NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT NUCLEAR STATION

UNIT II OPERATIONS

02-NLO-001-263-2-01 Revision 0

Ø7-192-91

TITLE: PLANT DC ELECTRICAL DISTRIBUTION

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Summary of Pages

(Effective Date: 8/20/90)

Number of Pages: 22

Date	Pages
August 1990	1 - 22

TRAINING DEPARTMENT RECORDS ADMINISTRATION ONLY:

VERIFICATION: _____ _____

DATA ENTRY: _____

REVIEW: _____ _____

I. TRAINING DESCRIPTION

A. Title of Lesson: Plant DC Electrical Distribution

B. Lesson Description: Provide instruction in the function and operation of plant equipment associated with the DC Distribution System. Emphasis is placed on knowledge and activities normally associated with Auxiliary Operator duties in the plant.

C. Estimate of the Duration of the Lesson: 4 hours

D. Method of Evaluation, Grade Format, and Standard of Evaluation: Written exam, passing grade of 80% or greater.

E. Method and Setting of Instruction: This lecture/facilitated discussion should be conducted in the classroom.

F. Prerequisites:

1. Instructor:
   a. Certified in accordance with NTP-16.
2. Trainee:
   a. In accordance with NTP-12.

G. References:

1. Plant Specific NLO Guidelines
2. NMP2 Operations Technology/DC Electrical Distribution, Rev. 0, 2
3. OP-73A/B
4. OP-74A/B
5. NMP2 FSAR Vol 16, Chapter 8, pg. 8.3-54
6. Gould Battery GB3384B10M PO E033A
7. Power Conversion Products Model
   3S-130-500CE
   3S-130-300CE
   3S-130-50CE
   FD-24-25CE
8. NMP2 Technical Specifications
9. INPO SOER #83-5

II. REQUIREMENTS

A. Requirements for Class:

1. INPO NLO Guidelines
2. NTP-12

III. TRAINING MATERIALS [(*) Optional]

A. Instructor Materials:

1. Whiteboard, markers, erasers
2. Transparencies
3. Overhead projector
4. Working copy of this Lesson Plan
5. Scientific Calculator (*)
6. Handouts, worksheets and answer keys (*)
7. Student text
8. Films (*)
9. Flipchart (*)
10. Training Record

B. Trainee Materials:

1. Text
2. Pens, pencils, paper
3. Binders (*)
4. Course Evaluation Forms

IV. EXAM AND MASTER ANSWER KEYS

A. Exams and answer keys will be on permanent file in the Records Room.

V. LEARNING OBJECTIVES

A. Terminal Objectives:

Upon satisfactory completion of this lesson, the trainee will demonstrate the knowledge required to:

TO-1.0	Monitor the DC Distribution System	(2630010104)
TO-2.0	Energize/De-energize DC Equipment	(2630050104) (2630060104)
TO-3.0	Start up a Battery Charger	(2630070104)
TO-4.0	Secure a Battery Charger	(2630090104)
TO-5.0	Remove a Battery from Service	(2639040104)
TO-6.0	Place a Battery in Service	(2639050104)

B. Enabling Objectives:

EO-1.0 Explain the purpose and function of the DC Distribution System.

EO-2.0 List the major components of the DC Distribution System.

EO-3.0 Given a list of major components of the DC Distribution System, describe the purpose and function of the major components.

EO-4.0 List the systems that interrelate with the DC Distribution System and describe that interrelationship.

EO-5.0 Regarding the DC Distribution System, determine and use the correct procedure to identify the actions and/or locate information related to NLO duties for the following:

a. Startup
b. Normal operation
c. Shut down
d. Off normal operation
e. Correcting alarm conditions

EO-6.0 For the precautions and limitations listed in N2-OP-73A/B and N2-OP-74A/B, explain the basis for each precaution and limitation.

EO-7.0 Regarding the DC Distribution System, 1) locate the correct drawing and 2) use drawings to perform the following:

a. Identify electrical and mechanical components
b. Trace the flowpath of electricity
c. Identify interlocks and setpoints
d. Describe system operation
e. Locate information about specific components
f. Identify system interrelations

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
I. INTRODUCTION		
A. Review Trainee Learning Objectives	(Throughout the lesson plan, TP numbers correspond to figure numbers in the trainee text).	EO-1.0
B. System Purpose		
1. The normal 125 VDC System provides a reliable DC source of power for DC control power circuits, instrumentation, DC motors, and other essential DC loads required during normal and abnormal conditions of the plant.		
2. The 24 VDC System provides a reliable DC source of power for the Source and Intermediate Range Neutron Monitoring Systems.		
3. The 125 VDC Emergency Power System provides a highly reliable source of continuous power to safety related control, instrumentation, and other essential DC loads required during normal plant conditions and safe reactor shutdown under all postulated Design Basis Accident (DBA) conditions.		
C. General Description	Use whiteboard to outline system composition.	
1. DC Distribution System consists of:		
a. Normal (non-safety related) DC System		
b. Emergency (safety-related) DC System		

2. Normal DC System (125 VDC, 24 VDC)
   a. 125 VDC System supplies:
      1) Normal switchgear
      2) Main transformer
      3) Reserve station service transformers
      4) Aux boiler transformer
      5) Other non-safety related loads
   b. Three separate 125 VDC busses
   c. Four 24 volt batteries, each supplying a separate bus.
3. Emergency DC System
   a. Three physically separate and electrically independent divisions corresponding to the divisions of Emergency AC (ENS, EJS).
   b. Each division of DC System supplies DC loads associated with corresponding AC System.

II. DETAILED DESCRIPTION

Show TP-2A/B

EO-2.0, EO-3.0, EO-7.0

A. Normal (non-safety related) DC System. (Required for normal plant operation, but not for safe shutdown, including normal 125 VDC System and normal 24 VDC System)

1. Normal 125 VDC System
   a. Components identified by black color or no color coding.
   b. Normal 125 VDC System feeds all non-safety related DC instrumentation, control, and other DC loads.
   c. Consists of 3 subsystems (A, B, C), each having its own battery bank, charger, and switchgear.
   d. Charger
      1) Each can supply rated loads (excluding UPS loads) and charge batteries from minimum to full charge within 24 hours.
      2) Thyristor controlled static chargers designed for constant potential type of charge.
      3) 125 VDC, 500 amp
      4) Output range from 124.8 to 145.2 VDC with input of 3 phase AC at 575 VAC.
      5) Two modes of operation:
         a) Float: output adjusted to 133 VDC.
         b) Equalize: Output adjusted to approximately 140 VDC.

Normal 125 VDC

600 VAC BUS	CHARGER	BATTERY	SWGR
2NJS-US5	2BYS-CHGR1A1	2BYS-BAT1A	2BYS-SWG001A
2NJS-US6	2BYS-CHGR1B1	2BYS-BAT1B	2BYS-SWG001B
2NJS-US6	2BYS-CHGR1C1	2BYS-BAT1C	2BYS-SWG001C

6) Charger 1C1 located in Control Building, elevation 214'.

7) Chargers 1A1, 1B1 in Switchgear Building, elevation 237'.

e. Batteries

1) Designed for continuous charge with minimal loss of active plate material.

2) Lead - calcium type battery

3) Two series strings of 60 cells connected in parallel to provide 125 VDC at 5100 A.H. capacity.

4) Bat. 1A, 1B in Switchgear Building on 237' elev.

5) Bat. 1C on 214' level in Control Building.

f. Switchgear

1) Consists of instrumentation, incoming breaks, feeder breakers and fuse compartments.

2) 1A & 1B on 237' elevation of Swgr. Building.

3) 1C on 214' elevation of Control Building.

(Discharge)

At negative plate $Pb + SO_4^{=} \rightarrow PbSO_4 + 2e^-$

At positive plate $PbO_2 + 4H_3O^+ + SO_4^{=} + 2e^- \rightarrow PbSO_4 + 6H_2O$

2. Normal 24 VDC System

Show TP-3

a. The 24 VDC System feeds all DC Neutron Monitoring System loads and Emergency Response Facility Optical Isolators.

b. Each of the two redundant systems consists of a three wire bus, two 24 VDC batteries, and two chargers. One battery is connected between the positive and common ground, the other between the negative and common ground.

c. Chargers

1) Air cooled wall mounted, single phase controlled ferroresonant chargers.

2) Capable of recharging from minimum to full charge within 24 hours while supplying normal system loads.

3) Rated at 25 amps, 24 volts DC.

4) Two modes of operation:

a) Float: Output voltage 26.5 VDC

b) Equalize: Output voltage 28 VDC

5) Overvoltage protection which trips charger's output breakers and sounds alarm in Control Room at 30 volts.

6) Low voltage alarm at 22.5 VDC.

d. Batteries

1) Twelve lead-calcium cells in a 3 cell per jar configuration.

2) Jars made of clear styrene acrylonitrile plastic, mounted on two tier racks, with 6 cells per tier.

3) Each battery bank can supply enough power to operate all required loads for four hours with a charger out of service.

Normal 24 VDC
(thru 600/240 XFMERS)

600 VAC BUS	CHARGER	BATTERY
2NJS-PNL500	2BWS-CHGR3A1	2BWS-BAT3A
	2BWS-CHGR3C1	2BWS-BAT3C
2NJS-PNL600	2BWS-CHGR3B1	2BWS-BAT3B
	2BWS-CHGR3D1	2BWS-BAT3D

4) Rated at 100 amp hours based on a constant discharge rate for 8 hours with minimum voltage of 1.75 volts per cell at end of 8 hour period.

e. Batteries and chargers located in Control Building at 214' elevation.

B. Emergency (Safety Related) DC Systems — Show TP-1A/B/C

1. Designated Div I, II, III corresponding directly to essential AC power systems divisions I, II, III.
2. Color Codes
   a. Green (Div I)
   b. Yellow (Div II)
   c. Purple (Div III)
3. Chargers
   a. Two 100% capacity chargers for each division.
   b. Sized to recharge the battery bank from minimum to full charge within 24 hours while supplying steady state DC loads.
   c. Two modes of operation:
      1) Float: 133 VDC
      2) Equalize: 140 VDC
   d. Thyristor controlled static chargers.

Division	600VAC	CHGR NO.
I.	PNL 2LAC*PNL100A	CHGR 2A1
	PNL 2EJS*PNL100A	CHGR 2A2
II.	PNL 2LAC*PNL300B	CHGR 2B1
	PNL 2EJS*PNL300B	CHGR 2B2
III.	MCC 3EHS*MCC201	CHGR 2C1
		CHGR 2C2

e. Div I, II rated at 300 amps, 125 VDC.
f. Div III rated at 50 amps, 125 VDC.

4. Batteries
   a. Div I, II: 60 cells, calcium grid, lead-acid batteries with 8 hour rating of 2550 A.H.
   b. Div III
      1) Lead-calcium type batteries
      2) Rated at 100 amp hours (8 hour rating)
      3) Consists of twenty 6 volt batteries in series.

5. Switchgear
   a. Div I, II (batteries, chargers, and breakers) are connected to switchgear 2BYS*SWG002A/B through a circuit breaker.
   b. Div III (batteries, chargers, and breakers) is connected to 2CES*IPL414 (DC panel board).
   c. Emergency switchgear busses:
      1) Ungrounded
      2) Div I, II are 2000 amp rated
      3) Div III is 100 amp rated
      4) Use manually operated, air circuit breakers.

III. INSTRUMENTATION, CONTROLS, AND INTERLOCKS EO-7.0

A. Instrumentation

1. Normal (non-safety related) 125 VDC
   a. Back of Control Room panel P-852 has indications of battery amps, charger amps, and bus current.
   b. Chargers provide local indications of charger voltage and current.
2. Normal 24 VDC
   a. Back of Control Room panel P-852 has indications of battery amps, charger amps, and bus current.
   b. Chargers provide local indications of charger voltage and current.
3. Emergency (safety related) 125 VDC
   a. Back of Control Room panel P-852 has indications of bus volts and amps and charger volts and amps.
   b. Chargers provide local indications of charger voltage and current.

B. Controls

1. One ground detection control switch and pushbutton are provided for each battery on the back of P-852.

2. The test pushbutton is used with the control switch in the normal position for ground indication.
3. Each charger has a float/equalize switch, and timer.

C. Interlocks

1. Div I, II, III chargers have an overvoltage circuit which disconnects the AC input to the chargers when the DC output voltage exceeds a manually preset valve.
2. 125 VDC Type K 1600 and K600 breakers have a racking shutter interlock. (Breaker must be open before shutter can be lifted to gain access to the racking mechanism)

IV. SYSTEM INTERRELATIONS

EO-4.0
EO-7.0

A. Battery Room has:

1. Smoke detection
2. Fire protection
3. Sufficient ventilation to limit hydrogen accumulation and maintain room temp between 65° - 104°.
4. Adequate lighting for inspection and maintenance.

B. AC power is supplied to DC Systems through chargers as previously listed.

C. The normal DC Distribution Systems should be in operation at all times to support the BOP and provide backup power for the RPS and lighting inverters, and computer inverter.

D. The 24 VDC System should be in operation at all times to provide power to IRM & SRM circuits.

Note: Loss of 24 VDC may cause a reactor scram depending on plant conditions, from IRM's or SRM's.

E. Technical Specifications 3.8.2.1, 3.8.2.2 (pg. 3/4 8-14, 3/4 8-19)

V. PRECAUTIONS AND LIMITATIONS

EO-6.0

A. Battery ventilation shall be kept in operation at all times to prevent the buildup of hydrogen gas.

Note: H_2 is burnable (deflagration) between 4-18% and explosive (detonation) between 18-59%.

B. Do not use open flame or spark producing tools in the Battery Room.

C. All tools used in the vicinity of the battery shall be taped.

D. When working with electrolyte, wear protective clothing including:

1. Rubber gloves
2. Apron
3. Face shield

E. Only authorized personnel are allowed in the Battery Rooms.

F. Cleanup electrolyte spills immediately to minimize grounds.

G. In the 24 VDC System, a battery eliminator jumper plug, located at the top of the circuit board behind a clear plastic plate, must remain in the "Eliminator" socket at all times to prevent the charger from becoming unstable and oscillating when the battery is disconnected.

H. Baking soda and flushing water must be on hand, and the eyewash station operable.

I. For emergency 125 VDC, check Tech Specs for continued operation when degraded conditions exist.

J. To prevent destructive voltage surges to the chargers, the charger must be connected to the battery prior to closing its AC input breaker.*

* Stress the importance of this precaution!

K. Electrical safety standards should be adhered to when performing lineup changes, and/or correcting faults in the systems. System should be walked down for fire and/or smoke following any high current, low voltage condition.

VI. SYSTEM OPERATION — EO-5.a

A. Startup — EO-7.0

1. Review the startup procedures of OP-73A/B and OP-74A/B.

a. Startup will involve completing line up prerequisites, closing the appropriate battery breaker, placing a charger in service and checking for proper operation of the equalizing circuit, and for battery grounds.

B. Normal Operation — EO-5.b

1. The DC Distribution System requires little Operator action during normal operation.

2. The batteries should be inspected on a regular basis and should include a check of the following:

a. General cleanliness of the battery and battery area.

b. Float voltage and charger current.

c. Cells for cracks or electrolyte leakage.

d. Cell plates for buckling, discoloring, grid cracks, or plate growth.

e. Ambient temperature and ventilation equipment.

f. Terminals and connectors for evidence of corrosion.

g. Electrolyte level

C. Shutdown

EO-5.c

1. Once the 125 VDC Normal, Emergency and 24 VDC Systems are placed into operation, they are not normally shut down. However, some components of the system may be taken out of service for maintenance, provided the limitations of the applicable section are observed.

D. Off Normal

1. Equalizing battery charge

a. Performed to ensure that all the sulfate is driven from the plates and that all cells are restored to uniform, maximum capacity.

b. Required when:

1) Low cell voltage on float

2) Low pilot cell specific gravity

3) After extended battery discharge

$Pb + SO_4^{=} \rightarrow PbSO_4 + 2e^-$ (discharge, at negative plate) EO-5.d

$PbO_2 + 4H_3O^+ + SO_4^{=} + 2e^- \rightarrow PbSO4 + 6H_2O$ (discharge at positive plate)

c. An equalizing charge can be performed in manual or automatic.

1) In auto, the timer is set for the desired time and voltage will increase to equalizing voltage. After the timer times out, the charger will automatically return to float voltage.

2) In manual, the timer is bypassed and the equalizing time is controlled by the Operator. The float/equalize switch is placed in the equalize position and voltage increases to the equalizing voltage. After the designated equalizing time is finished, the float/equalize switch is returned to the float position, and voltage returns to float voltage.

2. Removing/restoring a battery charger from service.

a. Removing a charger from service.

1) Open the AC breaker on the affected charger, followed by the DC breaker. Next the AC supply breaker for the charger is opened on the 600 VAC panel

b. Returning a charger to service.

1) Procedure is basically the same as the startup procedure previously discussed.

3. Removing/restoring a battery from service.

a. Removing a battery from service involves ensuring bus load is within the capacity of its charger and its charger is in operation, then opening the applicable battery breaker and checking to see that the charger is carrying the load at an acceptable voltage. Note that some loads may be required to be swapped over by moving fuse blocks prior to opening the battery breaker.

b. Restoring a battery to service involves clearing mark ups on equipment as required, and closing the appropriate battery breaker. Depending on how long and why the battery was off service, an equalizing charge may be required and fuse blocks should be returned to their normal supplies.

E. Annunciator Response

1. The following annunciators actuate on P-852 in the Control Room. The Control Room Operators will determine a more specific problem area based on computer points, and an Operator will be sent to investigate, who will report his findings back to the Control Room. The appropriate action will be taken following the OP's for correcting alarm conditions, located in the back of OP-73A/B and 74A/B.

EO-5.e

a. Normal 125 VDC System

1) "Station Bat 1A/1B/1C 125 VDC System Trouble" 852501

b. Normal 24 VDC System

1) "24/48 VDC Distribution Panel 300A Undervoltage" 852542

2) "24/48 VDC Distribution Panel 300B Undervoltage" 852552

c. Emergency 125 VDC System

1) "Div I Emer Bus BYS002A 125 VDC System Trouble" 852108

2) "Div II Emer Bus BYS002B 125 VDC System Trouble" 852208

3) "Div III Bus BYS002C 125 VDC System Trouble" 852308
4) "Div I/II/III 125 VDC Battery Breaker Open" 852345

F. Surveillance Testing
1. Performed on portions of the system required for nuclear safety (covered by Tech Specs)
2. The following surveillances are performed:
a. Div I/II/III Battery Performance discharge test
1) Used to determine proper battery capacity.
b. Quarterly Battery Surveillance Test
1) General battery inspection
c. Battery Intercell Resistance Test
1) Measures intercell and terminal connection resistance.
d. Battery Service Test
1) Test loads the battery
e. Div I/II/III Battery Charger Load Test
1) Demonstrates operational condition of the Div I/II/III battery chargers. (load tests the chargers)

G. Maintenance Procedures

1. Preventive maintenance procedures are performed on all portions of the DC Distribution System. Most of the maintenance is performed by the maintenance department who will brief the SSS on maintenance to be performed. NLOs may be required to shift equipment (such as chargers), as necessary to facilitate performance of maintenance as directed by the SSS.

H. Related Industry Events

1. Review INPO SOER 83-5
2. Explain potential consequences of loss of the DC Distribution System.
3. Stress importance of use of, and adherence to approved operating procedures.

VII. Review

A. Review Trainee Learning Objectives

B. Briefly Review Entire Lesson

C. Answer any Questions