TECHNICAL DATA

LIQUID-COOLED POWER TETRODE 4CW150,000E

The Eimac 4CW150,000E is a ceramic/metal high power tetrode recommended for use as an rf power amplifier for industrial and scientific applications This tube is also useful as a high voltage, high current pulse modulator or regulator tube in switch tube service and it can deliver peak power in the range of 4 megawatts in short pulse applications. This tube features a high efficiency liquid-cooled anode rated for 150 kilowatts of dissipation.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten Mesh	
Voltage	15.5 ± 0.75 V
Current at 10.0 Volts	215 A
Amplification Factor, Average, Grid to Screen..	
Direct Interelectrode Capacitances (grounded cathode)[2]	
Cin	370 pF
Cout	60 pF
Cgp	1.0 pF
Direct Interelectrode Capacitances (grounded grid)[2]	
Cin	175 pF
Cout	60 pF
Cpk	0.35 pF
Maximum Frequency for Full Ratings (CW)	110 MHz
Maximum Frequency for Reduced Ratings	200 MHz

MECHANICAL

Maximum Overall Dimensions:	
Length	14.25 in; 36.2 mm
Diameter	9.53 in; 24.21 mm
Net Weight	47 lbs; 21.4 kg
Operating Position	Vertical, Base Up or Down
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Anode Cooling	Water
Base Cooling	Forced Air
Base	Special, Coaxial
Recommended Socket for dc to HF	Eimac SK-2011A
Available Socket with reduced screen capacitance	YC-100

[1] Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. CPI Eimac Division should be consulted before using this information for final equipment design.
[2] In shielded fixture.

Communications & Power Industries
Eimac division

RADIO FREQUENCY POWER AMPLIFIER CATHODE GROUNDED
Grid driven Class C

ABSOLUTE MAXIMUM RATINGS:

DC ANODE VOLTAGE	22	kVdc
DC SCREEN VOLTAGE	2.5	kVdc
DC GRID VOLTAGE	-1.5	kVdc
DC ANODE CURRENT	20	Adc
ANODE DISSIPATION	150	kW
SCREEN DISSIPATION	1750	W
GRID DISSIPATION	500	W

TYPICAL OPERATION, below 30 MHz:

Anode Voltage	15	20	kVdc
Screen Voltage	1500	1500	Vdc
Grid Voltage	-750	-800	Vdc
Anode Current	12.4	15.2	Adc
Screen Current*	1.05	0.57	Adc
Grid Current*	120	125	mAdc
Driving Power*	1.4	2.0	kW
Useful Power Output*#	145	220	kW
Efficiency*	79.5	72	%
Power Gain*	20.1	20.4	dB

* may vary from tube to tube
# Delivered to load (VSWR under 1.25:1)

RADIO FREQUENCY LINEAR AMPLIFIER
Grid driven Class AB1

ABSOLUTE MAXIMUM RATINGS:

DC ANODE VOLTAGE	22	kVdc
DC SCREEN VOLTAGE	2.5	kVdc
DC GRID VOLTAGE	-1.5	kVdc
DC ANODE CURRENT	20	Adc
ANODE DISSIPATION	150	kW
SCREEN DISSIPATION	1750	W
GRID DISSIPATION	500	W

TYPICAL OPERATION:
Peak Envelope or Modulation Crest Conditions

Anode Voltage	18	kVdc
Screen Voltage	1500	Vdc
Grid Voltage	-320	Vdc
Zero-Signal Anode Current	4.0	Adc
Single-Tone Anode Current	13.5	Adc
Peak rf Grid Voltage	300	v
Anode Dissipation	75	kW
Screen Current*		mAdc
Grid Current*		mAdc
Driving Power*	2.5	kW
Anode Output Power #	168	kW
Resonant Anode Load Impedance	697	Ohms

* Will vary from tube to tube
# Delivered to load (VSWR under 1.25:1

)

PULSE MODULATOR OR REGULATOR SERVICE
ABSOLUTE MAXIMUM RATINGS:

DC Anode Voltage	40	kVdc
DC Screen Voltage	2.5	kVdc
DC Grid Voltage	-2.0	kVdc
Anode Dissipation	150	kW
Peak Cathode Current	200	amperes
Maximum Pulse Duration	0.01	second
Grid Dissipation	500	Watts
Screen Dissipation	1750	Watts

NOTE: Operation at altitudes significantly above sea level may require the use of a protective atmosphere or a reduction in the anode voltage and screen voltage maximum values shown. Use of the Eimac SK-2020 and SK-2021 Corona Rings are recommended for improved voltage hold-off.

NOTE: TYPICAL OPERATION data are obtained by actual measurement or by calculation from published characteristic curves. To obtain the anode current shown at the specified bias, screen and anode 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 anode 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.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Nom.	Max.	
Filament Current @ 15.5 Volts	200	---	230	A
Cut-off Bias (EB = 25 kVdc, EC2 = 1.5 kVdc, for Ib = 1.0 mAdc)			-625	V

APPLICATION

MECHANICAL

HANDLING – This product contains a thoriated-tungsten mesh filament and should be protected from shock and vibration. It is recommended that the tube be removed from equipment that is being shipped, to prevent damage that may occur in transit.

MOUNTING – The 4CW150,000A must be operated with its primary axis vertical. The base of the tube may be up or down at the option of the equipment designer.

SOCKETING – The Eimac Socket type SK-2011A is designed for use with the 4CW150,000E in dc or LF/HF applications. This socket or its equivalent is recommended to assure good contact and allow for forced-air cooling of the tube base.

The SK-2011A uses an integral screen bypass capacitor having a nominal value of 12,800 pF. This capacitor uses a Kapton dielectric film which is encapsulated for dust and moisture protection. The SK-2011A screen capacitor has a rated test voltage of 4 kVdc.

The Eimac type YC-100 socket is available for applications where reduced screen capacitance is desired, it has a nominal capacitance of 1600 pF (range values are 1500 to 2000 pF) and it is also rated at 4 kVdc.

When used as a grid-driven rf amplifier, the tube socket may be modified in order to attach bypass capacitors directly to the second filament terminal (the terminal between the lower filament ring and the control grid ring. This helps reduce cathode lead inductance which can be detrimental to net stage gain at frequencies above approx. 20 MHz.

In rf amplifiers anode connection should be made to the flange where the cooler jacket is attached. In pulse modulator or dc applications the threaded stud at the center of the anode cooler jacket is suitable for attaching a connecting strap or lead.

CORONA RINGS – Corona rings are available as optional items for use when the 4CW150,000E.

The SK-2020 corona ring is designed to mount on the socket and the SK-2021 attaches to the lower side of the anode flange. Used together, these corona rings are necessary when the tube is employed as pulse modulator, pulsed rf amplifier at anode voltage in excess of 25 kVdc or as an rf amplifier with high level amplitude modulation. Corona rings are also beneficial to prevent anode voltage flashovers when a tube is to be used at high elevations where breakdown of air occurs at lower voltage.

STORAGE – If a tube is to be stored as a spare it should be kept in its original shipping carton, with the original packing material, to minimize the possibility of handling damage. Before storage a new tube should be operated in the equipment for 100 to 200 hours to establish that it has not been damaged and operates properly. If the tube is still in storage 6 months later it should be operated in the equipment for another 100 to 200 hours to make sure there has been no degradation. If operation is satisfactory the tube can again be stored with great assurance of being a known-good spare.

ANODE COOLING – The maximum temperature rating for the anode cooler-to-ceramic seals on this tube is 250°C. Anode cooling is normally accomplished by circulating water through the radiator. Insufficient flow will cause the anode temperature to rise to levels which shorten tube life. Coolant must flow whenever filament power is applied to the tube (see STANDBY OPERATION).

The table lists the minimum cooling water requirements at various dissipation levels with a maximum inlet water temperature of 50°C. System pressure should not exceed 80 psi. The following data covers the minimum cooling water requirements at various levels of anode dissipation for a maximum anode core temperature of 225°C.

Additional flow may be added to accommodate for increased anode dissipation that occurs during amplifier tuning, high inlet temperature and degradation in water quality:

Anode Dissipation (kilowatts)	Minimum Water Flow (gpm)	Approx. Pressure Drop (psi)
20	5.0	2.8
40	9.0	5.8
60	12.5	9.3
80	16.5	14.2
100	20.0	19.2
125	23.5	27.5
150	26.0	36.0

Cooling water must be well filtered (with effecttiveness the equivalent of a 100-mesh screen) to eliminate any solid materials, to avoid the possibility of blockage of any cooling passages, as this would immediately affect cooling efficiency and could produce localized anode overheating and failure of the tube.

Tube life can be seriously compromised by poor water quality. Contaminated water will leave deposits on the cooling passages, causing localized anode heating and eventual tube failure. To minimize electrolysis and power loss, water resistivity at 25°C should always be one megohm per cubic centimeter or higher. Water resistivity can be continuously monitored in the reservoir by readily available instruments.

For detailed information, Application Bulletin #16, "Water Purity Requirements in Liquid Cooling Systems" is available upon request.

Other coolants such as Ethylene Glycol, Freon© and various oils are useful where ionic problems associated with water are a problem, but these should be evaluated carefully as their thermal transfer characteristics are always poor compared to pure water. Compatibility with such substances should be verified prior to use.

Pipe fittings are labeled "IN" and "OUT" on the outline drawing and on the tube cooler jacket but please note that this applies only when a tube is mounted with the anode cooler in an upright position (socket below the tube). If a tube is mounted with the cooler down then these fittings should be connected in the reverse direction (opposite to what is indicated on the tube, ie. the "IN" fitting will be used as the outlet and fitting indicated "OUT" is where water should be supplied for proper flow of coolant through the anode cooler.

Arbitrarily connecting the water supply and return lines without attention to this detail may result in an air bubble forming inside the cooler assembly and this may lead to an overheated anode. Careful attention should be paid to proper connection of the inlet and outlet fittings (supply and return lines) whenever a tube is placed in service.

BASE COOLING – Auxiliary forced-air cooling of the tube base is required to maintain the filament and grid seal temperatures at safe operating levels. The maximum temperature rating for the ceramic/metal seals of this tube is 250°C. Airflow of approx. 50 cfm at 50°C maximum at sea level should be directed through the socket toward the filament and grid seal areas on the base of this tube. Seal temperature is the final criteria of effective cooling, and temperature-sensitive paints are available to the equipment designer for testing before equipment design is finalized. Eimac Application Bulletin #20 "Measuring Temperature of Power Grid Tubes" is available on request.

It should be noted the contact fingers used in the socket collet assemblies (inner and outer filament, control grid and screen grid) are made of beryllium copper. If operated above 150°C for any appreciable length of time, this material will lose its temper (or springy characteristics) and then will no longer make good contact to the base contact areas of the tube. This can lead to arcing which can melt metal in a contact area and the tube's vacuum integrity may be destroyed.

Both anode and base cooling should be applied before or simultaneously with the application of electrode voltages, including filament power. Cooling should normally continue for a short period after removal of electrode voltages to allow the tube to cool down properly. An interlock system should be used to remove all voltages from the tube (including filament power) in case cooling fails or becomes impaired. When long life and consistent performance are factors cooling in excess of minimum requirements is normally beneficial.

STANDBY OPERATION – Coolant must be circulated through the anode water jacket whenever filament power is applied even though no other voltages may be present. Sixty to eighty percent of the filament power appears as heat in the anode. In the absence of coolant flow, temperatures will rise to levels which are detrimental to the tube. If the coolant lines become obstructed the coolant jacket may actually rupture from generated steam pressure.

ELECTRICAL

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. 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.

FILAMENT WARM UP – When cold, the resistance of a thoriated-tungsten filament is very low, therefore the initial starting (in-rush) current when filament voltage is applied can be many times the normal (hot) current; this can be detrimental to the longevity of a filament structure. Filament in-rush current should never exceed a value of twice the nominal rated current. The use of a special impedance-limited transformer or other "step-start" circuitry in the supply side (primary) of the filament transformer is recommended.
Full emission from a thoriated tungsten filament is normally available approx. 5 seconds after the filament voltage reaches nominal value. In some applications a delay of 1 minute or longer before all other tube voltages are applied may be recommended to allow the filament supports to reach operating temperature.

FILAMENT OPERATION – This tube is designed for commercial service, with no more than one normal off/on filament cycle per day. If additional cycling is anticipated it is recommended the user contact an Applications Engineer at CPI Eimac division for additional information.

FILAMENT VOLTAGE MANAGEMENT – With a new tube, or one that has been in storage for some period of time, operation with filament voltage only applied for a period of 30 to 60 minutes is recommended before full operation begins. This allows the active getter mounted within the filament structure to absorb any residual gas molecules, which have accumulated during storage.

At the rated (nominal) filament voltage the peak emission capability of tubes with thoriated tungsten filaments is many times that needed for rf amplifier service. A reduction in filament voltage will lower the filament temperature, which will substantially increase 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 voltage should then be increased a few 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 it is to be reduced below nominal in this manner, to avoid any possible adverse influence by normal line voltage variations.

Periodically throughout the life of the tube the procedure outlined above for voltage reduction should be repeated with voltage reset as required, to assure best tube life.

Eimac Application Bulletin #18 "Extending Transmitter Tube Life" contains valuable information and is available on request.

It should be noted that if this tube is used as a pulse modulator or in pulsed rf amplifier service the filament supply may require regulation to hold it at the nominal rated filament voltage of 15.5 Volts. Operation in excess of this value will allow greater peak current but with a compromise in the overall useful emission life which would be achieved by following the filament voltage management program described above.

Filament voltage should be measured at the tube base or socket using a known-accurate rms-responding meter. Variation in voltage should be limited to no more than five percent for consistent tube performance.

ELECTRODE DISSIPATION RATINGS – The maximum dissipation ratings for the 4CW150,000E must be respected to avoid damage to the tube. An exception is the anode dissipation which may be permitted to rise above the rated maximum during brief periods (ten seconds maximum) such as may occur during tuning of an rf amplifier.

In pulsed operation the actual electrode dissipation levels are dependent on the individual waveshapes encountered in the operating equipment. With a rectangular pulse, if pulse risetime and falltime are a significant percentage of pulse duration, dissipation may be considerably higher than shown by calculation. This is the result of significant anode current flow with high anode voltage drop during the rise and/or fall times.

When used as a high level anode-modulated rf amplifier, anode dissipation under carrier conditions should be limited to 100 kilowatts, as dissipation will rise to 150 kilowatts when modulated to 100% with a sinusoidal modulating signal.

GRID OPERATION – The maximum rated control grid dissipation is 500 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. The maximum dc grid (bias) voltage permitted is -1500 Volts dc.

SCREEN OPERATION – The maximum allowable screen grid dissipation is 1750 Watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With modulation dissipation is dependent on rms screen voltage and rms screen current. In switch tube applications with short-duration pulses, the product of instantaneous values of screen grid current times the dc screen voltage may exceed the average rating of 1750 Watts with no damage to the tube. However in cases where pulse duration equals or exceeds 0.1 second, the maximum average power rating of 1750 Watts must be respected to avoid causing irreversible changes in tube performance characteristics.

CW operation at VHF frequencies above the maximum frequency rating for CW service may add significantly to the total screen grid dissipation due to the ac charging current in internal capacitance between the screen grid and anode. Operation at lower anode voltage and/or lower drive levels will reduce the dissipation.

Anode voltage, anode loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

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 anode 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 essential if a series electronic regulator is employed.

PULSE OPERATION – When operated as a pulsed current source (switch tube) or a regulator tube at anode voltages above approx. 25 kVdc, a grid bias voltage should be established that assures anode current is cut-off (or set to a low value of anode current such as 1 milliamp) between pulses, to avoid the possibility of anode heating being concentrated at a localized area due to electron focusing effects that may occur. Range values for cut-off voltages expected are shown on p.2. Note that the actual value of bias required for cut-off is highly dependent on screen voltage. A tetrode used as a constant-current source will supply anode current which is determined to high degree (ref: three halves power law) by the screen voltage. Since the screen voltage required in most pulse modulator/regulator applications will be other than 1500 Volts specified, the circuit designer may have to establish a range of bias voltages necessary for a given screen voltage using empirical methods. Using tubes in parallel generally requires that individual tubes be supplied with grid bias obtained from separate, adjustable sources.

FAULT PROTECTION – In addition to the normal anode over-current interlock, screen current interlock, and cooling flow interlock(s), the tube must be protected from internal damage which could result from occasional arcing at high anode voltage. In all cases some protective resistance should be used in series with the tube's anode supply to absorb power supply stored energy in case an arc should occur. A maximum of 50 Joules of total energy may be permitted to be dissipated in an internal arc. 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, may be required. 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 protection is adequate. Eimac Application Bulletin #17 "Fault Protection" contains considerable detail and is available on request.

X-RADIATION HAZARD – High-vacuum tubes operating at voltages higher than 15 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents, is a potential X-ray source. Only limited shielding is afforded by the tube envelope. Moreover, the X-radiation level may increase significantly with tube aging and deterioration, due to leakage or emission characteristics as they are affected by the high voltage. X-ray shielding may be required on all sides of tubes operating at these voltages to provide adequate protection throughout the life of the tube. Periodic checks on the X-ray level should be made, and the tube should never be operated without required shielding in place. If there is any question as to the need for or the adequacy of shielding, an expert in this field should be contacted to perform an equipment X-ray survey. Operating high voltage equipment with interlock switches "cheated" and cabinet doors open in order to locate an equipment malfunction can result in serious X-ray exposure.

INTERELECTRODE CAPACITANCE – The actual internal electrode 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 tubes, 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 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, 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.

HIGH VOLTAGE – The 4CW150,000E operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed 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 effect. Public health agencies are concerned with the hazard, and the published OSHA (Occupational Safety and Health Administration) or other local recommendations to limit prolonged exposure of rf radiation should be followed.

HOT SURFACES – Air-cooled surfaces and the anode radiator of tubes can reach temperatures of several hundred degrees C and can cause serious burns if touched even several minutes after all power has been removed.

SPECIAL APPLICATIONS – When it is desired to operate this tube under conditions widely different from those listed here, write to CPI Eimac division, Application Engineering.

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 and are exposed to power tubes, or equipment that 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.

HIGH VOLTAGE – Normal operating voltages can be deadly. Remember the HIGH VOLTAGE CAN KILL.

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.

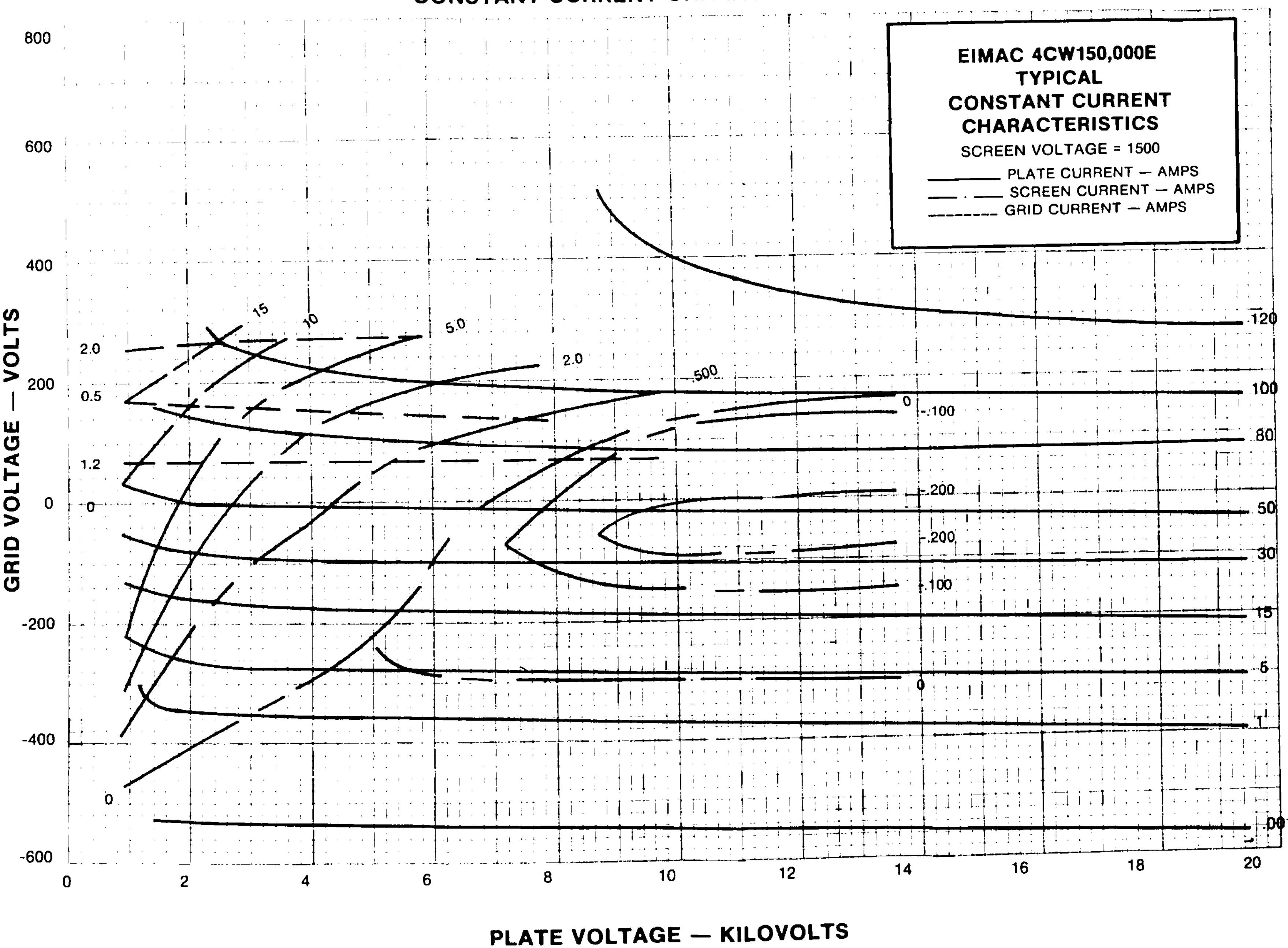
RF RADIATION – Exposure to strong rf fields should be avoided, even at relatively low frequencies. CARDIAC PACEMAKERS MAY BE AFFECTED.

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.

X-RAY RADIATION - High voltage tubes can produce dangerous and possibly fatal x-rays. If shielding is provided equipment should never be operated without all such shielding in place.

Please review the detailed Operating Hazards sheet enclosed with each tube, or request a copy from CPI, Eimac division Application Engineering at 1-650-592-1221.

GROUNDED CATHODE
CONSTANT CURRENT CHARACTERISTICS



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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.

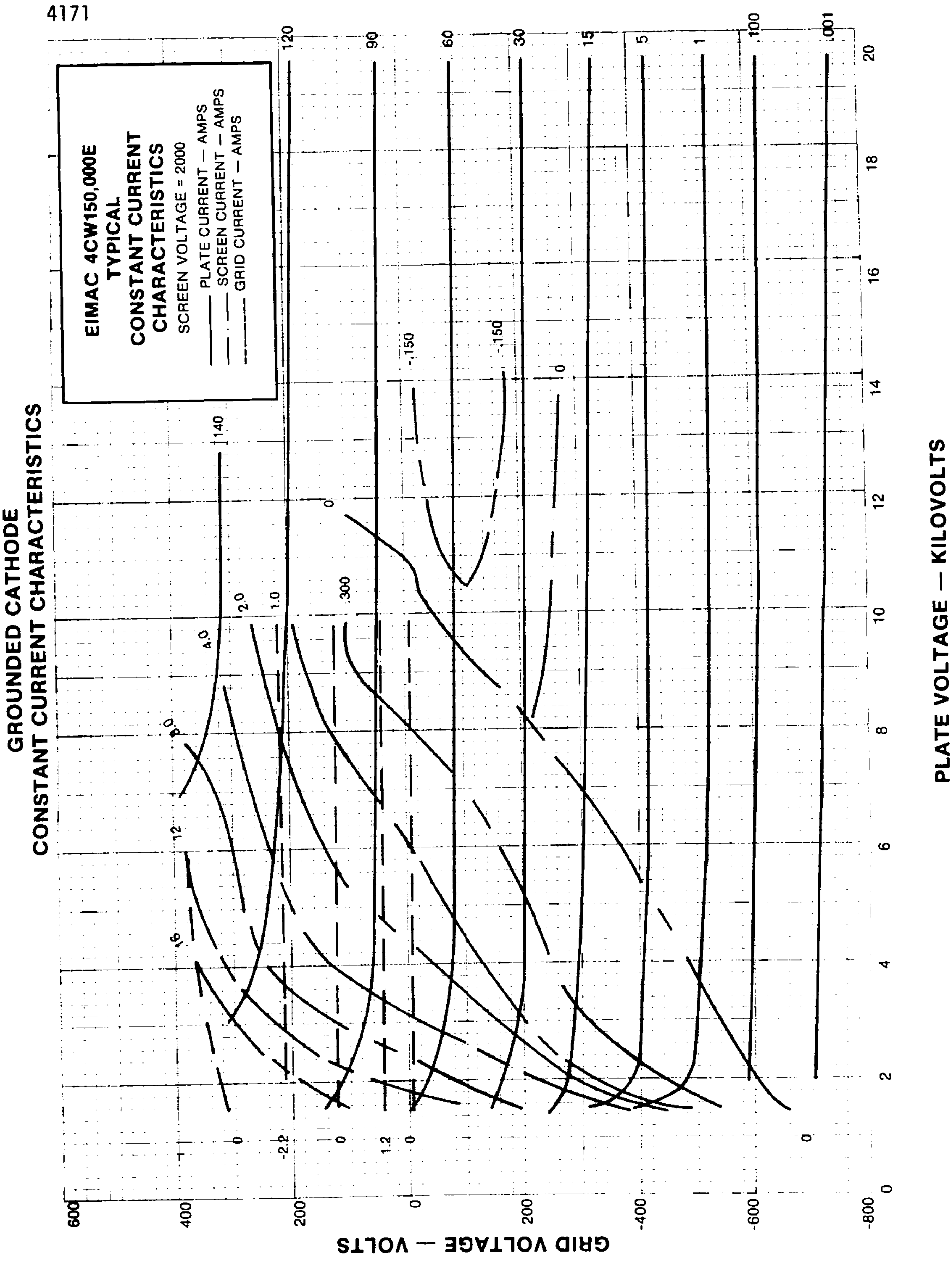
b. RF RADIATION - Exposure to strong rf fields should be avoided, even at low and medium frequencies. CARDIAC PACEMAKERS MAY BE EFFECTED.

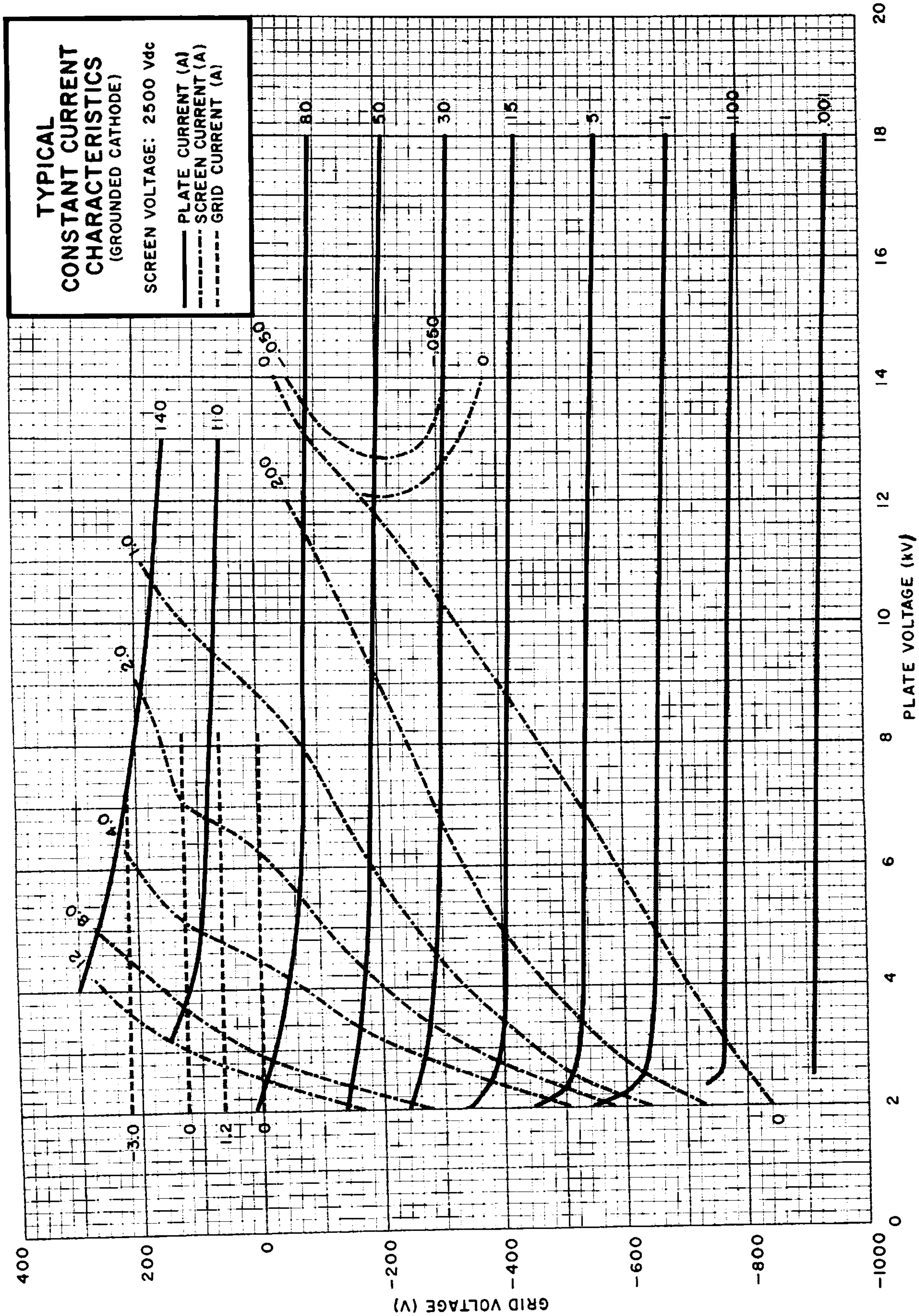
c. X-RAY RADIATION - High voltage tubes can produce dangerous and possibly fatal X-Rays.

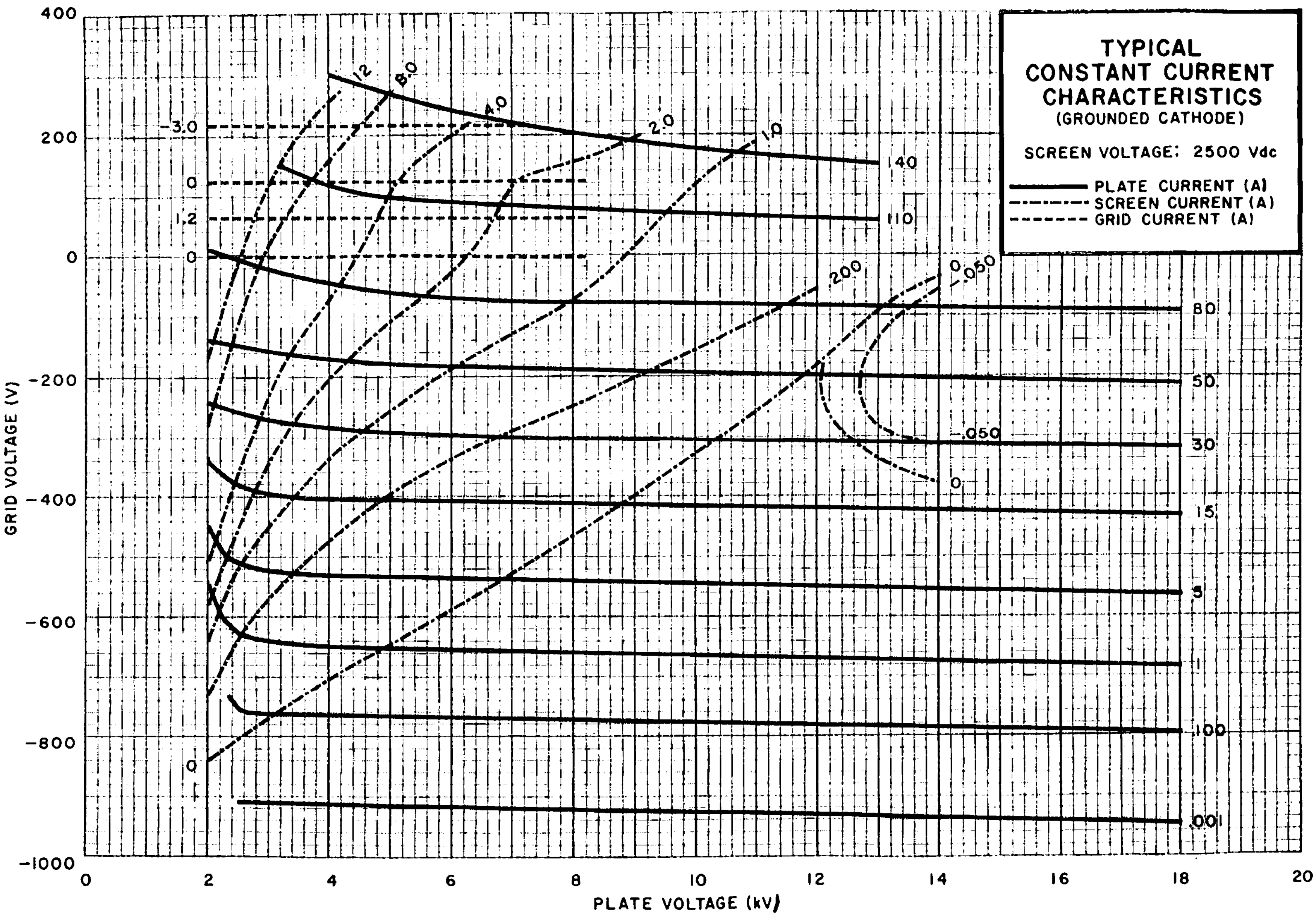
d. HOT WATER - Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.

f. HOT SURFACES - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred Degrees 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 Tube Division, 301 Industrial Way, San Carlos CA 94070.


4171
GROUNDED CATHODE
CONSTANT CURRENT CHARACTERISTICS
EIMAC 4CW150,000E
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 2000
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
PLATE VOLTAGE — KILOVOLTS
GRID VOLTAGE — VOLTS
120
90
60
30
15
5
1
.100
.001
140
4.0
2.0
1.0
.300
-.150
-.150
0
0
8.0
12
16
-2.2
1.2
600
400
200
0
200
-400
-600
-800
0
2
4
6
8
10
12
14
16
18
20


TYPICAL CONSTANT CURRENT CHARACTERISTICS
(GROUNDED CATHODE)
SCREEN VOLTAGE: 2500 Vdc
PLATE CURRENT (A)
SCREEN CURRENT (A)
GRID CURRENT (A)
PLATE VOLTAGE (kV)
GRID VOLTAGE (V)


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
(GROUNDED CATHODE)
SCREEN VOLTAGE: 2500 Vdc
PLATE CURRENT (A)
SCREEN CURRENT (A)
GRID CURRENT (A)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
400
200
0
-200
-400
-600
-800
-1000
0
2
4
6
8
10
12
14
16
18
20
140
110
80
50
30
15
5
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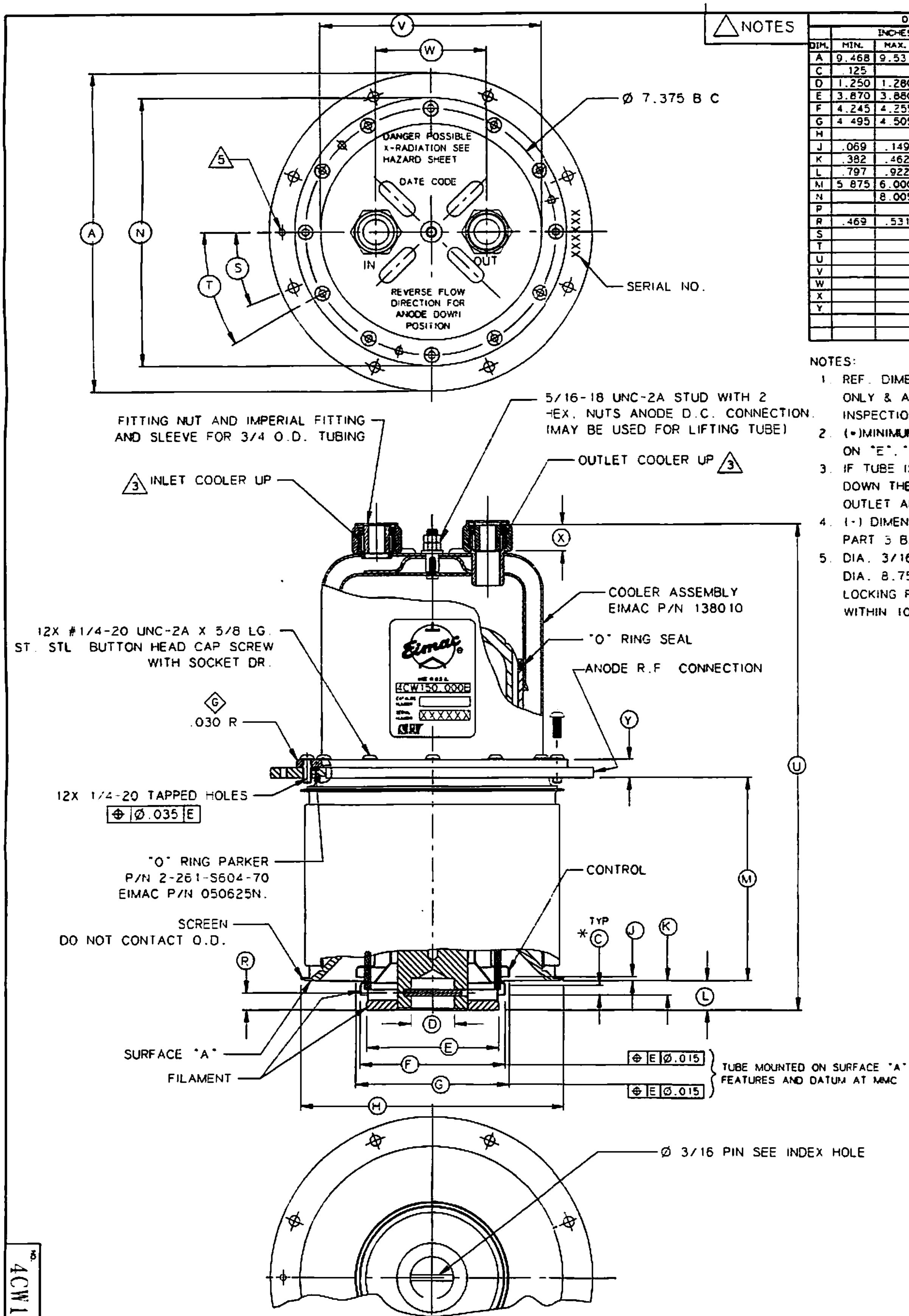
-3.0
1.2
0
-.050
.050



NOTES

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	9.468	9.531		240.49	242 00	
C	.125			3.175		
D	1.250	1.280		31.750	32.512	
E	3.870	3.880		98.30	98.55	
F	4.245	4.255		107.82	108.08	
G	4 495	4.505		114.17	114 43	
H			7 750			196 85
J	.069	.149		1.725	3.785	
K	.382	.462		9.703	11.734	
L	.797	.922		20.244	23.419	
M	5 875	6.000		149.23	152 40	
N		8.005			203 33	
P						
R	.469	.531		11.913	13.487	
S			22 50°			
T			30°			
U			14.000			355.60
V			6.500			165.09
W			3 250			82 51
X			.562			14.275
Y			.312			7 925

NOTES:

1. REF. DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. (*)MINIMUM CONTACT SURFACE. ON "E", "F" AND "G"
3. IF TUBE IS OPERATED COOLER DOWN THE WATER INLET AND OUTLET ARE REVERSED.
4. (-) DIMENSIONS INSPECTED ON A PART 5 BASIS.
5. DIA. 3/16 INDEX HOLE THRU ON DIA. 8.750 B.C. TO ALIGN WITH LOCKING PIN AND WATER FITTING WITHIN 10°.

LTR	DESCRIPTION OF CHANGE	SCO	DATE	BY
G	REDRAWN ON CAD \ ADD "N" DIM. \ RAD. WAS .06 IN ERROR	27177	12/04/03	SM/KA

DRAWN S. SINGH 12/04/03 ENGR APPR | SCALE: NONE
CHK'D K. AUTSEN 12/12/03 SUPERSEDES | FILE PATH: L:\OUTLINE\4CW1500000E

Eimac, Div of CPI

PART NO. 4CW1500,000E

OUTLINE

ELECTRON TUBE

NO. 4CW150,000E | G

NO. 4CW150,000E

MV: 7 • CR: 1 • SQ: 0.5