OVER-THE-HORIZON RADIO SYSTEMS
ITTL 12A OVER-THE-HORIZON RADIO SYSTEM
POWER AMPLIFIER, NUS 3296
MAINTENANCE AND CALIBRATION

CONTENTS PAGE

1. GENERAL 1

Chart 1—Calibration of Klystron Metering and Overload Protection Circuits 1

Chart 2—Power Supply Test and Maintenance 10

Chart 3—Cabinet Equipment Maintenance 13

1. GENERAL

1.01 This section provides the procedures for checking the metering circuits, the protection circuits, and the power supply circuits used in the NUS 3296 power amplifier. Procedures are also included for maintainance, cleaning, lubrication, and inspection of cabinet-mounted equipment.

CHART 1

CALIBRATION OF KLYSTRON METERING AND OVERLOAD PROTECTION CIRCUITS

This chart describes the test and calibration methods used in maintaining the amplifier metering and overload protection circuits. The tests should be performed in the order presented. These tests require that the amplifier shall be taken out of service and completely shut down in accordance with Section 403-415-301.

APPARATUS:

1—DC Power Supply, Hewlett-Packard 6285A, equipped with alligator-clip leads

1—Power Meter, Hewlett-Packard 430C

1—Bolometer Mount, Hewlett-Packard 476A

1—Vacuum Tube Voltmeter, General Radio 1800B

RF Coaxial Attenuators, 3, 6, 10, and 30 dB

CHART 1 (Cont)

STEP	PROCEDURE

A. Klyston Beam Current Metering and Overload Protection Circuits

1 Set the controls on the dc power supply as follows:

CONTROL	POSITION
LINE	OFF
VOLTAGE	Fully clockwise
CURRENT	Fully counterclockwise
METER	6A.

2 In the amplifier power supply enclosure, connect a clip lead between the two terminals of thyrite protector PR22FF located on the power supply bleeder rack.

3 In the power amplifier control cabinet, disconnect wire number 65 (red) from terminal 65 of terminal strip TB5AG. Position the wire in a manner that prevents contact with the equipment.

4 Connect the negative terminal of the dc power supply to the klystron collector terminal.

5 Connect the positive terminal of the dc power supply to ground on the amplifier cabinet.

6 Operate the BEAM circuit breaker to the ON position.

7 Operate the LINE switch on the dc power supply to the ON position. Observe the dc power supply meter and slowly adjust the CURRENT control clockwise until the BEAM circuit breaker on the amplifier trips.

Requirement: The dc power supply meter shall indicate 3.5 $\pm$0.1 amperes when the BEAM circuit breaker on the amplifier trips.

Note: If the requirement is not met, adjust potentiometer R12AG in the amplifier control cabinet to meet the requirement.

8 Adjust the CURRENT control on the dc power supply until the power supply meter indicates 1.5A and observe the BEAM CURRENT meter indication on the amplifier.

Requirement: 1.5 + 0.15 amperes

Note: This tests the BEAM CURRENT meter and its shunt.

CHART 1 (Cont)

STEP	PROCEDURE
9	On the dc power supply, operate the LINE switch to the OFF position. Dismantle the test connections, remove the jumper from across the thyrite protector, and replace red lead 65 to terminal 65 on terminal strip TB5AG.

B. Klystron Body Current Metering and Overload Circuits Calibration

10 Set controls on the dc power supply as follows:

CONTROL	POSITION
LINE	OFF
VOLTAGE	Fully clockwise
CURRENT	Fully counterclockwise
METER	.6A.

11 Connect the positive terminal of the dc power supply to the klystron collector terminal.

12 Connect the negative terminal of the dc power supply to ground on the amplifier cabinet.

13 Operate the BEAM circuit breaker on the amplifier to the ON position.

14 Operate the LINE switch on the dc power supply to the ON position. Observe the dc power supply meter and slowly adjust the CURRENT control clockwise until the BEAM circuit breaker on the amplifier trips.

Requirement: The dc power supply meter shall indicate 0.275 $\pm$0.010 ampere when the BEAM circuit breaker trips.

Note: If the requirement is not met, adjust potentiometer K13AG in the amplifier control cabinet to meet the requirement.

15 Adjust the CURRENT control on the dc power supply until the power meter indicates 0.2 ampere and observe the DRIFT TUBE CURRENT METER indication on the amplifier.

Requirement: The DRIFT TUBE CURRENT meter indication shall be 200 + 20 milliamperes.

Note: This tests the BODY CURRENT meter and its shunt.

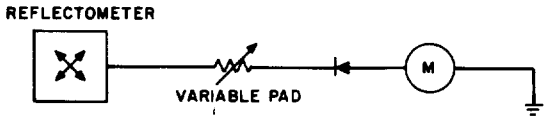
16 Operate the LINE switch on the dc power supply to the OFF position. Dismantle the test connections.

CHART 1 (Cont)

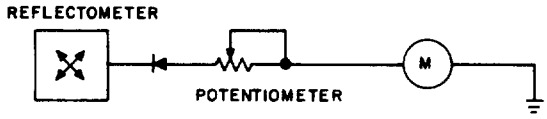
STEP	PROCEDURE

C. Calibration of Amplifier RF Power Metering Circuits

Note: The amplifier is equipped with power metering circuits that indicate incident and reflected power in the cavity loads and in the klystron input and output circuits. Each of the metering circuits contains an adjustable element used for calibration as shown in Fig. 1. The metering circuits should be calibrated before and after each klystron replacement. The procedure describes the method of calibrating one of the power metering circuits and should be repeated for each metering circuit.



A. POWER MEASURING CIRCUIT FOR HIGHER POWER LEVELS.



B. POWER MEASURING CIRCUIT FOR LOW POWER LEVELS.

Fig. 1—Amplifier Power Measuring Circuits

17 Remove the normal outputs for the reflectometer in the circuit under test.

18 Install a 30-dB pad, bolometer, and power meter as shown in Fig. 2.

19 Set up the controls on the 430C power meter as follows:

CONTROL	POSITION
BIAS CURRENT	OFF
POWER	ON
COEF	NEG
POWER RANGE	10MW
ZERO SET COARSE	Maximum clockwise
ZERO SET FINE	Midrange

CHART 1 (Cont)

STEP	PROCEDURE

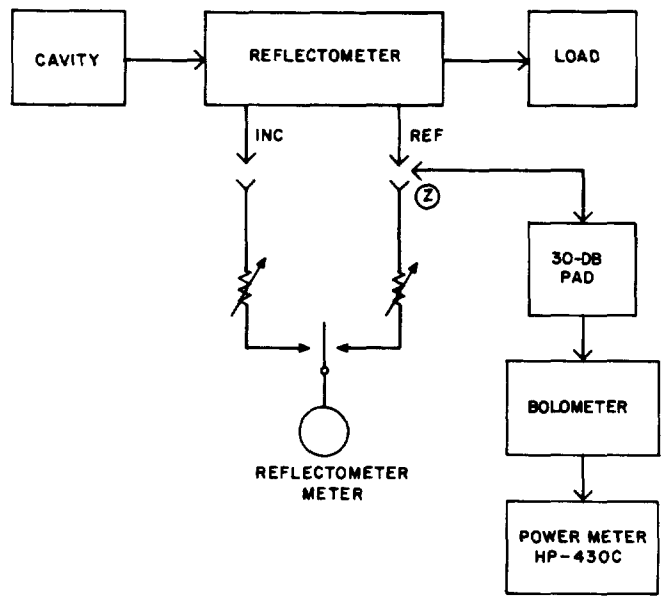


Fig. 2—Transmitter Power Measuring Circuits—Test Setup

20 Rotate the BIAS CURRENT switch on the 430C power meter clockwise, one step at a time, until a positive power meter indication is obtained. Adjust the ZERO SET COARSE control until the power meter indication is approximately 0 milliwatt.

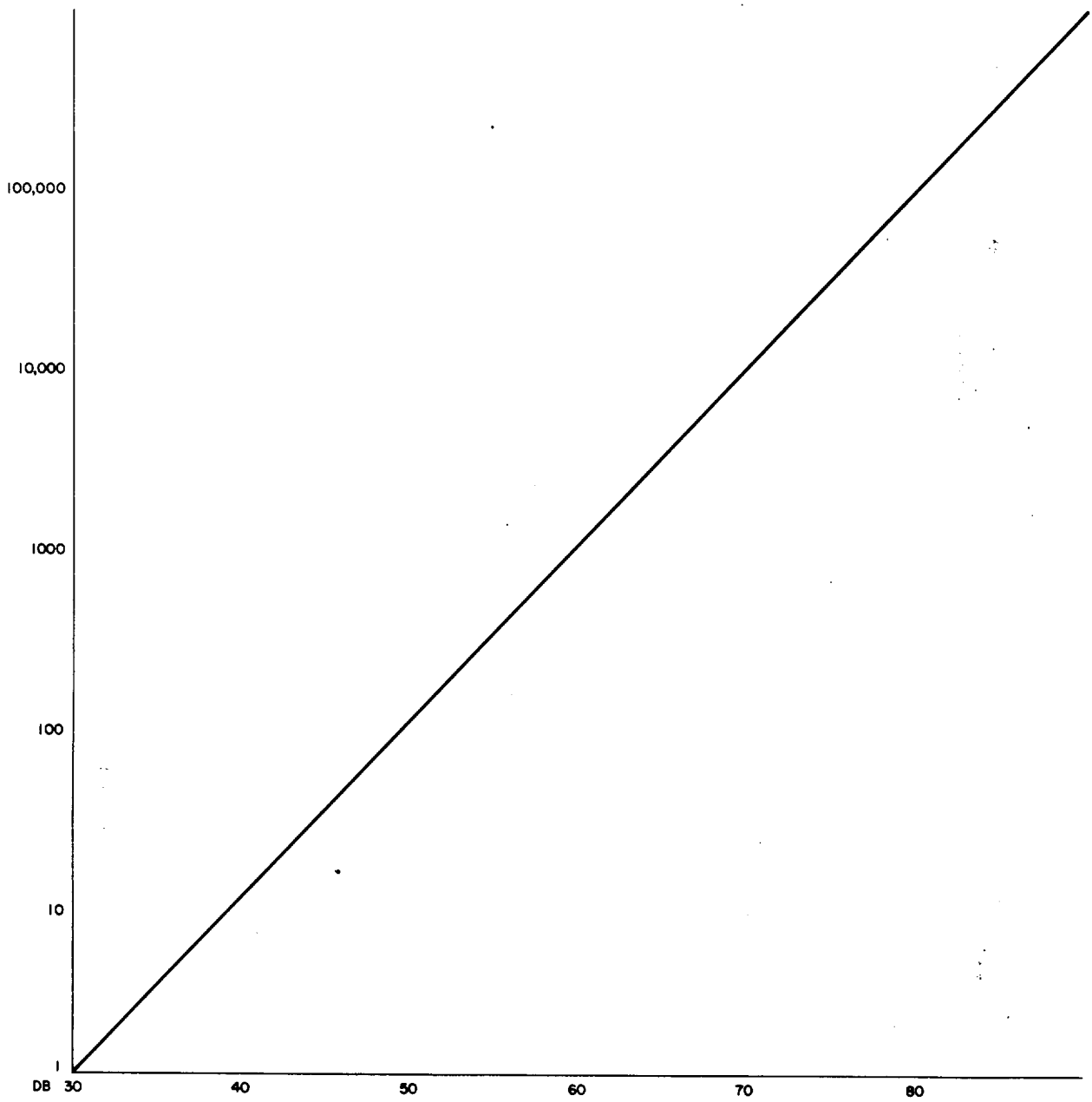
21 Use the ZERO SET FINE control to obtain an indication of 0 milliwatt.

22 Operate the HV circuit breaker on the converter-amplifier to the ON position.

23 Note the 430C power meter indication. If the indication is too low to provide a usable reading, it may be necessary to reduce the amount of test circuit attenuation or to change the power meter operating range by setting the RANGE switch to a lower range.

24 Determine the power going into the load by adding the reflectometer loss, the pad loss, and the indication on the 430C power meter.

Note: This will provide an indication of the load power in dB. To convert dB to watts, refer to Table A.



NOTE:
DB = 10 LOG_{10} POWER RATIO.

Table A

CHART 1 (Cont)

STEP	PROCEDURE

25 Reconnect the amplifier metering circuit elements. Adjust the metering circuit variable attenuator or potentiometer so that the power meter in the amplifier correlates with the power determined in Step 24.

D. Cavity Overvoltage Protection Circuits Test and Calibration

Note: The fifth and sixth primary cavities of the klystron are equipped with overvoltage protection circuits that must be calibrated after a klystron replacement and then periodically to compensate for component aging.

Fifth Cavity Overvoltage Protection Circuit Calibration

26 Set the controls on the dc power supply as follows:

CONTROL	POSITION
LINE	OFF
METER	24V
VOLTAGE	Fully counterclockwise
CURRENT	Fully clockwise

27 Operate the BEAM switch on the power amplifier to the OFF position. Verify that the BEAM circuit breaker is in the ON position.

28 Disconnect cable connector P20CN from the output terminal of NO. 5 overvoltage detector E31CN. Connect test equipment as shown in Fig. 3. Set the vacuum tube voltmeter to its −5 Vdc range.

29 Operate the LINE switch on the dc power supply to the ON position. Slowly adjust the VOLTAGE control clockwise just until the BEAM circuit breaker trips. Note the indication on the vacuum tube voltmeter.

Requirement: The circuit breaker should trip when the vacuum tube voltmeter indicates 3.4 $\pm$0.2 volts.

Note: If the requirement is not met, replace NO. 5 cavity overload relay K3AG.

30 Set the LINE switch on the dc power supply to the OFF position. Connect cable connector P20CN to the terminal of the NO. 5 overvoltage detector. Remove the test cable from the dc power supply.

CHART 1 (Cont)

STEP	PROCEDURE

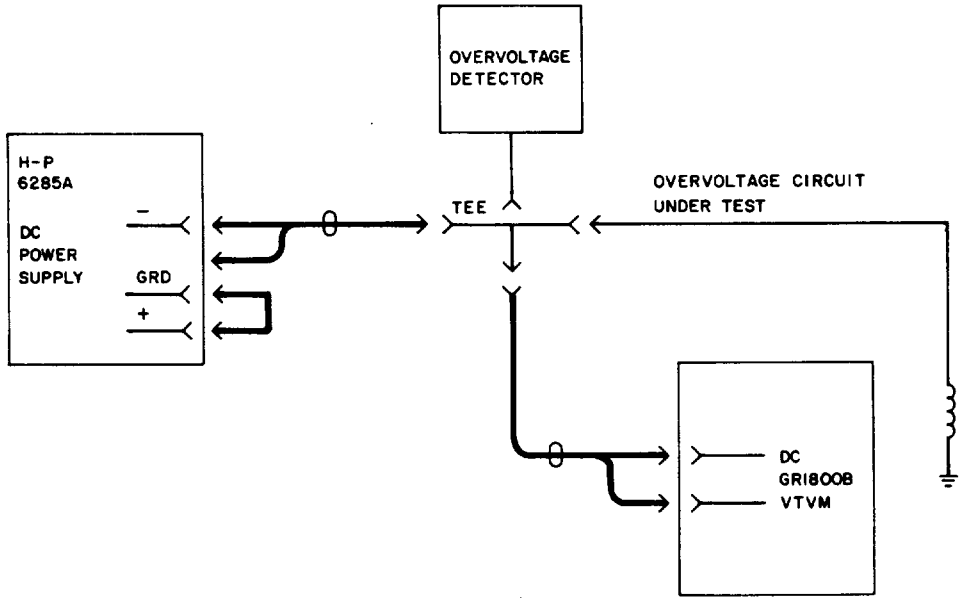


Fig. 3—Arrangement for Making Overvoltage Protection Circuit Calibration Tests

31 Operate the BEAM switch on the power amplifier to the ON position. Operate the BEAM voltage switches to obtain a REFLECTOMETER meter NO. 5 load incident power indication of 300 watts. Note the vacuum tube voltmeter indication.

Requirement: The output of the overvoltage detector shall be 1.2 $\pm$0.2 volts.

Note: If the requirement is not met, adjust attenuator E40CN to meet the requirement.

Output Cavity Overvoltage Circuits Calibration

32 Set the controls on the dc power supply as follows:

CONTROL	POSITION
LINE	OFF
METER	24V
VOLTAGE	Fully counterclockwise
CURRENT	Fully clockwise.

CHART 1 (Cont)

STEP	PROCEDURE

33 Operate the BEAM switch on the power amplifier to the OFF position. Verify that the BEAM circuit breaker is in the ON position.

34 Disconnect cable connector P21CN from overvoltage detector E32CN. Connect the test equipment as shown in Fig. 3. Set the vacuum tube voltmeter to its −5 Vdc range.

35 Operate the LINE switch on the dc power supply to the ON position. Slowly adjust the VOLTAGE control clockwise until the BEAM circuit breaker trips. Note the vacuum tube voltmeter indication.

Requirement: The circuit breaker should trip when the vacuum tube voltmeter indicates 3.4 $\pm$0.2 volts.

Note: If the requirement is not met, replace NO. 6 cavity overvoltage relay K4AG.

36 Operate the LINE switch on the dc power supply to the OFF position. Connect cable connector P21CN to the terminal of the NO. 6 cavity overvoltage detector assembly. Remove the test cable from the power supply.

37 Operate the BEAM circuit breaker and the BEAM switch on the power amplifier to the ON position. Operate the BEAM voltage switches to obtain an RF CURRENT meter indication of 5 kilowatts. Note the vacuum tube voltmeter indication.

Requirement: With the amplifier operated at 5 kilowatts output, the overvoltage detector output shall be 2.0 +0.1 volts.

Note: If the requirement is not met, adjust the NO. 6 primary cavity variable loop coupling to meet the requirement.

CHART 1 (Cont)

STEP	PROCEDURE

Antenna Reflected Power Protection Circuit Test

38 Set the controls on the dc power supply as follows:

CONTROL	POSITION
LINE	OFF
METER	24V
VOLTAGE	Fully counterclockwise
CURRENT	Fully clockwise

39 Operate the BEAM switch on the power amplifier to the OFF position and verify that the BEAM circuit breaker is in the ON position.

40 Disconnect cable connector P22CN normally used at the REF terminal of the klystron output line directional coupler. Connect the test equipment as shown in Fig. 3. Set the vacuum tube voltmeter to its −5 Vdc range.

41 Operate the LINE switch on the dc power supply to the ON position. Slowly adjust the VOLTAGE control clockwise. Note the vacuum tube voltmeter indication when the BEAM circuit breaker trips on the power amplifier.

Requirement: The BEAM circuit breaker should trip when the vacuum tube voltmeter indicates 3.4 $\pm$0.2 volts.

Note: If the requirement is not met, replace mismatch relay K2AG.

42 Connect cable connector P22CN to the terminal of the reflected power detector assembly. Dismantle the test setup.

CHART 2

POWER SUPPLY TEST AND MAINTENANCE

This chart provides the test and maintenance procedures for the NUS 3296 power amplifier power supply. Part A provides the test and adjustment procedure for the primary voltage regulator. Part B provides the beam rectifier maintenance procedure. Part C provides the bombarder rectifier test procedure. Part D provides the bleeder resistor tests. Part E provides the procedures and references to be followed in maintaining the variable autotransformers.

These procedures require that the power amplifier be removed from service in accordance with Section 403-415-301.

CHART 2 (Cont)

Warning: Dangerous voltages are present in this power supply. The safety precautions prescribed in Section 010-110-001 are applicable to all tests and procedures described in this chart.

APPARATUS:

1—Volt-Ohm-Milliammeter, KS-14510

STEP	PROCEDURE
	A. Primary Voltage Regulator Test and Adjustment
1	On the power amplifier, operate the LINE VOLTAGE switch to REGULATOR OUTPUT BC.
2	On the voltage regulator control panel, operate the CONTROL SELECTOR to AUTO. Operate the HOLDING EFFECT control fully clockwise.
3	On the regulator control panel, alternately operate the LOWER and RAISE levers while observing the power amplifier LINE VOLTAGE meter. Operate each lever only until the vibration caused by the motor control relay is sensed. Allow sufficient time between each lever operation to permit the voltmeter to stabilize. Adjust the HOLDING EFFECT control slowly counterclockwise until a point is reached where the voltmeter indication stabilizes at the same voltage following each lever operation.
4	Check the AC LINE VOLTAGE meter indication. ***Requirement:*** The regulated voltage across the primary BC phase legs should be 208 $\pm$1 volts. ***Note:*** If the requirement is not met, remove the regulating relay front cover and adjust the regulating relay compensating spring tension control to obtain a meter indication of 208 volts.
5	On the regulator control panel, alternately operate the LOWER and RAISE levers while observing the LINE VOLTAGE meter. Note the meter indications at the points where the vibration caused by the operation of the motor control relay is sensed. Compute the regulator bandwidth. This is the difference between the upper and lower value meter indications. ***Requirement:*** The regulator bandwidth should be between 2 and 4 volts. ***Note:*** If the requirement is not met, adjust the regulator stationary contact adjusting nut to obtain a bandwidth of 3 volts. The stationary contact adjusting nut is the larger of the two knurled controls at the top of the regulating relay.

CHART 2 (Cont)

STEP	PROCEDURE
6	Replace the regulating relay cover.
	B. Beam Rectifier Maintenance
7	Check for tripped beam overload circuit breakers. Any beam overload circuit breaker trip operation that is not accompanied by the extinguishing of a power amplifier overload indicating lamp can be attributed to a rectifier failure.
8	Complete the amplifier shutdown operation as described in Section 403-415-301. Open the power supply enclosure door and check all diodes. ***Warning: The power supply contains high voltages. Observe the safety precautions described in Section 010-110-001.***
	C. Bombarder Rectifier Test
9	Check the BOMBARDER VOLTS meter indication while the amplifier is in operation. Normal BOMBARDER VOLTS meter indication is evidence that the rectifiers are operating satisfactorily. ***Note:*** If low rectifier output is encountered, replace the rectifiers.
	D. Bleeder Tests
10	With the power amplifier completely de-energized, measure the resistance of each of the 19 bleeder resistors, R29FF through R47FF, using the OHMS X 1000 range. ***Requirement:*** Each bleeder resistor shall measure 100,000 $\pm$10,000 ohms. Replace all resistors that do not meet this requirement.
11	Inspect each resistor for signs of deterioration. Replace all defective resistors.
	E. Variable Autotransformer Maintenance
12	Periodically inspect the motor-driven beam control autotransformer and the manually operated bombarder control autotransformer for brush wear and general condition. The maintenance methods described in Sections 028-705-801 and 029-706-710 should be used as applicable.
	F. Beam Rectifier Transformer Oil Level Check
13	Periodically check the oil level of the beam rectifier transformer and maintain the oil level above the LOW mark on the oil level gauge.

CHART 3

CABINET EQUIPMENT MAINTENANCE

This chart contains the procedures and references required for the checking, maintenance, cleaning, and inspection of the cooling system and other cabinet-mounted equipment of the NUS 3296 power amplifier.

STEP	PROCEDURE
	A. Air Cooling System Maintenance
1	Periodically inspect the air filter located at the rear of the amplifier. Replace clogged or worn filters.
2	Using a damp cloth, wipe away any dust accumulated at the air intake.
3	Periodically lubricate the pillow-block bearings of the belt-driven cabinet blower using Mobilux NO. 2 grease. Do not overload with grease. Refer to Sections 770-220-304 and 770-220-305 for blower belt maintenance methods.
4	Periodically lubricate the two cabinet blower motors and the two power enclosure blower motors using approximately 10 drops of SAE-10 oil at each oil cup.
5	Replace noisy blower assemblies.
6	Check that the air flow switch associated with the power amplifier blower under test opens when the blower stops. The airflow switch operation can be checked by noting the position of the switch vanes when the amplifier blowers are shut down. Replace or repair switches that remain in the operated position when the blower stops.
	B. Equipment Cleaning and Inspection
7	Regularly clean the power amplifier and the power supply using the general cleaning methods described in Section 069-305-301.
8	Clean porcelain insulation using a detergent and water solution.
9	Use a brush or vacuum cleaner to clean irregular surfaces. Use a damp cloth to wipe accumulations of dust from high-voltage wiring.
	Caution: Care must be taken to avoid disturbing controls.
10	Using Table B, inspect items listed and correct any irregularities. Table B may be used as a guide but inspection is not limited to the items listed.

TABLE B

POWER AMPLIFIER INSPECTION CHECK LIST

ITEM	CHECK FOR:
High-Voltage Grounding Switches	Loose connections, alignment, binding
Wiring	Damaged insulation, loose lacing, missing identification tags, dressing
Coaxial and X-ray Cables	Loose connections, damaged or worn connectors, broken sheath connections, defective cable
Meter Switches	Binding, loose knobs
Lamps	Defective lamps, broken jewels or sockets
Transformers	Oil leaks, loose connections
Terminal Strips	Loose connections
Components	Loose power plugs, missing hardware, damaged or worn controls
Cabinet and High-Voltage Enclosure	Doorlock operation, misplaced tools or parts, dirt, general appearance