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WANL-TME-1285

November, 1966

Westinghouse Astronuclear Laboratory

Operational Manual for the XE-1 High Voltage
Power Supply (938J164)

MASTER

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TITLE: OPERATIONAL MANUAL FOR THE XE-1
HIGH VOLTAGE POWER SUPPLY (938J164)

DATE: November 1966

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TABLE OF CONTENTS

	<u>Page</u>
1.0 GENERAL	1
1.1 Introduction	1
1.2 Description.	1
1.2.1 Specifications	1
1.2.2 Construction.	6
2.0 INSTALLATION	6
2.1 Incoming Inspection	6
2.2 Mounting	7
3.0 PRINCIPLES OF OPERATION.	7
3.1 Positive Output Supply	7
3.2 Negative Output Supply	8
4.0 OPERATING INSTRUCTIONS.	8
4.1 Controls – Operational and Semi-Permanent	8
4.2 Front Panel.	8
4.2.1 Fusing.	8
4.2.2 Component Panel	9
4.2.2.1 Test Jacks	9
4.2.2.2 Potentiometers.	9
4.2.2.3 Switches	9
4.3 Operational Checkout	9
4.3.1 Test Equipment	9
4.3.2 Mechanical Checkout.	10
4.3.3 Electrical Checkout	10

WANL-TME-1285

TABLE OF CONTENTS (Continued)

	<u>Page</u>
5.0 MAINTENANCE	11
5.1 Preventive Maintenance	11
5.2 Corrective Maintenance	11
6.0 TEST SPECIFICATION AND PROCEDURE	12

LIST OF FIGURES

<u>FIGURE</u>	<u>TITLE</u>	<u>PAGE</u>
1	High Voltage Power Supply Front Panel	3
2	High Voltage Power Supply Top View	4
3	High Voltage Power Supply Rear View	5
4	XE-1 High Voltage Power Supply (TSCS) Acceptance Test Setup	31
5	High Voltage Power Supply Assembly Drawing - 938J164	32
6	High Voltage Power Supply Schematic Diagram - 978D497	33
7	High Voltage Power Supply Wiring Diagram - 909E495	34

XE-1 HIGH VOLTAGE POWER SUPPLY (938J164) OPERATIONAL MANUAL

1.0 GENERAL

1.1 Introduction

This operational manual contains the general description, theory of operation, alignment procedures, maintenance, and repair data for the XE-1 High Voltage Power Supply.

1.2 Description

The high voltage power supply is a transistorized high regulation, low ripple power supply providing two isolated variable output voltages.

1.2.1 Specifications

The mechanical and electrical specifications for the high voltage power supply are as follows:

Mechanical

Height	7 inches
Width	19 inches
Depth	19 inches
Mounting	The unit is designed for mounting in a standard 19" instrument rack with chassis guides (Zero Pak AT-2RN-20-21). These are included with the unit.

WANL-TME-1285

Electrical

Input

Supply Voltage 115 VAC RMS $\pm 10\%$ Supply Frequency 60 CPS $\pm 5\%$

Output (High Voltage Section)

Voltage Adjustable between 50 and 500 VDC

Current 0 to 20 Ma. DC

Polarity Positive to Coaxial Conductor

Isolation Both sides of the high voltage can be operated up to a maximum of 1000 volts off chassis ground

Output (Compensated Voltage Section)

Voltage Adjustable between -10 and -300 VDC

Current 0-2 milliamperes DC

Polarity Negative to Coaxial Conductor

Isolation Both sides of the high voltage to be operated up to a maximum of 1000 V off chassis ground.

Accuracy

Adjustment Adjustable to within 1 volt of desired setting

Resetability To within $\pm 0.4\%$ F.S.

Figure 1
High Voltage Power Supply Front Panel

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Figure 2
High Voltage Power Supply Top View

Figure 3
High Voltage Power Supply Rear View

Regulation	High Voltage Section $\pm 0.05\%$ vs. line and load Compensation Section $\pm 0.05\%$ vs. line and load
Ripple	Less than 0.004% or 2 m.v. rms (whichever is greater)
Temperature Coefficient	Less than 0.033% plus 2 mv. per $^{\circ}\text{C}$

1.2.2 Construction

Figure 1 is a photograph of the front panel of the High Voltage Power Supply. An indicating type fuse, mounted next to a spare fuse holder is located at the lower center of the front panel. A locking type handle permits locking the chassis into the rack. Meters are with half bezel recess mounted. Figure 2 is a top view photograph of the High Voltage Power Supply. The component panel showing test jacks and controls location is seen at the front of the drawer. The power supply modules are mounted beneath the perforated top cover. Figure 3 shows the drawer rear view. The Bendix Power input jack J1 is seen on the left lower rear of the drawer. The positive and negative output jacks, J2 and J3, respectively, are mounted on an insulated board on the lower right of the drawer.

2.0 INSTALLATION

2.1 Incoming Inspection

The equipment was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars, dents, or scratches and should be in perfect electrical order upon receipt. To confirm this, the equipment should be inspected

for physical damage from transit and tested for electrical performance using the procedure of Section 5. If there is damage or deficiency, repairs should be made before final use.

2.2 Mounting

The following procedure should be used for the proper installation. Mount the removable part of the chassis guides at the desired selected level in a standard 19 inch rack. WANL Drawing 938J164 gives the mounting dimensions, plan view, and construction details of the chassis, panel, and connectors.

3.0 PRINCIPLES OF OPERATION

The High Voltage Power Supply uses three Harrison Labs regulated power supply modules (Model 6357A/J01) designated PS1, PS2, and PS3 on schematic diagram 978D497.

3.1 Positive Output Supply

The positive voltage output is derived from two of the modules operated in series, arranged for remote programming in a master-slave arrangement. Programming controls (fine and coarse) are comprised of potentiometers R1 and R2 on schematic diagram 978D497. Power module PS2 is slaved to power module PS1 so that output voltage of both supplies changes equally when programming potentiometers R1 or R2 are adjusted. The slaving circuit is comprised of the resistors R7 and R8 connected in series between power modules PS1 and PS2, and resistors R5 and R6 connected in series across the remote programming terminals, 1 and 8, of power supply module PS2. The resistors and programming potentiometers have a temperature coefficient of 20 ppm/ $^{\circ}$ C or less to minimize the overall

WANL-TME-1285

temperature coefficient. Refer to the Harrison Labs Instruction and Operation Manual for Model 6357A/J01 Power Supply, to obtain further detailed information on the principles of operation of the power supply modules.

3.2 Negative Output Supply

Power supply module PS3 provides the negative output voltage. The output voltage is adjustable by means of fine and coarse controls comprised of potentiometers R3 and R4. These potentiometers have a temperature coefficient of 20 ppm or less to assure the overall power supply stability. Further detailed information on the Principles of Operation of power supply module PS3 may be obtained by reference to Harrison Labs Instruction and Operation Manual for Model 6357A/J01 Power Supply.

4.0 OPERATING INSTRUCTIONS

After installing the High Voltage Power Supply according to procedures detailed under Installation Instructions, a mechanical and electrical checkout should be made. Controls, adjustments, and operational test procedures follow here.

4.1 Controls - Operational and Semi-Permanent

Access to alignment controls is limited because of the location of all operating controls on a component panel inside the High Voltage Power Supply. An indicating fuse is located on the front panel.

4.2 Front Panel

4.2.1 Fusing

One 0.75 ampere fuse and associated indicating lamp is accessible at the bottom center of the panel face.

4.2.2 Component Panel

4.2.2.1 Test Jacks

Four test jacks are located on the component panel at the front of the chassis. These are designated as follows:

TP1	+500 VDC
TP2	+250 VDC
TP3	COM
TP4	-200 VD

4.2.2.2 Potentiometers

Four potentiometers with 10 turn dials are positioned along the rear of the component panel, in the order indicated from left to right.

Positive		Negative	
Coarse	Fine	Coarse	Fine

4.2.2.3 Switches

A power ON-OFF switch is located at the right rear corner of the component panel.

4.3 Operational Checkout

4.3.1 Test Equipment Needed

The meters on the front panel can be used to adjust output voltages and verify circuit operation. For very accurate voltage adjustments a digital voltmeter (EAI or equivalent) may be connected to the appropriate test jacks on the component panel.

4.3.2 Mechanical Checkout

Before application of primary power for the electrical checkout, examine gear carefully for mechanical rigidity of all mounted components, connectors, knobs, and the like.

4.3.3 Electrical Checkout

Before turning on the main power connect loads. Turn on power and allow equipment to warm up for a minimum of 30 minutes.

4.3.3.1 Positive Supply Adjustment

Adjust Coarse and Fine Controls on Component Panel to give desired reading on Meter M1 or on a digital voltmeter connected to test points TP1 and TP3.

4.3.3.2 Negative Supply Adjustment

Adjust Coarse and Fine Controls on Component Panel to give the desired reading on Meter M2, or on a digital voltmeter connected to test points TP3 and TP4

4.3.3.3

The High Voltage Power Supply is ready for use after the above adjustments have been completed. Remove DVM leads from the test jacks and close the drawer.

5.0 MAINTENANCE

5.1 Preventive Maintenance

The equipment is designed so that no special maintenance procedures are required, other than the normal good housekeeping rules used for similar type electronic equipment. Good housekeeping practices include periodic dusting, cleaning, inspection, and the like.

5.2 Corrective Maintenance

If there is any apparent or suspected failure or improper functioning of the equipment, it should be checked out in accordance with Test Specification T-711855. Also, refer to Harrison Labs Instruction and Operation Manual for Model 6357A/J01 Power Supply. Initial symptoms of malfunction and corrective action are as follows:

<u>Symptom</u>	<u>Action</u>
Blow Fuses	Replace
Blow Lamps	Replace
Loose Controls	Tighten
Off-Voltage at Test Points. . .	Check Mains
Faulty Meter Readings	Realign
Overheating, Smoke, & Odors .	Examine for shorts in load or output cables.
Intermittents	Search for and correct high resistance joints or loose connections.

If any of the preceding symptoms persist, it is an indication of deepseated malfunction and assistance from a qualified repair facility should be requested.

WANL-TME-1285

6.0 TEST SPECIFICATION AND PROCEDURE

Each unit has been tested in accordance with the procedures and must comply with the limits of WANL Specification Number T-711855 which is included as part of this manual.

TEST SPECIFICATION NUMBER T-711855

TITLE

Acceptance Test Specification and Procedure

XE-1 High Voltage Power Supply (TSCS)

DATE: September 1966

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WANL-TME-1285

TEST SPECIFICATION

XE-1 HIGH VOLTAGE POWER SUPPLY (TSCS)

1.0 SCOPE

This document contains the requirements for the acceptance testing of the High Voltage Power Supply (WANL Drawing 938J164).

2.0 REQUIREMENTS

2.1 The acceptance test shall consist of the following:

2.2.1 Visual Examination - To be performed by Quality Control

2.2.2 Weights and Dimensions - To be performed by Quality Control.

2.2.3 Dielectric Strength - To be performed by Quality Control.

2.2.4 Insulation Resistance - To be performed by Quality Control.

2.2.5 Functional Test - To be performed by Electronics and Instrumentation and witnessed by Quality Control.

2.2 The acceptance test shall be performed in the order of and as specified in the procedure. Discrepancies found during the visual examination shall be corrected and reinspected before performing the functional test. Failure or inability to obtain a required measurement during formal functional testing shall result in establishing a "hold" on the test. The failure or inadequacy shall be recorded by Quality Control

WANL-TME-1285

and shall be reviewed by the WANL Engineering Review Board.

The equipment shall be repaired and sections of the test repeated as determined by the ERB.

Visual examination shall be performed on the reworked or repaired areas before resuming testing.

3.0 APPLICABLE DOCUMENTS

- 3.1 Drawing 938J164 Assembly, High Voltage Power Supply.
- 3.2 Drawing 978D497 Schematic Diagram, High Voltage Power Supply.
- 3.3 Drawing 909E495 Wiring Diagram.

4.0 EQUIPMENT REQUIRED

1 Variac	Powerstat Type 116 or equal
1 25K 10W Resistor	
1 Multimeter	(Simpson 269 or equal)
1 Bourns Pot 200K 5 Watt	
1 Digital Voltmeter	(EAI or equal)
1 SPDT Switch	
1 Del Electronic Model	5HPT-2-1 or equal
1 10 MA DC Ammeter	+5% accuracy
1 Megger	(General Radio Megohmmeter 1862-B or equal)
1 50 MA DC Ammeter	+5% accuracy
1 AC Voltmeter	Hewlett Packard 400D or equal.

5.0 ACCEPTANCE TEST PROCEDURE

The following test procedures shall be used to test the High Voltage Power Supply.

- 5.1 Visual Examination - The equipment under test shall be presented in its final form together with the applicable schematic, wiring diagram, and assembly drawing. The visual examination shall consist of the following parts:

WANL-TME-1285

- 5.1.1 Workmanship, Assembly, and Fit - The inspector shall inspect the equipment for workmanship to WANL requirements, and to assure that the overall chassis is of the proper dimensions per the assembly drawing, Westinghouse Drawing Number 938J164. Rev. _____
Workmanship OK _____
- 5.1.2 Materials, Parts, and Finishes - The equipment shall be inspected to assure that the materials, parts, and finishes are in accordance with the applicable assembly drawings. Incoming inspection records on materials, parts, and finishes shall be utilized to determine conformance to the assembly drawings where possible.
Materials OK _____
- 5.1.3 Treatment for Prevention of Corrosion - The equipment shall be inspected to assure that the coatings for prevention of corrosion have not been impaired during the manufacturing cycle.
Treatment OK _____
- 5.1.4 Safety Requirements - The equipment shall be inspected to insure that no safety hazard, such as sharp edges, etc., exist on the equipment which are potential hazards to personnel operating or maintaining the equipment.

WANL-TME-1285

Safety OK _____

- 5.1.5 Marking - The markings on the equipment shall be inspected to ensure conformance to the applicable drawings and to assure that they are acceptable as to permanence and readability.

Marking OK _____

- 5.1.6 Visual Examination Review - After the visual examination of the equipment has been completed, all deficiencies shall be reviewed by WANL Engineering and Quality Control and corrected by one of the following methods:

- a. Drawing changes where drawing deficiencies are noted.
- b. Design changes if necessitated.
- c. Rework of the parts affected.

5.2 Weights and Dimensions

- 5.2.1 The unit shall be weighed and the weight shall be recorded.

Weight _____ lbs.

- 5.2.2 The unit shall be measured and the overall dimensions of width, height, and depth recorded.

WANL-TME-1285

Width _____in.

Height _____in.

Depth _____in.

- 5.3 Dielectric Strength - Apply a test voltage of 1000 volts RMS at 60 cps between the chassis and circuit common, TP3, with all external leads connected to circuit common (except chassis ground Pin E of Connector J1) for a period of not less than 1 minute. The voltage shall be increased slowly from zero to the 1000 volt level and maintained for 1 minute and then slowly reduced to zero. After completion of the test, there shall be no evidence of punctured insulation or arcing.

Insulation OK _____

- 5.4 Insulation Resistance - Apply a test voltage of 500 volts DC between chassis and circuit common, TP3, with all external leads connected to common (except the chassis ground Pin E of Connector J1) using a General Radio Megger, Type 1826B or equal. The insulation resistance shall be greater than 10 megohms.

Insulation resistance _____meg.

- 5.5 Functional Tests - Connect the High Voltage Power Supply in the test setup of Figure 1. Apply power and allow the equipment to warm up for a minimum of 30 minutes.

5.5.1 Output Voltage Range

5.5.1.1 Turn pots R1 and R2 full counterclockwise. Adjust output load current (See Figure 1) to zero. Output voltage at TP1 should be less than 50V.

Voltage at TP1_____

5.5.1.2 Turn pots R1 and R2 full clockwise. Adjust output load current (See Figure 1) to 20 milliamperes. Output voltage at TP1 should be more than 500 volts. Output voltage at TP2 should be one-half that measured at TP1. $\pm 5\%$.

Voltage at TP1_____

Voltage at TP2_____

5.5.1.3 Turn pots R3 and R4 full counterclockwise. Adjust output load current on compensating supply to zero. Output at TP4 should read a negative voltage magnitude less than ten.

Voltage at TP4_____

5.5.1.4 Turn pots R3 and R4 full clockwise. Adjust output load current to 2 milliamperes. Output at TP4 should read a negative voltage of 300 VDC or greater. Record value read on the digital voltmeter.

Voltage at TP4_____

WANL-TME-1285

5.5.2 Adjustment Accuracy

5.5.2.1 Set pot R1 to read lowest value on Meter M1. Adjust pot R2 to full counterclockwise position. Record voltage at TP1 measurement on digital voltmeter versus pot R2 position for dial readings. from zero to 1000 divisions in five equal increments. Record readings. Slope of curve should be greater than 4 divisions per volt.

R2 Dial Setting	TP1 Voltage
0	
200	
400	
600	
800	
1000	

Min. Slope (Div/Volt) _____

5.5.2.2 Set pot R3 to read lowest value on meter M2. Adjust pot R4 to full counterclockwise position. Record voltage at TP4 measured on digital voltmeter versus pot R4 position for dial readings from zero

WANL-TME-1285

to 1000 divisions in five equal increments. Record readings. Slope of curve should be greater than 4 divisions per volt.

R ₄ Dial Setting	Voltage
0	
200	
400	
600	
800	
1000	

Min. Slope (Div/Volt) _____

5.5.2.3 Repeat tests of paragraphs 5.5.2.1 and 5.5.2.2 with pots R1 and R3 respectively adjusted for maximum output voltage.

Pot R2	Voltage
0	
200	
400	
600	
800	
1000	

Min. Slope (Div/Volt) _____

WANL-TME-1285

Pot R4	Voltage
0	
200	
400	
600	
800	
1000	

Min. Slope (Div/Volt) _____

5.5.3 Resetability

5.5.3.1 Adjust pots R1 and R2 full clockwise.

Reset Pot R2 toward zero, duplicating pot positions of paragraph 5.5.2.3. Record pot position versus voltage at TP1. Voltage at any pot position of paragraph 5.5.2.3 should not differ by more than 0.25 volts for readings of this test.

Record data.

R2 Dial	Voltage	Voltage from 5.5.2.3	Volts Difference
0			
200			
400			
600			
800			
1000			

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Max. Difference _____

5.5.3.2 Repeat test of 5.5.2.1 with pot R1 positioned full counterclockwise and pot R2 positioned full clockwise. Duplicate pot positions and compare corresponding voltages of paragraph 5.5.2.1. Voltage at any pot position of paragraph 5.5.2.1 should not vary more than 0.25 volts for readings of this test. Record data.

R2 Dial Setting	Voltage	Voltage From 5.5	Volts Difference
0			
200			
400			
600			
1000			

Max. Difference _____

5.5.3.3 Adjust pot R3 full clockwise. Reset pot R4 toward zero, duplicating pot positions of paragraph 5.5.2.3. Record position of pot R4 versus voltage at TP4. Voltage at any pot position should not differ by more than 150 millivolts from readings

of this test. Record data.

R ₄ Dial Setting	TP ₄ Voltage	Voltage Difference
0		
200		
400		
600		
800		
1000		

Max. Difference _____

5.5.3.4 Repeat test of 5.5.3.3 with pot R₃ positioned full counterclockwise. Duplicate pot positions and compare corresponding voltages of paragraph 5.5.2.2. Voltage at any pot position of paragraph 5.5.3.3 should not vary more than 150 millivolts for readings of this test. Record data.

R ₄ Dial Setting	TP ₄ Voltage	Voltage Difference
0		
200		
400		
600		
800		
1000		

Max. Difference _____

5.5.4 Meter Accuracy

5.5.4.1 Measure voltage at TP1 on the digital voltmeter. Take corresponding readings on meter M1. Deviation of meter M1 readings from those at TP1 should be less than ± 25 volts. Record data.

Voltage at TP1	M1 Volts	Volts Difference
50		
100		
150		
200		
250		
300		
350		
400		
450		
500		

Max. Difference _____

5.5.4.2 Repeat test 5.5.4.1 for voltage measured at TP4 and meter M2. Deviation of meter M2 readings should be less than ± 15 volts. Record data.

WANL-TME-1285

Voltage at TP4	M2 Volts	Volts Difference
-25		
-50		
-75		
-100		
-125		
-150		
-200		
-250		
-300		

5.5.5 Regulation Max. Difference _____

5.5.5.1 Turn pots R1 and R2 counterclockwise until digital voltmeter reads 500 V from TP1 to TP3. Adjust output load current (See Figure 1) to zero (open circuit). Measure "no load" voltage. Adjust output load current to 20 milliamps. Read output voltage from TP1 to TP3 on the digital voltmeter. Calculate regulation from the equation

$$R = \frac{E_{NL} - E_{FL}}{E_{NL}} \times 100\%$$

Regulation, R, should be less than $\pm .03\%$.

Regulation _____

- 5.5.5.2 Repeat measurement of 5.5.5.1 at TP4 with load current adjusted to be 2 milliamperes (output voltage from TP4 to TP3 is 300 V).

Regulation _____

- 5.5.5.3 Measure regulation against line voltage for positive output, TP1, and negative output, TP4, for no load and full load conditions on each supply. Vary line voltage from 103 V (RMS) to 127 V (RMS). Regulation should be better than $\pm 0.01\%$ of normal 115 V (RMS). Record data.

5.5.5.3 continued on next page.

- 5.5.6 Ripple - Measure ripple RMS voltage using an AC Voltmeter for each supply for all combinations of low line, 103 VAC, high line, 127 VAC, minimum output voltage and maximum output voltage at full load. Ripple shall be less than 0.002% or 1 millivolt, whichever is greater.

5.5.5.3 (Continued)

Line Voltage	No Load Volts		20 MA Full Load Volts	Regulation %	No Load Volts		2 MA Full Load Volts	Regulation %
	TP1		TP1		TP4		TP4	
103 V								
115 V								
127 V								

5.5.6 (Continued)

Line AC	+DC Volt	Ripple %	-DC Volt	Ripple %
115V	TP1 50V		TP4 25	
	500V		250	
127	50		25	
	500		250	
103	50		25	
	500		250	

5.5.7 Fuse Indicator Check

5.5.7.1 Apply 117V AC 60 CYC to J1-C and J1-D and close "Power On" switch (S1). Meters M1 and M2 should indicate a voltage.

5.5.7.2 Remove fuse F1. Fuse indicator should light and meters M1 and M2 should read zero. Use S10 B10 fuses due to turn on transients CF.

Fuse Indicator OK _____

5.5.7.3 Replace fuse

5.5.8 Continuity Check

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- 5.5.8.1 Remove all power from the high voltage power supply unit.
- 5.5.8.2 Check the following circuits for short (≤ 1 ohm) using the multimeter.

FROM	TO	OK
J1-E	Chassis	
TP-1	J2-PIN	
TP-3	J2-Shell	
TP-3	J3-Shell	
TP-4	J3-PIN

XE-1 High Voltage Power Supply (TSCS)

Acceptance Test Setup

Figure 4

SECTION A-A

HIGH VOLTAGE POWER SUPPLY

POSITIVE.

FRONT VIEW

- [illegible]

[illegible]

High Voltage Power Supply Assembly Drawing - 938J164

Figure 6

High Voltage Power Supply Schematic Diagram - 978D497

[illegible]

High Voltage Power Supply Wiring Diagram - 909E495

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