (Rev 1)
   1X3D-BH-G03H (Rev 3)
   1X3D-BH-G03I (Rev 2)
   1X3D-BH-G03J (Rev 3)

   One Line Diagrams

   1X3D-AA-A01A (Rev 12)
   1X3D-AA-K01A (Rev 7)

REFERENCES:

6. Vendor Manuals

   AX4AK01-509 (Rev 0)
   AX4AK01-510 (Rev 2)
   AX4AK01-563 (Rev 6)

7. FSAR: 8.3, 9.5.4, 9.5.5, 9.5.6, 9.5.7, 9.5.8

8. OAP Commitments:

   SOER 83.006 "Unavailability of emergency power caused by diesel and breaker unavailability"
   SOER 83.001 "Diesel generator failures"
   SER 84.042 "System interdependency oversights results in loss of redundant safeguards functions"
   IEN 85.028 "Partial loss of AC power and diesel generator degradation"
   IEN 84.069 "Operation of emergency diesel generators"
   OMR 297 "Grid high voltage and undervoltage trip relays contribute to EDG output breaker lockout"
   NUREG 1216.000 "Safety evaluation report-related to operability and reliability of emergency diesel generators manufactured by Transamerica DeLaval Inc." (Not an OAP action item, but a training commitment)

9. INSTRUCTIONAL UNITS:

   NL-IU-11203-C-001 Respond to Emergency Diesel Generator Lube Oil System Alarms
   NL-IU-11203-C-002 Respond to Emergency Diesel Generator Jacket Water System Alarms

10. TRANSPARENCIES:

    NL-TP-11203-C-001 Starting Air System
    NL-TP-11203-C-002 Starting Air System, One Circuit
    NL-TP-11203-C-003 Air Compressor, Cutaway Front View
    NL-TP-11203-C-004 Air Compressor, Cutaway Side View
    NL-TP-11203-C-005 Air Dryer, Basic Flow Paths
    NL-TP-11203-C-006 'A' Train DSL GEN Air Start Solenoid Valves
    NL-TP-11203-C-007 Starting Air Valve
    NL-TP-11203-C-008 Air Start Distributor Layout
    NL-TP-11203-C-009 Diesel Alarms Assoc. with Starting Air
    NL-TP-11203-C-010 Lube Oil Keepwarm Syst. Basic Flowpath
    NL-TP-11203-C-011 Engine-Driven L.O. Syst. Basic Flowpath
    NL-TP-11203-C-012 Outline of Aux Skid Base
    NL-TP-11203-C-013 Alarms Associated with Lube Oil System
    NL-TP-11203-C-014 Major Flowpaths. Jacket Water Syst.
    NL-TP-11203-C-015 Alarms Associated with Jacket Wtr. Cooling Syst.

REFERENCES:

11. Student Handouts

    NL-HO-11203-C-001 Emergency Diesel Generator Auxiliaries

12. Other

    DCP 88.049 Jacket Water

III. LESSON OUTLINE:

NOTES

I. INTRODUCTION

This lesson describes the operation of the engine-related auxiliary systems of the diesel generator. Auxiliary systems to be presented include:

Air Start System
Lube Oil System
Crankcase Ventilation
Jacket Water Cooling System
Combustion Air Supply and Exhaust System

The fuel oil system, which includes fuel oil transfer, is covered separately as one control of the engine and generator

II. PRESENTATION

A. Air Start System

1. Purpose

Provide means for quick starting of the diesel upon receipt of a start signal, by injecting high pressure air into the cylinders

Have students refer to 1X4DB170-1, Rev 21

2. Functions

Objective 1

a. Starting Air Supply - 2 circuits

b. Supply engine pneumatic control air (60 psi) to operate logic for engine protective circuits

NL-TP-11203-C-001

c. Air for barring device

d. Air for rolling engine

e. Air for governor booster servomotor

Governor oil pressure low initially

3. Components and Flowpaths

NL-TP-11203-C-002
Students must be able to draw

a. Compressors (2 per engine)

1) Two stage, reciprocating, three cylinder, with intercooler between low and high pressure stages. Lubricated by constant-temp splash system. Compressors are air-cooled, and intercooler is forced-air cooled by shaft mounted fan
76 scfm, 250 psig

NL-TP-11203-C-003

NL-TP-11203-C-004

III. LESSON OUTLINE:

NOTES

2) 480V Electric motor and belt drive INB1 (Train A), INB0 (Train B)

Objective 4a

3) Function: Provide a method of re-filling the starting air receiver, and sized to refill its receiver from minimum cranking pressure to 250 psig within 30 minutes

Objective 2a

b. Aftercooler (2 per engine)

1) Air-to-air heat exchanger

2) 480V electric motor drives fanblade

3) Function: Removes heat of compression from high-pressure air being discharged from the compressor

Objective 2b

c. Air dryer (2 per engine)

NL-TP-11203-C-005

1) Mechanical, refrigeration, 200 scfm, powered from 120V/240V DIST PN INY1i (Tr. A) INY01 (Tr. B)

Objective 4b
Similar to house air conditioner

2) Runs continuously, independent of air compressor

3) Function: Remove moisture from compressed air discharged from compressor

Objective 2c

d. Air receivers (2)

1) Vertical, cylindrical, rated for 275 psig

2) Function: Allow at least five starting attempts consecutively without compressor assistance

Objective 2d

3) On normal starts, each attempt is five seconds maximum

4) On emergency starts, starting air is supplied until engine runs, or <150 psig in receivers

5) Engine can still be started down to about 90 psig (normal start)

III. LESSON OUTLINE:

NOTES

e. Barring device supply

1) Pneumatic device, used to turn the engine by engaging into flywheel holes and extending

2) Function of air supply: To cause the shaft of the barring device to move, in response to the positioning of a 3-way air control valve — Objective 2e

3) Air supply is filtered, supplied from only one receiver, and normally isolated

f. Air supply to engine control panel (control air)

1) Supplied from both receivers through a shuttle valve

2) Air pressure supplied at 250 psig, regulated to 60 psig

3) Function of control air supply: Provides medium to operate the engine's pneumatic control system — Objective 2f

g. Air start solenoid valves (admission valves)

1) Four per engine, two per bank, each bank having an 'A' control power and 'B' control power solenoid — NL-TP-11203-C-006

2) When open, supply air to the air start manifold

3) Function: Open on an engine start or engine roll signal to provide starting air to the air manifold for each bank, and close, when required, to conserve air pressure — Objective 2g

h. Air start valves — Objective 2j

1) 16 total, one per cylinder

2) Open from piloting air (from air distributors) — NL-TP-11203-C-007

III. LESSON OUTLINE:

NOTES

3) Spring pressure (plus firing pressure) to close

4) Function: Open to supply starting air to cylinders, from the two starting air supply manifolds

i. Air start distributors (2)

Objective 2h

1) One per bank, camshaft-driven

NL-TP-11203-C-008

2) Lubricated by "oil spitter"

3) Air supplied <u>to</u> distributor from starting air manifolds (one per bank) when manifold is pressurized

4) Air distributed <u>from</u> distributors for piloting open the starting air valves for each cylinder in the correct sequence

j. Air start supply manifold

1) One per engine bank

2) Located at engine heads, in front of injector pumps

3) Function: Distribute starting air to the air start valve for each bank cylinder, and to the air start distributor for that bank, when the air start admission valve is open

Objective 2i

4) If a cylinder's air start valve sticks open, air start manifold gets very hot - paint burning off and piping may turn red. If feeling manifold to check for stuck-open air start valve do not grasp with hand

Objective 10

4. Instrumentation, controls and permissives

a. Air compressors

1) Auto start at 225 psig, decreasing receiver pressure

Objective 5

2) Auto stop at 250 psig, increasing receiver pressure

III. LESSON OUTLINE:

NOTES

3) Trip on low oil level in crankcase

4) Not powered in situation while INBI (or INBO) are de-energized

b. Aftercooler fans

1) Auto start and stop when compressor starts and stops

2) Not powered in SI situation while INBI (or INBO) de-energized

c. Air dryers

1) Run continuously

2) Crankcase heater must be energized at least 24 hours prior to anticipated start, so refrigerant will not condense in crankcase

3) Not powered during SI situation while INBI1 (or INBO1) are de-energized

d. Receivers

1) Pressure indicator on each receiver

e. Air start solenoid valves

1) Normal start signal: All four open until engine reaches 200 rpm ("engine running" signal) but not for more than 5 seconds — Objective 8, 6

2) Emergency start signal: All four open until engine reaches 200 rpm, but if no start occurred, will continue to supply air until air pressure is 150 psig. Operator must determine reason for failure to start, and correct it — Objective 8, 6

3) Can supply air again, below 150 psig, using <u>normal</u> starting

4) With loss of "A" control power at engine control panel, both engine banks still get supply of starting air. Some with loss of "B" power

III. LESSON OUTLINE:

	NOTES
f. Pressure instruments and alarms	
1) Receiver pressure, each receiver, gauge at the receiver	Objective 7
2) Starting air pressure - left bank (eng. control panel)	
3) Starting air pressure - right bank (eng. control panel)	
4) Control air pressure (engine control panel)	Directly related
5) DG "LOW PRESS CONTROL AIR" annunciator, 55 psig decr.	NL-TP-11203-C-009
6) DG "DISABLED, LOW PRESS STARTING AIR", either header pressure less than 215 psig	
7) DG "HIGH PRESS STARTING AIR" annunciator, either header 260 psi or greater	
8) DG "FAILED TO START" annunciator, engine did not reach 200 rpm within 5 seconds of start signal	
9) DG "SWITCH NOT IN AUTO" annunciator air compressor or aftercooler switch not in AUTO	Plus several other DG switches
5. Operations	
a. Checks made on rounds	
1) Control and starting air bank pressure - control air, 58 - 62 psig - starting air, 225 - 250 psig	
2) Air compressor general inspection	
3) Air compressor power on	
4) Air receivers and dryers - blowdown until moisture free	Note - May require indiv. verification from Proc. 11882-1, Rev 1
b. DG Operability test	

III. LESSON OUTLINE:

NOTES

1) 31 day test, can be more often

Also a 184-day test

2) Depending on what month it is, an air receiver is isolated for test start of DG, then reopened

Certain months, neither isolated

3) During the new DG run (or afterwards), each compressor is checked for auto-starting, and checked for amount of time required to recover from 150 to 250 psig. Must be 1/2 hour or less

Proc. 14980-1

c. Air dryers - principle of operation

1) Moist, compressed air, saturated with water vapor, enters dryer

2) Precooled by outgoing refrigerated air

3) Further cooled at air-to-refrigerant heat exchanger. Vapor in the cooled air condensing to water droplets by chilling

Objective 3
Principle of operation: Chilling to condense moisture for removal

4) At separator, water droplets separate to a drain trap

5) Cooled dry air travels to air-to-air heat exchanger where it takes heat from incoming air

d. Blowing down to remove moisture

1) Places <u>possible</u>:

Receiver drains
After cooler drain traps
Dryer blowdown
2 Capped drain valves
Capped strainer drain

Individual verification possibly required. See P&ID-170-1
Objective 9

e. Abnormal conditions

1) "Hot" starting air manifold after start

Objective 10

a) Indicates stuck or leaking air start valve for one or more cylinders

b) Can get hot enough to burn paint from pipe

III. LESSON OUTLINE:

NOTES

2) Loss of control air (previously discussed)

a) Engine can not be shut down using normal methods if already running

3) Low air pressure

a) If there is no supply of air from at least one receiver, at 210 psig or greater, the diesel generator is "inoperable"

b) Must have the <u>pressure</u> and the path must not be isolated

B. Lube Oil System

1. Purposes

a. Provide oil for lubricating and cooling of engine and turbocharger bearings and other components during engine operation

b. Provide oil for prelubricating and warming of engine bearings and other components when engine is in standby

2. Functions

a. Engine running

1) Lubricate

Prevent metal-to-metal contact of bearings, gears, and turbocharger bearings, by lube oil pumped from a reservoir to the components

2) Cool

Remove heat, and transfer it to the jacket water system when the engine is operating

3) Clean

Remove contaminants from engine oil

b. Engine in standby

Objective 12
NOTE: Explain that some components, generator's such as the bearing, and Woodward governor-actuator, have their own oil systems, not associated with the engine's lube oil system

III. LESSON OUTLINE:

NOTES

1) Prelubricate

The main lube header is pressurized somewhat by an electric motor-driven pump. Bearings are prelubricated. Turbocharger bearings are not pre-lubricated while in standby, but a "drip" flow is supplied.

Objective 12

(.35 gal/hr)

NO rocker lube is provided while in standby. Possibility of hydraulic lock of a cylinder if oil leaked inside it

2) Warm

The oil is warmed by an electric immersion heater

Prevents extreme viscosities on start, and allows quick starts

3) Clean

Keep-warm oil system has a filter and strainer

3. Components and Flowpaths

NL-TP-11203-C-010 Students must be able to sketch for Objective 13

a. Keep-warm circuit flowpath

1) Lube oil sump tanks

- 2 interconnected reservoirs

2) Keep-warm heater

- electric immersion heater heats lube oil. Thermostatically controlled

- Powered from MCC INBO (INBI for B Train)

Objective 15c

3) Keep-warm suction isolation valve

4) Keep-warm pump

- runs when engine is in standby
- stops when engine starts

III. LESSON OUTLINE:

NOTES

- supplies lube oil for prelubrication when engine is in standby
- Powered from 480V MCC 1NB0/1NB1

Objective 11a
Objective 15b

5) Keep-warm filter (one/engine)

6) Keep-warm strainer (one/engine)

NL-TP-11203-C-011

b. Flowpath when engine is running

Objective 14
Students sketch main flowpath

1) Sump tank

- 2 interconnected, 350 gal tanks/ engines

Objective 17a, b

2) Pump suction foot valve

- Suction pressurized by keep-warm system when in standby
- 70 psig relief, protects suction piping between pump and foot valve during engine "rock back", or reversing, just when engine comes to stop

3) Engine-driven main lube oil pump

- 500 gpm
- positive displacement, rotary gear
- driven by engine gearset

Objective 15a

4) Pressure regulators

- 2 in parallel
- regulate oil pressure to 55 psig
- sensing line from main oil header
- regulators receive part of pump discharge, divert it to sump to maintain pressure (on main header)

NL-TP-11203-C-012

5) Lube oil cooler (1 per engine)

- lube oil on shell side, 500 gpm being cooled

Objective 16c

- jacket water on tube side, as cooling medium

Objective 16b

III. LESSON OUTLINE:

NOTES

- lube oil cooled by jacket water at lube oil cooler. The jacket water is in turn cooled by NSCW at the jacket water cooler

Objective 16a

6) Duplex oil filter (one filter of the duplex)

- full-flow, duplex, cartridge type
- 500 gpm rating, 150 psig, 200°F rating
- 10 micron particle retention
- can be swapped to standby filter of duplex with engine running
- continuous vent to lube oil sump

7) Lube oil strainer (one of a pair)

- basket-type, stainless steel screen, 80 micron particle retention
- helps prevent passing of particles should a filter cartridge deteriorate

4. Instrumentation, Controls, Permissives

a. Lube oil keep-warm pump

1) Auto starts when engine is stopped

Objective 18 (part)

2) Auto stops when engine is started. Not powered in SI situation while INBI (or INBO) are de-energized

3) Pressure indicator at engine front gauge panel normally reads discharge pressure. Can be aligned to show suction pressure

b. Keep-warm heater

1) Thermostat set for 150°F

2) Heater de-energized when keep-warm pump stops, energizes by thermostat if keep-warm pump is running

Objective 18 (part)

III. LESSON OUTLINE:

NOTES

3) NO low sump tank level cutout for heater

c. Lube oil keep-warm filter

1) Diff press gauge at engine front gauge panel

d. Lube oil keep-warm strainers

1) Diff press gauge at engine front gauge panel

e. Turbocharger drip sightglasses

1) Should show very small steady oil stream, or drips, while in standby

f. Engine driven lube oil pressure gauge

1) At engine front gauge panel

2) Possible to realign it to show suction pressure

g. Lube oil cooler

1) Jacket water temperatures to and from lube oil coolers (local, at cooler)

2) Lube oil temperature to and from lube oil cooler (local, at cooler)

h. Lube oil filter (duplex main)

1) "HI DIFF PRESS LUBE OIL FILTER" alarm (20 PSI) — NL-TP-11203-C-013

2) Diff pressure gauge on engine control panel

3) Diff pressure gauge at engine front gauge panel

4) Pointer on linked 3-way valves indicates which filter of the duplex is in service

i. Lube oil strainers (main)

1) Diff pressure gauge on engine front gauge panel

III. LESSON OUTLINE:

NOTES

j. Turbochargers

1) Oil pressure indicating gauges on engine control panel. Dual needle - red (right), - black (left)

2) "DG LOW PRESS TURBO OIL - LEFT" 20 psig

3) "DG LOW PRESS TURBO OIL - RIGHT" 20 psig

4) "DG TRIP LOW PRESS TURBO OIL" Trips engine at 15 psig turbocharger oil pressure (except after emergency start)

k. Oil temperature alarms and engine trips

1) LOW TEMP LUBE OIL - IN (140°F)

2) LOW TEMP LUBE OIL - OUT (140°F)

3) HI TEMP LUBE OIL - IN (175°F)

4) HI TEMP LUBE OIL - OUT (190°F)

5) DG TRIP HIGH TEMP LUBE OIL (200°F)

l. Sump tank level

1) "LOW LEVEL LUBE OIL" alarm (26" above tank bottom)
QEAB and PDG 2/PDG 4

Objective 21

2) "PUSH TO READ" level indicator "Bubbler" type, using supply of control air, and reading its back-pressure

Not particularly accurate

Located on engine control panel (PDG 2, PDG 4)

3) Dipstick (markings shown)

- MIN STATIC
- MAX STATIC
- MAX OPERATE

III. LESSON OUTLINE:

NOTES

Dipstick located at top of right-hand tank (tank nearest the lube oil duplex filters)

(right-hand, as facing the engine from the flywheel end)

5. Operations (Lube Oil)

a. Oil temperature control

1) In standby, temperature is controlled by thermostat setting of keep-warm heater

Objective 19

2) When engine is running, temperature controlled by jacket water temperature which is, in turn, controlled by JW temperature control valve

JW - Jacket water

b. DG Trips

Some have already been mentioned. Listed together here.

1) 2/3 low lube oil pressure on main lube oil header, 30 psig
Trips DG regardless of how started
"LOW OIL PRESS SENSOR MALFUNCTION" alarm if 1/3 sensors have malfunctioned. A second sensor malfunction can cause trip

Objective 20

2) "TRIP, HIGH TEMP LUBE OIL" (200°F)

3) "TRIP, LOW PRESS TURBO OIL" (15 psig)

4) "TRIP, HIGH TEMP ENGINE BEARING" (228°F)#

#A related trip

- After a low pressure turbo oil trip, or high temperature trip, the engine is prevented from normal restart for 90 seconds. Engine will still emergency start

- The high engine bearing trip can not be reset until maintenance personnel replace some fusible metal rods which are part of the detection system of the main bearings. The DG will still emergency start

The fusible rods melt at 228°F

- After low lube oil pressure trip, EMERGENCY TRIP RESET pushbutton must be pressed to allow a restart attempt

III. LESSON OUTLINE:

NOTES

c. Checks made on rounds for lube oil system — From Proc 11882-1

1) Lube oil temp - IN pos. 19 on thermocouple readout, 140 - 165°F (temperature to engine) — Note Proc 13145-1 calls for 142-170°F

2) Lube oil temp - OUT pos. 20 on thermocouple readout, 140 - 165°F (temperature from engine)

3) DG lube oil sump level high or low

4) Lube oil keep-warm pump pressure 30 to 50 psi

5) Lube oil keep-warm strainer 0 - 20 psid

6) Lube oil keep-warm filter 0 - 20 psid

d. Adding oil to sump — Objective 24

1) Added to sump in accordance with procedure 13145-1

2) Can be added while running or shutdown

3) Level should increase 1" for each 55 gal.

4) Added to dipstick connection on top of sump

5) Using electric or hand-driven pump

e. Prelubricating turbocharger — NL-TP-11203-C-014

1) Turbocharger prelubricated prior to planned run

2) One to two minutes before engine start, turbocharger orifice bypass valve is opened, providing flow of lube oil to turbocharger bearings

3) Bypasses the drip orifices

4) Bypass valve closed shortly after engine start

III. LESSON OUTLINE:

NOTES

5) Drip lubrication lubricates turbo bearings using oil supplied by the keep-warm circuit, at a rate low enough not to leak past seals into the turbine section

Objective 23

Thrust bearing has high delta P across it initially at start

Drip bypass supplies pressurized lube oil from the keep-warm circuit to augment drip lubrication to the turbocharger bearings for planned start by providing lube oil at a higher rate

6) Number of non-prelubricated starts are tracked

f. Abnormal operations

1) Failure of engine-driven main oil pump

Objective 25a
Reg: FSAR 9.5.7 table 9.5.7-2

- Engine trips on low lube oil pressure or high bearing temperature (220°F)

- Engine inoperable

2) Failure of cooling system - how lube oil is affected

- Engine temperatures rise, and rate of rise depends on load

- Engine will trip, on a jacket water trip, or possibly lube oil temperature high

3) Inoperable keep-warm pump

Objective 25b

- detected by low lube oil temperature alarms

- DG declared inoperable, and MAINTENANCE MODE selected until pump can be restored

From 17035-1, 13145-1

4) Inoperable lube oil keep-warm heater

Objective 25c

- If lube oil temperature drops below 120°F, the DG is started to maintain temperature above 120°F

III. LESSON OUTLINE:

	NOTES
5) Tube leaks in lube oil heat exchanger - Engine L.O. pressure higher than jacket water pressure - Possibly discovered by increasing JW standpipe level, along with decreasing lube oil sump level	
6) From lube oil pressure on <u>engine control panel gauge</u> (engine running) - Approx. 55 psig normal; <u>low</u> pressure alarm at 40 psig - Lube oil filter clogged - Lube oil strainer clogged - Lube oil pressure regulator is failed open - Engine driven pump malfunction - Low lube oil level in sump - High oil temperature	Objective 22
7) Low turbocharger oil pressure on dual gauge at engine control panel (left or right) <u>low</u> pressure: - Lube oil filter clogged - Lube oil strainer clogged - Lube oil pressure regulators fail open - Engine-driven lube oil pump malfunction - Low lube oil sump level - Turbocharger prelube valve open - High oil temperatures	Objective 22
8) High differential pressure on the lube oil filter diff pressure gauge, engine control panel	Objective 22 1X4DB170-1

III. LESSON OUTLINE:

	NOTES
- in service lube filter clogged	Alarms at 20 psid
9) PDI at engine front gauge panel lube oil filter diff pressure high reading	Objective 22
- in service lube filter clogged	Same as above
10) Hi differential pressure across lube oil keep-warm strainer or filter (keep-warm pump running)	Objective 22
- clogged filter or strainer	
11) High differential pressure across lube strainer	Objective 22
One in service, one in standby	
In-service strainer clogged	
12) Pump discharge pressure main oil pump	Objective 22
- Some general causes as low header pressure (6) above	
13) Keep-warm pump discharge pressure	Objective 22 1X4DB170-1
Low: possible pump failure, or hot oil	
High: strainer or filter blocking	

C. Crankcase Ventilation System

1. Purpose

   Removes fumes and vapors from the crankcase

2. Functions — Objective 26

   a. Remove vapors and fumes with 2 electrically driven fans

   b. Maintain negative crankcase pressure to reduce oil sweparge

   c. Relieve gases in event of a crankcase explosion

3. Components and Flowpaths

III. LESSON OUTLINE:

NOTES

a. Two motor driven blowers pulling air and vapors from the crankcase, when the engine is running to expel vapors

1) Electrical supply: 120 VAC distribution panels (INY11 and INY02) supplied from 480V MCC INB1 (and INB0) panels

b. Blowers discharge through an oil separator

c. Separated oil returns to crankcase

d. Crankcase air and fumes discharge to outside the DG building

e. Relief doors

1) Relieve gases and pressure should a crankcase explosion occur inside the engine

2) Relieves to DG room

3) Relief doors have flame traps to help keep flames from escaping the engine

On left side of engine only, relieve towards wall, rather than towards MCC's control panels, or personnel paths

4) Relief doors open at about 1 1/2 psig and reclose quickly to prevent entry of fresh oxygen to the engine crankcase

5) If not for the relief doors, the engine side covers might blow off in a crankcase explosion, spreading fire

4. Instrumentation, Controls and Permissives

a. Manometer on engine control panel

1) Right side of manometer U-tube connected to engine vacuum

Objective 30

2) Read the top of the right and left columns. Difference in inches is the reading

b. Alarm on Annunciator Panel

1) "DG TRIP HI CRANKCASE PRESS"

III. LESSON OUTLINE:

NOTES

a) 3 psig crankcase pressure

Objective 29

b) DG can be restarted in 90 seconds (normal start)

c) DG can be emergency started immediately

2) Crankcase fan permissives

a) Start when DG starts

Objective 28

b) Stop when DG stops

c) Do not run when INBI (or INBO) are not powered

3) Increasing crankcase pressure, causes/ effects

5. Operations

A. Causes of off-normal manometer readings, and effects on manometer or operations

Objective 27

1) Normal readings, engine running, CC fans on

Actual loaded and unloaded manometers vary from engine to engine

- unloaded: slight negative, about -2.0 to -2.5" H2O

- loaded: less negative, about -1.5" to 2.0" H2O due to more blowby

Ref: Test logs in AX4AK01-509, Sect. E

- long term decrease in crankcase vacuum: Ring and cylinder wear of engine increased inleakage of air from leaks of air into the crankcase

2) Engine running CC fans off

- Slight positive pressure, approx. + 1/2" to +1"

- Effects: possible leakage of oil from engine covers, if not snug

- Loose valve covers or side covers cause vacuum to be lower than normal

III. LESSON OUTLINE:

NOTES

3) Crankcase explosion

Cause crankcase relief doors to open, relieving pressure, at approx. 1 1/2 psig

Cause of crankcase explosion: Hot spot, such as a hot bearing or other internal components igniting vapors

Engine trips at 3 psig crankcase pressure

If the engine had tripped due to the high crankcase pressure sensor, and you are not sure if it was real or spurious, if the liquid was blown out of the manometer, it was real

D. Jacket Water Cooling System

1. Purpose

a. The jacket water system provides enough engine cooling to allow continuous engine operational maximum load

b. When the engine is shutdown, the jacket water system provides engine warming to promote engine starting

2. Functions

a. Engine running, provides cooling water for:

Objective 31
NL-TP-11203-C-018

1) Lube oil, at lube oil cooler

2) Combustion air, at 2 combustion air coolers

3) Governor oil, at governor cooler

4) Turbochargers (2)

5) Exhaust jackets

6) Engine, through internal passages

7) Standpipe supports

b. Engine in standby, provides heating of the above

III. LESSON OUTLINE:

NOTES

3. Components and flowpaths

NL-TP-11203-C-014

a. Jacket water pump

Students to be able to draw for Objective 32 and give functions

1) Single stage, centrifugal

2) Driven by engine, through gearset

3) 1800 gal/min, 117 ft head, 1470 rpm

4) Function to circulate water through the coolant loop of the diesel generator during periods of engine operation to remove heat from the engine

Objective 32a

b. Thermostatic valve Objective 32c

1) Function: Provide capability to bypass the jacket water around the jacket water cooler, for temperature control

2) Full bypass at 152°F or less

3) Full flow at 170°F for greater

4) Inlet of valve receives 750 gpm of JW pump

Travel stop attached to TCV 19096 to limit travel to control max flow

c. Jacket water cooler

Objective 32b

1) Function: Provides a means of removing heat from the engine when the engine is operating, transferring heat to NSCW

2) Jacket water on shell side

3) NSCW on tube side, flows continually

d. Jacket water standpipe

Objective 32d

1) Functions:

- Allow for volumetric changes due to temperature variations
- Provide makeup water
- Absorb pump pressure variations

III. LESSON OUTLINE:

NOTES

- Provide positive suction head to the jacket water and keep-warm pumps

2) 600 gallons

e. Lube oil cooler — Objective 32e

1) Purpose: Provide means of removing heat from engine lube oil

2) Jacket water through tube side, at 900 gpm

3) Lube oil through shell side

f. Jacket water keep-warm pump — Objective 32f

1) Function:

- Circulate heated water from the standpipe through the lube oil cooler and engine components, while the engine is in standby, to promote engine starting

2) Horizontal, centrifugal pump

3) 50 gal/min, 50 ft head

4) Powered from 480 VAC MCC INBI/INBO — Objective 33a

g. Jacket water keep-warm heater — Objective 32g

1) 75 KW immersion heater

2) Function:

Heats the water which the keep-warm pump circulates

3) Thermostatically controlled

4) 480VAC MCC INBI/INBO — Objective 33b

4. Instrumentation, controls, permissives

a. Jacket water keep-warm pump permissives — Objective 34

1) Stops when engine starts

2) Starts when engine stops

III. LESSON OUTLINE:

NOTES

- Power to INBI/INBO not available in SI conditions

b. Jacket water keep-warm heater permissives

1) Starts if keep-warm pump is running AND thermostat (150°F) demands start

2) De-energized when pump stops

c. Diesel generator trips associated with JW system — Objective 35

1) 2/3 high jacket water temperature sensors

- 200°F water temperature exiting engine

- trips DG, regardless of how started

- shutdown signal terminated after about 90 seconds, and engine can be restarted if problem was corrected

2) Jacket water pressure low trip

- 6 psig or less JW pressure

- Trips DG after normal start — Alarms only if emergency start

d. Annunciator alarms — NL-TP-11203-C-015

1) DG LOW TEMP JACKET WATER - IN 140°F

2) DG LOW TEMP JACKET WATER - OUT 140°F

3) DG HI TEMP JACKET WATER - IN 175°F

4) DG HI TEMP JACKET WATER - OUT 190°F

5) DG TRIP HI TEMP JACKET WATER
2/3 Outlet header temp. detectors
200°F

6) DG LOW PRESS JACKET WATER

< 8 psi water pressure being supplied to engine

7) DG TRIP LOW PRESS JACKET WATER
< 6 psi

III. LESSON OUTLINE:

NOTES

8) DG LOW LEVEL JACKET WATER
Standpipe level 4" below centerline of J4 return header

9) DG HI JACKET WATER TEMP SENSOR MALF

1/3 JW trip sensors failed

Second sensor failure can cause trip

e. Local indications and interpretations of abnormal readings

1) JW pressure, engine pump IN or OUT

- At engine's front gauge panel (auxiliary skid)

- Dual function, suct. press or disch press, normally aligned to show disch pressure

- Low discharge pressure indicated:

Pump failure
Pump not running
Low standpipe level
Downstream break

- High discharge pressure indicated:

Blocked discharge flowpath

2) JW keep-warm pressure, pump IN or OUT

- At engine's front panel (Auxiliary skid)

- Dual function, suction or discharge pressure, normally aligned to show disch pressure

- Low discharge pressure indicated:

Pump failure
Pump not running
Low standpipe level
Downstream break
Suction isolation valve closed

- High discharge pressure indicated:

Possible blocked discharge flowpath

III. LESSON OUTLINE:

NOTES

3) Jacket water pressure gauge on engine control panel

- Reads JW pressure downstream of lube oil cooler, being supplied to engine

- Low Pressure

  Engine driven JW pump malfunction
  Leak in JW system
  Low level in JW standpipe

4) JW IN, JW OUT thermocouple digital readouts

- At engine control panel

- At normal range 142°F to 170°F

- Low reading can indicate:
  Keep-warm pump heater or thermostat malfunction

- High reading can indicate:
  Three-way temperature control valve stuck in bypass
  Engine driven JW pump malfunction
  Loss of or insufficient NSCW flow
  Engine overload
  Biofouling of NSCW side of jacket water cooler

5) Wide range level instrumentation, and narrow level instrumentation

- Low level indicated:
  Loss of water (leak or drain valve open)
  Water temperature low

- High level indicated:
  Temperature increase
  Leak into system (NSCW or lube oil)

5. Operations

a. Engine normally in standby

1) JW temperature being maintained by cycling on/off of JW kW heater, controlled by thermostat set for 150°F
Water being circulated by JW keep-warm

Objective 37 (Partial)

III. LESSON OUTLINE:

	NOTES
pump, running continuously (while in standby)	
2) Checked on rounds, every 8 hours - JW IN (thermocouple readout) - JW OUT (thermocouple readout) - Jacket water keep-warm pump pressure (engine front panel)	
3) NSCW flowing through JW cooler, engine running or in standby. NSCW provides cooling water for the diesel generators	Objective 38
Engine can run loaded only about 3 minutes without NSCW flow	
4) Demineralized water	
- Provides makeup of water to the standpipe	Objective 38
- Manual makeup through normally isolated valves	
- Chemistry Dept. treats jacket cooling water by adding chemicals to control PH, copper corrosion and ferrous corrosion	
b. Engine running	
1) Checks mode, and readings taken on DG operating log (11885-C)	Including JW checks
2) JW temperature is being maintained by thermostatic control valve, by-passing some flow around, and allowing some flow through the JW cooler, to maintain JW temperature	Objective 37 (Partial)
- 152°F and below, valve is fully by-passing - 170°F and above, full flow through cooler	
E. Combustion Air Supply and Exhaust	
1. Purpose	

III. LESSON OUTLINE:

NOTES

Provide filtered, compressed air for combustion, and a means for removal of exhaust products

2. Functions of system

Objective 39

a. Filter air being supplied to engine.

b. Silence air being supplied to engine, and exhaust from engine, to minimize noise levels in DG building

c. Increase engine efficiency by compressing the air being supplied for combustion, then cooling it through coolers

d. Isolate when required on an engine trip, by shutting off the combustion air damper for each bank

3. Components and Flowpaths

NL-TP-11203-C-016
Objective 41
Students draw system flowpath
NL-TP-11203-C-017

a. Intake air filter

1) Removes dust and grit from air before it enters engine

2) Oil bath type ("Cycoil" brand)

3) 109 gal of oil in reservoir

4) 25,100 scfm rated flow

5) Located on 2nd level of building

b. Intake silencers

1) Minimize DG room noises

2) 2 Tubular duct silencers per unit

c. Turbochargers

1) Combination exhaust driven turbine/ centrifugal blower on common shaft

2) Two, one for each bank

3) Exhaust turbine function: to cause blower to turn

III. LESSON OUTLINE:

NOTES

4) Blower function: to pressurize the fresh, filtered combustion air

5) Water cooled by Jacket Water system

6) Oil lubricated bearings

d. Combustion air coolers (intercoolers)

1) One for each bank

2) Jacket water cooling medium

3) Removes heat of compression from turbocharged air

4) 900 gpm jacket water flow

e. Combustion air supply dampers

1) Two, one per cylinder bank

2) Close on engine trips to isolate combustion air supply (smother)

3) Actuated by cylinder-type pneumatic actuators

Air supplied to extend actuators, closing the dampers

Spring pressure opens dampers when air is vented from actuator

f. Air intake manifold

1) Distribute combustion air supply to each cylinder

2) Runs beneath "catwalks", each bank

g. Exhaust outlet manifolds

1) Exhaust gasses from each cylinder

2) Collect in common pipe and discharge to turbocharger

h. Turbochargers

1) Turbine blades driven by gasses exhausting from engine cylinders

III. LESSON OUTLINE:

NOTES

i. Exhaust silencer (muffler)

1) Upstairs in DG building

2) Conducts heat and exhaust products out of building, plus minimizes DG building noise

4. Instrumentation, Controls, Permissives

a. No active controls (Start/Stop switches)

b. On engine trip, combustion air dampers close, strangling air supply to engine

c. Shut rapidly (less than about 1.5 sec.) on overspeed of engine

Overspeed trip occurs at 517.5 rpm

d. Shut slowly on other trips due to the path that the control air must take

NOTE: Dampers shutting more quickly on overspeed is due to an engine-damaging overspeed incident at Grand Gulf. Slow response of overspeed tripping devices, plus improper recovery from governor maintenance allowed the engine to overspeed on a test start. Modification at VEGP added a second overspeed vent valve to ensure dampers close rapidly on an overspeed trip

From IEN 86.007

e. Associated DG trips and alarms

1) LOW PRESS TURBO OIL - RIGHT

2) LOW PRESS TURBO OIL - LEFT

3) TRIP, LOW PRESS TURBO OIL

Already covered with lube oil information

4) Vibration trip - vibration sensor on each turbocharger, plus two engine vibration sensors

5) Turbocharger associated trips will not trip the DG if DG had been emergency started (SIS, or manual)

f. Local engine panel

1) Combustion air pressure

III. LESSON OUTLINE:

NOTES

- Intake manifold pressure being supplied by turbochargers

- LEFT-TEST-RIGHT selector, one gauge

- Proportional to load (approx)

- Difference in bank pressures can indicate turbocharger problems

2) Thermocouple digital readouts

- Thermocouples 1-8, left bank cyl.

- Thermocouples 9-16, right bank cyl.

- Thermocouples 17, 18 - turbocharger stock exhaust temperatures

5. Operations

a. Principle of operation of turbocharger

1) Turbine receives exhaust, and spins

Objective 40

2) As exhaust-driven turbine spins, so does its bearing-supported shaft

3) At other end of shaft, blower wheel pulls fresh air in, pressurizes it, and discharges to an intercooler

4) Turbocharger pressurizes intake manifold

5) Amount of air being pulled in depends on flow of exhaust being discharged, so turbocharger speed will vary with load due to heat increase with load

6) Scavenges exhaust from cylinder after exhaust stroke

7) Fills cylinder with air charge of high density on intake stroke

8) Turbocharger bearings

- "Drip" lube from lube oil keep-warm system, while engine is in standby

III. LESSON OUTLINE:

NOTES

- "Prelubrication" just prior to planned engine start (1-2 minutes) until after engine started, bypasses drip orifices, from lube oil keep-warm system

- Normal lube - provided by engine's main oil pumps, upon start

9) Turbocharger cooling

- Jacket water system

b. Temperature monitoring

Objective 43

1) Turbocharger inlet temperature limited to 1200°F

Manufacturer's warranty - 1200°F max to turbine

2) Not directly read, so we use a cylinder exhaust temperature limit of 1050°F maximum

3) Cylinders cool slightly between strokes, and cylinder thermcouples will read average temperatures, so cylinder temperature <u>readings</u> will be less than the temperature of the exhausts from the cylinders combined

4) May approach 1050°F at 110% (overload) testing

5) Each cylinder should be within ± 50°F of average of all cylinders

c. Air intake filter operation

Objective 45

1) Oil bath air cleaner

- Air flows into filter through bug screen, and up through a venturi-type liquid lift tube which forces the oil through an outlet at top to engine

- Air mixes with oil droplets at holes in distribution plate

- Oil, dust, grit filtered by self-cleaning pad, and drain back to reservoir

III. LESSON OUTLINE:

NOTES

- Mist eliminator pad further removes oil mist

2) Importance of proper oil level

- Level too high, could be from:
  Water is reservoir
  Dust displacing oil level

- Low or no oil level
  Dust enters engine cylinders and can cause premature wear

- Slight sludge buildup in bottom of reservoir a part of normal operation

d. Water in intake manifolds

1) Can damage engine head or cylinder, if water also enters a cylinder, causing cracks, leaks

Water is incompressible
Objective 44

2) Detected by 1/4" bleed line at bottom of each intake manifold

3) 4 lines total, "one at each engine corner"

4) Provide tell-tale, in case there is water intake manifold

5) Provide small but continual blowdown with engine running

6) Water leaks possible from turbocharger or intercooler

III. SUMMARY

A. Review Objective

B. Answer Questions

EMERGENCY OPERATING PROCEDURE

05-21-90

ECA-0.0 LOSS OF ALL AC POWER

MANUAL SET NO. 11

FOR INFORMATION

PURPOSE

This procedure provides actions to respond to a loss of all AC power.

SYMPTOMS/ENTRY CONDITIONS

The symptoms are:

- Both emergency AC buses are de-energized.

The entry conditions are:

- 19000-C, E-0 REACTOR TRIP OR SAFETY INJECTION, Step 3.

9005240472

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

IMMEDIATE OPERATOR ACTIONS

NOTE

CSFSTs should be monitored for information only. Function restoration procedures should NOT be implemented.

1. Verify Reactor Trip: • Reactor trip and bypass breakers - OPEN. • Neutron flux - LOWERING.	1. Manually trip reactor.
2. Verify Turbine Trip: • All turbine stop valves - SHUT.	2. Manually trip turbine.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
3. Check If RCS Is Isolated:	
a. PRZR PORVs - SHUT.	a. IF PRZR pressure is less than 2315 psig, THEN manually shut PORVs.
b. Letdown orifice isolation valves - SHUT. • HV-8149A • HV-8149B • HV-8149C	b. Manually shut valves.
c. Letdown isolation valves - SHUT: • LV-0459 • LV-0460	c. Manually shut valves.
d. Excess letdown isolation valves - SHUT. • HV-8153 • HV-8154	d. Manually shut valves.
e. Reactor vessel head vent isolation valves - SHUT: • HV-8095A • HV-8095B • HV-8096A • HV-8096B	e. Manually shut valves.
f. RCS sample valves - SHUT: • HV-3548 • HV-3502 • HV-3513 • HV-3514 • HV-3507 • HV-3508	f. Manually shut valves.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
4. Verify AFW Flow - GREATER THAN 570 GPM.	4. Perform the following: a. Ensure TDAFW pump is running: • HV-5106 - OPEN. • HV-3009 - OPEN. -OR- HV-3019 - OPEN. b. Ensure AFW throttle valves - OPEN.

SUBSEQUENT OPERATOR ACTIONS

NOTE

- 91001, EMERGENCY CLASSIFICATION AND IMPLEMENTING PROCEDURE should be implemented at this time.
- If LOP sequencer has initiated, it may be necessary to reset sequencer by placing sequencer power switch to OFF before normal incoming feeder breaker can be closed.

5. Try To Restore Power To Any AC Emergency Bus:	
a. Start diesel generator.	a. Dispatch operator to emergency start diesel generator using the emergency start break glass station at the DG panel by initiating 13145, DIESEL GENERATORS.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
b. Verify AC emergency bus of started DG automatically energized: • DG output breaker - CLOSED.	b. Manually energize AC emergency bus. IF bus can NOT be energized, THEN manually trip diesel generator. Initiate 13427, 4160V AC ELECTRICAL DISTRIBUTION SYSTEM to energize at least one AC emergency bus using any available power supply. • Either RAT via Normal Incoming Feeder Breaker if off site power available. • Either diesel generator. • Either RAT via Emergency Incoming Feeder Breaker if offsite power available.
c. Check AC emergency busses - AT LEAST ONE ENERGIZED.	c. Go to Step 6.
d. Return to procedure and step in effect.	

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION

- When power is restored to any AC emergency bus, recovery actions should continue starting with Step 24.
- If an SI signal exists or if an SI signal is actuated during this procedure, it should be reset to permit manual loading of equipment on an AC emergency bus.
- Two NSCW pumps should be available to automatically load on its AC emergency bus to provide diesel generator cooling.

6. * Place The Following Equipment Switches In The PULL-TO-LOCK Position:
   - CCPs
   - RHR pumps
   - SI pumps
   - Containment spray pumps
   - CCW pumps
   - ACCW pumps
   - MDAFW pumps
   - Containment fan coolers

7. Check AC Emergency Busses Status:

   a. At least one AC emergency bus - ENERGIZED.

      a. Dispatch operator to locally restore AC emergency busses.

         WHEN one AC emergency bus is energized, THEN go to Step 24.

         Continue with Step 8.

   b. Go to Step 24.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
8. Dispatch Operator To Locally Shut Valves To Isolate RCP Seals: • RCP seal injection isolation valves outside containment: • HV-8103A • HV-8103B • HV-8103C • HV-8103D • RCP seal return isolation valve outside containment: • HV-8100 • ACCW return isolation valve outside containment: • HV-1975	
9. Verify If CST Is Isolated From Hotwell: Dispatch operator to verify hotwell level valve positions: a. COND MAKEUP LV-4415B - SHUT. b. COND DUMP LV-4415A - SHUT.	a. Shut COND MAKEUP LV-4415B INLET ISO 1305-U4-044. b. Shut COND DUMP LV-4415A OUTLET ISO 1305-U4-043.
10. Check SG Status: a. MSIVs and their bypass valves - SHUT. b. MFIVs and BFIVs - SHUT. c. Blowdown isolation valves - SHUT. d. SG sample isolation valves - SHUT.	10. Manually shut valves. IF valves can NOT be manually shut, THEN locally shut valves.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION

A faulted or ruptured SG that is isolated should remain isolated. Steam supply to the TDAFW pump must be maintained from at least one SG.

NOTE

To preserve battery life, operate only one valve at a time.

11. Check SGs Secondary Pressure Boundaries:

- Check pressures in all SGs:
  - NO SG PRESSURE LOWERING IN AN UNCONTROLLED MANNER.
  - NO SG COMPLETELY DEPRESSURIZED.

- Isolate faulted SGs:
  - Shut the TDAFW throttle valves on affected SG(s).
    - HV-5122 (SG 1)
    - HV-5125 (SG 2)
    - HV-5127 (SG 3)
    - HV-5120 (SG 4)
  - Shut TDAFW pump steam supply valve from affected SG:
    - HV-3009 (SG 1)

      -OR-

    - HV-3019 (SG 2)
  - Verify SG ARV shut.

    IF SG ARV NOT shut, THEN manually shut.
  - Locally shut the MDAFW throttle valves on affected SG(s):
    - HV-5139 (SG 1)
    - HV-5132 (SG 2)
    - HV-5134 (SG 3)
    - HV-5137 (SG 4)

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
12. Check If SG Tubes are Intact: • Main steamline radiation monitors - NORMAL. • Condenser air ejector radiation - NORMAL. • SG sample radiation - NORMAL. • SG blowdown radiation - NORMAL.	12. Try to identify ruptured SGs. WHEN ruptured SGs identified, THEN isolate ruptured SGs: • Isolate AFW flow by shutting the TDAFW throttle valves on affected SG(s): • HV-5122 (SG 1) • HV-5125 (SG 2) • HV-5127 (SG 3) • HV-5120 (SG 4) • Shut TDAFW steam supply valve from affected SG: • HV-3009 (SG 1) -OR- • HV-3019 (SG 2) • WHEN SG pressure is less than 1160 psig, THEN verify SG ARV shut. IF SG ARV NOT shut, THEN manually shut. • Locally shut the MDAFW throttle valves on affected SG(s): • HV-5139 (SG 1) • HV-5132 (SG 2) • HV-5134 (SG 3) • HV-5137 (SG 4)

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
13. Check Intact SG Levels:	
a. Narrow range level - GREATER THAN 5% [27% FOR ADVERSE CNMT].	a. Maintain maximum AFW flow until narrow range level GREATER THAN 5% [27% FOR ADVERSE CNMT] in at least one SG.
b. Control AFW flow to maintain narrow range level between 5% [27% FOR ADVERSE CNMT] and 50%.	b. IF narrow range level in any SG continues to rise in an uncontrolled manner, THEN isolate ruptured SG: • Isolate AFW flow by shutting the TDAFW throttle valves on affected SG(s): • HV-5122 (SG 1) • HV-5125 (SG 2) • HV-5127 (SG 3) • HV-5120 (SG 4) • Shut TDAFW pump steam supply valve from affected SG: • HV-3009 (SG 1) -OR- • HV-3019 (SG 2) • WHEN SG pressure less than 1160 psig, THEN verify SG ARV shut. IF SG ARV NOT shut, THEN manually shut. • Locally shut the MDAFW throttle valves on affected SG(s): • HV-5139 (SG 1) • HV-5132 (SG 2) • HV-5134 (SG 3) • HV-5137 (SG 4)

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
14. Check DC Bus Loads: a. As time permits and at the discretion of the Unit Shift Supervisor, shed all unnecessary battery loads using Attachment A. b. Monitor all battery voltages.	
15. Check CST Level - GREATER THAN 15%.	15. Switch to alternate CST. • Locally open HV-5113.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION

- To prevent injection of accumulator nitrogen into the RCS, SG pressure should not be lowered to less than 165 psig.
- SG NARROW range level should be maintained GREATER THAN 5% [27% FOR ADVERSE CNMT] in at least one intact SG. If level cannot be maintained, SG depressurization should be stopped until level is restored in at least one SG.

NOTE

- The SGs should be depressurized at a rapid rate (within the capacity of the TDAFW pump) to minimize RCS inventory loss.
- PRZR level may be lost and reactor vessel upper head voiding may occur due to depressurization of the SGs. Depressurization should not be stopped to prevent these occurrences.

16. Depressurize Intact SGs To 265 PSIG:

a. Check SG narrow range levels - GREATER THAN 5% [27% FOR ADVERSE CNMT] in at least one SG.

a. Perform the following:

1) Maintain maximum TDAFW flow until narrow range level GREATER THAN 5% [27% FOR ADVERSE CNMT] in at least one SG.

2) WHEN narrow range level GREATER THAN 5% [27% FOR ADVERSE CNMT] in at least one SG, THEN do Steps 16b, c, d, and e.

Continue with Step 17.

b. Dispatch operator to locally dump steam using SG ARVs.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
c. Check RCS cold leg temperatures - GREATER THAN 280°F [290°F FOR ADVERSE CNMT].	c. Perform the following: 1) Control SG ARVs to stop SG depressurization. 2) Continue with Step 17.
d. Check SG pressure - LESS THAN 265 PSIG.	d. WHEN SG pressures lowered to less than 265 psig, THEN do Step 16e. Continue with Step 17.
e. Locally control SG ARVs to maintain SG pressures at 265 psig.	
17. Check Reactor Subcritical: • Intermediate range channels - ZERO OR NEGATIVE STARTUP RATE. • Source range channels - ZERO OR NEGATIVE STARTUP RATE.	17. Control SG ARVs to stop SG depressurization and allow RCS to heat up.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
NOTE Depressurization of SGs will result in SI actuation. SI should be reset to permit manual loading of equipment on AC emergency bus.	
18. Check SI Signal Status:	
a. SI - HAS BEEN ACTUATED.	a. WHEN SI actuated, THEN do Step 18b, 19 and 20. Go to Step 21.
b. Reset SI.	
19. Verify Containment Isolation Phase A - ACTUATED: CI-A MLB indicators - CORRECT FOR SI.	19. Manually actuate Phase A. IF valves do not shut, THEN manually or locally shut at least one valve at each penetration. Locally shut any open valve as time permits.
20. Verify Containment Ventilation Isolation: Dampers and valves - SHUT: MLB indicators - CORRECT FOR SI.	Manually shut dampers and valves. IF dampers can NOT be manually shut, THEN locally shut dampers.
21. Check Containment Radiation - LESS THAN 100 R/HR.	21. Manually shut containment isolation valves as necessary. IF valves can NOT be manually shut, THEN locally shut valves.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
22. Check If AC Emergency Power Is Restored:	
• Check AC emergency busses - AT LEAST ONE ENERGIZED.	• Continue to control RCS conditions and monitor plant status: 1) Check status of local actions: • AC power restoration. • RCP seal isolation. • DC power supply. 2) Check status of auxiliary boration system: • BAST temperature greater than 78°F. IF temperature less than setpoint, THEN dispatch personnel to reduce BAST boron concentration. 3) Check status of spent fuel cooling: • Spent fuel pool low level annunciator - NOT ACTUATED. IF actuated, THEN dispatch personnel to initiate makeup to the spent fuel pool using 13719, SPENT FUEL POOL COOLING AND PURIFICATION SYSTEM. 4) Return to Step 11.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
23. Restore any DC loads shed in previous actions. Align de-energized inverters per 13431, 120V AC 1E VITAL INSTRUMENTS DISTRIBUTION SYSTEM, prior to closing DC Feeder Breakers.	
24. Stabilize SG Pressures:	
• Manually control SG ARVs.	• Locally control SG ARVs.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION

The loads placed on the energized AC emergency bus should not exceed the capacity of the power source.

25. Verify Following Equipment Loaded On Energized AC Emergency Bus:

- 480V AC switchgear:

UNIT 1

TRAIN A	TRAIN B
1AB04	1BB06
1AB05	1BB07
1AB15	1BB16
1NB01	1NB10

UNIT 2

TRAIN A	TRAIN B
2AB04	23B06
2AB05	2BB07
2AB15	2BB16
2NB01	2NB10

- Essential 480V AC loads:
  - Battery chargers.
  - Instrumentation and control.
  - Emergency lighting.
  - Communications.
  - Battery room fans.

25. Manually or locally load equipment as necessary using the appropriate electrical procedures.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
26. Verify NSCW Operation:	
a. Verify valve alignment - OPEN. TRAIN A: HV-1806, HV-1808, HV-1822, HV-1830 TRAIN B: HV-1807, HV-1809, HV-1823, HV-1831	a. Manually align valves as necessary.
b. Verify at least two NSCW pumps - RUNNING.	b. Manually start pumps.
27. Select Recovery Procedure:	
a. Check RCS subcooling monitor indication - GREATER THAN 24°F [38°F FOR ADVERSE CNMT].	a. Go to 19102-C, ECA-0.2 LOSS OF ALL AC POWER RECOVERY WITH SI REQUIRED.
b. Check PRZR level - GREATER THAN 9% [36% FOR ADVERSE CNMT].	b. Go to 19102-C, ECA-0.2 LOSS OF ALL AC POWER RECOVERY WITH SI REQUIRED.
c. Check ECCS equipment - HAS NOT ALIGNED FOR SI INJECTION UPON AC POWER RESTORATION.	c. IF ECCS equipment has aligned to injection phase, THEN go to 19102-C, ECA-0.2 LOSS OF AC POWER RECOVERY WITH SI REQUIRED.
d. Go to 19101-C, ECA-0.1 LOSS OF ALL AC POWER RECOVERY WITHOUT SI REQUIRED.	

END OF PROCEDURE TEXT

ATTACHMENT A

DC Loads Which May Be Shed
During Loss Of All AC

Breaker	Affected Loads
1AD1	
1AD1-04	Miscellaneous Radiation Monitors, SSMP, SG ARVs, BOP Actuations, Sequencer
1AD11	
1AD11-01	4160 SWGR Control Power
1AD11-02	480 SWGR Instrument Power
1AD11-03	480 SWGR Instrument Power
1AD11-04	480 SWGR Instrument Power
1AD11-05	SG ARV
1AD11-07	SG ARV
1AD11-08	Miscellaneous Sample & CNMT Isolation Valves
1AD11-09	RX Trip SWGR
1AD11-10	HVAC Panel
1AD11-12	SSPS
1AD11-13	13.8 SWGR Control Power
1AD11-14	13.8 SWGR Control Power
1AD11-15	13.8 SWGR Control Power
1AD11-17	Accumulator N2 Isolation
1AD11-20	13.8 SWGR Control Power

ATTACHMENT A (CONT'D)

DC Loads Which May Be Shed
During Loss Of All AC

Breaker	Affected Loads
1AD12	
1AD12-04	RCDT Vent & Pump Discharge Valves, Letdown Isolation, Instrument Air CNMT Isolation, NSCW Tower Blowdown Isolation
1AD12-05	Accumulator Test CNMT Isolation
1AD12-07	PSDA Control Power
1AD12-08	MSIVs, FWIVs, BFIVs
1AD12-10	Isolation Devices
1AD12-14	SG Blowdown Isolation, MSIVs, NSCW Acid Pump, SI Actuation Control Power
1AD12-16	Letdown Isolation, Isolation Devices
1AD12-18	Isolation Devices

ATTACHMENT A (CONT'D)

DC Loads Which May Be Shed During Loss Of All AC

Breaker	Affected Loads
1BD1	
1BD1-04	Miscellaneous Radiation Monitors, SSMP, BOP Actuations, Sequencer
1BD11	
1BD11-01	4160 SWGR Control Power
1BD11-02	480 SWGR Instrument Power
1BD11-03	480 SWGR Instrument Power
1BD11-04	480 SWGR Instrument Power
1BD11-07	SG ARV
1BD11-08	Miscellaneous Sample & CNMT Isolation Valves
1BD11-09	RX Trip SWGR
1BD11-10	HVAC Panel Control Power
1BD11-13	13.8 SWGR Control Power
1BD11-14	SG ARV
1BD11-15	13.8 SWGR Control Power
1BD11-17	Accumulator N2 Isolation
1BD11-19	13.8 SWGR Control Power
1BD11-20	13.8 SWGR Control Power

ATTACHMENT A (CONT'D)

DC Loads Which May Be Shed
During Loss Of All AC

Breaker	Affected Loads
1BD12	
1BD12-02	Boric Acid to Charging Valve from PSDB
1BD12-04	Instrument Air CNMT Isolation, NSCW Tower Blowdown Isolation
1BD12-05	SSPS
1BD12-06	ACCUMULATOR Test Isolation, SI Test Isolation, Letdown Isolation, Excess Letdown Isolation
1BD12-07	PSDB Control Power
• 1BD12-08	MSIVs, FWIVs, VFIVs, PRT Vent Isolation, PRT Primary Water Isolation
1BD12-10	Isolation Devices
1BD12-14	Isolation Devices
1BD12-16	Isolation Devices
1BD12-17	Boric Acid To Charging Valve From QMCB
1BD12-20	SG Blowdown Isolation, AFW Pump B Discharge Valves, RHR Hx Out Position Indication, DG ESF Supply Fan, MFRV, BFRV, NSCW Acid Pump Isolation

ATTACHMENT A (CONT'D)

DC Loads Which May Be Shed
During Loss Of All AC

NOTE

The "C" battery should be carefully conserved to maintain power for Train C AFW control.

Breaker	Affected Loads
1CD1	
1CD1-08	RHR HL Suction Isolation
1CD1-09	Vital Instrumentation powered from 120V AC Panel 1CY1A:

SG 1 NR Level	LI-518
SG 2 NR Level	LI-528
SG 3 NR Level	LI-538
SG 4 NR Level	LI-548
SG 3 WR Level	LI-503*
SG 2 Pressure	PI-526A
SG 3 Pressure	PI-536A
RCS Loop 3 Tavg	TI-432*
PRZR Level	LI-461
PRZR Pressure	PI-457
RWST Level	LI-992A
Power Range NI	NI-43B

* All instrumentation listed above except SG 3 WR level and RCS Loop 3 Tavg have redundant indications powered from 1AY1A or 1BY1B. These parameters for Loop 3 can be monitored using equivalent instrumentation powered from 1AY1A or 1BY1B. SG 3 level can be obtained from NR instruments and RCS Loop 3 temperature can be obtained from WR TC and/or WR TH.

1CD11	
1CD11-10	DC SWGR Space Heaters
1CD11-14	HVAC Panel
1CD11-15	Isolation Devices
1CD11-18	Isolation Devices
1CD11-21	13.8 SWGR Control Power

ATTACHMENT A (CONT'D)

DC Loads Which May Be Shed
During Loss Of All AC

NOTE

All loads on "D" battery may be shed. "D" battery may be held in reserve to maintain the capability of providing selected vital instrumentation powered from 120V AC Panel 1DY1B if "A" or "B" batteries degrade.

Breaker	Affected Loads
1DD1	
1DD1-04	DC SWGR Space Heaters, Isolation Devices, 13.8 SWGR Control Power
1DD1-08	RHR HL Suction Isolation
1DD1-09	Vital Instrumentation Powered From 120V AC Pnl 1DY1B:

SG 1 NR Level	LI-517
SG 2 NR Level	LI-527
SG 3 NR Level	LI-537
SG 4 NR Level	LI-547
SG 4 WR Level	LI-504*
SG 1 Pressure	PI-516A
SG 4 Pressure	PI-546A
RCS Loop 4 Tavg	TI-442*
PRZR Pressure	PT-458
Power Range NI	NI-44B
Source Range SUR	NI-31D*
Intermediate Range SUR	NI-35D*

* All instrumentation listed above except SUR, SG 4 WR level and RCS Loop 4 Tavg have redundant indications powered from 1AY1A or 1BY1B. These parameters for Loop 4 can be monitored using equivalent instrumentation powered from 1AY1A or 1BY1B. SG 4 level can be obtained from NR instruments and RCS Loop 4 temperature can be obtained from WR TC and/or WR TH. Source Range instrumentation powered from 1AY1A and 1BY1B is available.