

NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT NUCLEAR STATION

UNIT II OPERATIONS

02-NLO-001-262-2-03 Revision 1

07-192-91

TITLE: UNINTERRUPTIBLE POWER SUPPLIES

	SIGNATURE	DATE
PREPARER	<i>[Signature]</i>	8-17-90
TRAINING SUPPORT SUPERVISOR	<i>Jane Le Clair</i>	17 Nov 8-18-90
TRAINING AREA SUPERVISOR	<i>[Signature]</i>	8/17/90
PLANT SUPERVISOR/ USER GROUP SUPERVISOR	<i>[Signature]</i>	8/20/90

Summary of Pages

(Effective Date: 8/20/90)

Number of Pages: 21

Date	Pages
August 1990	1 - 21

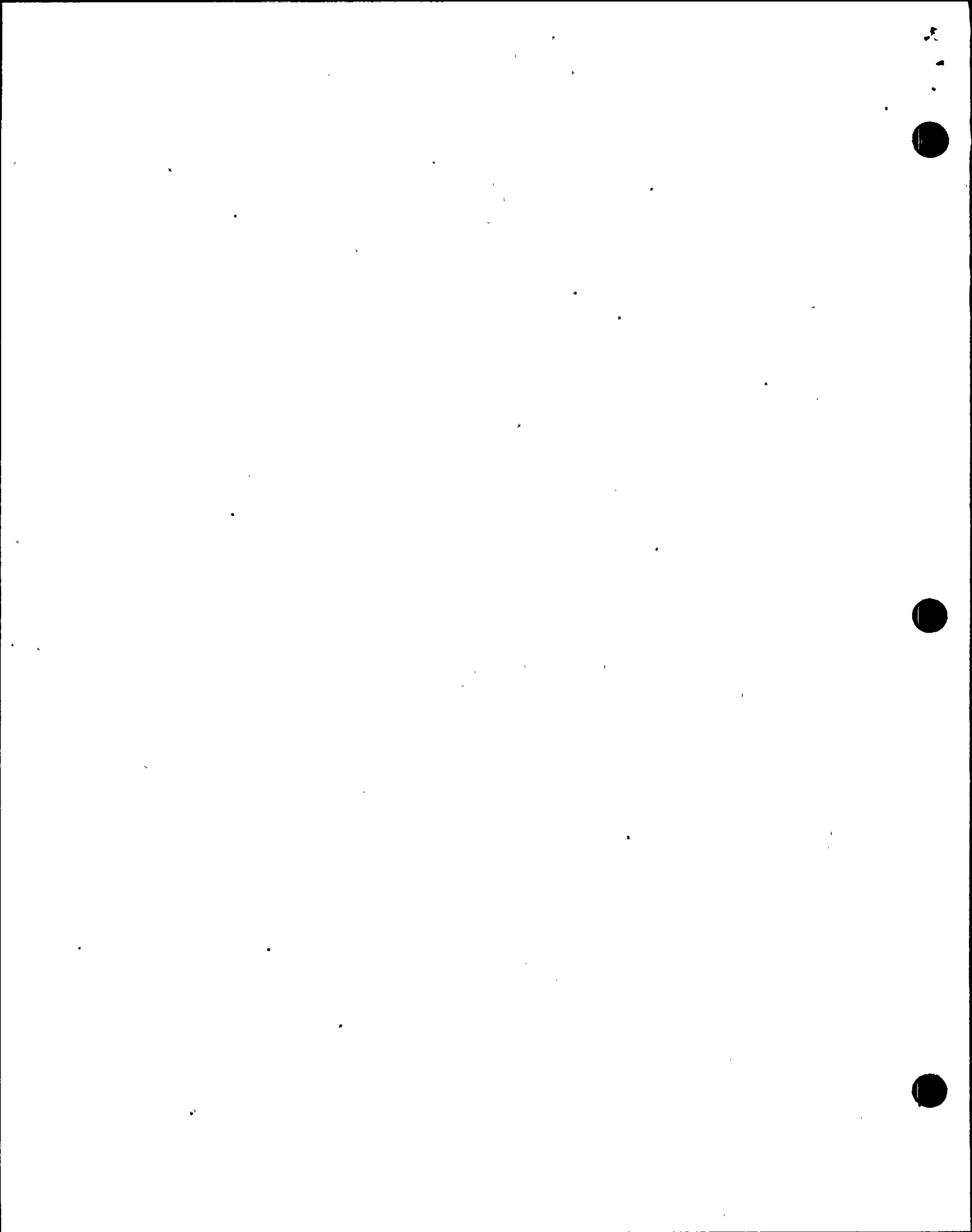
MASTER

TRAINING DEPARTMENT RECORDS ADMINISTRATION ONLY:

CONTROLS RECORDS:

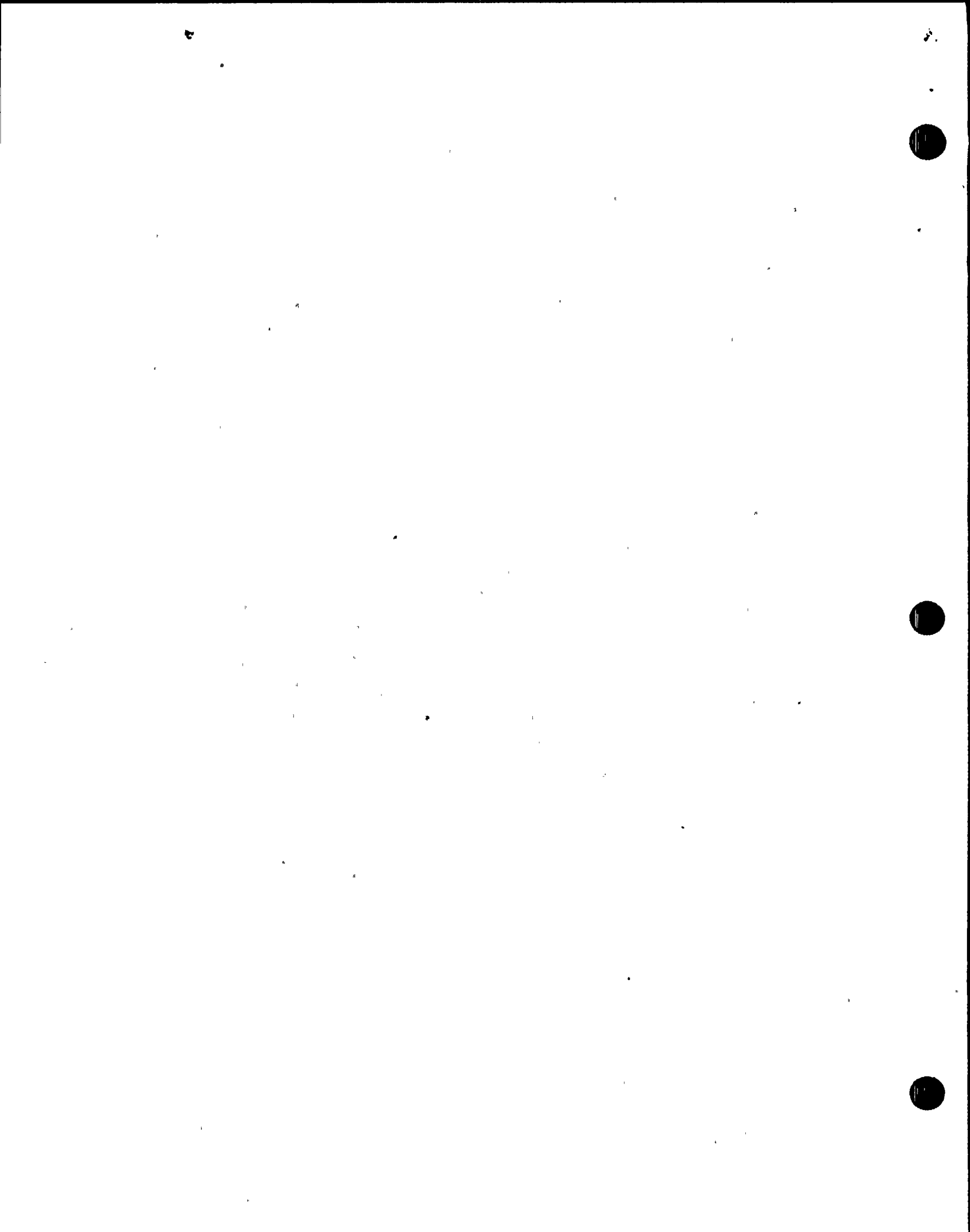
DOCUMENT

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I. TRAINING DESCRIPTION

- A. Title of Lesson: Uninterruptible Power Supplies
- B. Lesson Description:
1. Provide training in the understanding of UPS operation, arrangement of power supplies, effects of UPS failures on the operation of the plant and UPS recovery activities.
 2. Training may also be conducted in the plant by locating and simulating operation of each type of UPS.
- C. Estimate of the Duration of the Lesson: Classroom - 3.0 hours
Plant - 2.0 hours
- D. Method of Evaluation, Grade Format, and Standard of Evaluation:
Written Exam requiring 80%
- E. Method and Setting of Instruction: Classroom Lecture and Plant Walk-through (Note: Plant Walk-through is optional to the training)
- F. Prerequisites:
1. Instructor:
 - a. Demonstrated knowledge and skills in the subject, at or above the level to be achieved by the trainees, as evidenced by previous training or education, or
 - b. SRO license for Nine Mile Point Unit Two or a similar plant, or successful completion of SRO training, including simulator certification at the SRO level for Nine Mile Point Unit Two.
 - c. Certified in accordance with NTP-16.
 2. Trainee:
 - a. Meet eligibility requirements per 10CFR55, or
 - b. Be recommended for this training by the Operations Superintendent or his designee or the Training Superintendent.



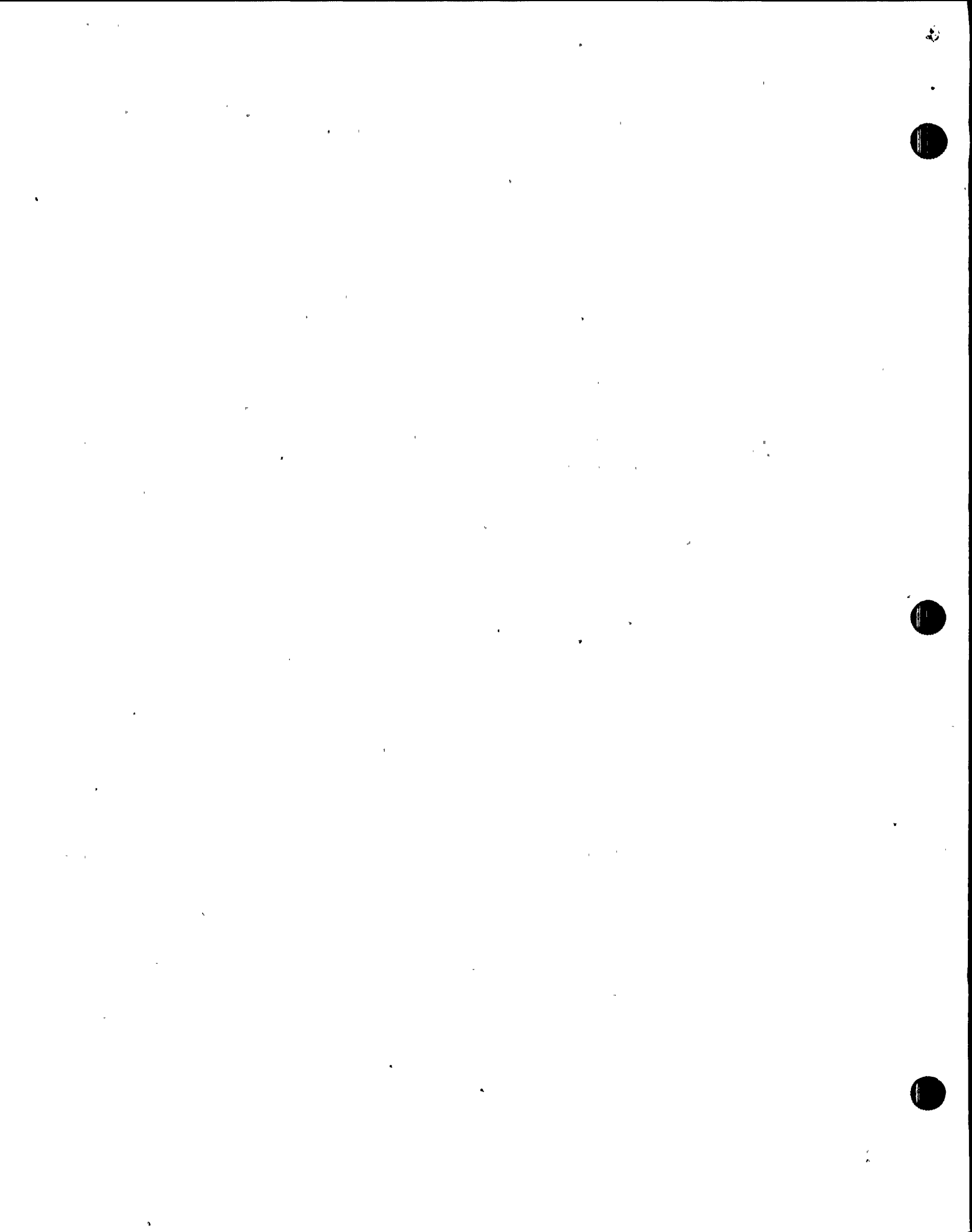
G. References:

1. Manufacturer's Manuals
 - a. Exide Electronics 75-KVA UPS (2VBB-UPS1A, B, C, D, G) E035A, VI/101 710 343-77223, NMPC access# 430000742
 - b. Elgar Corporation 25-KVA UPS (2VBA*UPS2A/B) E035A, Inst. 1.560-5002, NMPC access# 430002188
 - c. Elgar Corporation 10-KVA UPS (2VBB-UPS3A/B) E035A, Inst. 1.560-5003, NMPC access# 430002477
 - d. Exide Electronics 5-KVA UPS (2VBB-UPS1H) E035A, Inst. 1.560-5006, NMPC access# 430004490
2. Procedures
 - a. N2-OP-71, "13.8KV/4160/600V AC Power Distribution"
 - b. N2-OP-72, "Standby and Emergency AC Distribution System"
3. Significant Operating Experience Report (SOER) #83-3 "Inverter Failures", May 5, 1983
4. Drawings
 - a. EE-1BH-5
 - b. EE-1CA-7
5. Technical Specifications
 - a. 3/4.8.4.4 Electrical Equipment Protection Devices
 - b. 3/4.8.3.1 Onsite Power Distribution Systems Operating
 - c. 3/4.8.3.1.2 Onsite Power Distribution Systems - Shutdown
6. LER 87-069

II. REQUIREMENTS

A. Requirements for Class

1. AP-9, Rev. 2, "Administration of Training"
2. NTP-10, Rev. 4, "Training of Licensed Operator Candidates"
3. NTP-11, Rev. 6, "Licensed Operator Retraining and Continuing Training"
4. NTP-12, Rev. 4, "Unlicensed Operator Training"



III. TRAINING MATERIALS

A. Instructor Materials:

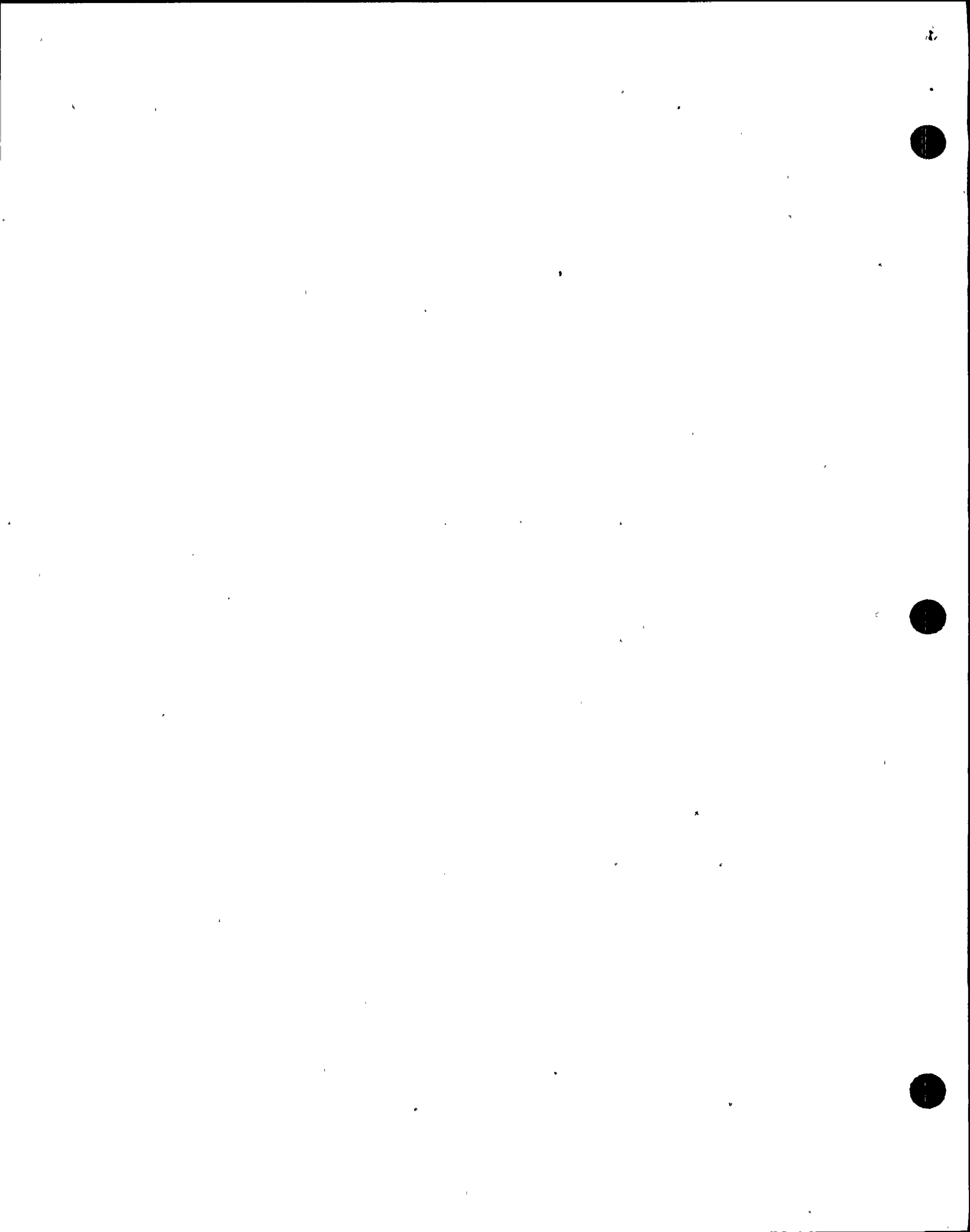
1. Transparency Package
2. Overhead Projector
3. Whiteboard and Felt Tip Markers
4. N2-OP-71
5. N2-OP-72
6. UPS - Lesson plan
7. UPS - Handout
8. SOER #83-3 Inverter Failures, May 5, 1983
9. LER 87-069
10. Training Record

B. Trainee Materials:

1. UPS - Handout
2. LER 87-069
3. SOER 83-3
4. Applicable portions, N2-OP-71
5. Applicable portion, N2-OP-72
6. Course Evaluation Forms

IV. EXAM AND MASTER ANSWER KEYS

Will be generated and administered as necessary. They will be on permanent file in the Records Room.



V. LEARNING OBJECTIVES

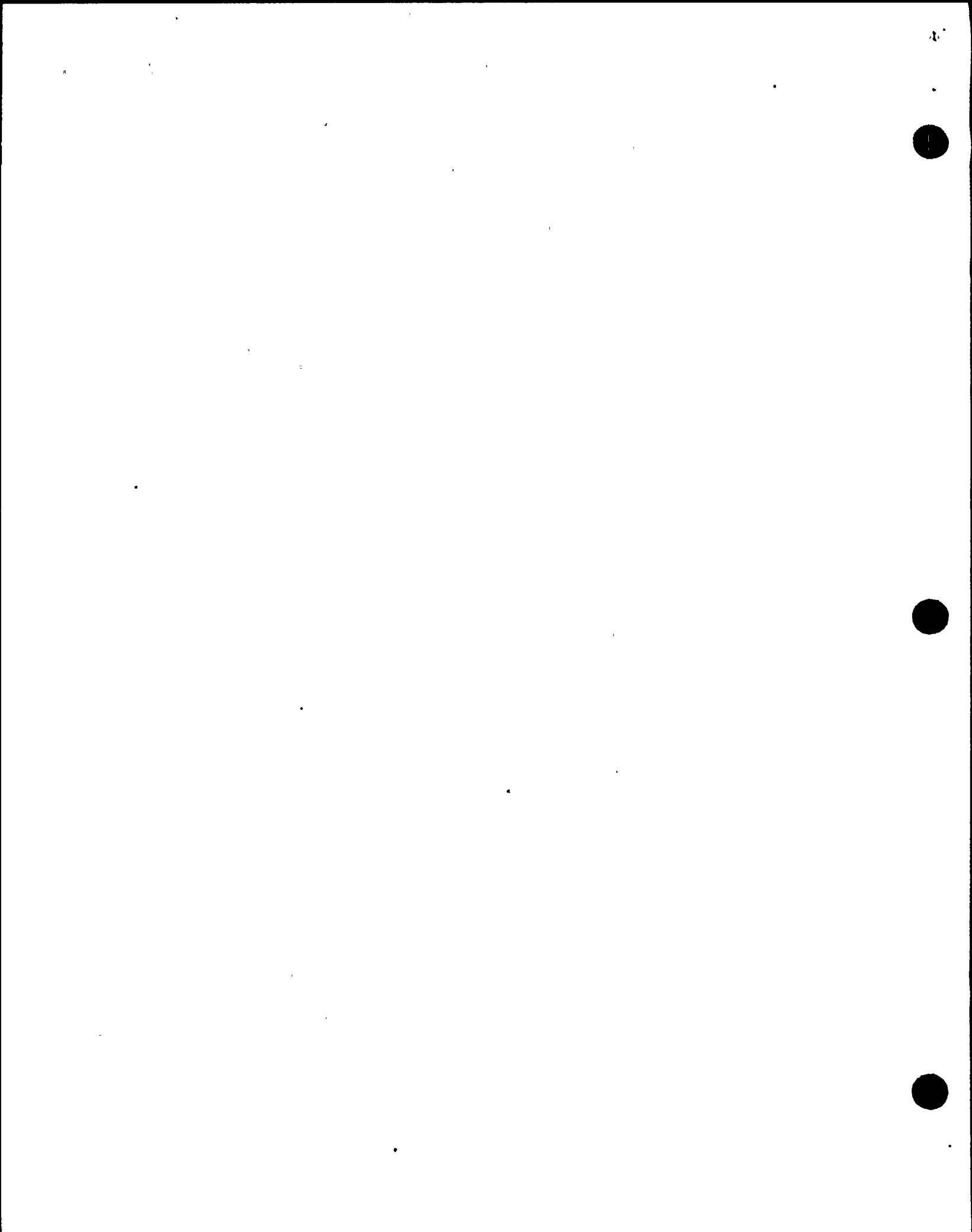
A. Terminal Objectives:

Upon satisfactory completion of this lesson the trainee will |1
demonstrate the knowledge to: |

- TO-1.0 Perform a startup of an Uninterruptible Power Supply. |
(2629130104)
- TO-2.0 Perform individual uninterruptable power supply periodic |1
checks. (2629100104)
- TO-3.0 Perform a forward and reverse transfer of an
Uninterruptible Power Supply. (2629050104)
- TO-4.0 Transfer the load to the main tenance supply and shutdown
the Uninterruptible Power Supply. (2629110104)

B. Enabling Objectives:

- EO-1.0 State the purpose of the Uninterruptible Power Supplies
(UPS).
- EO-2.0 Describe the function of the following basic UPS
components:
 - a. Battery (DC supply)
 - b. AC to DC converter
 - c. Isolation diode
 - d. DC to AC inverter
 - e. Static switch |1
 - f. Maintenance supply regulator
- EO-3.0 Utilizing a UPS diagram describe the operation of a UPS |1
including:
 - a. Available power sources. |1
 - b. Normal and maintenance lineups.
 - c. Automatic transfer sequences.
- EO-4.0 Describe a forward transfer and reverse transfer.
- EO-5.0 Describe the four different models of Uninterruptible
Power Supplies used at Nine Mile Point 2.
- EO-6.0 Identify the major loads carried by the ten
Uninterruptible Power Supplies at Nine Mile Point 2. |1
- EO-7.0 Utilize N2-OP-71 (AC Power Distribution) and N2-OP-72
(Standby and Emergency AC Distribution) to identify the
appropriate actions and/or locate information related to:
 - a. Startup
 - b. Shutdown
 - c. Off Normal Conditions |1
 - d. Procedures for Correcting Alarm Conditions



I. INTRODUCTION

Student learning objectives

Review SOER 83-3 "Inverter Failures"

Review LER 87-069

A. System Purpose

1. Provide a continuous source of constant, filtered AC power to selected plant loads, instrumentation and control loads.

Stress the importance of a thorough knowledge of UPS operation being necessary for safe plant operation.

EO-1.0

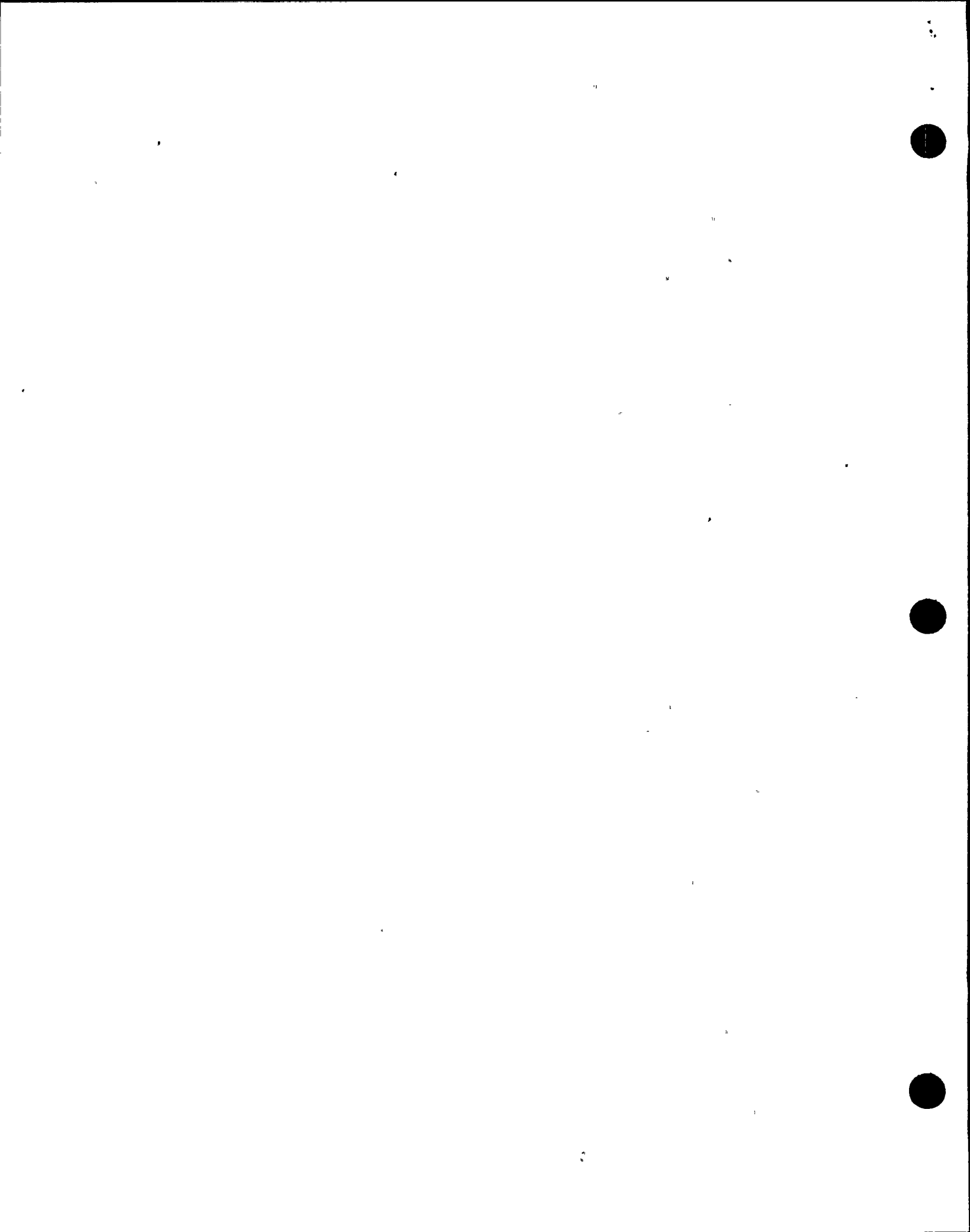
B. General Description

1. Uninterruptible Power Supplies (UPS) provide 120VAC loads.
 - a. UPS has three (3) power sources.
 - b. UPS transfers loads upon loss of input power automatically without power loss to load.
2. Upon loss of normal AC power supply the UPS will automatically begin accepting power from the backup source (DC Or batteries).
 - a. As long as the battery voltage does not fall to an undervoltage condition, the UPS can continue to operate off the battery indefinitely.
 - b. When the normal source is reenergized, the UPS will automatically (bias off) stop drawing from the batteries and draw power again from its normal source.

Show TP#3

Show major components and trace flowpath.

Go over three power sources.



3. If there is loss of normal AC power to any UPS combined with a loss of (battery) DC power, the UPS will automatically transfer its load to its maintenance (alternate) AC source.
 - a. Once the UPS is on the maintenance source it can operate indefinitely on maintenance power until normal power is available.
 - b. Once normal power is available the load is automatically transferred back to the UPS.

Show TP#3
Explain transfer

II. UPS BASIC COMPONENT DESCRIPTION

A. Description of individual component/sections

1. External battery
 - a. Supplies a reliable source of backup DC power (RSVDC) when the rectifier or AC input power fails to the DC link bus.
2. AC to DC converter (rectifier section)
 - a. Normal supply of filtered DC power to the DC link bus.

Show TP#4
Trace flowpath

Sometimes called "charger section"

EO-2.a

Eo-2.b

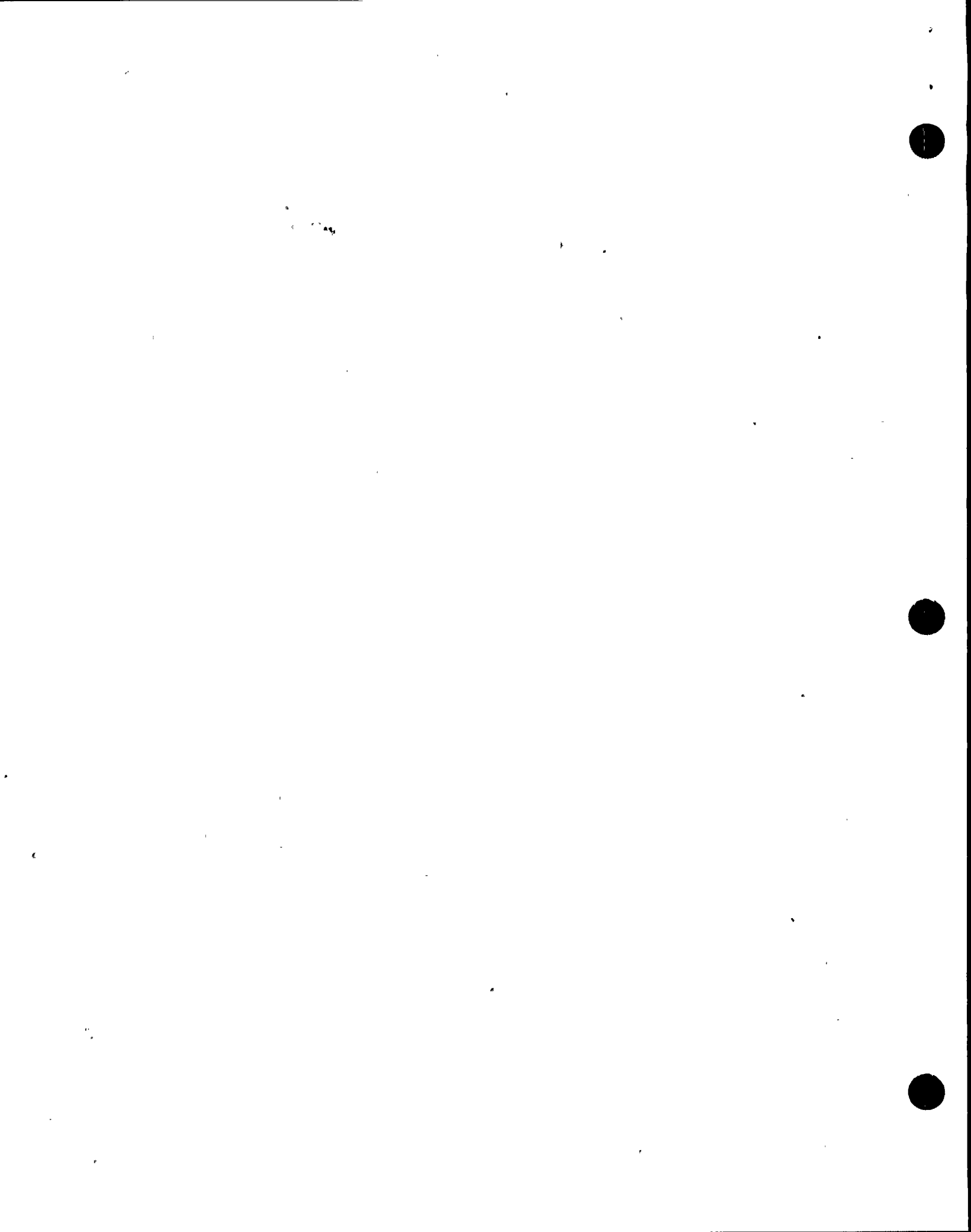


- | | |
|--|--------|
| <p>3. Isolation Diode</p> <p>a. Prevents AC to DC converter (rectifier) from supplying DC power to the external battery bus and its associated loads. (Rectifier only designed to supply power to the UPS loads)</p> | EO-2.c |
| <p>4. DC to AC inverter section</p> <p>a. Converts DC power from the DC link bus to filtered AC. This gives a good conditioned power output.</p> | EO-2.d |
| <p>5. Static Switch</p> <p>a. Provides a means of switching (make-before-break) to the maintenance (AC) supply in the event of a sudden UPS failure or overload.</p> | EO-2.e |
| <p>6. Maintenance supply regulator</p> <p>a. Provides an maintenance source of regulated AC power to UPS loads in the event of an UPS failure or overload.</p> <p>b. Provides an alternate source of regulated AC power to UPS loads during preventive or corrective maintenance of UPS.</p> | EO-2.f |

Alternate or maintenance source is often referred to as "dirty power" because it is not filtered.

|1

NOTE: Fluctuations on the input and distortion on the input are not "seen" on the output.



III. UPS OPERATION

A. Normal Operation

- | | | |
|--|--------|---|
| 1. UPS loads are supplied AC power from the inverter through the static switch. | EO-3.0 | |
| 2. The inverter is supplied filtered DC power from the DC link bus. | EO-3.0 | |
| 3. Normal power supply to the UPS is a three phase AC supply which feeds the AC to DC converter. | EO-3.0 | 1 |

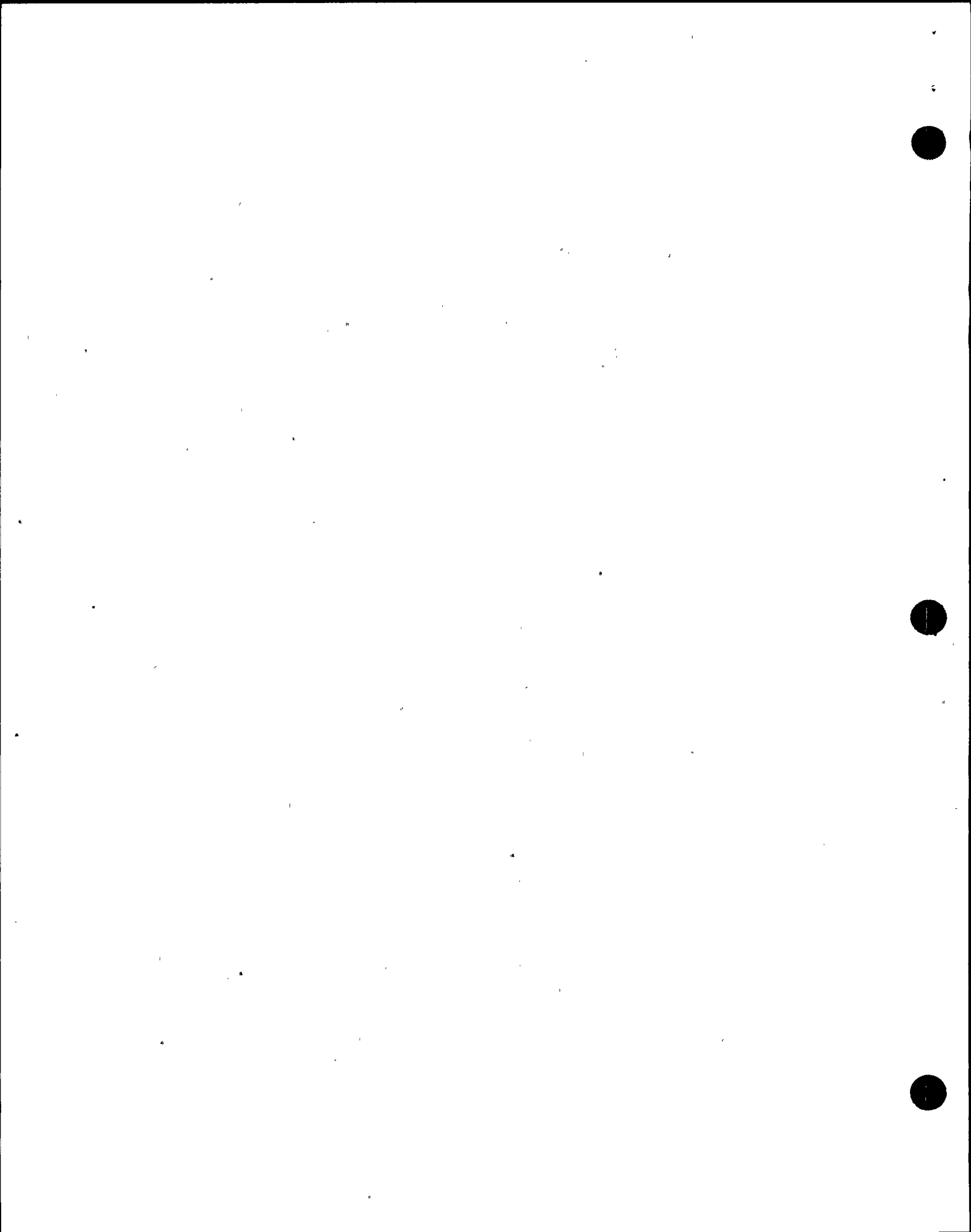
Show TP#4

B. Loss of Normal (AC) Power

- | | | |
|--|----------------|--------|
| 1. On loss of normal AC power the battery (backup power source) will feed DC power to the DC link bus. | No transfer. | EO-3.0 |
| 2. There is no interruption in power to the load. | Explain diode. | |
| 3. Annunciator in the Control Room will alert the operator that UPS is on battery backup. | | |

C. Overload Condition

- | | | |
|--|---|--------|
| 1. If while running on the normal AC supply an output overload is sensed, the UPS will transfer to its maintenance supply. | Overload is actually sensed by a drop in voltage on the output of the inverter. | EO-4.0 |
| 2. The transfer is accomplished through the static switch without power interruption to the load. | The transfer is OV/UV transfer.
Show TP#4
Show how breakers and static switch perform transfer. | 1 |



3. When the overload condition is clear the UPS will transfer back to the normal supply.

D. UPS Startup

1. UPS is interlocked to prevent starting from the battery (backup) supply.
2. Battery input breaker will not close unless down stream voltage is above 105VDC.
3. With normal AC supply breaker closed SCR output slowly builds up across the capacitors preventing damage.

Starting from battery would instantly place high voltage across the capacitors on AC/DC converter. This could damage capacitor banks.

E. Transfers

1. Types .
 - a. Forward transfer
 1. Transfer from maintenance to inverter output (UPS).
 - b. Reverse transfer
 1. Transfer from inverter output (UPS) to maintenance supply.
2. Automatically
 - a. Overvoltage/undervoltage on output of inverter
3. Manually
 - a. Via pushbuttons on front of control panel.

Show TP#4

Explain reverse transfer.

EO-4.0



IV. INSTRUMENTATION AND CONTROLS (UPS SERIES ONE)

A. The UPS has the following local instruments:

1. DC voltmeter (1)
2. DC input ammeter (2)
3. AC output voltmeter (1)
4. AC output ammeter (1)
5. AC output frequency meter (1)
6. Elapsed time meter

Show TP#5

EO-5.0

Point out instruments

One labeled charger output

B. Status lights on the UPS front panel indicate breaker position for:

1. CB-1
2. CB-2
3. CB-3
4. and CB-4

Tracks hours on inverter.

Good for over eleven years.

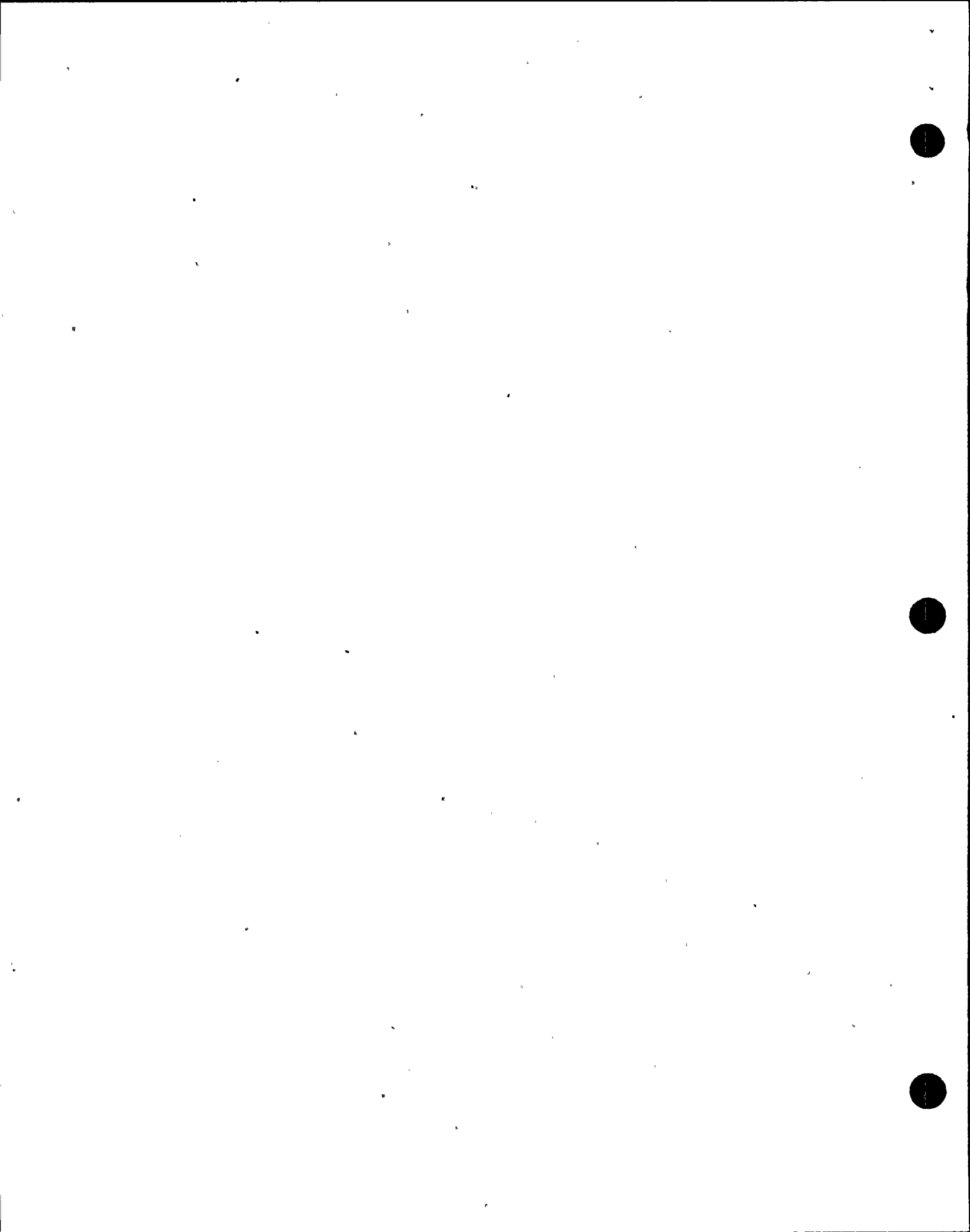
C. Alarm LED's warn of problems with UPS at the:

1. Battery
2. Inverter
3. Charger

These alarm conditions are indicated on the local panel and cause a common annunciator in the Control Room.

UPS SYSTEM TROUBLE

Each UPS has a system trouble annunciator.



- D. Two DC supply indicators are also on the UPS front panel.
1. One light indicates the loss of external DC.
 2. One light indicates BLOCKING DIODE CONDUCTING
 - a. This will also cause UPS battery operation annunciator in the Control Room.

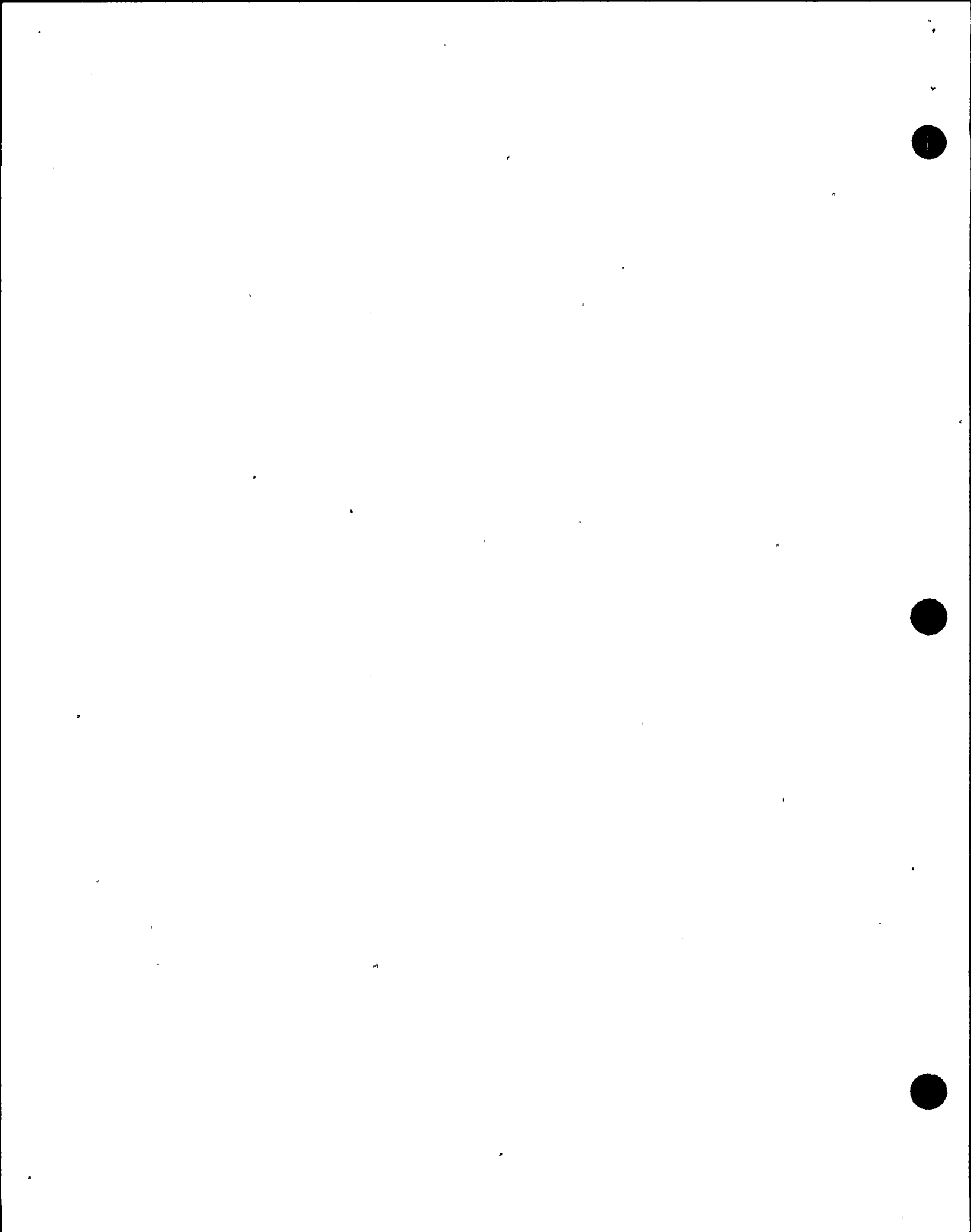
E. Controls

Show TP#5

1. Transfer control
 - a. bypass position - reverse transfer (UPS-maintenance)
 - b. manual restart - forward transfer automatically (maintenance-UPS) if inverter running in SYNCH and CB3 is in close permissive.
 - c. auto restart - forward transfer (maintenance-UPS) after 40 seconds of stable AC input power inverter starts up SYNCs to maintenance then will transfer to UPS provided CB3 in close permissive.
2. CB3 toggle switch
 - a. close permissive - (up position) will allow auto forward and reverse transfer of UPS.
 - b. Open - maintains CB3 open (no transfers)

Show TP#4

Point out that the static switch transfers, then CB3 and CB4 perform a make before break transfer.



3. On/off - pushbuttons
 - a. on - starts up the unit.
 - b. off - shuts down the unit.

Show TP#5
Point out pushbuttons

V. UPS SERIES 2 AND 3

- A. Fundamentally the same as UPS series one.
 1. Sizes differ
 2. Electrical load capability differ.
 3. Total phases that can be supplied will vary.
- B. Category Differences
 1. UPS 2A/2B are Cat I power supplies.
 - a. They are located in CAT I areas and supply CAT I loads (Division I - UPS 2A) (Division II - UPS 2B)
 2. UPS 3A/3B are CAT II power supplies but they do supply CAT I loads.
 - a. The UPS's are each separated from the loads by two electrical protection assemblies (EPA's) in series.
 - b. EPA's will trip on undervoltage, over-voltage or under frequency to protect the load from the source.
- C. Transfers
 1. Automatically - works the same as series one.

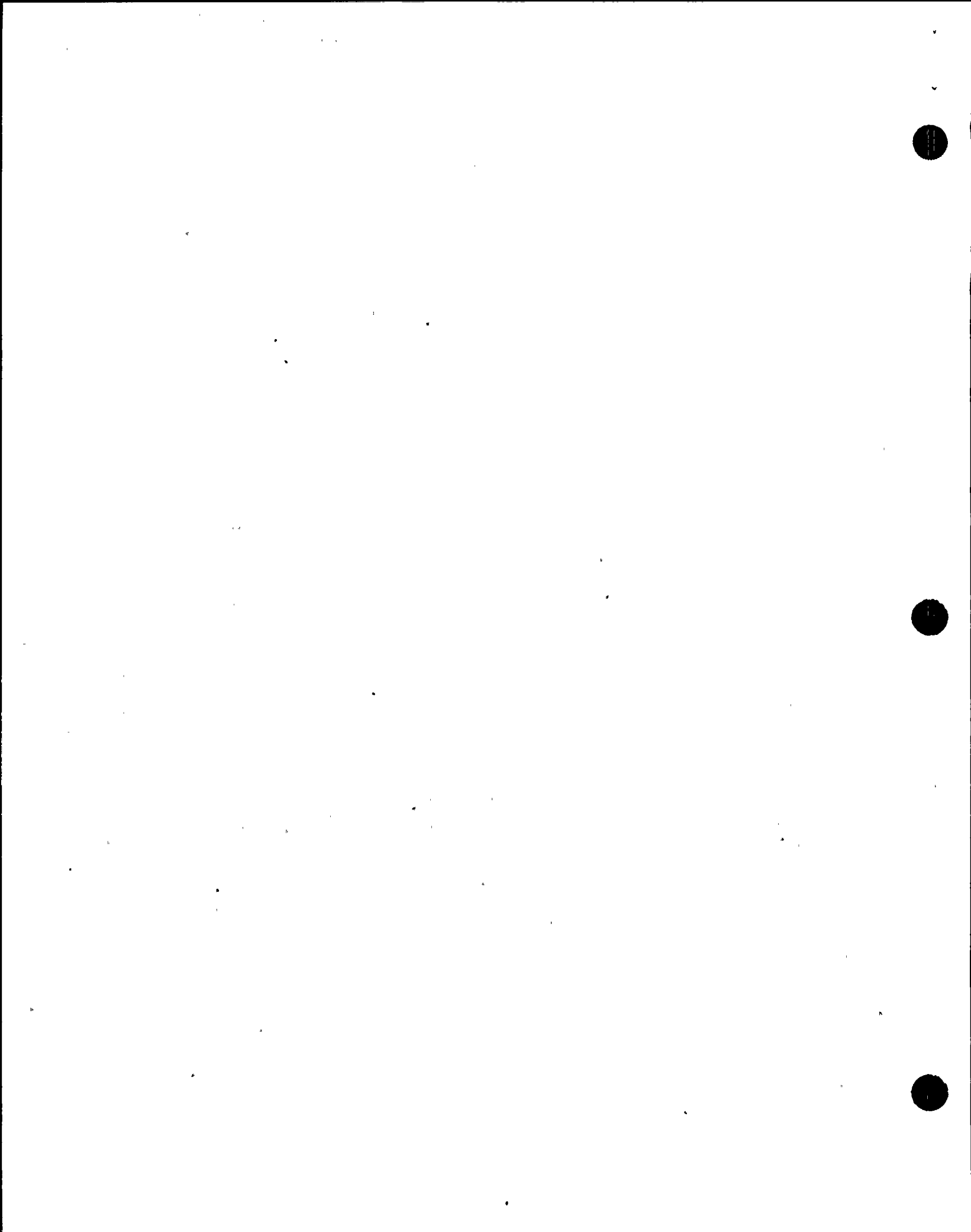
Show TP#6
Describe and show differences for UPS 2A/2B.
Show TP#7
Describe and show differences for UPS 3A/3B.

EO-5.0

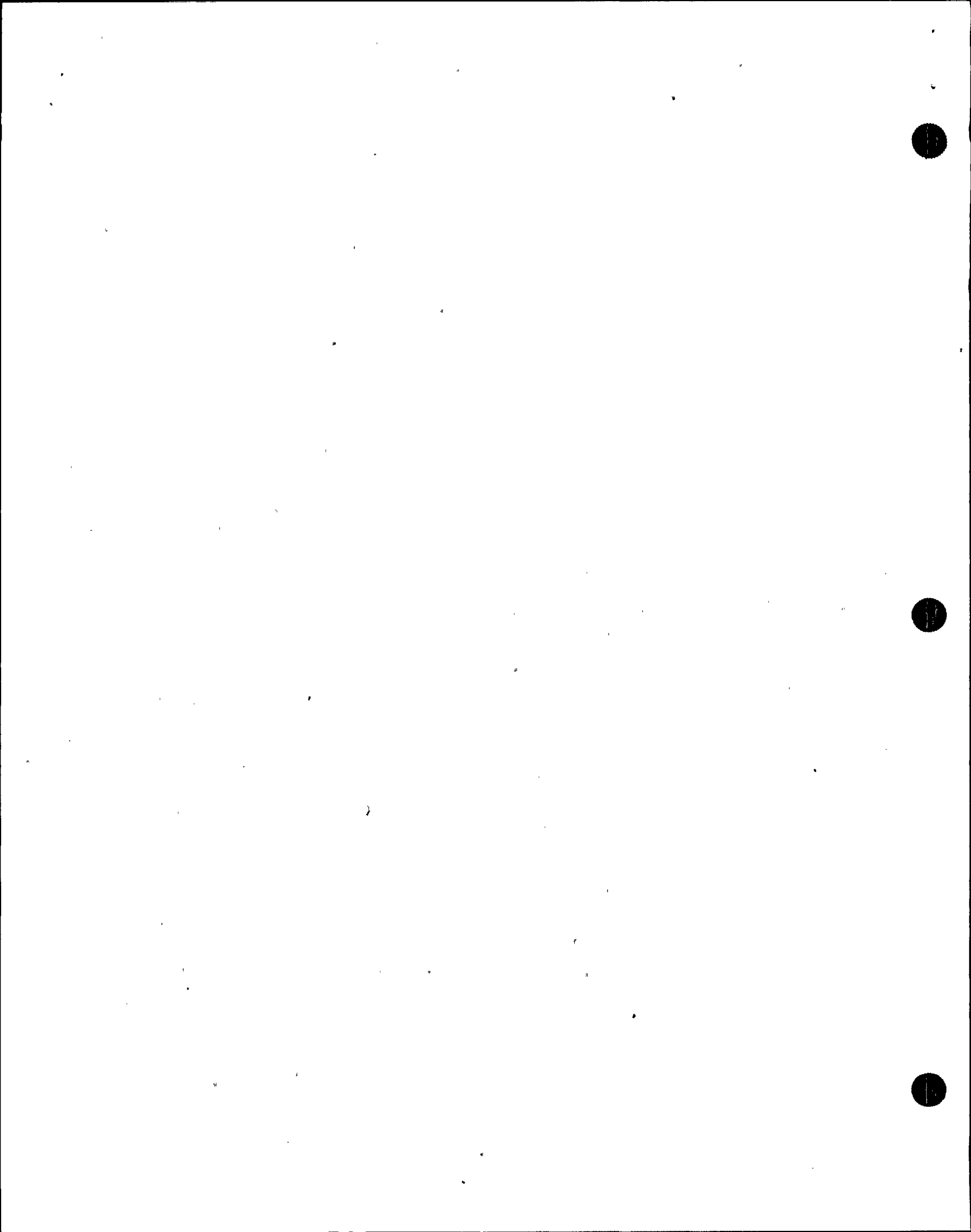
UPS 2A and 2B are required operable by T.S.
3.8.3.1 and 3.8.3.2

EPA's require a manual reset.

EPA's covered by T.S. 3/4.8.4.4.4



2. Manual
 - a. To maintenance pushbutton
 - b. To UPS pushbutton
 - c. Manual switch may also be used.
- D. Instrumentation and Controls (UPS series 2 and 3)
 1. The UPS has local indication of:
 - a. DC volts for rectifier and battery.
 - b. Battery current
 - c. AC voltage
 - d. AC frequency
 - e. AC amps
 - f. Elapsed time meter
 2. Status lights on the UPS front panel indicate breaker position.
 3. Alarm LED's on UPS front panel warn of problems with:
 - a. Battery
 - b. Inverter
 - c. ChargerThese alarms cause common annunciator in the Control Room "UPS System Trouble".
 4. Controls UPS - 2
 - a. Reverse/forward transfer pushbuttons
 - b. Manual transfer switch on output selectable to static switch or maintenance supply.



5. Controls UPS - 3

- a. Reverse/forward transfer pushbuttons.
- b. Manual transfer switch on output selectable to static switch, inverter or maintenance supply.

Show TP#8
Point out the controls

VI. UPS - 1H STACK UPS

EO-5.0

- A. Elimination of the rectifier section of the unit -
uses a "four quadrant" power inverter bridge
(power transistors main component)

Show TP#9
Point out power inverter

1. Bridge can feed either way - DC through bridge to output or AC backwards through bridge to charge the battery.
2. Units now even less susceptible to input AC variations and more compact.
3. Very few user controls to manipulate - almost totally self-sufficient.

B. Instrumentation and Controls

Show TP#10
Point out instrumentation on 1H.

1. Indications
 - a. Digital display of keypad selected parameter
2. Status lights
 - a. Various alarm indicators locally display UPS trouble.



3. Controls

- a. System metering keypad - pushbutton of desired reading output to digital display.
- b. System test - provides a temporary loss of AC input while button depressed. Loads then supplied via internal battery pack.

VI. PROCEDURES

A. Startup

1. UPS - series 1/3
 - a. N2-OP-71
2. UPS - series 2
 - a. N2-OP-72
3. Stack UPS - 1H
 - a. N2-OP-71

B. Shutdown

1. Procedure located under off normal procedures.
2. Transfer (reverse) to maintenance.
 - Open battery input
 - Open AC input

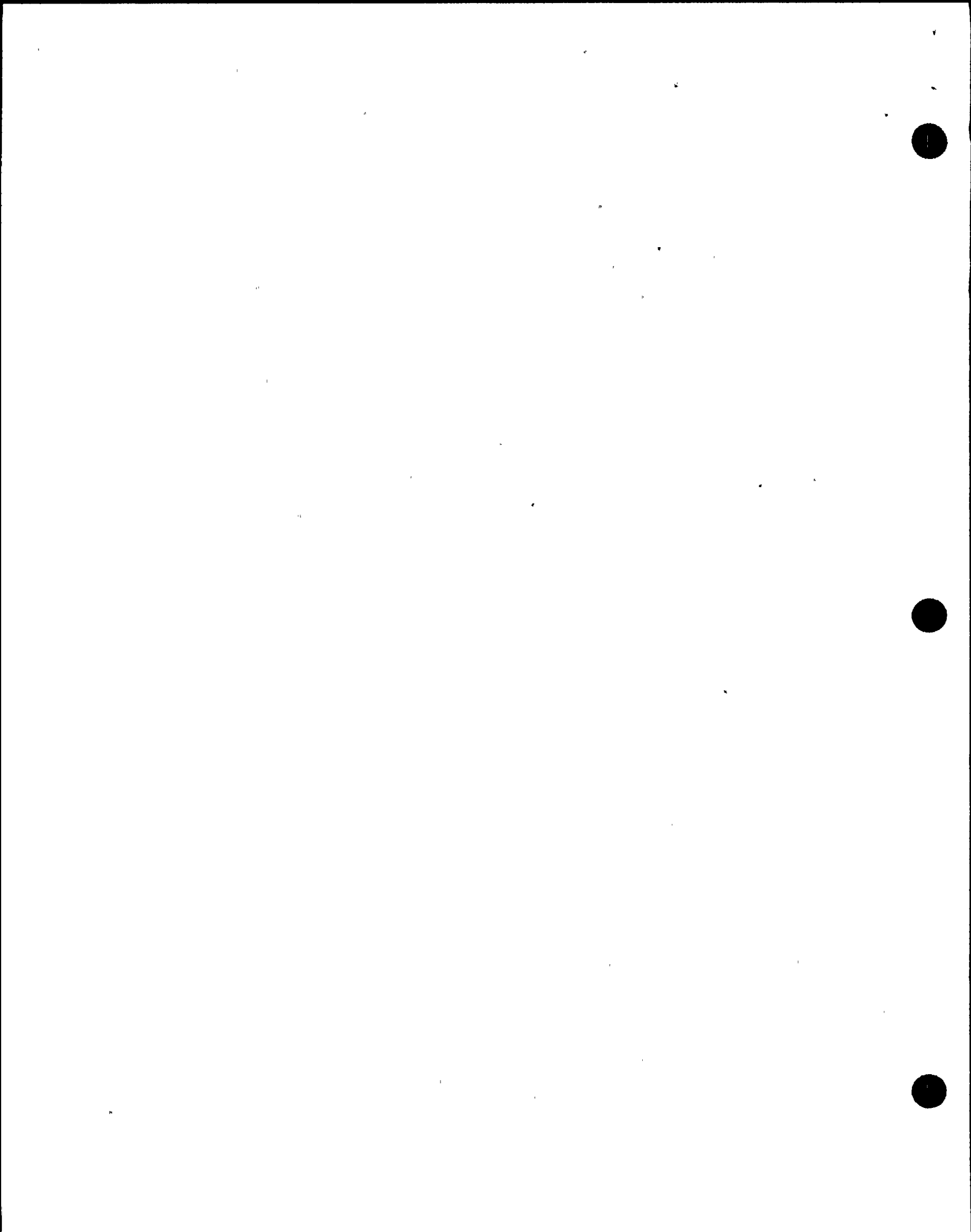
Using most recent revisions of N2-OP-71 and N2-OP-72, review actions

EO-7a

Note: This section is in response to SOER 83-3

Knowledge of inverter failure recovery actions are vital to preventing recurrence.

EO-7.b



C. Off normal operations

1. Loss of AC input power (normal)
 - a. No operator action required, all units will begin accepting power from the batteries. Upon restoration of AC power, batteries bias off and power is drawn from the AC source via rectifier.
2. UPS energized from AC input, (normal) lose DC input power.
 - a. No effect on UPS or its loads. Therefore this requires no operator action. (Alarm on series 1 "no external DC").
3. Units on AC input, with DC available, lose maintenance supply.
 - a. Alarm only ("SYNC loss") (series 1 "maintenance out of limits").
4. UPS normal lineup DC switchgear volts at 141.0 VDC.
 - a. Alarm only ("on battery power") and ("blocking diode conducting")

EO-7.c

EO-7.c

Alarm due DC input breaker tripping on under-voltage
Using most recent revisions of N2-OP-71 and N2-OP-72

EO-7.c

EO-7.c



EO-7.c

- 5. Loss of AC input and DC input power simultaneously.
 - a. Crash transfer - UPS automatically transfers its load to its maintenance AC source. Upon restoration of AC input power load is automatically retransferred back to UPS.
- 6. Inverter fault (UPS - series 1) CB-1, CB-3 fail to transfer electrically.
 - a. Possible loss of UPS loads.
 - b. If power is required to UPS loads lift covers up by squeezing breaker cover release bar (located at bottom of cover) and lifting cover upward. Operate breakers manually as required.

NOTE: Procedures do not cover this situation, will point out how to operate these breakers in the plant.

EO

- D Procedures for Correcting Alarm Conditions
 - 1. Briefly discuss alarms and actions for correcting alarms.

EO-7.d

SYSTEM INTERRELATIONS

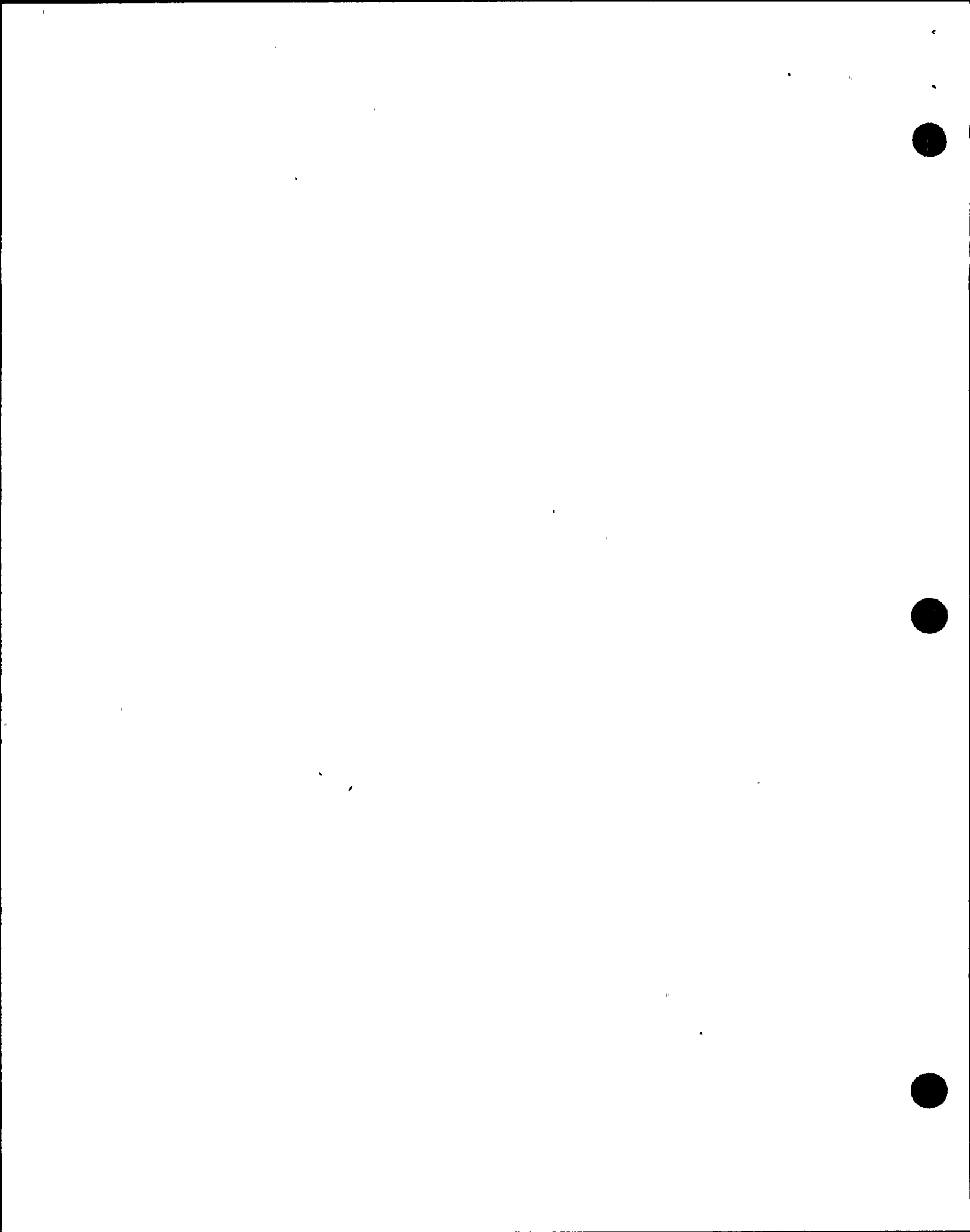
- A Normal AC distribution
 - 1. Supplied as the normal power source for UPS 1 and 3 series.
 - 2. Stub busses 2NJS-US5 and US6 supply maintenance power to UPS1 and 3 series.



- B. Emergency AC Power
1. UPS 2 series are supplied normal and maintenance power from 600 volt emergency load centers.
- C. DC Power System
1. Normal DC power provides the backup power source to the UPS 1 and 3 series.
 2. Emergency DC power provides the backup power source to the UPS 2 series.
- D. Reactor Protection System
1. UPS 3 series provides power to the RPS logic systems. EO-6.0
- E. Containment Isolation System
1. UPS 3 series supplies power for the Containment Isolation logic system. EO-6.0
- F. Digital Radiation Monitoring System
1. UPS 1B supplies power to some of the radiation monitors. EO-6.0
 2. UPS 1G supplies power to the DRMS Data Acquisition System (DAS) and the system unibus and CPU's.
- G. Plant Process Computer
1. UPS 1G supplies power to the various components of the process computer. EO-6.0
- H. Gaseous Effluent Monitoring Systems
1. UPS 1H (also called stack monitor UPS) supplies power to the GEMS. EO-6.0



- | | |
|--|--------|
| I. Liquid Radwaste | EO-6.0 |
| 1. The radwaste computer receives power from
- UPS 1A. | |
| J. Essential Lighting | EO-6.0 |
| 1. UPS 1A and 1B provides power to plant
essential lighting. | |
| K. Plant Communications | EO-6.0 |
| 1. Gaitronics is supplied by UPS 1A and 1B. | |
| 2. UPS 1B also supplies plant leaky wire radio
system. | |
| L. Neutron Monitoring System | EO-6.0 |
| 1. UPS 1A and 1B supply power to the rod block
monitor average power range monitors, the
NMS recorders on panel 603 and the recirc
system flow recorder on panel 602. | |
| M. Reactor Manual Control System | EO-6.0 |
| 1. UPS 1A supplies power to the following RMCS
components. | |
| a. RPIS power supply | |
| b. RMCS display and select matrix. | |
| c. Scram timing circuit | |
| d. Rod drive control system | |
| e. RMCS select logic | |
| f. CRD temperature recorder | |
| N. Feedwater Level Control System | EO-6.0 |
| 1. UPS 1B supplies the AC power for FWLC. | |



VIII. DETAILED SYSTEM REFERENCE REVIEW

Review each of the following referenced documents with the class.

- A. Reference list Appendix "A"
- B. Procedures
 - 1. N2-OP-71, "13.8 KV/4160V/600VAC power distribution"
 - 2. N2-OP-72, "Standby and Emergency AC Distribution System"

IX. SYSTEM HISTORY

- A. Review related modifications with class (if applicable).

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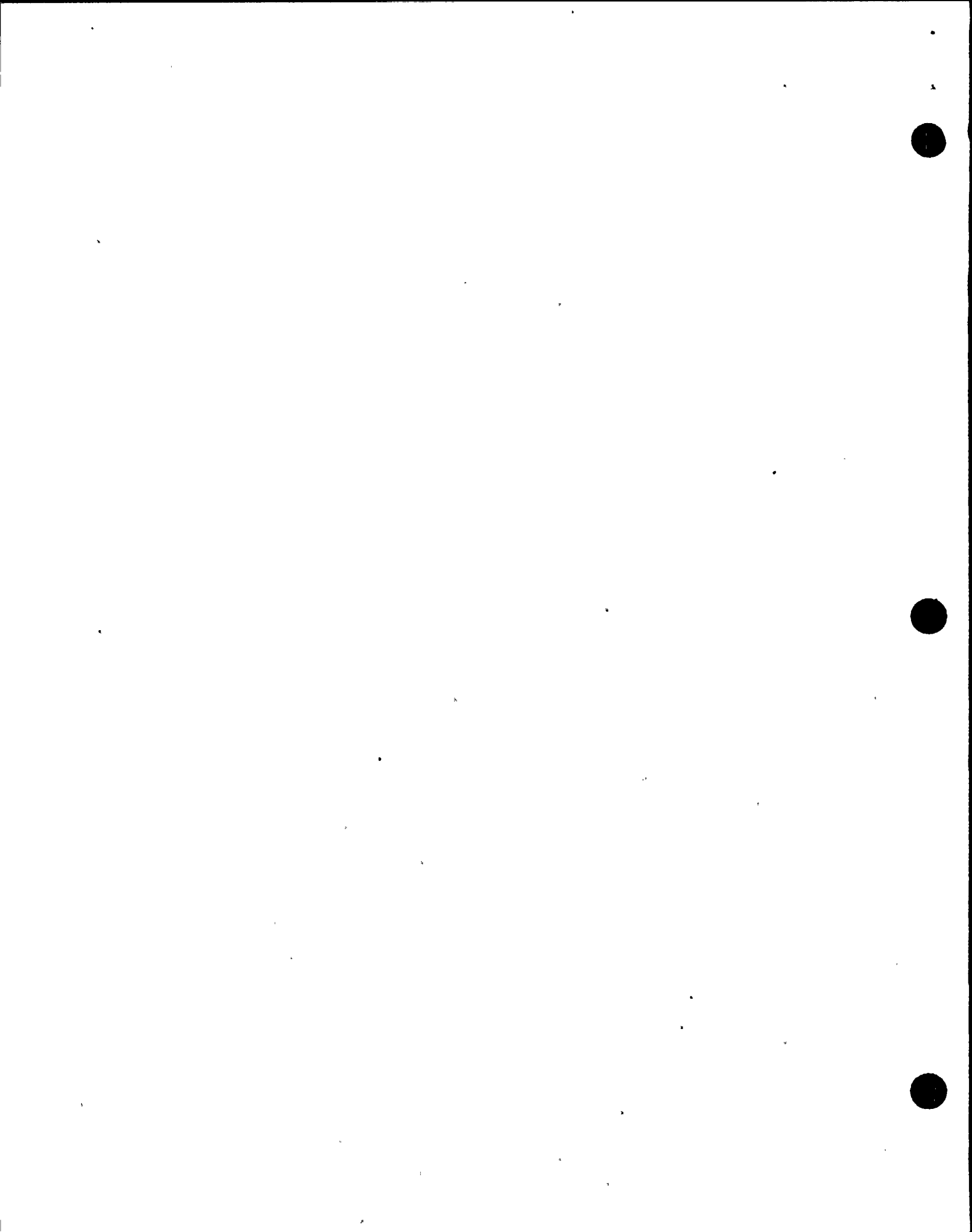
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X. WRAP - UP

- A. Review the student learning objectives.

XI. PLANT WALKTHROUGH (2 HOURS)

- A. UPS locations
- B. Major components
- C. Operation (Operations Support required)
 - 1. Walkthrough shutdown and startup of UPS Series - 1 (To be chosen by SSS)



2. With operations support walkthrough , maintenance to UPS transfer and vice versa.
 3. Manual operation of CB-1, CB-3 inside UPS series 1 in event they fail to transfer.
- D. Questions
- E. Review student learning objectives.

