



TECHNICAL DATA

8 9 9 0
(formerly X-2213)

VHF
RADIAL BEAM
POWER TETRODE

The EIMAC 8990 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 110 MHz.

The 8990 has a gain of over 18 dB in FM broadcast service, and is also recommended for radio-frequency linear power amplifier service, and for VHF television linear amplifier service. The anode is rated for 20 kW of dissipation with forced-air cooling and incorporates a highly efficient cooler of new design.

GENERAL CHARACTERISTICS¹

ELECTRICAL

Filament: Thoriated Tungsten

Voltage	10.0 ± 0.5 V
Current, at 10.0 volts	140 A

Amplification Factor, average

Grid to Screen	6.7
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Direct Interelectrode Capacitances (cathode grounded):

Cin	190 pF
Cout	23.5 pF
Cgp	1.5 pF

Direct Interelectrode Capacitances (grid and screen grounded):

Cin	83 pF
Cout	24.5 pF
Cpk	0.2 pF

Frequency of Maximum Ratings (CW)	110 MHz
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¹ Characteristics & operating values are based on calculations and measured data. These figures may change without notice as a result of data or product refinement. EIMAC Div. of Varian should be consulted before using this information for final equipment design.

MECHANICAL

Maximum Overall Dimensions:

Length	9.500 In.
Diameter	8.800 In.
Net Weight (Approximate)	14.0 Lbs

Operating Position Axis vertical, base up or down

Cooling Forced air

Operating Temperature, maximum

Ceramic/Metal Seals and Anode Core	250°C
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Base Special, concentric

Recommended Air System Socket SK-320

Recommended Air Chimney SK-326

(Effective 4 May 1978)



RADIO FREQUENCY POWER AMPLIFIER
OR OSCILLATOR

TYPICAL OPERATION (frequencies to 30 MHz)

Class C Telegraphy or FM
(Key-Down Conditions)

Plate Voltage	7.5	9.0	kVdc
Screen Voltage	750	900	Vdc
Grid Voltage	-200	-250	Vdc
Plate Current	3.68	4.01	Adc
Screen Current ¹	208	222	mAdc
Grid Current ¹	91	88	mAdc
Peak rf Grid Voltage ¹	265	300	v
Calculated Drive Power	24.1	26.4	W
Plate Dissipation ¹	5.84	7.93	kW
Plate Output Power ¹	21.8	28.2	kW
Load Impedance	1062	1136	Ω

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000 VOLTS
DC SCREEN VOLTAGE	2000 VOLTS
DC PLATE CURRENT	5.0 AMPERES
PLATE DISSIPATION	20,000 WATTS
SCREEN DISSIPATION	450 WATTS
GRID DISSIPATION	200 WATTS

¹ Approximate value

TYPICAL OPERATION, COMMERCIAL FM SERVICE (measured values at frequency shown, in EIMAC cavity amplifier)

Frequency of Operation	88.3	107.7	MHz
Plate Voltage	9.0	9.0	kVdc
Screen Voltage	800	800	Vdc
Grid Voltage	-400	-300	Vdc
Plate Current	4.08	4.15	Adc
Screen Current	200	200	mAdc
Grid Current	40	38	mAdc
Drive Power	325	360	W
Useful Power Output ¹	28.75	28.9	kW
Efficiency	80.5	77.4	%
Gain	19.5	19.0	dB

¹ Delivered to the load



APPLICATION

MOUNTING - The 8990 must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the circuit designer.

SOCKET & CHIMNEY - The EIMAC air-system socket SK-320 and air chimney SK-326 are designed especially for use with the 8990. The use of the recommended air flow through this socket provides effective forced-air 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°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 the rated maximum.

The cooling characteristics of the anode are shown in the attached graph, for power levels from 7.5 kW to 20 kW dissipation. The designer is cautioned to keep in mind that this is ABSOLUTE data, with pure dc power, with no safety factors added, and the pressure drop figures make no allowance for losses in filters, ducting, and the like.

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. It is also considered good practice to add a 15% safety factor to the indicated airflow, and allow for variables such as dirty air filters, rf seal heating at VHF, 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 cooling is required in the center of the stem (base), by means of special directors or some other provision. An air interlock system should be incorporated into the design to automatically remove all voltages from the tube in case of even partial failure of the tube cooling air.

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.

FILAMENT OPERATION - The rated nominal filament voltage for the 8990 is 10.0 volts, as measured at the socket or tube base. Variation in voltage should be maintained within plus or minus five percent. During application of filament voltage the inrush current should be limited to no more than twice normal current.

The peak emission capability at nominal filament voltage is normally more than that required for communication service. A small decrease in filament temperature due to reduction in filament voltage can increase tube life by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely effect equipment operation. This is done by measuring some important parameter of performance (such as plate current, power output, or distortion) while filament voltage is reduced. At some point in filament voltage there will be a noticeable change in the operating parameter being monitored, and the operating filament voltage must be slightly higher than the level at which deterioration was noted. When filament voltage is to be reduced in this manner it should be regulated and held to plus or minus one percent, and the actual operating value should be checked periodically to maintain proper operation.



ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings for the 8990 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, such as may occur during tuning.

GRID OPERATION - The 8990 control grid has a maximum dissipation rating of 200 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should normally be kept near the values shown in the TYPICAL OPERATION section of the data sheet whenever possible.

SCREEN OPERATION - The power dissipated by the screen of the 8990 must not exceed 450 watts. Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with the filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 450 watts in the event of circuit failure. 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 8990 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, and this is absolutely essential if a series electronic regulator is employed.

FAULT PROTECTION - In addition to normal plate overcurrent interlock and screen current interlock it is good practice to protect the tube from internal damage which could result from a plate arc at high voltage. In all cases some protective resistance, 10 to 50 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a tube arc should occur. If power supply stored energy is high some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a tube arc is recommended.

HIGH VOLTAGE - Normal operating voltages used with the 8990 are deadly and the equipment must be designed properly and operating precautions must be followed. All equipment must be designed so that no one can come into 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.

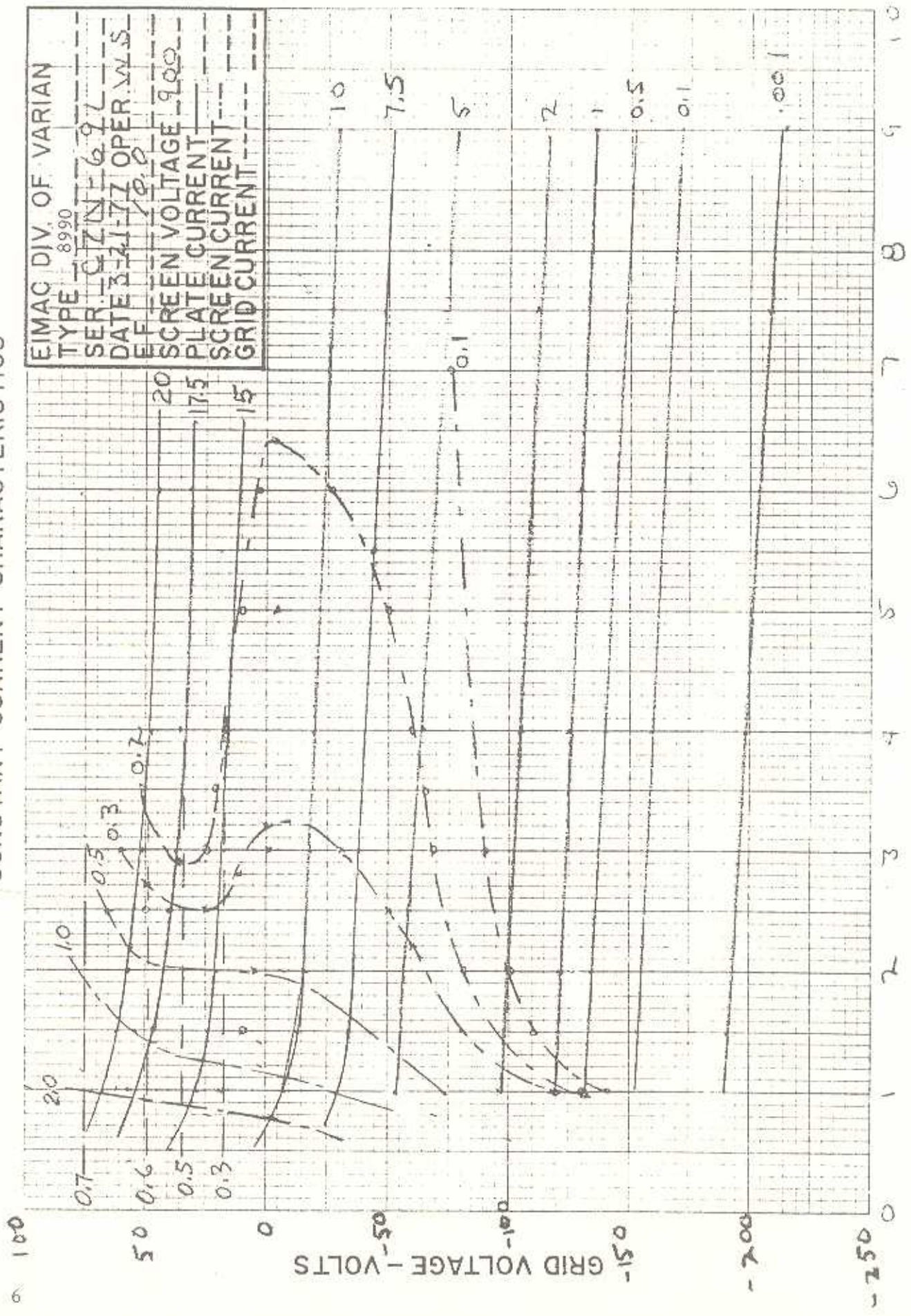


INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual 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 specially constructed test fixtures which effectively shield all external tube leads from each other and eliminate 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, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally 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 any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those listed here, write to Application Engineering, Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, CA 94070 for recommendations.

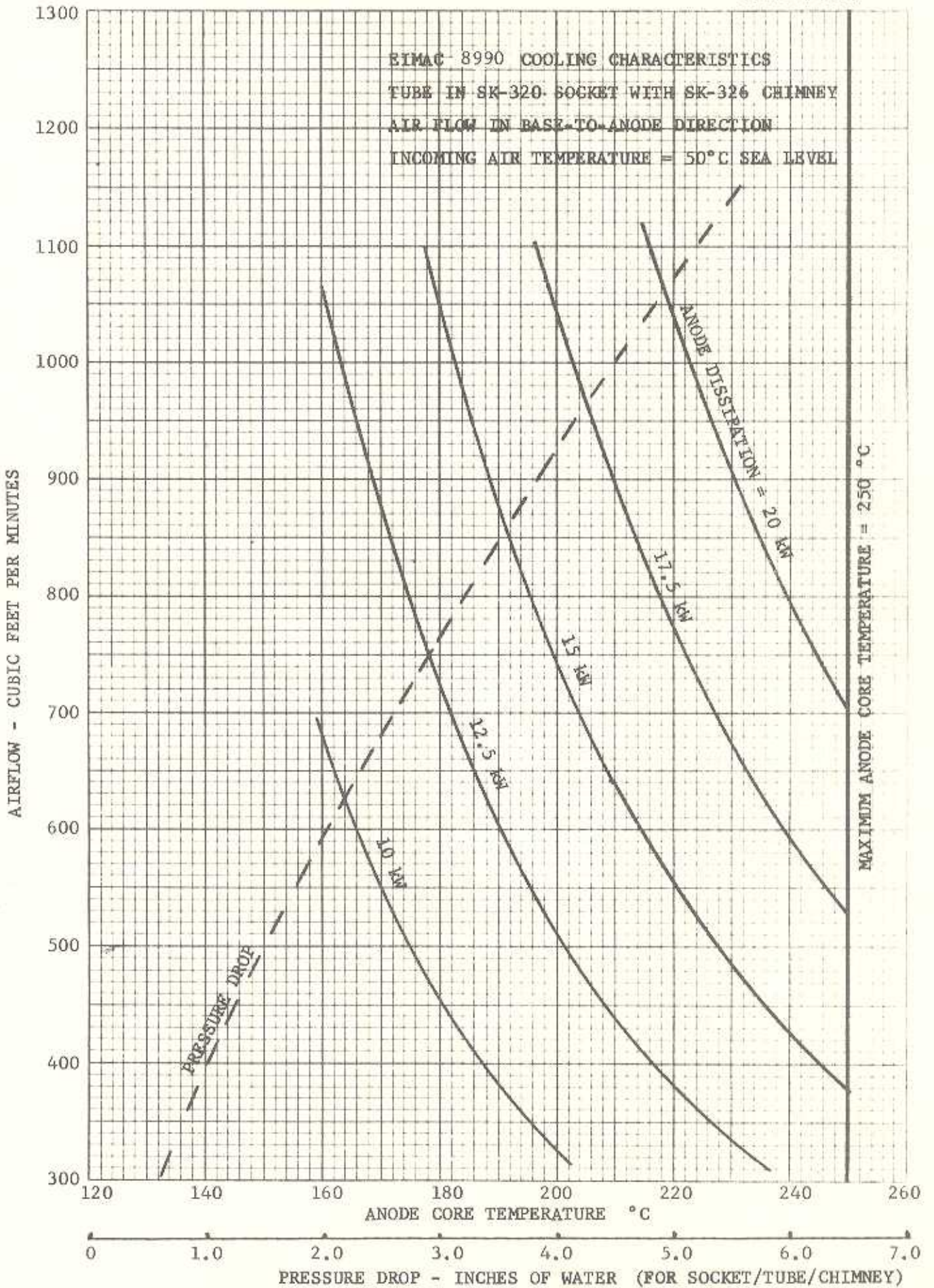
GROUND CATHODE
CONSTANT CURRENT CHARACTERISTICS



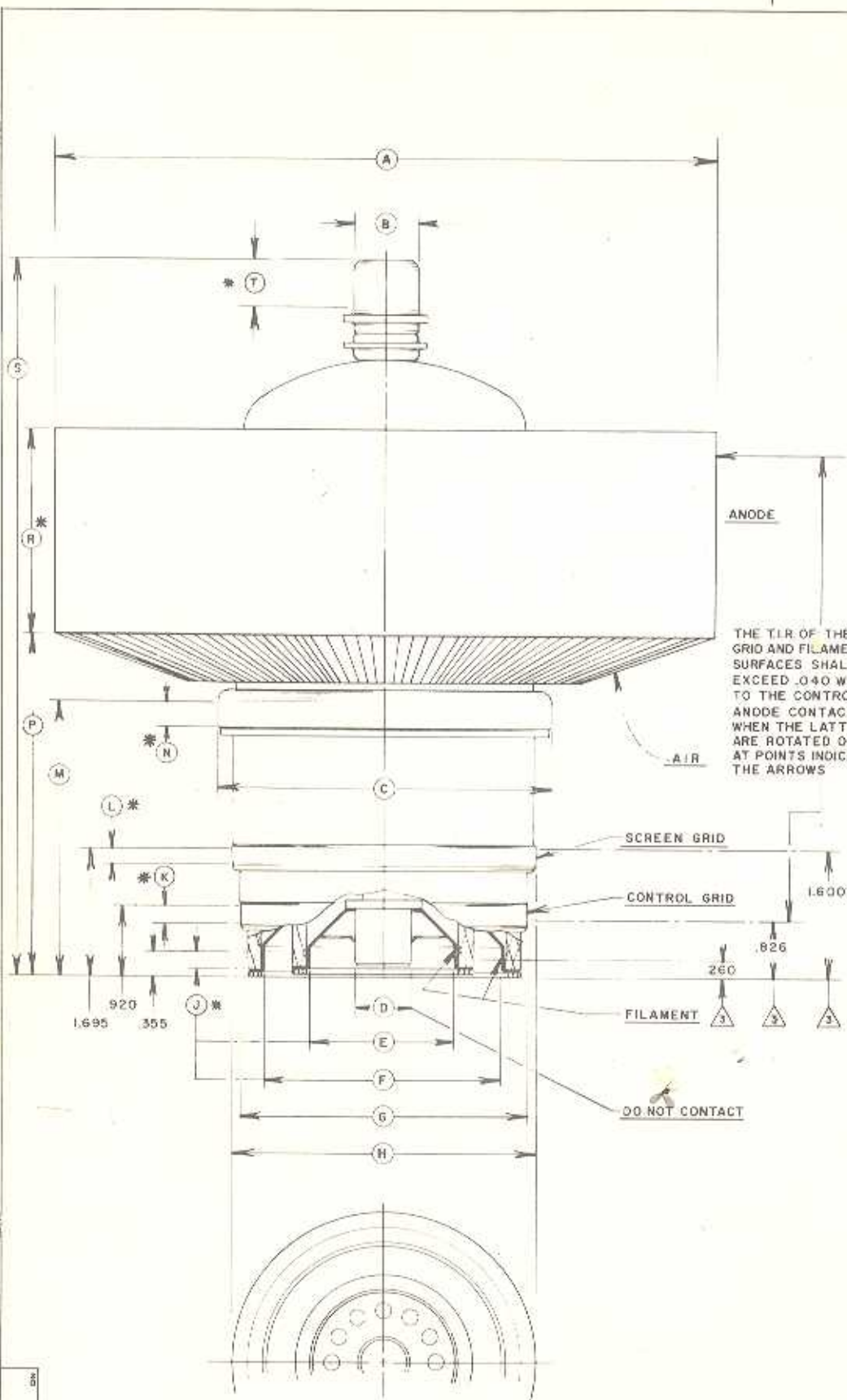
EIMAC DIV. OF VARIAN
 TYPE ⁸⁹⁹⁰ 6ZN6
 SER. 3-41-77 OPER. W.S.
 DATE 10.0
 SCREEN VOLTAGE 900
 PLATE CURRENT
 SCREEN CURRENT
 GRID CURRENT

PLATE VOLTAGE — KILOVOLTS

EIMAC 8990 COOLING CHARACTERISTICS
 TUBE IN SK-320 SOCKET WITH SK-326 CHIMNEY
 AIR FLOW IN BASE-TO-ANODE DIRECTION
 INCOMING AIR TEMPERATURE = 50°C SEA LEVEL



TUBE NO. _____ PLOTTED BY _____ DATE _____
 COMMENTS: EIMAC 17X10 5-17-58



DIM	DIMENSIONS			MILLIMETERS		
	MIN.	NOM.	MAX.	MIN.	MAX.	REF.
A	8.670	8.800				
B	.855	.895				
C	4.406	4.468				
D	.600	.760				
E	1.896	1.936				
F	3.133	3.173				
G	3.792	3.832				
H	3.980	4.020				
J	.188					
K	.188					
L	.188					
M	3.718	3.781				
N	.219					
P	4.593	4.656				
R	2.705	2.825				
S	9.465	9.840				
T	.500					

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.

THE TIR OF THE SCREEN GRID AND FILAMENT CONTACT SURFACES SHALL NOT EXCEED .040 WITH RESPECT TO THE CONTROL GRID AND ANODE CONTACT SURFACE WHEN THE LATTER SURFACES ARE ROTATED ON ROLLERS AT POINTS INDICATED BY THE ARROWS

169084

REV	DATE	BY	DESCRIPTION
A	3-1-77	D.H.	DIM A WAS 8.770 - 8.900, S WAS 2.272 - 2.648
B	4-25-77	D.H.	DIM. V WAS 2.330 - 2.450
C	5-4-77	D.H.	REVISED DIM. AND SYMBOLS
D	8-26-77	D.H.	DIM S WAS 9.125 - 9.500

DATE	4 JAN 77	DESIGNED BY	W.C.L. D.H.	1-13-77	DATE	8990
169084						