05-39-90

Georgia Power

POWER GENERATION DEPARTMENT

VOGTLE ELECTRIC GENERATING PLANT

TRAINING LESSON PLAN

TITLE:	EMERGENCY DIESEL GENERATOR - ENGINE CONTROL AND PROTECTION	NUMBER:	NL-LP-11204-00-C
PROGRAM:	OUTSIDE AREA OPERATOR	REVISION:	0
AUTHOR:	G. D. STONE	DATE:	10/26/87
APPROVED:	TA Craig	DATE:	5/11/89

INSTRUCTOR GUIDELINES:

I. FORMAT

A. Lecture with visual aids

FOR INFORMATION ONLY

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.

MASTER COPY

I. PURPOSE STATEMENT:

FOLLOWING COMPLETION OF THIS LESSON, THE STUDENT WILL POSSESS THOSE KNOWLEDGES SYSTEMATICALLY IDENTIFIED FOR THE PERFORMANCE OF DIESEL ENGINE CONTROL AND PROTECTION SYSTEM TASKS

II. LIST OF OBJECTIVES:

1. State the uses of the pneumatic portion of the emergency diesel engine control and protection system.

2. State the source of air supplied to the pneumatic engine control system.

3. List the basic uses of the A, B, and C control circuits, and state how they are monitored.

4. List the diesel engine and generator control panel permissives that are necessary for the following to occur:

   a. Normal manual start, from control room
   b. Normal manual start, from engine control
   c. Automatic start on loss of offsite power
   d. Automatic start on safety injection signal

5. List the protective trips available to the diesel generators after a normal start.

6. List the protective trips available to the diesel generator after an emergency start has occurred.

7. Describe the operation of the PULL-TO-RUN/PUSH-TO-STOP button at the engine front.

8. For the following pushbuttons on the diesel engine control panel, state the response which will occur when each is pushed (or actuated).

   a. EMERGENCY START (when glass is broken)
   b. START
   c. OPERATION MODE
   d. MAINTENANCE MODE
   e. ENGINE ROLL
   f. EMERGENCY STOP (break glass, pushbutton)
   g. EMERG-STOP RESET
   h. STOP
   i. RESET FROM LOCA

II. LIST OF OBJECTIVES

9. For the following indicators on the diesel engine control panel, state the significance of each being lit:

   a. UNIT AVAILABLE
   b. EMERGENCY STOP
   c. DIESEL AUTO START SIGNAL
   d. SHUTDOWN SYSTEM ACTIVE
   e. SAFETY INJECTION SIGNAL
   f. IN TEST SEQUENCE
   g. 52-G CLOSED
   h. READY TO LOAD
   i. RUNNING
   j. STOPPING
   k. BYPASS TEST FAILURE
   l. STARTING

10. State the function of the Woodward Governor System.

11. Give a brief description of the uses for the three control knobs on the EGB-35 governor actuator, and the approximate values to which they are normally set:

    a. LOAD LIMIT
    b. SPEED SETTING ADJUSTMENT
    c. SPEED DROOP

12. Describe how the Woodward type SG Overspeed Trip functions to shutdown the diesel engine.

13. Describe the response of the fuel rack shutdown cylinder and combustion air valves to a diesel trip signal.

14. State the permissives which allow barring of the diesel engine, and state the difference between barring and rolling.

15. Give a brief description of the cylinder moisture check.

16. Discuss how trends in the parameters monitored by logging (using 11883-C) during operation can be used to determine operational problems.

17. State a probable consequence of starting the EDG with an inadequate governor oil level, or without proper governor venting by maintenance personnel.

18. State the method of detecting engine imbalance and the possible consequences of sustained engine operation in an unbalanced condition.

19. State the reason for the cylinder moisture check after the emergency diesel generator has been run, and give the time scheduled for the check.

REFERENCES:

1. PLANT VOGTLE PROCEDURES:

   - 13145, DIESEL GENERATOR (REV 8)
   - 13146, DIESEL GENERATOR FUEL OIL TRANSFER SYSTEM (REV 1)
   - 14980, DIESEL GENERATOR OPERABILITY TEST (REV 1)
   - 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. STANDBY (EMERGENCY) DIESEL GENERATOR, VOGTLE TRAINING TEXT CHAPTER 16C, VEGP

4. PLANT MANUAL CHAPTER 36, 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. F.S.A.R.: 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 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: NONE

10. TRANSPARENCIES:

NL-TP-11204-001	LESSON OBJECTIVES
NL-TP-11204-002	BASIC DG GOV. CONTROL
NL-TP-11204-003	EGB-35 GOV/ACTUATOR CUTAWAY
NL-TP-11204-004	EGB-35 GOV/ACTUATOR 3-VIEW
NL-TP-11204-005	OVERSPEED TRIP, FRONT/SIDE
NL-TP-11204-006	OVERSPEED TRIP - CROSS-SECTION
NL-TP-11204-007	ENGINE CONTROLS, PD62/PD64
NL-TP-11204-008	DG CONTROLS, QEAB

11. STUDENT HANDOUTS:

NL-HO-11204-C-001	EMERGENCY DIESEL GENERATOR: ENGINE CONTROL AND PROTECTION

III. LESSON OUTLINE:

NOTES

I. INTRODUCTION

A. This lesson describes how the diesel engine controls function in the starting, running, and stopping of the engine, and include a review of engine protection devices

B. The operation of Woodward governing systems used for adjusting engine speed and load are presented

C. There is a separate lesson for the generator and its protection

D. Present Lesson Objectives

NL-TP-11204-001

II. PRESENTATION

A. Overview, Engine Controls

1. Provides a means of starting, loading, running, and stopping the diesel generator

2. Locations

a. Normal control from control room (QEAB)

b. Backup control from diesel engine control panel: PDG-2 (Train A)
PDG-4 (Train B)

3. Two basic modes of operation

a. Operational mode

1) Control circuits armed

2) Must be in operational mode to be operable

b. Maintenance mode

1) Start circuits locked out

2) Used for repair, maintenance, barring rolling

3) Pushbutton on local panel

4) DG INOPERABLE in MAINT. MODE

4. Selection of control station

a. LOCAL/REMOTE switch

III. LESSON OUTLINE:

NOTES

1) Switch on Generator Control Panel
PDG-1 Train A
PDG-3 Train B

2) Normally in REMOTE

(control room operation)

3) MAINTENANCE mode selection possible only after local operation is selected

4) DG "INOPERABLE" in LOCAL

- No start on SIS (Auto)
- No start on Loss of Offsite Power (Auto)
- Can be manually started, PDG-2/PDG-4
- Can be emergency started PDG-2/PDG-4

B. General Functions

1. Electrical control circuits

a. Three circuits, A, B and C, 125VDC

b. Function

1) Start and stop inputs

2) Alarm functions

3) Generator interface

4) Control of auxiliaries

2. Pneumatic control circuits

a. 60 psig control air, supplied from Air Start System (regulated from approx. 250 psig to 60 psig)

Objective 2
Drawing
09-500-76021-2
in AXLIAK01-509

b. Ball check valves allow supply, even if one receiver depressurized

c. Functions and uses

1) Monitor various engine parameters, i.e., pressures and temperatures

Objective 1

III. LESSON OUTLINE:

NOTES

2) Generate a shutdown signal in response to sensor tripping, to cause engine trip by closing combustion air dampers and move fuel racks to "no fuel"

d. Pneumatic logic is binary logic

1) Example: three-way valves, one passage closes as another opens

2) AND, OR, NOT, MEMORY, etc.

e. Pneumatic delay circuits

1) Timing chamber in accumulator; air is metered through orifice

2) It takes a specific time to bleed or charge the accumulator with control air

3. Pneumatic/Electric Interfaces

a. Solenoid valves

1) Inputs from electrical system, generates pneumatic signals

b. Pressure switches

1) Outputs from pneumatic system, used as status and control inputs to electrical portion

4. Governing Systems - General

NL-TP-11204-002

a. Function: control amount of fuel oil being supplied to engine by injector pumps, in order to control DG, speed or load

Objective 10

b. Generator Output Sensed

1) Speed - (frequency of AC) - UNIT

2) Load - (volts and amps) - Parallel

c. Load or speed signal compared to control input

1) Control input is speed setting of potentiometer

2) Local or control room handswitch adjusts motor driven potentiometer

III. LESSON OUTLINE:

NOTES

d. Governor-Actuator

1) "Error signal" from electric control causes changes in governor-actuator output

2) Output from governor-actuator controls flow of fuel to engine

3) Governor-actuator has a centrifugal (mechanical) section governor to back up the electric governor

C. Components

1. Woodward EGB-35 Governor-actuator

More detail in Vendor's Manual AXUAK01-564

a. Stalled work capacity 35 ft-lbs torque

b. Electric governor section, mechanical governor, and actuator to position terminal (output) shaft

NL-TP-11204-003

c. Self-contained hydraulic oil supply

Oil supply critical

1) Oil heat exchanger cools governor oil, using jacket water

2) Self-contained oil pumps

d. Small DC speed - adjusting motor on top of ours is not connected for use

e. Mechanical governor

1) Centrifugal speed sensing flyweight head, driven by the engine, opposed by "speeder" spring force

f. Electric governor

1) Receives output of EGA control box

2) Polarized coil produces force proportional to current in coil changing electric signal to hydraulic

g. Three external adjustments

1) Load limit knob

Objective 11a

a) Limits maximum engine load, whether the unit is controlled by mechanical or by electric

NL-TP-11204-004

III. LESSON OUTLINE:

NOTES

governor/actuator

b) Range: "MIN FUEL" to "MAX FUEL"

c) Normal Setting: MAX FUEL

2) Speed setting adjustment knob — Objective 11b

a) Sets the speed to which the mechanical governor will control engine speed

b) 470 rpm (approx. 4 1/2% higher than normal speed)

c) Vernier dial, turning knob changes tension on speeder spring

d) Setting adjustment varies from governor-to-governor, but ranges of 11 - 14 expected. Actual setting must be obtained from standby mode status checks. Checklists in Procedure 13145-1, or Operability Test

e) Speed setpoint of mechanical governor (470 rpm) is high enough to not interfere with normal operation of electric governor

3) Speed droop control knob - sets speed droop of mechanical governor — Objective 11c

a) Normal setting is 2.5

(5% speed droop of mechanical governor)

b) Speed droop can be calculated by noting difference in no-load and full-load speed, divided by no-load speeds

c) Example: Assume that all we had was a mechanical governor. If the engine is started, the speed would go to 470 rpm, if speed droop was 4 1/2%

(470-450)/470

Now we load the generator, and by full load, diesel generator speed should

III. LESSON OUTLINE:

NOTES

have "dropped" to 450 rpm, due to the added load

h. Booster Servomotor

1) Compressed air from the starting air system moves a spring-loaded piston inside the servomotor

2) Governor oil on other side of piston

3) Oil under pressure supplied to governor, and governor moves fuel linkage to fuel-on

4) Engine fires at once, rather than waiting for buildup of governor oil pressure

Woodward EG-A Control Box

a. Electronic unit, in generator control panel — 1X3D-BH-G03G

b. Works along with speed-setting potentiometer (GOV"MOP" on print)

c. Function - to produce a signal to the electric portion of the EGB-35 governor-actuator, to control speed (and frequency) if in unit mode, or load, if in parallel (droop) mode

d. Speed detected by output frequency of generator

1) Frequency signal converted to DC, and compared to DC signal of speed-setting potentiometer

2) Speed (frequency) is the sensed and controlled parameter when in isochronous (unit) mode

3) When speed (frequency) agrees with speed demanded by speed-sensing potentiometer, a constant signal will be sent to electric governor section of EGB-35 governor-actuator

e. Load is detected by generator output voltage and current

1) DC signal produced, proportional

III. LESSON OUTLINE:

NOTES

to KW output of generator

2) DC LOAD signal summed with opposing signal from speed-setting potentiometer

3) When the load signal and speed-setting potentiometer do not agree, a current is sent to a coil in the electric portion of the governor-actuator

4) Electric signal changed to a hydraulic signal

3. Woodward Overspeed Trip, Type SG

NL-TP-11204-005

a. Driven from same engine that drives the fuel pump

b. Self-resetting after trip, when speed drops below tripping speed

c. 517.5 rpm tripping speed

d. Flyweight, spinning, proportional to engine speed, tends to lift a plunger value

NL-TP-11204-006

e. Flyweight assembly opposed by speeder spring

Objective 12

f. At trip speed, oil under pressure passes through pilot plunger, lifting power piston

g. Power piston causes terminal shaft to rotate

h. Arm out terminal shaft moves, striking two air vent valves

i. Vent values - do not self-reset, must be manually reset

j. Vent values cause air to be supplied to close air damper and extend fuel shutdown cylinder

D. Controls and Instrumentation

1. 125VDC: 2 Class 1E, and one non-1E, interfaced with DG for control purposes

A & B one 1E
C is non-1E

a. 'A' Power (125V DC)

1X3D-BH-G03C
Objective 3 (part)

1) Starting (basic uses)

III. LESSON OUTLINE:

NOTES

a) Deactivate shutdowns (on emerg. start)

b) 1 sec. field flash delay

c) Two air start solenoids energize

d) Activate shutdowns (normal start)

e) Safety inj start from SSPS

f) Breakglass emerg start (PS-45A)

g) Loss of offsite power (sequencer)

h) Speed switches (200 and 440 rpm)

2) Monitoring (basic use)

a) Optical isolators

b) Several generator related (and other) annunciators

3) DIST pnl 1AD11, Bkr 72-11 (Train A)

4) DIST pnl 1BD11, Bkr 72-11 (Train B)

5) 'A' Power monitored by:

"A power available" white indicating light on PDG2/PDG4

b. 'B' Power (125VDC)

1) Starting (basic use)

Objective 3 (part)

a) Similar functions as 'A' circuit

2) Stopping functions (basic use)

a) EMERG stops

b) MAINT/OPERATIONAL mode circuits

c) STOP circuits

d) "IN TEST SEQUENCE" indicator (sequencer in testing)

3) DISTR. panel 1AD12, BKR 72-11 (Tr. A)

4) DISTR. panel 1BD12, BKR 72-11

III. LESSON OUTLINE:

NOTES

(Tr. B)

5) 'B' power monitored by:

"B power available" white indicating light on PDG2/PDG4

c. 'C' Power (125VDC)

1) Alarms (basic use)

a) Failed to start alarm <200 rpm in 5 sec

1X3D-BH-G03E Objective 3 (part) PS-9N 1, 2 from fuel rack cyl. extended

Reset P.B. part of annunciator reset sw

2) Power for PDG2/PDG4 panel indicating lights (basic lights)

3) Annunciator power (basic use) (logic, horn)

4) Crankcase fan and generator heater control power

5) DISTR panel IND31, BKR 72-07 (A train) (Non 1-E)

6) DISTR panel IND32, BKR 72-11 (B train) (Non 1-E)

7) 'C' power monitored by:

"C power available" white indicating light on PDG2/PDG4

d. 120VAC

1) Power to thermocouple digital indicator panel "Doric Trendicator"

2) Hour-meter

3) Panel heater and interior light

2. Engine Starts

a. Normal engine starts

1) Control Room - manual pushbuttons

2) Diesel generator control panel (local) pushbuttons

III. LESSON OUTLINE:

NOTES

3) Automatic - loss of offsite power

b. Emergency engine starts

1) Automatic: safety injection signal

2) Manual: local emergency breakglass

3. Permissives for engine starts - normal — 1X5DW170-2

a. Normal start - pushbutton, control room (QFAB) — Objective 4a

1) Local/remote switch (LRS) in REMOTE

2) DG is in OPERATIONAL mode

b. Normal start - pushbutton, local engine panel (PDG2/PDG4) — Objective 4b

1) LRS in LOCAL

2) DG is in OPERATIONAL mode

c. Normal start - loss of offsite power - automatic start — Objective 4c

1) LRS in REMOTE

2) From sequencer, loss of voltage, 2/4 UV for .8 seconds at 70% nominal voltage

3) From sequencer, degraded voltage 2/4 UV for 20 sec, at 88.5% normal voltage

NOTE: Alarm is 2/4 UV 93.1% for 10 sec.

4) DG for the bus with the UV starts

d. What occurs on man. normal starts

1) Start air solenoids energize

a) Start air to engine until 200 rpm or 5 seconds

2) Safe shutdown trips inservice (some initially bypassed for 90 sec.)

3) Accessories affected

III. LESSON OUTLINE:

NOTES

a) Gen space heater off

b) JW keepwarm pump off

c) LO keepwarm pump off

d) Hour-meter actuated

4) Generator's field flashed

a) After 1 second, OR

b) When 200 rpm reached

5) At 440 rpm (and 90% generator voltage)

a) Permissive to close breaker

b) Breaker closure requires other permissives, covered in another lesson plan

c) Breaker stays open

6) Auto normal start same, except:

a) On loss of offsite power, governor speed-setting potentiometer (and voltage regulator's adjusting potentiometer) pre-position to 60 HZ and 4160V position

b) Speed and voltage can not be adjusted for 15 seconds from initiation

c) DG output breaker closes:

90% voltage, 440 rpm

4. Permissives for engine starts, emergency — 1X5DN 170-2

a. Automatic emergency start - SIAS

1) LRS in Remote — Objective 4d

2) DG "OPERATIONAL" mode

3) Start air pressure > 150 psig

4) Safety injection signal occurs

b. Manual emergency start

III. LESSON OUTLINE:

NOTES

1) DG in "OPERATIONAL" mode

2) Break the lens on the breakglass for emergency start (button is released)

3) LRS in either position

c. What happens on emergency start

1) Shutdown system deactivated, leaving only four trips available

2) Normal trip signals bypassed

3) Governor and voltage regulator motor operated potentiometers pre-position (60HZ, 4160 VAC)

Also, if in PARALLEL, gov. is is changed to UNIT N3D-BH-G03G, H "UPR" relay

4) Air start solenoid valves close:

200 rpm, or air receiver pressure drops to 150 psig

(If start did not occur, local checks made before wasting more air. Restarts can be made using normal starts)

5) Engine starts, comes to speed, gen. voltage established

5. Modes

a. Operational Mode

PS-40A

1) Must be in Operational mode for any start

2) To enter

a) Barring device locked out

b) No shutdown signals present

c) Press "Return to Operational Mode"

b. Maintenance Mode

1) No DG start available in Maint. Mode

2) To enter

a) Go to LOCAL first

III. LESSON OUTLINE:

NOTES

b) Shutdown system active (no SIS)

c) Engine not running

d) Maintenance pushbutton pressed

3) Can Air Roll DG - if barring device is locked out

c. LOCAL/REMOTE switch

1) Switch on gen. control panel

2) In Remote, engine can start on:

a) Normal manual start, control room

b) Loss of offsite power

c) Safety injection signal

3) In Local, engine can start on:

a) Start pushbutton on PDG2/PDG4 (normal start)

NOTE: Local emergency start Breakglass starts can occur if local or remote

6. Trips, automatic

1X5DW170-2

a. After normal start

Objective 5

1) Lube oil temp high, 200°F

2) Engine bearing temp high, 228°F "resetting" involves replacing fusible rod temp. detectors

NOTE: The following are inhibited from causing an engine trip for the first 90 seconds after start

3) Crankcase pressure high, 3 psi

4) Turbocharger oil pressure low, 15 psig

5) Jacket water pressure low, 6 psig

6) Vibration (two engine sensors, and one for each turbocharger)

NOTE: The above six trip signals

III. LESSON OUTLINE:

NOTES

lock-out a normal restart for 90 seconds, but will not lock-out an emergency start

7) Generator fault, 186B

a) Normal restart after resetting of lockout

b) No 90-seconds post-trip timer

NOTE: The following four trips will also stop the DG if emergency started

8) Generator differential, 187, via 186A lockout

a) Lock-out, and Emerg Trip Reset P.B. to restore

9) 2/3 lube oil pressure low, 30 psig

a) Emerg trip reset P.B.

10) 2/3 high jacket water temp 200°F

a) Emerg trip reset P.B.

11) Overspeed, 517.5 rpm

a) Must manually reset two air valves

b) Emerg trip reset

7. Trips after Emergency start

Objective 6

a. 186A Generator Differential Trip

1) Lockout relay reset, and Emerg Trip reset pushbutton to restore, plus administrative guidance

Guidance from SS needed to reset

b. 2/3 Low Lube Oil Pressure, 30 psig

1) Emerg trip reset P.B. to restore and allow restart

c. 2/3 Hi Jacket Water Temp, 200°F

1) Emerg trip reset P.B. to restore and allow restart

d. Overspeed, 517.5 rpm

III. LESSON OUTLINE:

NOTES

1) Reset two air valves and Emerg trip reset to restart

8. Manual Stops

1X5DW 170-2

a. Normal Stops

1) Control Room stop P.B.

a) LRS in Remote

2) PDG2/PDG4 stop P.B.

a) LRS in Local

b. Emergency Stops

1) Control Room Emerg Stop P.B.s

a) 2/2 P.B. (pressed at same time)

b) LRS in Remote

2) PDG2/PDG4 Emerg Stop

a) Breaks glass, push button

b) LRS either position

3) Must press Emerg Trip Reset to allow recovery

a) DG inoperable after an Emergency Stop, until restored

c. Stopping after Emergency Start

1) "Reset LOCA" pushbutton, then normal stop

2) The Emerg Stop method WILL stop DG, but it is inoperable until reset and placed back in service, and is not the procedural method for normal recovery

9. Response to Trip Signal

a. DG output breaker trips

b. Generator excitation circuits tripped (A & B)

Objective 13

c. Fuel Rock Shutdown Cylinder Extends

"extensible link"

III. LESSON OUTLINE:

	NOTES
1) Control air to actuator	
2) Fuel racks on injector fuel pumps go to "no fuel"	1X4AK01-443-4
d. Combustion air valves - both close	
1) Control air to actuators	
e. Governor and regulator potentiometers: pre-position in preparation for next start	STRESS AIR required to shut-down DG
10. PULL-TO-RUN/PUSH-TO-STOP switch	Objective 7
a. Located at front of auxiliary skid	
b. Will trip DG when pushed	
c. DG restart sends air signal to reset the switch, so does not keep DG shut down, if needed	
11. Controls on Engine Control Panel	NL-TP-11204-007
a. EMERGENCY START - breakglass Breaking glass (or removing lens cover) allows spring loaded button to "pop" out. DG starts, with normal shutdown deactivated	Objective 6a 1X3D-BH-G03C, 1X3D-BH-G03D, 1X5DN107-2
b. START - Pressing START pushbutton starts DG (if LRS is in LOCAL) with normal shutdown in service	Objective 8b
c. OPERATIONAL mode - returns DG from MAINT mode to OPERATIONS mode. Must be in OPERATIONAL mode to start DG	Objective 8c
d. MAINTENANCE mode - with LRS in LOCAL, pressing pushbutton takes DG out of OPERATIONAL mode, inhibiting all starts - DG will not start. Must be in MAINTENANCE mode for barring and rolling operations. DG inoperable	Objective 8d
e. ENGINE ROLL - in MAINT. mode, allows spinning of DG while P.B. is pressed. Engine does not start. The DG will stop spinning when the button is released	Objective 8e
f. EMERGENCY STOP - breakglass in either local or remote with LRS, breaking glass and pushing button stops DG locally. It can not be restarted until emerg. stop has been	Objective 8f Glass is broken, buttons pushed.

III. LESSON OUTLINE:

	NOTES
reset, so DG is INOPERABLE until EMERG STOP is reset	Differs from EMERG START breakglass
g. EMERGENCY STOP-RESET - Pressing pushbutton resets manual or automatic EMERGENCY STOPS, once trip conditions have been cleared. Permissive to restart DG, if no other trip signals present	Objective 8g
h. RESET FROM LOCA - Resets Emergency Start signal to DG start circuits, and places normal shutdown trips in service, allowing a normal stop (control room or local) Normal recovery method after emergency start	Objective 8i
i. STOP - will stop the DG from PDG2/PDG4 if LRS is in LOCAL, and engine has been started under normal start	Objective 8h
j. TEST BYPASS - tests blocking of normal DG trips when DG is running under an Emergency Start	
k. Annunciator Pushbutton 1) TEST 2) SILENCE (horn) 3) ACKNOWLEDGE 4) RESET	
Annunciator pushbuttons must be depressed in correct sequence when an alarm occurs SILENCE/ACKNOWLEDGE/RESET	Keeps logic correct
Horn does not sound if engine is not running and alarm occurs - prevents burning up horn in unattended building	
RESET also resets latching relays for FAILED TO START alarm	
l. PUSH-TO-READ pushbuttons for day tank and lube oil sump level indicators 1) Control air supplied to "bubblers"	
12. Indicating lights on PDG2/PDG4	
a. EMERGENCY STOP - RED	Objective 9b 1X3D-BH-G03D

III. LESSON OUTLINE:

NOTES

1) Lit until reset, can not restart until reset — R-23B-3 contact

2) From Manual Emerg Stop, or one of the four Auto Emerg Stops

b. 52G CLOSED - RED — Objective 9g

1) Gen. output breaker closed

c. SHUTDOWN SYSTEM ACTIVE - RED — 1X3D-BH-G03E Objective 9d

1) Engine normal shutdowns active

2) Lit on normal start

3) Extinguished on EMERGENCY STARTS

d. BYPASS TEST FAILURE - RED — 1X3D-BH-G03E

If lit red during Emerg Start, with TEST BYPASS pressed, indicates a normal trip can trip the DG — PS-36N Objective 9k

e. UNIT AVAILABLE - BLUE — Objective 9a 1X3D-BH-G03E, and 1X5DN107-2

No overspeed, and DC start ckt. power available, STARTING AIR PRESSURE > 150 psig, barring device locked out

f. DG AUTO START Signal RED — Objective 9c

DG Auto Start signal exists from Loss of Offsite Power, or Safety Injection

g. SAFETY INJECTION SIGNAL - GREEN — Objective 9e

Lit on EMERGENCY START - from shutdown syst deactivate signal

h. IN TEST SEQUENCE - RED — 1X3D-BH-G03D, Relay DG 1A-AX Objective 9f

- SEQUENCER (SFSS) IN TESTING

- K 357

i. READY TO LOAD - BLUE — Objective 9h

1) Engine at 440 rpm

2) DG voltage $\geq$ 90% normal

j. RUNNING - RED — SOL202-3A, B Speed switches

III. LESSON OUTLINE:

NOTES

1) Engine speed above 200 rpm — Objective 9i

k. STOPPING - RED — Objective 9j

1) Lit on unit trip — PS9-NI

2) Engine will not normal start when lit

3) Pressing START will only waste air

l. STARTING - RED — Objective 9l, 1X3D-BH-G03E,

1) Lit when starting is initiated — 1X4AK01-44-9

2) Normal or emergency starts — PS32-N2

m. 'A' POWER AVAILABLE

1) 125VDC control power to 'A' circuit — 1X3D-BH-603C

2) CB 1-2 on engine panel, 1E sources

n. 'B' POWER AVAILABLE — 1X3D-BH-603D

1) 125 VDC control power to 'B' circuit

2) CB 3-4 on engine panel, 1E sources

o. 'C' POWER AVAILABLE - 125 VDC Control Power to 'C' Circuit. CB 5-6 on engine panel, Non-1E source — 1X3D-BH-G03F

E. Operations

NORMAL OPERATIONS

1. Local control panels - normal standby

a. All annunciator lights extinguished

b. "UNIT AVAILABLE" light lit

c. 'A' POWER AVAILABLE light lit

d. 'B' POWER AVAILABLE light lit

e. 'C' POWER AVAILABLE light lit

f. REMOTE/LOCAL switch on generator panels in REMOTE

g. JW Keep-warm pressure gauge 15 - 25 psig

h. L.O. keep-warm pressure gauge 30 - 50 psig

III. LESSON OUTLINE:

	NOTES
i. Control air pressure gauge 58 - 62 psig	
j. L.O. IN, OUT (Digital Thermo- couple 142 - 170°F	
k. JW IN, OUT (Digital Thermo) 142 - 170°F	
2. Cylinder Moisture Checks	
a. DG inoperable while in LOCAL	
b. Reason for running - to check for evidence of water which may have leaked into a cylinder. This can cause hydraulic lock of a cylinder, causing cylinder and head cracks or damage, if an engine start is attempted with full air pressure	Objective 19
c. Shift Supervisor notified of ANY moisture discovered, or if resistance is encountered when barring	
d. When performed:	
1) Prior to a scheduled run, if not done within previous four hours	
2) Four to eight hours after shutdown	
3) 24 hours after shutdown	
e. Rolling is use of starting air to spin the engine, without its starting	Objective 14 (part)
f. Barring is slowly turning the engine a small amount at a time. Barring is done with a barring device, using air pressure to extend a rod, with the rod pushing the engine's flywheel at holes in the flywheel	
g. Permissives/interlocks to allow barring	Objective 14 (part)
1) LRS in LOCAL	
2) Engine not running	
3) No LOCA signal present	
4) MAINTENANCE mode selected	
5) Removal of lockout pin	
h. Cylinder moisture check - brief description	Objective 15

III. LESSON OUTLINE:

NOTES

NOTE: Permission must be obtained - DG inoperable during check - Licensed Operator must consult Tech Spec

1) LRS to LOCAL - PDG1/3

2) MAINTENANCE pushbutton pressed - PDG2/4

3) Verify fuel and air shutdown cylinder fully extend

4) Open all cylinder cocks

   Note presence of any moisture BEFORE barring AND after

5) Open air supply valve to barring device

6) Unlock pneumatic barring device by removing lockout pin

7) Engage device in flywheel, bar over at least two revolutions of the flywheel

   This takes each piston through all four combustion cycles

8) Check for evidence of moisture

9) Disengage and lockout barring device

10) Verify "BARRING DEVICE ENGAGED" alarm resets

11) Close isolation valve from receiver to barring device

3. Engine Imbalance

Objective 18

a. Cylinders not carrying an equal load

b. Detected by observing cylinder exhaust temperature on Digital Thermocouple Readout (Doric Trendicator). One (or more) cylinder's temperature excessively higher or lower than the average indicates possible imbalance

c. Cylinder exhaust temperature which is greater than $\pm$ 50^{0}F of average should be

Ref: AXUAK01-509,

III. LESSON OUTLINE:

NOTES

investigated

Page 8-3, and G-H-1, 2

d. Causes:

Misadjustment of fuel injection pumps (possibly following maintenance activities)

Injector problems

Dirt, impurities in fuel oil

According to factory rep, plugging of two spray nozzles on an injector will cause fuel line to injector to rupture

e. Results of cylinder imbalance - cylinder(s) carrying excessive load, possible:

1) Scored pistons and liners

2) Excessive vibration

3) Excessive piston, valve, bearing, and crankshaft wear

4) Excessive fuel consumption

5) Excessive lube oil usage

4. Reviewing the DG Operating Log (1185-C)

Commitment SOER 83-001 begins

a. Majority of engine problems preceded by some change in operating data. Data changes can be so slight that tends may be hard to detect in short time intervals

Trends easier to determine if readings are taken under the same conditions

b. Long-term:

From Vendor's Manual

1) Lube oil pressure starts to decrease, but lube oil temperature stays constant

a) Bearing wearing

b) Lube oil wearing

c) Relief valve not functioning properly

d) Possibly fuel dilution

III. LESSON OUTLINE:

NOTES

2) Lube oil pressure drops, lube oil temperature increases

a) Problem with heat exchanger, possibly plugging up

3) Lube oil consumption increasing

a) Piston rings starting to foul

b) Valve guide wear

c) Leaks in lube oil cooler

(Lube oil pressure higher than JW pressure, so leaks will be into the water system)

4) Crankcase vacuum starts to decrease

a) Piston ring wear, causing blow-by

5) Jacket water temp. starting to rise

a) JW cooler starting to foul

b) Would be hard to determine, since temperature control valve can cause outlet temperature to vary up to 15°F

6) Jacket water outlet temperature drops (greater temp. differential across engine)

a) Poor combustion

b) Leaky head gasket(s)

c) Scuffed pistons

d) JW system not vented

e) Faulty water pump

c. Short term, possibly found by reviewing previous few logs

From 17035-1 Objective 21 begins

1) Keepwarm filter plugging (engine not running)

2) Exhaust temperature in one cylinder different than average

III. LESSON OUTLINE:

NOTES

a) Bad fuel pump, or injector nozzle

3) Exhaust stack temperatures above limits

a) Engine overloaded

4) Lube oil temperature IN/OUT increasing

a) Inadequate coolant flow through lube oil HX

b) Inadequate NSCW flow through JW cooler

c) High NSCW temp

d) Biofouling of NSCW side of JW cooler

e) Engine overload

5) Fuel oil pressure decreasing

a) Fuel oil filter clogged

b) Fuel oil strainer clogged

c) Pressure regulator failing open

d) Fuel pump malfunction

6) Jacket water pressure decreasing

a) JW pump malfunction

b) Leak in system

c) Standpipe level decreasing

7) Lube oil pressure decreasing

a) Lube oil filter clogging

b) Lube oil strainer clogged

c) Pressure regulator(s) failing open

d) Pump malfunction

e) Low sump level

8) Fuel filter diff. press. increasing

III. LESSON OUTLINE:

NOTES

a) In-service filter fouling

b) Can switch to standby filter with engine running (Procedure 13145-1)

9) Lube oil filter diff. pressure increasing

a) In-service filter clogging

b) Can switch to standby filter with engine running (Procedure 13145-1)

10) Turbocharger oil pressures decreasing

a) Lube oil filter clogged

b) Lube oil strainer clogged

c) Lube oil pressure reg. failing open

d) Engine-driven lube oil pump malfunction

e) Low lube oil sump level

Also, short-term, turbocharger prelube valve left open

Objective 21 ends
SOER 83.001 ends

ABNORMAL OPERATIONS

1. Loss of Control Air Pressure

   a. Running DG continues to run

   b. Cannot be shut down by normal means, since fuel rack shutdown cylinder will not extend and air dampers will not close

   c. Loss of engine protection

2. Low Governor Oil Level

IEN 86.07
Objective 17

   a. Probable engine overspeed and trip

   b. Uncontrollable engine speed

   c. This occurred at Grand Gulf nuclear station, causing internal engine damage. Maintenance had been performed on the governor, and it was incorrectly vented when reinstalled. In their case, the

III. LESSON OUTLINE:

NOTES

overspeed trip device was incorrectly adjusted. On engine startup, the engine overspeed several seconds

1X4AK01-443-4

d. Our DG was modified, with a second overspeed air vent valve, so combustion air dampers respond quicker

3. Transferring LRS

a. On PDG1/3

b. If parallel with RAT and LRS transferred to LOCAL

1) Governor and voltage regulator taken out of DROOP, to UNIT

2) Governor will now sense for speed

3) Any difference in speed (detected) signal and setting of speed-set potentiometer will be detected

4) Governor will try to make up for the error signal, taking on a large load, and tripping on overcurrent

4. Prolonged Operations

a. DG should not be operated for prolonged periods at less than 30% power

b. DG should be loaded to at least 50% for two hours every 24 during low or no-load operation

5. Failure of Class 1E Safety-Related Switchgear Circuit Breakers to close on demand (Refer to IEN 83-50, August 1, 1983)

Begin IEN 83.050

a. Failures attributed to a problem within the circuit breakers closing control circuitry located inside the breaker cubicle

b. Typical causes for failures include:

1) Blown control circuit fuses

2) Intermittent electrical connections

3) Dirty or corroded contacts

4) Malfunctions in the spring charging

III. LESSON OUTLINE:

NOTES

motors or associated spring position switch contacts

c. Nearly 25% of tabulated events involve diesel generator output breakers

1) Due to more permissive interlocks associated with the closing circuit of these breakers - reason for relatively high percentage of occurrences

d. Important for breakers to be checked frequently for proper status, i.e., control power, spring charge, etc.

End
IEN 83.050

III. SUMMARY

A. Review Lesson Plan Objectives for Summary