

# PLANAR TRIODE LIFE AND RELIABILITY SUMMARY

## Results from Adverse Environment Tests

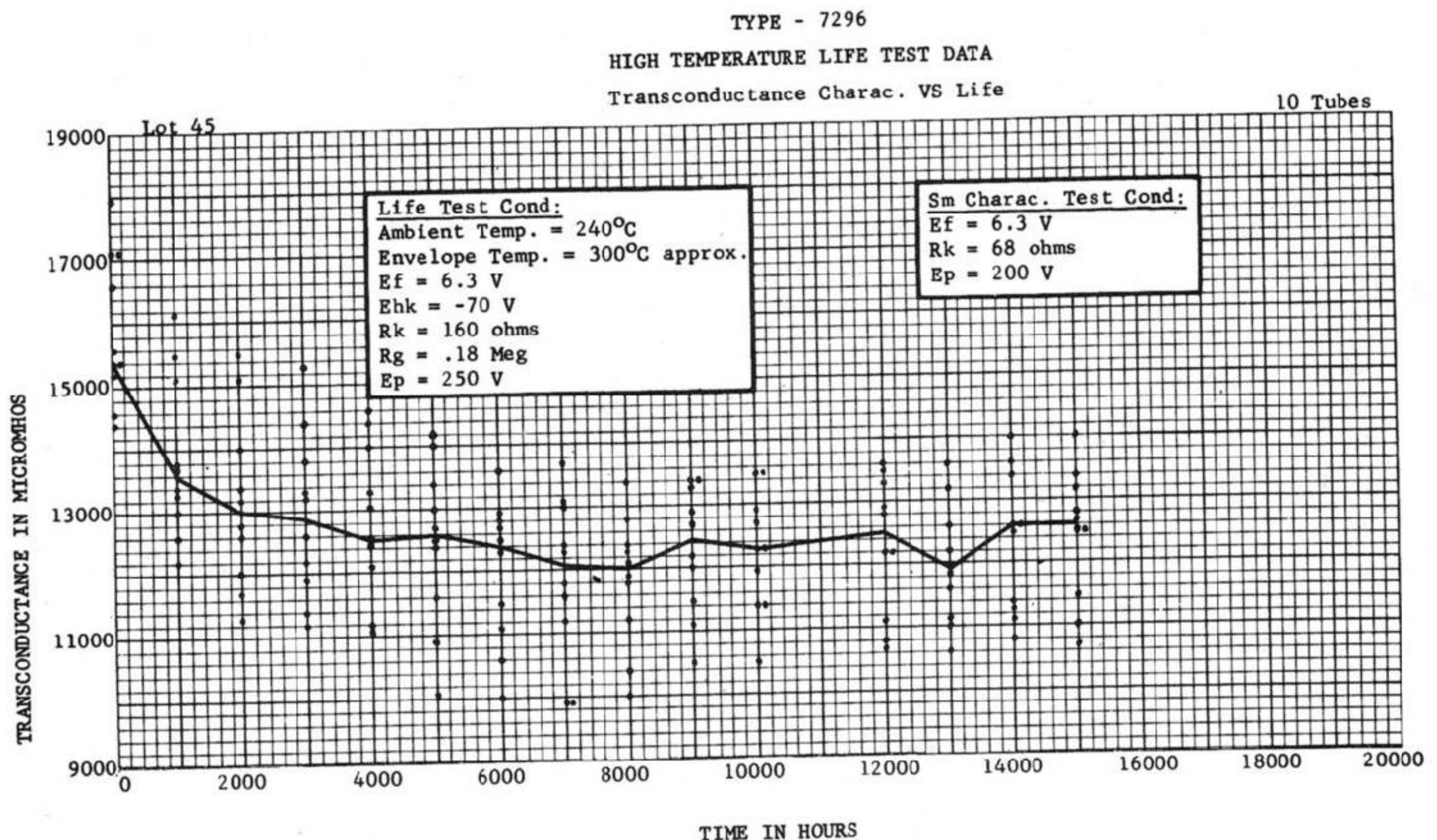
### Temperature and Humidity

While it is generally recommended that the published temperature ratings not be exceeded where emphasis is on long and reliable life, some interesting long-life evaluations at higher-than-rated temperatures have been made as a matter of design capability study. A summary of these tests is as follows.

<u>Type</u>	<u>Lot</u>	<u>Amb. Temp.</u>	<u>Env. Temp.</u>	<u>Ef*</u>	<u>LT.Duration</u>	<u>n</u>
7296	472	400°C	450°C	5.4V	2000 Hr.	10
7296	305	500°C	550°C	4.3V	4000 Hr.	10
7296	45	240°C	300°C	6.3V	15000 Hr.	10
7296	46	240°C	300°C	6.3V	15000 Hr.	10
Z-2354	253	400°C	450°C	5.0V	17000 Hr.	10

\* Note that lots 472 and 305 of the 7296 and lot 253 of the Z-2354 were life tested at reduced heater voltage. This was done to obtain longer tube life by keeping the cathode temperature within bounds.

These data demonstrate the capability of reliable operation at higher than rated temperatures provided that due considerations are given to proper heat sinking and commensurate derating of the heater voltage. As an example of these tests, a Transconductance vs Time graph of 7296 (Lot #45) is in the following graph.





In addition to the high temperature evaluations, the effects of high humidity environment have been investigated with regard to absorption of moisture into the ceramic and seal areas. The test consisted of a sample of type 7768 tubes subjected to steam vapor of approximately 100°C and 95-100 percent relative humidity. These conditions were in accordance with MIL-STD 1311A, Method 1011 with the exception that the duration was extended to 1000 hours. At the completion of this test, the tubes were checked for electrical characteristics and found to have withstood the steam bath with no deleterious effects.

### Mechanical

Planar tubes ability to withstand severe mechanical stresses, such as might be encountered in missile applications, is included in the regular acceptance criteria of the test specifications. Vibration fatigue testing is performed through the range of 30-2000 Hz at acceleration levels up to 30 g for a duration of 6 hours to assure that the tubes are free from mechanical resonances. In addition, tubes are subjected to mechanical shock at a typical level of 450 g for 1 millisecond duration. Test experience has shown the design capability of these tubes to be generally well in excess of the actual test requirements. For higher levels of shock and vibration, the bonded heater versions of the planar triode family is recommended.

## II. Results of Production and Engineering Quality Control Tests

### (a) Shelf Life or Storage

It may be appropriate here to make an observation about shelf life. Although normally taken for granted, this can be especially important in certain applications where the tubes are held non-operating for long periods of time but expected to function properly when the equipment is finally turned on. One such evaluation was made on a group of 65 type 7077 tubes which were held in storage for nearly 8 years from 1/25/60 to 12/22/67. Test data of the electrical characteristics were recorded before and after this holding period and the tubes were found to have remained essentially unchanged. Similar investigations on planar tubes have likewise shown that degradation during extended storage periods is not a significant problem.

### (b) Operation Life

As a part of the regular lot acceptance testing, each lot is sample tested under operating conditions which are typically set at the maximum rated values for plate



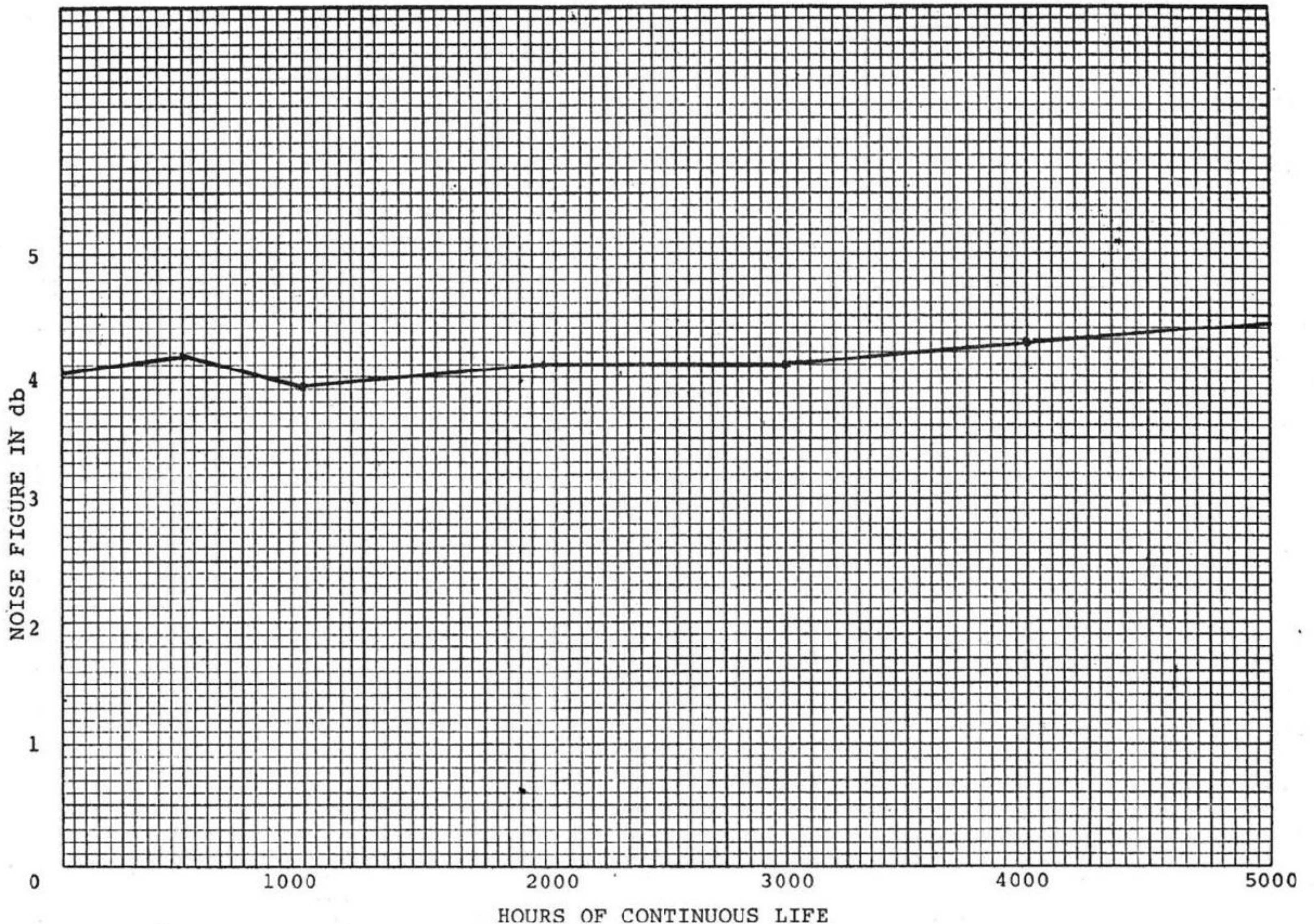
dissipation, cathode current, and plate voltage for 1000 hours duration. Exemplary failure rates determined from accumulations of these data are as follows.

Type 7077 (Small Signal RF Amplifier)

Results of 7077 life tests have consistently indicated a very good reliability. Cumulative 1000 hour test data during a recent production period show a failure rate of 0.4%/1000 hrs. (4 defectives out of 960,000 tube hours) giving an MTBF of 250,000 hours. This low failure rate is typical of that experienced over several years production.

The above data was taken under DC conditions with various performance criteria determined at down period intervals. One of the most important criteria of the 7077 is noise figure. The following graph is a plot of this recorded rf performance on 50 tubes run to 1000 hours, 25 of which were extended out to 5000 hours life test. Noise Figure was measured at a frequency of 450 MHz.

TYPE 7077 NOISE FIGURE LIFE





TYPES 7911, GE13971, GE18651 (PULSED AMPLIFIER OR OSCILLATOR TYPES)

Cumulative results of life tests under plate pulsed oscillator operating conditions are as follows:

<u>TYPE</u>	<u>LOT</u>	<u>SAMPLE</u>	<u>HOURS</u>	<u>FAIL</u>
7911	68-09	5	5000	-
	68-06	5	5000	-
	68-01	5	5000	-
	67-50	5	5000	-
	67-46	5	5000	-
GE13971	X6	4	4000	-
	X7	3	3000	-
	X8	2	2000	-
	X9	3	3000	1
	X10	3	3000	-
	X11	3	3000	-
	X12	4	4000	-
	X13	4	4000	-
	X14	3	3000	-
	X15	3	1000	-
	X16	4	4000	-
GE18651	A	4	4000	-
	A6-7	4	4000	-
	A8	4	4000	-
	A11	4	4000	-
	B	4	4000	-
	C2	4	4000	-
	C3	4	4000	1
	D	4	4000	-
	9E	3	3000	-
	69-49	4	4000	-
	TOTAL:	100 tubes	100,000 tube hrs.	2 defectives

**IN-SERVICE LIFE RESULTS**

Recent life tests were conducted in two transmitter-amplifier chains for a new DME design. This amplifier was part of a Distance Measuring Equipment life tested under simulated field conditions. This amplifier chain had a bandwidth of 13% centered around 1100 MHz. In this equipment, acceptable performance is defined as a minimum power output of 500 W.

Failure Rate = 2%/1000 Hrs. (MTBF = 50,000 Hrs.)

TRANSMITTER TEST

