1

Georgia Power

POWER GENERATION DEPARTMENT

VOGTLE ELECTRIC GENERATING PLANT

05-41-90

TRAINING LESSON PLAN

TITLE:	SEQUENCER OPERATION	NUMBER:	LO-LP-28201-09-C
PROGRAM:	LICENSED OPERATOR TRAINING	REVISION:	09
AUTHOR:	L. FITZWATER	DATE:	7/18/89
APPROVED:	TRCraig	DATE:	7/26/89

INSTRUCTOR GUIDELINES:

I. LESSON FORMAT

A. Lecture with visual aids

II. MATERIALS

A. Overhead projector

B. Transparencies

C. White board with markers

III. EVALUATION

A. Written or oral exam in conjunction with other lesson plans

IV. REMARKS

None

FOR INFORMATION ONLY

MASTER COPY

I. PURPOSE STATEMENT:

Following completion of this lesson the student will possess those knowledges of Sequencer Operation systematically identified for the performance of Licensed Operator tasks.

II. LIST OF OBJECTIVES:

1. State the purpose of the safeguards sequencer.(012GEN0007, 064000k411)

2. List the source of power to the sequencers.

3. State the purpose of the Automatic Test Circuit(ATI) on the sequencer.

4. List the input signals that will start the safeguards sequencer, including setpoints and coincidences.

5. Assess the response of the safeguards sequencer with respect to load shedding, the sequencing of major loads and starting/loading the diesel generator for all of the following conditions.(064000k410,064000k411,064000A307)

   a. SI actuation(either/both trains)
   b. ESF bus UV(either/both trains)
   c. ESF bus UV followed by SI prior to completion of UV load sequence
   d. SI followed by ESF bus UV prior to SI load sequence
   e. SI and ESF bus UV simultaneously
   f. More than 2 UV conditions within a 2 hour period

6. Describe how and why the sequencers are reset following a loss of power to the ESF buses and failure of the D/G breaker to close.

REFERENCES:

1. Plant Vogtle Procedures

   13503 "Reactor Control Solid State Protection System"
   14600 "ESFAS slave relay and final device test, train A"
   14601 "ESFAS slave relay and final device test, train B"
   14420 "Solid State Protection System train A(B) operability test
   14700 "Manual reactor trip test"
   14701 "Reactor trip breakers U/V and shunt trip test"
   14710 "Remote shutdown panel transfer switch and control circuit
   18 month surveillance test"
   14901 "Turbine trip reactor trip actuating device operational test"
   13435 "Circuit breaker racking procedure"
   17004 "ARP for ALB 04 panel on 1A1 on MCB"
   17005 "ARP for ALB 05 panel on 1A2 on MCB"
   17006 "ARP for ALB 06 panel on 1A2 on MCB"
   17007 "ARP for ALB 07 panel on 1A2 on MCB"
   17009 "ARP for ALB 09 panel on 1C1 on MCB"
   17010 "ARP for ALB 10 panel on 1C1 on MCB"
   17011 "ARP for ALB 11 panel on 1C1 on MCB"
   17012 "ARP for ALB 12 panel on 1C1 on MCB"
   17013 "ARP for ALB 13 panel on 1B1 on MCB"
   17014 "ARP for ALB 14 panel on 1B1 on MCB"
   17016 "ARP for ALB 16 panel on 1B1 on MCB"
   17061 "ARP Process control panel"
   17062 "ARP Process control panel"
   17063 "ARP Process control panel"
   17102 "ARP for the safety-related display console QRM 2"

2. Technical Specifications: 2.1, 2.2, 3.3.1, 3.3.2, 3.3.3.5.1

3. Vogtle Training Text, Chapter 25 (partial); 8b

4. Plant Manual, Chapter 11

5. Design Manual, DC-1604, DC-1605, DC-1622

6. P&IDs, Logics, and other Drawings:

   1X3D-BD-U01A, -U01B
   1X3D-AA-G02A, -G02B
   1C3D-AA-H01B, -H02B
   1X3D-BC-C04J, -K, -L, -M
   1X3D-CD-B04A, -B, -C, -D
   1X3D-CD-B09A, -B, -C, -D
   1X3D-BE-H04A, -B, -C, -D
   1X3D-BE-H03A, -B, -C, -D
   1X3D-BD-U01C, -D
   1X6AU02-176
   16AT01-555, -556, -557
   1X6AA02-225, through 240, -414, -415, -416
   1X6AT01-591

REFERENCES:

7. Vendor Manuals and other references:

   1X6AX01-367 Westinghouse Safeguards Test Cabinet Test Manual
   1X6AX01-466 Westinghouse SSPS Tech Manual
   1X6AX01-272 SSPS Final Device or Actuator Testing Test Procedure
   AX3AE03-365 Safety Features Sequencer System
   VEGP I&C Technology, Solid State Protection System
   VEGP PLS
   VEGP Logic Diagrams

8. FSAR, sections 7.2, 7.5.5, 6.2.2

9. Commitments

   FF 88.032 PLPS-5 NRC Exam Feedback
   ER 88.030 CUI During Sequencer Energization
   FF 89.016 DRMS Feedback

10. Transparencies

    LO-TP-28201-001 Lesson Objectives
    LO-TP-28201-002 Basic Safeguard Sequencer
    LO-TP-28201-003 SIS Only Simplified SEQ Logic
    LO-TP-28201-004 U/V Only Simplified SEQ Logic
    LO-TP-28201-005 U/V Logic
    LO-TP-28201-006 Simplified Sequencer Logic
    LO-TP-28201-007 SIS and U/V Simplified SEQ Logic

11. Student Handouts
    none

III. LESSON OUTLINE:

NOTES

I. INTRODUCTION

A. The Sequencer System is used to sequence on ESF loads under an SI and/or loss of power

B. Present lesson objectives — LO-TP-28201-001

C. Present lesson plan format — Write on board

1. Functions of safeguards sequencer
2. Power supply and loads
3. Sequencer operation
4. Review objectives

II. PRESENTATION

A. Function of safeguards sequencer — LO-TP-28201-002

1. The safeguards sequencer subsystem performs the load shed and subsequent load sequencing operations necessary to mitigate the effects of a major plant accident. — Objective 1

a. Load shedding - is the stripping of all or part of the loads from the 1E bus upon receipt of an actuation signal.

Load shedding removes loads (all loads) not essential to safe plant shutdown and prevents the diesel from being overloaded when it ties onto the 1E bus on an undervoltage condition.

b. Load sequencing - is the automatic starting of essential equipment in a timed sequence of order.

Load sequencing ensures selected ESF equipment is started as required in response to a plant accident in a manner which ensures even loading of the diesel generator within its prescribed design limits.

B. Source of Power

1. Sequencers are powered from 1E power sources — Objective 2

120V AC distribution panels

III. LESSON OUTLINE:

NOTES

1AY2A - Train A

1BY2B - Train B

2. Also has battery backup internal to allow for retention of logic step if power lost and then restored.

   a. If power lost to sequencer during the sequence operation and then restored, sequence will begin where it left off.

C. SI Loads Sequenced

1. Major SIS Loads

Train A only (Train B loads are similar)

Time	Load
.5 sec	CCP A
5.5 sec	SIP A
10.5 sec	RHR pump A
15.5 sec	Containment spray pump A (W/CSAS)
20.5 sec	CCW pumps 1 and 3 AFW 3
25.5 sec	NSCW pumps 1 and 3 CCW 5 (spare if needed)
30.5 sec	CIMT cooling units 1, 2, 5, and 6 (slow speed) NSCW 5 (spare if needed)

2. Major U/V Loads

Time	Load	
.5 sec	CCP A	
5.5 sec	-------	
10.5 sec	-------	
15.5 sec	ACCW 1	
20.5 sec	CCW 1 and 3 AFW 3	
25.5 sec	NSCW 1 and 3 CCW 5 (spare if needed)	
30.5 sec	CIMT cooling units 1 & 2 (fast speed)* NSCW 5 (spare if needed)	Actual start #1 & Cntmt fans - 50.5
50.5 sec	CIMT cooling units 5 & 6 (fast speed)*	Actual start #5 & Cntmt fans - 70.5

*CIMT cooling units must not all be started at the same time to prevent overloading the diesel

III. LESSON OUTLINE:

NOTES

generator. Analysis has shown that if all four were allowed to be started at the same time, DG voltage could drop below 80 percent of nominal and cause excessive heating in large motor windings.

Sequencer provides containment cooling unit motor auto-start circuit with start signal at 30.5 second step. However, motor will start at 50.5 due to an additional time delay of 20 seconds by agastat time delay in the auto start circuit.

Note 15 of 1X3DB-AA-K02A

D. Sequencer Operation

1. Safety injection

Objective 4
Objective 5a
LO-TP-28201-003

a. Basic sequencer functions upon sensing the SIS from one train

1) Starts respective trains diesel generator

2) Starts timed incremental load sequence on SI

3) Blocks U/V sequence

b. Detailed sequencer operation

1) DG receive start signal through the sequencer

a) Sequencer has the capability to be supplied with the opposite train SI signal via an isolation device, NOT USED AT VOGTLE i.e., will not start the other trains diesel

b) The DG breaker will not close if no U/V detected on respective safety bus

c) "DG READY FOR LOADING" indications when >440 rpm and 90% voltage

d) Diesel generator breaker

- Breaker will not close if no U/V is detected on each respective safety bus

- Breaker will open on SIS if the

III. LESSON OUTLINE:

NOTES

generator is in parallel with the preferred or alternate normal power source (this function is performed by SSPS)

2) Sequencing operation

a) Sequencing starts after the following delays

- 90 ms delay - for step timing bus reset

- 0.5 sec. delay - to start load sequencing

b) U/V logic is blocked by SI to establish appropriate loads to be sequenced

3) Block Auto/Man signal

a) Prevents operator from stopping components sequenced on by the DG until the signal clears

b) If components stopped during sequencing they would auto restart due to the sequencer signal and could result in overheat of components

* Cannot stop them even if placed in PTL

* Operator can manually start components at any time

c) Clears ~ 36 secs after sequencer activated

d) Operates in SI or UV mode of operation

2. Undervoltage

Objective 5b

LO-TP-28201-004

a. Basic sequencers function upon sensing undervoltage conditions AA02 or BA02

1) Shed all loads; load center transformers remain connected

III. LESSON OUTLINE:

	NOTES
2) Start diesel generator	
3) Trip 4160VAC preferred power supply breaker	
4) Shut DG BRKR (when permissives satisfied)	
5) Start timed incremental load sequence	
6) If undervoltage sensed on both trains the above sequence occurs on both trains	
b. Undervoltage sensing	
1) Each bus is monitored by 4 PTs which provide an input to the sequencer	LO-TP-28201-005
a) PT signal supplied via isolation device to the sequencer bistables	
b) Each device feeds a set of 3 bistables	
c) Sequencer monitors for 3 different abnormal voltage levels	
2) Third level voltage	
a) At less than or equal to 93.1 percent for greater than or equal to 10 seconds on 1/4 channels	Provide alarm to alert personnel. Sequencer does no run.
b) SEQ A(B) TROUBLE" - QEAB-ALB-36/37	
3) Second level voltage	Ojective 4 Sequencer runs
a) At less than or equal to 88.5 percent for greater than or equal to 20 seconds on 2/4 channels	
b) "4160V SWGR (Bus) TROUBLE" - QEAB-ALB-36/37	
c) Start sequencer operation	
4) First level voltage	Objective 4
a) At less than or equal to 70 percent for greater than or equal to 0.8 seconds on 2/4 channels	

III. LESSON OUTLINE:

NOTES

b) "4160V SWGR (Bus) TROUBLE" - GEAR ALB-36/37

c) Start sequencer operation

c. Detailed sequencer operation

1) UV Simultaneously

a) DG start signal

b) Trip preferred normal and alternate incoming breaker to 1E bus (.2 sec time delay pick up)

c) Shed all bus loads except load center transformers (.2 sec time delay pick up)

2) Shut DG breaker if following permissive satisfied

a) DG ready to load

Greater than 440 RPM and greater than 90 percent rated voltage

b) Preferred incoming breakers open

c) No bus faults as indicated by no bus lockouts on preferred incoming breakers

d) DG close permissive from sequencer (indicates load shed completed)

e) No lockouts on diesel engine or generator

f) Breaker "Local-Control-Room" selector switch in the "Control Room" position

g) Breaker switch located in Control Room in "Auto" position

3) Start sequencer loading

Only if DG breaker closes

a) .5 second delay - allows on line transformers to receive initial surge upon bus energization

III. LESSON OUTLINE:

NOTES

b) Sequencer loads at 5 second intervals

c) Sequencing completed at 30 seconds after start

4) When last timer activates (30.5 sec) - electric input automatically resets U/V activation circuits

5) BLOCK AUTO/MANUAL SIGNAL CLEARS at 36 seconds after sequencer start to allow operator induced load manipulation

d. Protection against excessive loading cycle — Objective 5f

1) Logic prevents more than 2 UV conditions from activating the sequencer within a 2 hour period

2) Prevent exceeding manufacturer's recommendations concerning motor starts (overheat due to starting current)

3) When 3rd sequence in 2 hour period attempted

a) Initiates load shed

b) Opens preferred feeder breakers

c) Starts DG and closes breaker but no loads are started

e. Sequencer LOP reset button (Unit 2 only) — Unit 1/Unit 2 difference Objective 6

1) Allows resetting of the sequencer following a loss of power where the DG breaker fails to close and offsite power is subsequently restored

2) Before sequencer begins stepping to allow components to load, the DG breaker must close

3) All blocking relays are activated until the sequencer runs and auto/man block

a) Blocks annunciators and stopping circuits

III. LESSON OUTLINE:

NOTES

4) Resetting the sequencer resets the timer to zero and the Auto/Manual block

5) This allows the operator to

a. stop loads that would start when power was restored

b. resets alarms

c. resets the sequencer such that it will start all loads when a UV condition is sensed

3. Safety injection with undervoltage

a. Cases considered

LO-TP-28201-006
LO-TP-28201-007

1) SIS and U/V simultaneously

2) SIS following U/V

3) UV following a SI

b. SIS and U/V simultaneously

Objective 5e

1) Common signals (immediate)

a) DG receive start signals

b) Auto/Manual operation of ESF equipment blocked

2) U/V outputs

a) Load shed 1E and non-1E loads (.2 secs)

b) Trip RAT normal supply feeder breaker (.2 sec)

c) DG auto closure permissive to DG breaker (.8 sec)

3) SIS outputs

a) Block U/V signal to load sequencer

b) Activate step timing bus (.5 sec) after

III. LESSON OUTLINE:

	NOTES
(1) DG started	
(2) DG breaker shut	
4) Auto/Manual operation of ESF equipment unblocked at 36 seconds after signal receipt	
c. SIS following U/V	
1) If sequencer is sequencing on U/V loads when SI received:	Objective 5c
a) Sequencer resets to SI mode (90 ms delay)	
b) SI loads will sequence on as required	
2) If U/V sequencer has timed out, receipt of SIS will be same as for SI without U/V condition	
d. UV following a SI	Objective 5d
1) if SI occurs prior to SI sequence being completed, a combination of the two sequences will occur	
2) first all the loads will be shed	
3) this is followed by the opening of the buses preferred power supply breaker	
4) a close signal is then sent to the diesel generator output breaker	
5) the SI sequencer then sequences on the SI loads	
E. Automatic Test Insertion(ATI)	
1. Purpose: provides a continious surveillance of the sequencers operability to detect faults in its sensing and/or output circuits	Objective 3
2. If a fault is sensed by ATI, ATI operation is halted and an audible alarm is activated to alert the operator	

III. LESSON OUTLINE:

	NOTES
3. ATI operation is halted if any of the following faults are detected a. circuit fault is detected b. manual testing is initiated c. receipt of a UV d. receipt of a SI	
4. ATI circuitry is located in the SFSS logic cabinet	
F. CVI During Sequencer Energizing	ER 88.030 Vogtle Unit 1 11/13/88
1. Refuel outage	
a. "A" train deenergized for testing	
2. Feeder breaker 1AY2A-08 closed to energize the "A" sequencer following completion of test	
a. CRI received when breaker was closed	FF 89.016
b. ZIP circuit on the Elgar inverter shut down the inverter when the sequencer was energized	ZIP circuit is in termal overcurren protection in 1AD1I11 inverter
c. CVI was caused by radiation monitors powered from 1AY2A 1) Fail to actuate on loss of power	
d. It was assumed that the inverter momentarily shut down and restarted as a result of re-energizing the sequencer panel	
3. Similar event occurred in March 1987 on inverter 1BD1I12	
a. Containment isolation A occurred caused by rad monitors fed from 1BY1B	
4. Corrective actions	
a. Possible future design change which would prevent the ZIP circuit from being actuated at the present setpoint of overcurrent	
b. To prevent ESF actuations on breaker closing at 1AY2A (1BY2B) 1) Take all the radiation monitors fed by 1AY2A (1BY2B) to a condition which would preclude an actuation when the	

III. LESSON OUTLINE:

	NOTES
~~sequence is being powered up~~	
III. SUMMARY	

III. LESSON OUTLINE:

NOTES

A. Review lesson objectives

1. STATE THE PURPOSE OF THE SAFEGUARDS SEQUENCER.

   The safeguards sequencer subsystem performs the load shed and subsequent load sequencing operations necessary to mitigate the effects of a major plant accident.

2. LIST THE SOURCE OF POWER TO THE SEQUENCERS.

   Sequencers are powered from 1E power sources

   120V AC distribution panels

   1AY2A - Train A

   1BY2B - Train B

3. STATE THE PURPOSE OF THE AUTOMATIC TEST CIRCUIT(ATI) ON THE SEQUENCER

   provides a continious surveillance of the sequencers operability to detect faults in its sensing and/or output circuits

4. LIST THE INPUT SIGNALS THAT WILL START THE SAFEGUARDS SEQUENCER, INCLUDING SETPOINTS AND COINCIDENCES

   a. SI signal

   b. Undervoltage on AA02 or BA03

      1. Second level voltage

      a) At less than or equal to 83.5 percent for greater than or equal to 20 seconds on 2/4 channels

      2. First level voltage

      a) At less than or equal to 70 percent for greater than or equal to 0.8 seconds on 2/4 channels

5. Assess the response of the safeguards sequencer with respect to load shedding, the sequencing of major loads and

III. LESSON OUTLINE:

NOTES

starting/loading the diesel generator for all of the following conditions.(064000k410,064000k411,064000A307)

a. SI actuation(either/both trains)

1) Starts respective train diesel generator

2) Starts timed incremental load sequence on SI

3) Blocks U/V sequence

4) The DG breaker will not close if no U/V detected on respective safety bus

5) only SI or UV from the opposite train will start the other diesel

b. ESF bus UV(either/both trains)

1) Shed all loads; load center transformers remain connected

2) Start diesel generator

3) Trip 4160VAC preferred power supply breaker

4) Shut DG BRKR (when permissives satisfied)

5) Start timed incremental load sequence

6) If UV sensed on both buses, the above sequence occurs for both trains

c. ESF bus UV followed by SI prior to completion of UV load sequence

1) Sequencer resets to SI mode (90 ms delay)

2) SI loads will sequence on as required

d. SI followed by ESF bus UV prior to SI load sequence

1) if SI occurs prior to SI sequence being completed, a combination of the two sequences will occur

2) Diesels start

III. LESSON OUTLINE:

NOTES

3) First all the loads will be shed

4) this is followed by the opening of the buses preferred power supply breaker

5) a close signal is then sent to the diesel generator output breaker

6) the SI sequencer then sequences on the SI loads

e. SI and ESF bus UV simultaneously

1) DG receive start signals

2) Auto/Manual operation of ESF equipment blocked

3) Load shed 1E and non-1E loads (.2 secs)

4) Trip RAT normal supply feeder breaker (.2 sec)

5) DG auto closure permissive to DG breaker (.8 sec)

6) Block U/V signal to load sequencer

7) Activate step timing bus (.5 sec) after

f. More than 2 UV conditions within a 2 hour period

1) Logic prevents more than 2 UV conditions from activating the sequencer within a 2 hour period

2) Prevent exceeding manufacturer's recommendations concerning motor starts (overheat due to starting current)

3) When 3rd sequence in 2 hour period attempted

a) Initiates load shed

b) Opens preferred feeder breakers

c) Starts DG and closes breaker but

III. LESSON OUTLINE:

NOTES

No loads are started

6. Describe how and why the sequencers are reset following a loss of power to the ESF buses and failure of the D/G breaker to close.

   a. Allows resetting of the sequencer following a loss of power where the DG breaker fails to close and offsite power is subsequently restored

   b. Before sequencer begins stepping to allow components to load, the DG breaker must close

   c. All blocking relays are activated until the sequencer runs and auto/man block

      1) Blocks annunciators and stopping circuits

   d. Resetting the sequencer resets the timer to zero and the Auto/Manual block

   e. This allows the operator to

      1) stop loads that would start when power was restored

      2) resets alarms

      3) resets the sequencer such that it will start all loads when a UV condition is sensed