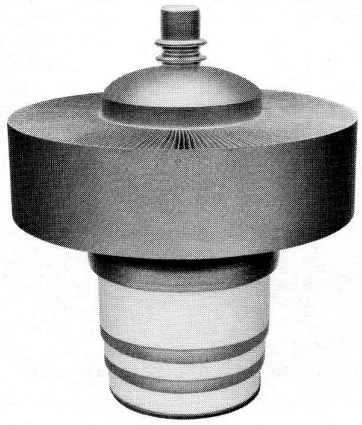
TECHNICAL DATA

8989
4CX12,000A

VHF
POWER TETRODE

The EIMAC 8989/4CX12,000A is a ceramic/metal power tetrode intended for use in audio or radio frequency applications. It features a type of internal mechanical structure which results in high rf operating efficiency. Low rf losses in this structure permit operation at full ratings up to 250 MHz.

The 8989/4CX12,000A has a gain of over 18 dB in FM broadcast service, and is also recommended for rf linear amplifier service, and for VHF television linear amplifier service. The anode is rated for 12 kilowatts of dissipation with forced-air cooling and incorporates a highly efficient cooler of new design.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	7.5 ± 0.37 V
Current @ 7.5 volts	120 A
Amplification Factor (average) Grid to Screen	6.7
Direct Interelectrode Capacitance (grounded cathode)[2]	
Cin	160 pF
Cout	18.5 pF
Cgp	1.0 pF
Direct Interelectrode Capacitance (grid & screen grounded)[2]	
Cin	70 pF
Cout	18.6 pF
Cpk	0.1 pF
Maximum Frequency for Full Ratings (CW)	250 MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length (height)	9.84 In; 25.0 cm
Diameter	7.76 In; 19.7 cm
Net Weight (approximate)	14 lbs; 6.4 kg
Operating Position	Vertical Only
Cooling	Forced Air
Maximum Operating Temperature, Ceramic/Metal Seals & Anode Core	250°C
Base	Special Concentric
Recommended Air System Socket (for dc, LF, HF applications)	EIMAC SK-300A
Recommended Air System Socket (for VHF applications)	EIMAC SK-360
Recommended Air Chimney	EIMAC SK-336
Available Screen Bypass Capacitor Kit for SK-360 (8000 pF @ DCWV = 5000)	EIMAC SK-355
Available Anode Connector Clip	EIMAC ACC-3

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM - Key Down Conditions

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	10.0	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	3.5	AMPERES
PLATE DISSIPATION	12.0	KILOWATTS
SCREEN DISSIPATION	300	WATTS
GRID DISSIPATION	150	WATTS

* Approximate value # Calculated data

Typical Operation (Frequencies to 30 MHz) #

Plate Voltage	9.0	kVdc
Screen Voltage	750	Vdc
Grid Voltage	-250	Vdc
Plate Current	2.83	Adc
Screen Current *	135	mAdc
Grid Current *	63	mAdc
Peak rf Grid Voltage *	335	v
Driving Power *	23	W
Plate Dissipation *	5470	W
Plate Output Power *	20	kW
Load Impedance	1590	Ohms

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RADIO FREQUENCY POWER AMPLIFIER
Commercial FM Service

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	10.0	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	3.5	AMPERES
PLATE DISSIPATION	12.0	KILOWATTS
SCREEN DISSIPATION	300	WATTS
GRID DISSIPATION	150	WATTS

* Approximate # Delivered to the load

Measured Operation, Commercial FM Service
Operation in EIMAC CV-2210 Cavity at 108.1 MHz

Plate Voltage	8.0	8.0	10.0	kVdc
Screen Voltage	750	800	800	Vdc
Grid Voltage	-300	-400	-300	Vdc
Plate Current	1.6	2.58	2.81	Adc
Screen Current *	115	120	130	mAdc
Grid Current *	51	38	32	mAdc
Driving Power *	165	250	275	W
Useful Power Output #	11.0	15.8	22.5	kW
Efficiency	84	77	80.2	%
Gain	18.4	18.0	19.1	dB

TYPICAL OPERATION values are obtained by measurement or by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations.

APPLICATION

MECHANICAL

MOUNTING - The 4CX12,000A must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the designer.

SOCKET & CHIMNEY - The EIMAC air-system sockets SK-300A and SK-360, and air chimney SK-336 are designed especially for use with the 4CX12,000A. The SK300A may be used for dc, LF or HF applications, while for VHF service the SK-360 should be used. The SK-355 screen bypass capacitor kit is available for use with the SK-360. The recommended air flow through either socket, in a base-to-anode direction, provides effective cooling of the base, with air then guided through the anode cooling fins by the air chimney.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250 Deg.C, and sufficient forced-air cooling must be used in all applications to keep the temperature of the anode (at the base of the cooling fins) and the temperature of the ceramic/metal seals comfortably below this rated maximum.

It is considered good engineering practice to design for a maximum anode core temperature of 225°C and temperature-sensitive paints are available for checking base and seal temperatures before any design is finalized. Application Bulletin #20 titled TEMPERATURE MEASUREMENTS WITH EIMAC POWER TUBES is available on request.

It is also good practice to allow for variables such as dirty air filters, rf seal heating, and the fact that the anode cooling fins may not be clean if the tube has been in service for some length of time. Special attention is required in cooling the center of the stem (base), by means of special directors or some other provision. An air interlock system should be incorporated in the design to automatically remove all voltages from the tube in case of even partial failure of the tube cooling air.

Minimum air flow requirements for a maximum anode temperature of 250°C for various altitudes and dissipation levels are listed. The pressure drop values shown are approximate and are for the tube mounted in an SK-300A socket with an SK-336 air chimney, with air passing through the socket in a base-to-anode direction and then on to the anode cooler. Pressure drop in a typical installation will be higher because of system loss.

Inlet Air Temperature = 25°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	7500	120	0.27
	10000	170	0.55
	12500	260	1.12
5000 Feet	**Plate Diss. Watts**	**Flow Rate CFM**	**Press. Drop In.Water**
	7500	140	0.40
	10000	210	0.56
	12500	310	1.14
10,000 Feet	**Plate Diss. Watts**	**Flow Rate CFM**	**Press. Drop In.Water**
	7500	170	0.40
	10000	250	0.70
	12500	380	1.29

Inlet Air Temperature = 35°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	7500	130	0.30
	10000	190	0.69
	12500	300	1.28
5000 Feet	**Plate Diss. Watts**	**Flow Rate CFM**	**Press. Drop In.Water**
	7500	160	0.45
	10000	240	0.70
	12500	360	1.43

10,000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	7500	190	0.45
	10000	290	0.85
	12500	430	1.59

Inlet Air Temperature = 50°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	7500	160	0.41
	10000	240	0.84
	12500	360	1.58

5000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	7500	190	0.45
	10000	290	0.85
	12500	440	1.74

10,000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	7500	230	0.56
	10000	350	1.00
	12500	530	2.05

When long life and consistent performance are factors cooling in excess of minimum requirements is normally beneficial.

Air flow must be applied before or simultaneously with the application of power, including the tube filament, and should normally be maintained for a short period of time after all power is removed to allow for tube cooldown.

ELECTRICAL

FILAMENT OPERATION - During turn-on the filament inrush current should be limited to 300 amperes. At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in filament voltage will lower the filament temperature, which will substantially increase tube life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The filament voltage should then be increased two or three tenths of a volt above the value where performance degradation was noted for operation. The operating point should be rechecked after 24 hours. Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations.

Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. Periodically throughout the life of the tube the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best tube life. EIMAC Application Bulletin #18 titled EXTENDING TRANSMITTER TUBE LIFE is available on request.

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings for the 4CX12,000A must be respected to avoid damage to the tube. An exception is the plate dissipation which may be permitted to rise above the rated maximum during brief periods (10 seconds maximum) such as may occur during tuning.

GRID OPERATION - The maximum control grid dissipation is 150 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage. A protective spark-gap device should be connected between the control grid and the cathode to guard against excessive voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 300 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. Energy limiting circuitry (which will activate if there is a fault condition) and spark gap over-voltage protection are recommended as good engineering practice.

The tube may exhibit reversed (negative) screen current under some operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, to assure that net screen supply current is always positive. This is absolutely essential if a series electronic regulator is employed.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and air-flow interlock, the tube must be protected from damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with each tube anode, to help absorb power supply stored energy if an internal arc should occur. If power supply stored energy is high an electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, is recommended. The test for each electrode supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a 6-

inch section of #30 AWG copper wire. The wire will remain intact if the test is met.

EIMAC's Application Bulletin #17 titled FAULT PROTECTION contains considerable detail, and is available on request.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of a specially constructed test fixture which shields all external tube leads or contacts from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. The capacitance values shown in the technical data are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in the appliction. Measurements should be taken with the mounting which represents approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; attn: Applications Engineering; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

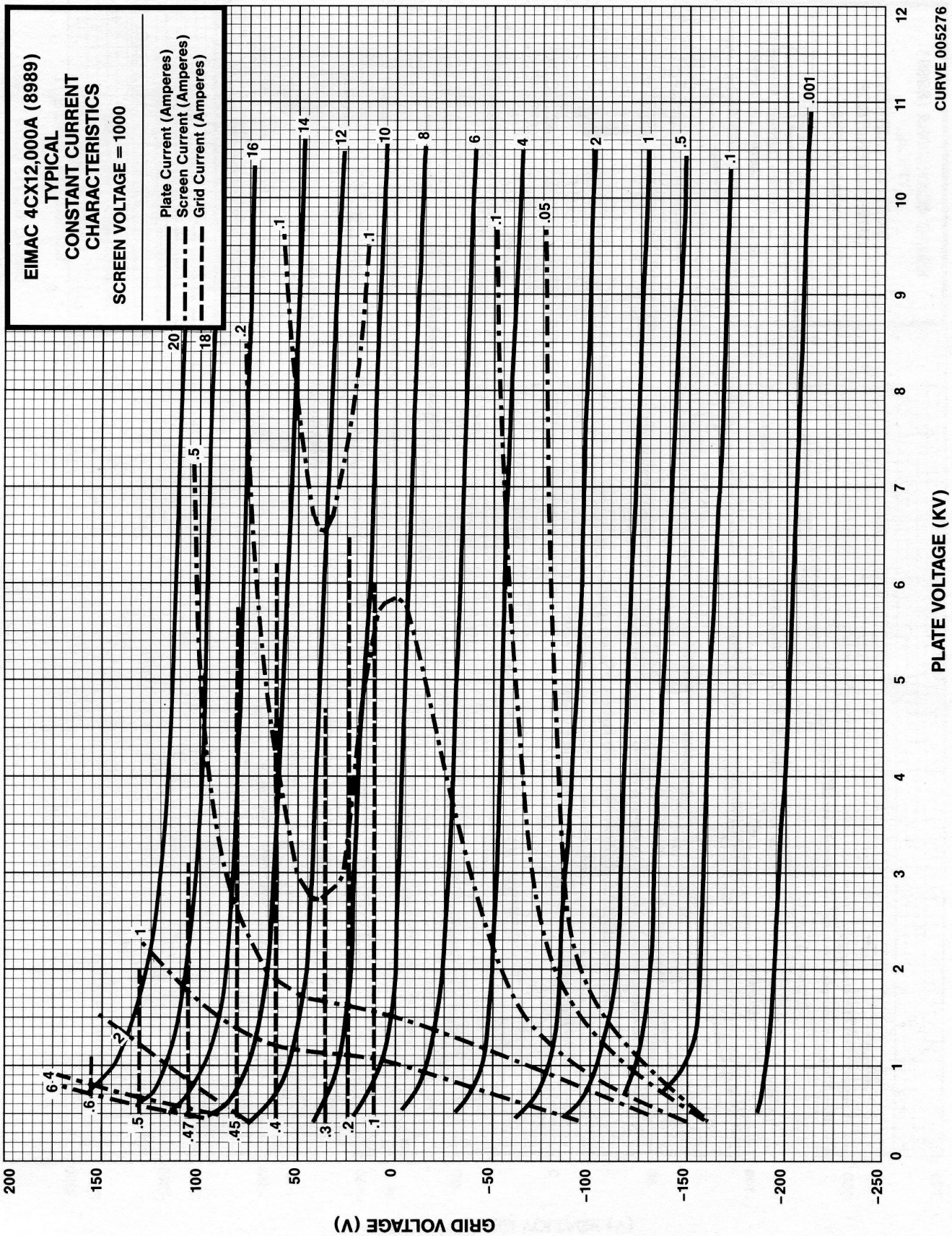
a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

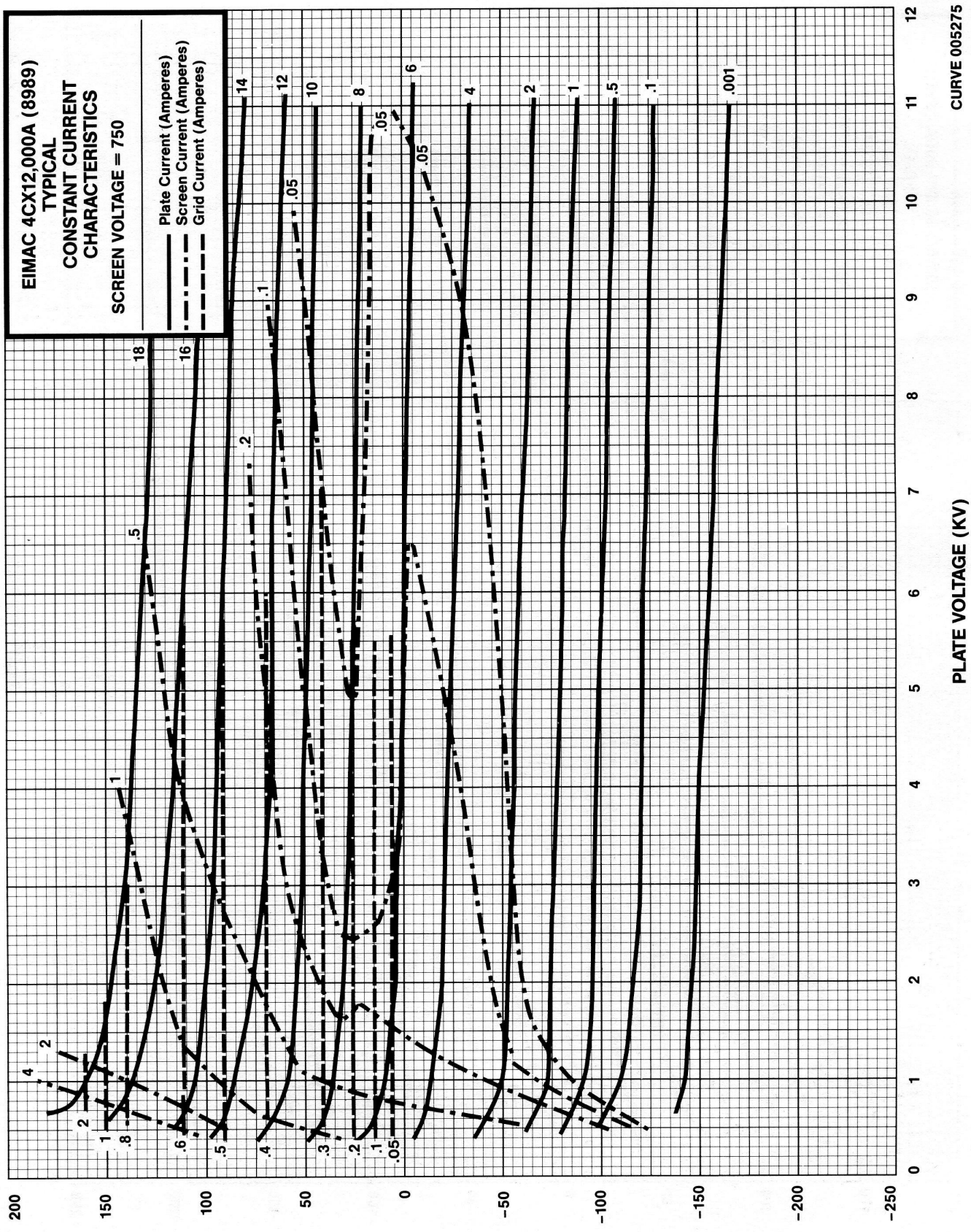
b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

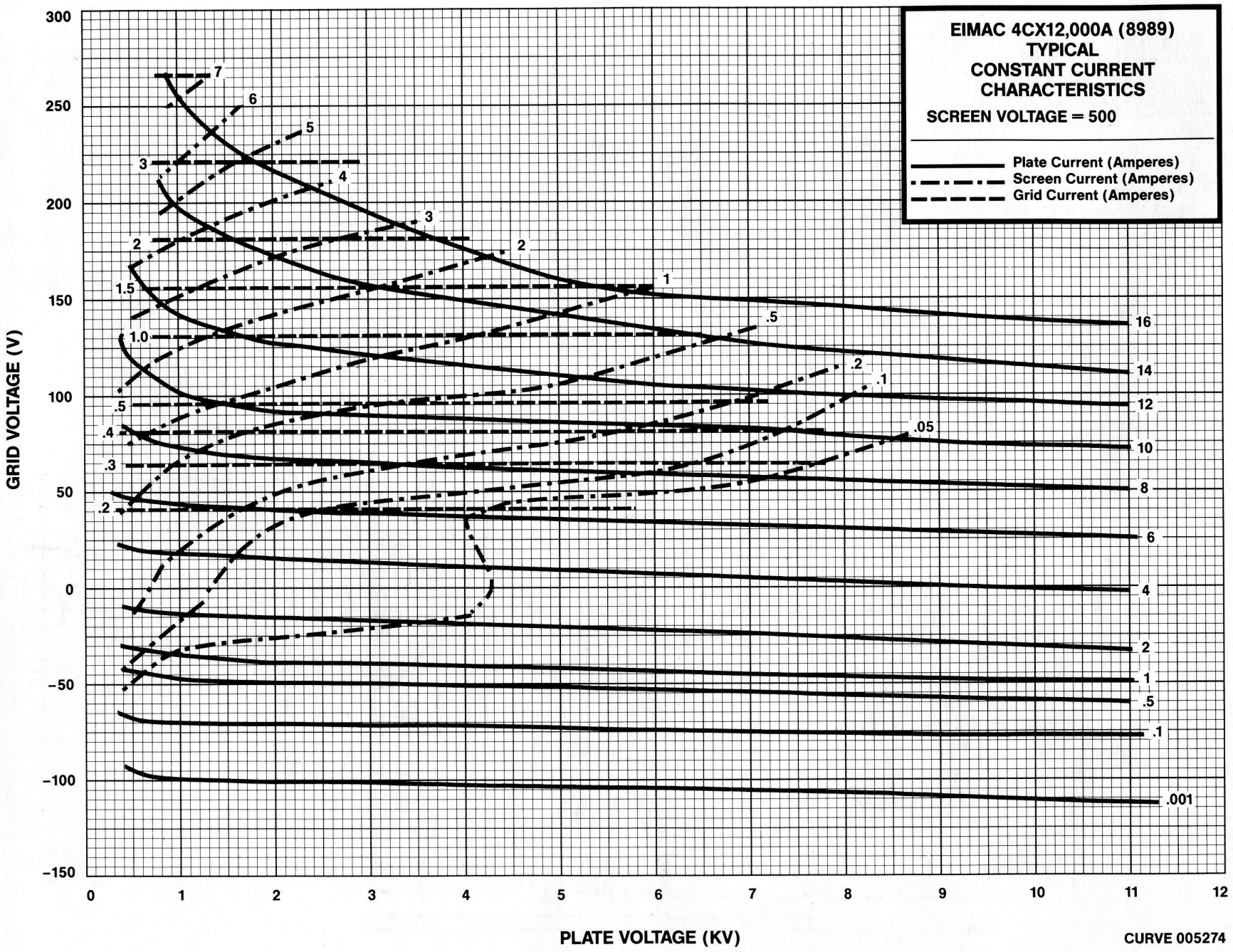
c. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

d. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Application Engineering, 301 Industrial Way, San Carlos CA 94070.


EIMAC 4CX12,000A (8989)
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1000
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE 005276


EIMAC 4CX12,000A (8989)
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE 005275



CURVE 005274

	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	7.700	7.760		195.58	197.10	
B	.855	.895		21.72	22.73	
C	4.406	4.468		111.91	113.49	
D	.600	.760		15.24	19.30	
E	1.896	1.936		48.16	49.17	
F	3.133	3.173		79.58	80.59	
G	3.792	3.832		96.32	97.33	
H	3.980	4.020		101.09	102.11	
J	.188			4.78		
K	.188			4.78		
L	.188			4.78		
M	3.718	3.781		94.44	96.04	
N	.219			5.56		
P	4.593	4.656		116.66	118.76	
R	2.100	2.200		53.34	55.88	
S	9.465	9.840		240.41	249.94	
T	.500			12.70		

NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES
2. * CONTACT SURFACE
3. OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES