GEIGER TUBE SPECIFICATIONS

	TGC 1 & 2	TGC 3	TGC 4 & 5	TGC 6
Window Material	Mica	Mica	Glass	Glass
Window Thickness in mg/cm^2	TGC 1: 3 to 4 TGC 2: less than 2	less than 2	TGC 4: 300 TGC 5: 30	30
Starting Potential	1100-1250 V	1100-1400 V	740-780 V	740-780 V
Minimum Length of Plateau	300 Volts	300 Volts	150 Volts	150 Volts
Slope of Plateau per 100V	~1%	~1%	~2%	~2%
Useful Life in Counts	$>1 \times 10^9$	$>1 \times 10^9$	$>2 \times 10^8$	$>2 \times 10^8$
Fill Gas with Organic Quench	Helium at 72 cm of Mercury	Argon at 72 cm of Mercury	Argon	Argon
Background at Operating Voltage in Counts per Minute	25 (Shielded by 2" of lead at sea level in Boston)	25 (Shielded by 2" of lead at sea level in Boston)	40 (Without shielding at sea level in Boston)	25 (Without shielding at sea level in Boston)
Recovery time	200 μ sec.	400 μ sec.	90 μ sec.	75 μ sec.
Basing	Medium 4-pin radio tube base	Medium 4-pin radio tube base	TGC 4, 4A, 5 & 5A: Medium 4-pin radio tube base TGC 5Z & 5ZA: none	Pee-wee 3-pin radio tube base
Cathode Coating	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Center Wire	Tungsten	Tungsten	Tungsten	Tungsten
Coating on outside of tube	none	none	TGC 4, 5 & 5Z: none TGC 4A, 5A & 5ZA: opaque paint	opaque paint
Suitable for Dip Counting	no	no	TGC 4, 5 & 5Z: yes TGC 4A, 5A & 5ZA: no	no
Overall Dimensions not including base pins	3⅝" x 1½" D	TGC 3: 3⅞" x 1½" D TGC 3A: 3⅝" x 1½" D	TGC 4, 4A, 5 & 5A: 6" x 1 5/16" D (Glass D: ¾") TGC 5Z & 5ZA: 5⅜" x ¾" D	4⅞" x ⅝" D
Shipping Weight	2 lbs.	2 lbs.	2 lbs.	2 lbs.

DESCRIPTION

The Tracerlab TGC series self-quenching Geiger-Mueller tubes are suitable for the measurement of beta particles, gamma rays, and x-rays, for radioassay or for monitoring. The TGC-1 will respond to all but x-rays and low energy beta radiation, while the TGC-2 is specifically designed for low energy beta emitters such as Carbon-14 and Sulfur-35. In both of these tubes at least 98% of all beta particles entering the sensitive volume are counted. The TGC-3 is particularly sensitive to soft x-rays such as result from K-capture and is available as the TGC-3 with beryllium and copper filters which fit into a threaded collar on the top of the tube, or as the TGC-3A without filters or threaded collar.

These three tubes are mica end-window tubes which are intended primarily for radioassay work. The effective window diameter (1.1 inches) was selected after considerable experimentation in our radioassay laboratories because it effects an optimum compromise among various factors including high sensitivity and low background. The tubes show negligible memory effect. Because of the extremely fragile mica windows, care should be exercised in handling the tubes. For protective purposes they are covered with a metal cap which should be removed before counting beta particles.

The TGC-4, TGC-4A, TGC-5, TGC-5A and TGC-6 all glass G-M tubes are designed primarily for monitoring, usually with battery operated instruments, and the TGC-4 and TGC-5 may be used for dip counting as well. The TGC-4 and TGC-4A are sensitive primarily to gamma, while the TGC-5, TGC-5A, TGC-5Z and TGC-5ZA will respond to both beta and gamma radiation except for low energy beta particles. The TGC-6 is also sensitive to medium and high energy beta radiation and all gamma radiation. It is a smaller tube and can therefore be used with instruments for which the TGC-5 is too large.

The above Tracerlab Geiger tubes have a stainless steel cathode coating on the inside of the glass shell and are not photosensitive. The TGC-4A, TGC-5A, TGC-5ZA and TGC-6 also have an outside coating of opaque paint.

In addition to the tubes listed here, Tracerlab is constantly developing new tubes and is in a position to quote on special tubes.

BASING

All TGC series tubes except the TGC-5Z, TGC-5ZA and TGC-6 have medium four pin bases. Pins number 2 (+) and 4 (—) are internally connected to the anode center wire and the cathode cylinder, respectively. The external connections will depend on the particular circuit arrangement used. Pin No. 4 is commonly grounded while Pin No. 2 is connected to the high voltage supply, either through a series "recovery" resistor or through a vacuum tube preamplifier circuit. Since stray pickup may cause spurious counting, all leads to the Geiger tube should be electrically shielded. Care should be taken, however, to keep the total shunt capacity added by the shielding to less than 150-200 mmf in order to keep the resultant recovery time less than the natural dead time of the Geiger tube. This prevents the coincidence loss from being excessive. Also, too much shunt capacity may reduce the pulse size below the input sensitivity of the scaler.

The TGC-6 has a three-pin pee-wee base. For this tube pin 2 (+) is connected in the same way as pin 2 in the case of the four-pin base, and similarly pin 1 (—) takes the place of pin 4. A diagram of the two different tube bases is shown below.

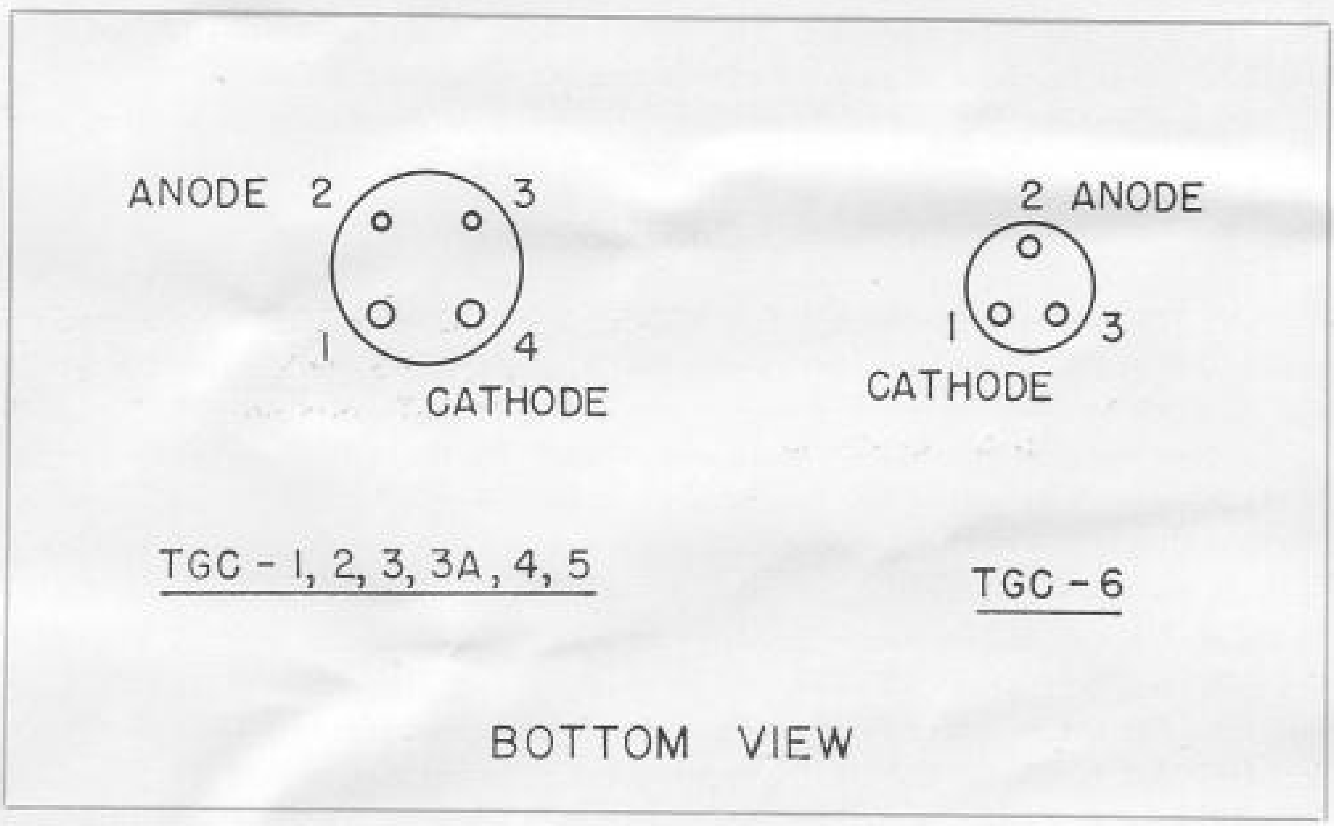
The TGC-5Z has no plug-in base but only an anode and a cathode wire.

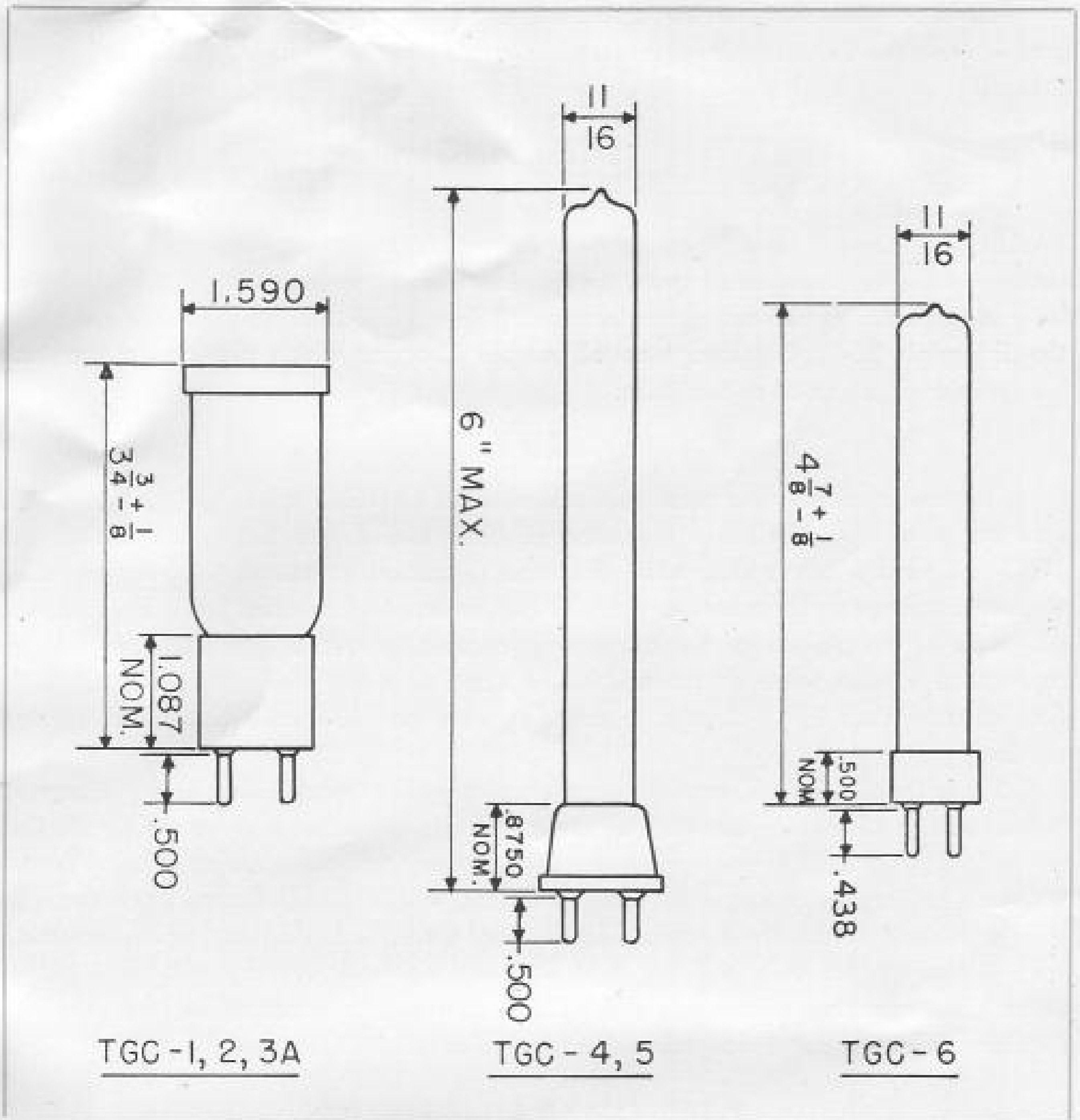
OPERATION

With the tube connected to the preamplifier or scaler and with a radioactive source near the tube window, the high voltage applied to the tube is gradually increased from about 1000 volts for the TGC-1, 2, or 3 and 700 volts for the TGC-4, 5, or 6 until counting begins. This is called the STARTING VOLTAGE; it is the lowest voltage applied to the tube at which the output pulses from the Geiger tube will trigger an input circuit. The experimentally observed value of the STARTING VOLTAGE should correspond approximately to the value recorded on page 6 of this folder (provided that the tube is a TGC-1, or 2 or 3 and is used with a scaler having an input sensitivity of 0.25 volt with a capacity loading of approximately 50 mmf).

Due to the difference in input circuits encountered in the field and the fact that the tubes show some upward shift in characteristics with life, the OPERATING POINT of each Geiger tube should be determined by running a PLATEAU CURVE.

Starting with conditions of fixed counting geometry, let the tube warm up by allowing it to count at the recommended operating voltage for approximately fifteen minutes. Then decrease the voltage to the STARTING POTENTIAL and increase it in increments of about twenty volts, recording the counting rate for approximately 4000 counts at each point. The observed counting rate will rise sharply, passing through a fairly well defined region of inflection called the KNEE,





after which the counting rate levels off and remains relatively independent of applied voltage for several hundred volts. This flat region is called the PLATEAU. The plateau should not be explored beyond the specified length since voltages in excess of this value may damage the tube by causing it to go into continuous discharge.

For reproducible results select an OPERATING POINT approximately 75 volts above the KNEE. It is undesirable to operate the tube closer to the KNEE, since this point increases slightly in voltage with tube life. Operating the tube at the high end of the plateau shortens the life of the tube due to the greater consumption of quench gas per pulse. Once an operating point has been selected it is suggested that the counting rate of a long life Beta source be recorded under standard geometry conditions. By recounting this reference at periodic intervals one can determine whether the tube is giving reproducible results. If the results deviate significantly beyond the expected statistics a new operating point should be selected.

The tube should never be operated at a voltage which is more than 30% greater than the STARTING POTENTIAL, because the "continuous discharge" region is rapidly approached above this point and the tube life may be seriously reduced.

SHIELDING

When counting samples of low activity, the Geiger-Mueller tube should be shielded with lead. This will reduce the background count and thereby improve the ratio of total to background counting rate. It will also reduce the effect of miscellaneous radioactive sources in the laboratory. The TGC-1, 2, and 3 tubes plug into the Tracerlab SC-9D Shielded Manual Sample Changer which provides a two inch lead shield on all sides of the tube.

LIFE

The use of a stainless steel cathode shell in all TGC series Geiger tubes has resulted in a very significant extension of their useful life. The useful life of the TGC-1, 2, and 3 tubes ends when the tube (1) ceases to count, (2) goes into continuous discharge or (3) counts erratically. As the end of the useful life is approached, the slope of the plateau of the characteristic curve increases. It is common practice to replace a tube when its plateau has a slope of more than 20% per 100 volts (i.e., greater than 20% change in counting rate per 100 volts change in applied voltage).

Since the TGC-4, 5, and 6 tubes are frequently used with battery operated instruments, a different definition of useful life applies to them. When their starting potential exceeds 860 volts they may no longer operate satisfactorily with the 900 volt battery pack for which they are designed, if the batteries have decayed with age, and hence their useful life is then concluded. At that point, however, their slopes are normally still less than 5% per 100 volts, so that they are still of value when operated with a variable voltage supply. This accounts for the relatively shorter useful life for these tubes that is indicated in the table of specifications.

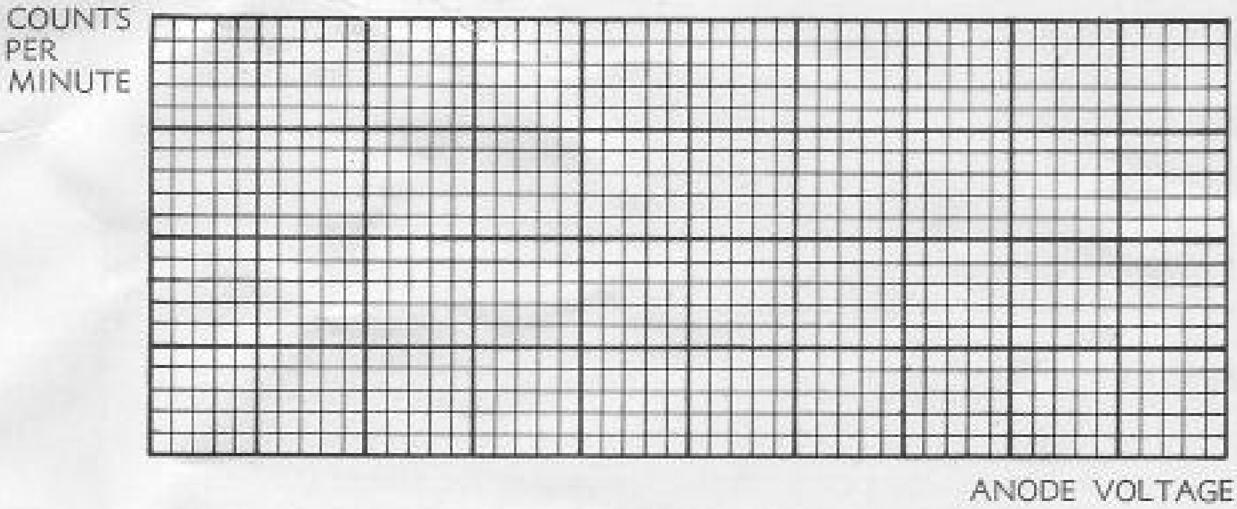
TUBE CHARACTERISTICS

The following are the characteristics of the TGC-1, 2, or 3 tube with which this pamphlet is being sent. If this instruction sheet accompanies a TGC-4, 5, or 6 tube the characteristics of the tube can be found in the table of specifications.

Model Number TGC5........Starting Voltage ....
Serial Number 5BM66....Recommended Operating Voltage 900........
Window Thickness ......mg/cm² Date Tested 5-13-53................

CHARACTERISTIC CURVE

The characteristic curve, coordinating counting rate and anode voltage for the TGC-1, 2, or 3 tube for which the data is given above is shown on the following graph. It is recommended that the purchaser determine a characteristic curve, as described above, before using the counter. 4096 counts were taken for each point on the curve shown below, giving a probable error for each point of approximately $\pm 1\%$.



BETA ABSORPTION CURVE

The absorption curves shown below were computed from the equations:*

$$\frac{I}{I_o} = e^{-\alpha d} \qquad \alpha = \frac{0.02}{E_{max}^{1.33}}$$

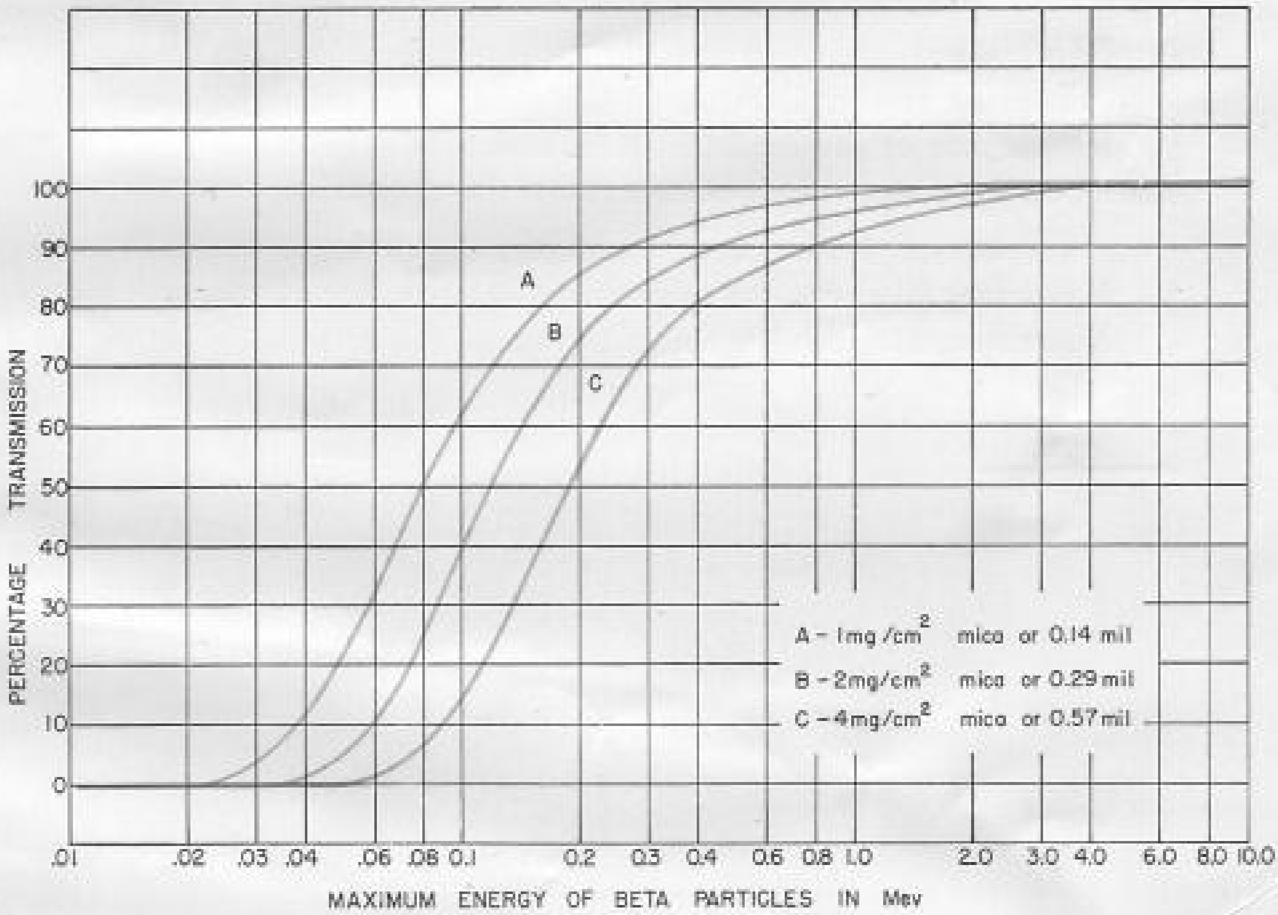
In the special case of mica window beta-gamma tubes,

$\frac{I}{I_o}$ = ratio of the number of beta particles entering the sensitive volume of the counter to the number striking the mica window.

α = absorption coefficient in cm^2/mg.

d = thickness of window in mg/cm^2.

E_{max} = the maximum energy of the beta particles as determined from range-energy relationships.



*The Science & Engineering of Nuclear Power, Vol I p 53, Addison-Wesley Press 1947.

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