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Total-Dose Radiation Effects Data for Semiconductor Devices

1989 Supplement

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February 15, 1990

NASA

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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Steady-state, total-dose radiation test data are provided for electronic designers and other personnel using semiconductor devices in a radiation environment. The data are presented in graphic and narrative formats. All tests were conducted at the Jet Propulsion Laboratory (JPL). Two primary radiation-source types were used: Cobalt-60 gamma rays and a Dynamitron electron accelerator capable of delivering 2.5-MeV electrons at a steady rate.

All data were generated in support of National Aeronautics and Space Administration (NASA) Space Projects and Programs by the JPL Radiation Effects and Testing Group (Section 514).

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May 5, 1990

JPL/NASA GROUND TEST RADIATION DATA BANK

This notice is an update regarding the method of accessing the JPL/NASA electronic data bank (called RADATA), that is accessible on either of two JPL 11/780 VAX computers. For those not familiar with RADATA, a brief description will be given:

The JPL/NASA electronic data bank called "RADATA" consists of JPL total-dose and Single Event Effects (SEE) ground based test data available for government and industry use. The data bank is accessible via the users personal computer and dial-up modem at no cost to the user. The data bank is completely menu driven and permits the user to peruse the table of contents, view data, and down load to their disk drive if desired. Also, data can be requested and received by U.S. postal mail.

To access RADATA , use full duplex (the system uses auto baud rate detection for speeds up to 9600 baud), 8 bit format, 1 stop bit and no parity. After you have set protocol, use one of the following methods to access RADATA:

ACCESS AT JPL:

1. Direct dial X4-4360 or access ILAN and connect to the "VLSI" or the "DSFVAX".
2. Enter RADATA to the USERNAME: prompt and press RETURN/ENTER.

ACCESS USING OFF-LAB TELEPHONE DIAL-UP:

1. Dial (818)354-4360 (VLSI VAX).
2. After the CONNECT prompt, press the RETURN/ENTER key twice, then input RADATA to the USERNAME prompt and press RETURN/ENTER again.

(Alternate OFF-LAB back-up access):

If RADATA cannot be accessed on the VLSI VAX [dialing (818)354-4360)], use the following back-up method:

1. Dial (818)393-4156 (DSFVAX).
2. After you connect, the screen will go blank. Press RETURN/ENTER twice (the screen will remain blank).
3. Type in RADATA in UPPER CASE LETTERS only (the characters will not be displayed on the screen) then press the RETURN/ENTER key again.

ACCESS USING DECnet(SPAN):

If your facility has a VAX computer tied to DECnet you may access RADATA as follows:

1. Log-on your VAX computer.
2. Access the JPL computer by inputting SET HOST JPLLSI or SET HOST JPLGP.
3. Enter RADATA to the USERNAME: prompt and press RETURN/ENTER.

ACCESS USING TELNET:

If your facility is tied into MILNET or ARPANET, you may access RADATA as follows:

1. Enter TELNET VLSI.JPL.NASA.GOV or TELNET DSFVAX.JPL.NASA.GOV after the prompt sign.
2. Input RADATA to the username prompt and press RETURN/ENTER twice.

After you have logged on the computer, using any of the above access methods, you will be guided by selecting various menus and self help instructions.

Footnote:

RADATA is sponsored by the NASA Office of Safety, Reliability, Maintainability and Quality Assurance and is carried out by the JPL Electronic Parts Reliability Section.

May 5, 1990

JPL/NASA RADIATION DATA BANK USERS SURVEY

In order to maximize the effectiveness and convenience of using the RADATA Electronic Ground Test Radiation Data Bank, we are requesting you fill out and return this questionnaire:

1. Things that I like about the data bank:

____

____

____

2. Things that need improvement:

____

____

____

3. Additional comments:

____

____

____

NAME:______________________MAIL STOP:__________

AFFILIATION:_________________TELEPHONE:__________

STREET ADDRESS:________________________________

CITY:____________STATE:__________ZIP CODE:________

SEND REPLY TO:

Jet Propulsion Laboratory
4800 Oak Grove Dr.
Pasadena, CA 91109
C/O Data Bank Manager, M/S 303/220

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The research described in this publication was carried out by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

ABSTRACT

Steady-state, total-dose radiation test data are provided for electronic designers and other personnel using semiconductor devices in a radiation environment. The data are presented in graphic and narrative formats. All tests were conducted at the Jet Propulsion Laboratory (JPL). Two primary radiation-source types were used: Cobalt-60 gamma rays and a Dynamitron electron accelerator capable of delivering 2.5-MeV electrons at a steady rate.

All data were generated in support of National Aeronautics and Space Administration (NASA) Space Projects and Programs by the JPL Radiation Effects and Testing Group (Section 514).

PREFACE

The 1985 supplement (JPL Publication 85-43) was presented in two volumes, due to the extensive amount of data available. Volume I contained optical diode and transistor data, and Volume II contained integrated circuit data.

The amount of data generated since the October 15, 1985 release of Volume I and the integrated circuit data generated since the May 15, 1986 release was not sufficient to require two volumes. Hence, the 1989 supplement is presented in one book.

For those interested, a Single Event Phenomena (SEP) data book is also available at no cost by writing to:

Jet Propulsion Laboratory
Document Review Group 111-113
4800 Oak Grove Drive
Pasadena, CA 91109

Request JPL Publication 88-17, titled "Heavy Ion-Induced Single Event Phenomena (SEP) Data for Semiconductor Devices from Engineering Testing," and dated July 1988.

ACKNOWLEDGMENT

The authors would like to acknowledge the skill and dedication of Steven Conrad and Michael Weideman, who were instrumental in providing the data for this publication.

The work in this report was carried out for a number of spacecraft projects and the National Aeronautics and Space Administration (NASA) Microelectronics Radiation Effects Ground Test Program.

The sponsor of this publication is the NASA Office of Safety, Reliability, Maintainability and Hardness Assurance; NASA Headquarters, Code Q.

INDEX OF DEVICE TYPES

*See Appendix A

CONTENTS

SECTION I

INTRODUCTION

The data presented in this 1989 supplement describe the results of Total Ionizing Dose (TID) tests of optical diodes, bipolar transistors, and integrated circuits. The data were obtained by the Jet Propulsion Laboratory (JPL) in order to assure the "hardness" (radiation resistance) of components to be used in a variety of radiation environments; however, the data are applicable to any ionizing (total dose) radiation environment. Two primary radiation-source types were used: Cobalt-60 gamma rays and a Dynamitron electron accelerator capable of delivering 2.5-MeV electrons at a steady rate.

The electrical parameter data are presented in graphic or narrative format for various operating conditions as a function of dose. A measure of the statistical variation of each device lot is provided by the tabulated standard deviations at the bottom of each graph. Where there are irradiations of two or more different lots of a given device type, each lot is treated as an entirely separate test.

All data taken here substantially meet the requirements of MIL-STD-883, method 1019, for environments where short-term annealing is not a relevant problem. Each test consisted of three or more radiation levels at room temperature, and the devices under test were maintained at the established project worst-case bias conditions during the radiation exposure. Electrical parameter measurements were commonly taken within 10 to 60 minutes of completion of irradiation.

SECTION II

DOCUMENT USES AND LIMITATIONS

The purpose of this report is to provide test data for optical diodes, transistors, and integrated circuits exposed to steady-state ionizing radiation. As such, it offers a useful comparison of the radiation response of different devices that might be considered in the development (circuit design) of a radiation-hardened system. It also offers a quick method for determining the weak links in an existing system, and an approximation of the system radiation tolerance as a whole.

The data presented here cannot be used as a substitute for a comprehensive testing program of the devices actually used in a given system. It will be clear on inspecting the data herein that there are large lot-to-lot or wafer-to-wafer variations in the sample responses of a given device type. The response difference from functionally identical devices fabricated by different manufacturers is even greater. There was no attempt to remove "maverick" (outlier) devices from the data plots, so some data plots may appear anomalous when compared to other plots for the same device type. It should be noted that given manufacturers may make minor adjustments in their processing procedures that will result in a major difference in the device radiation response.

SECTION III

RADIATION SOURCES AND DOSIMETRY

A. DYNAMITRON

Some of the transistor tests were performed using the JPL Dynamitron electron accelerator which provided a 2.5-MeV electron beam with beam currents ranging from 10^8 to 10^{10} electrons/cm^2/second. The tests described here were irradiated at a given fluence level for exposure times between 5 and 45 minutes.

The test geometry for the Dynamitron facility consisted of an electron beam brought out of the beam tube through a 0.05-mm titanium window, copper and aluminum scattering foils, and 0.9 m of air. Each of these materials scatters the electrons slightly so that the scattered beam has a uniformity variation of less than 20 percent over the test device array, which is confined within a 25-cm-diameter circle perpendicular to the beam direction. At the center of the circle is the aperture of a vacuum Faraday cup, which is used to measure the electron beam flux and fluence. The beam is centered on the Faraday cup with a quadrupole magnet prior to the installation of the test samples. The output from the Faraday cup is a current that is fed into a current integrator, which is calibrated daily against a standard current source. The integrator is set to shut off the electron beam automatically when the desired fluence level is received at the Faraday cup.

B. COBALT-60 SOURCES

The JPL Cobalt-60 gamma ray source was used for all of the IC tests. The gamma rays consisted primarily of 1.17 and 1.33 MeV photons with lower energy photons and secondary electrons arising from scattering and absorption. The gamma field was uniform within $\pm$ 10 percent in the parts exposure area, which was verified by thermoluminescent dosimetry (TLD), consisting of lithium fluoride/Teflon microrods. The main source calibration was performed with Landsverk ion chambers of $\pm$ 2 percent accuracy, traceable to the National Bureau of Standards, and monthly dose rate computations performed to account for the radioactive decay of the Cobalt-60 source. Exposure times with the Cobalt-60 sources were typically 5 to 20 minutes for each radiation level. Longer times (up to 4 hours) were required for high total dose exposures because the maximum uniform dose rate available was 100 rads (Si)/second.

Dose rate testing was performed from 100 rad(Si)/second to 0.0058 rad(Si)/second with a corresponding increase in time for the low rates.

SECTION IV

TEST SETUP AND PROCEDURES

A. GENERAL REMARKS

The test setup and procedures used here were developed in accord with the specifications of MIL-STD-883, method 1019. All tests were done at 25 °C ± 3 °C, using low noise power sources and instrumentation subject to periodic calibration. Some tests were performed *in situ* (without removing the test devices from the radiation area), whereas others required remote testing, using a mobile bias fixture to maintain bias except during the brief measurement period.

A detailed test plan was written for each test including test device description, irradiation bias conditions, radiation levels, electrical parameters to be measured, and measurement conditions. The data were processed by computer with the calculation of normal means and standard deviations made after deletion of clearly erroneous data. Individual data can be retrieved, if required, by specifying the JPL log number given with each data plot to the Radiation Effects and Testing Group (Section 514) at JPL.

B. TRANSISTORS AND OPTICAL DEVICES

Transistors and optical devices were measured *in situ* using a matrix board switching panel set up outside the irradiation area. The matrix board interfaces the devices under test (DUT) to the power supplies and measurement equipment via a special 15-m (50-ft), double-shielded cable (Figure 4-1). A built-in potentiometer for each DUT could be used to control bias voltages and currents. The matrix board was designed with very high insulation resistance so that very low current measurements (10-50 pA) could be made.

C. INTEGRATED CIRCUIT TESTING

For non-*in situ* remote tests the DUTs were removed from the radiation site for approximately 10 to 60 minutes between each radiation level. A mobile bias (battery) was applied to the devices at all times except during parameter measurements. Remote measurements were performed using a Tektronix 178/577 curve tracer, a Hewlett Packard 4062C, Semiconductor Parametric Test System, or a bench fixture. Occasionally, custom-built test circuits were used to simulate the circuit application of the devices tested, such as a grounded, shielded, low current measurement fixture.

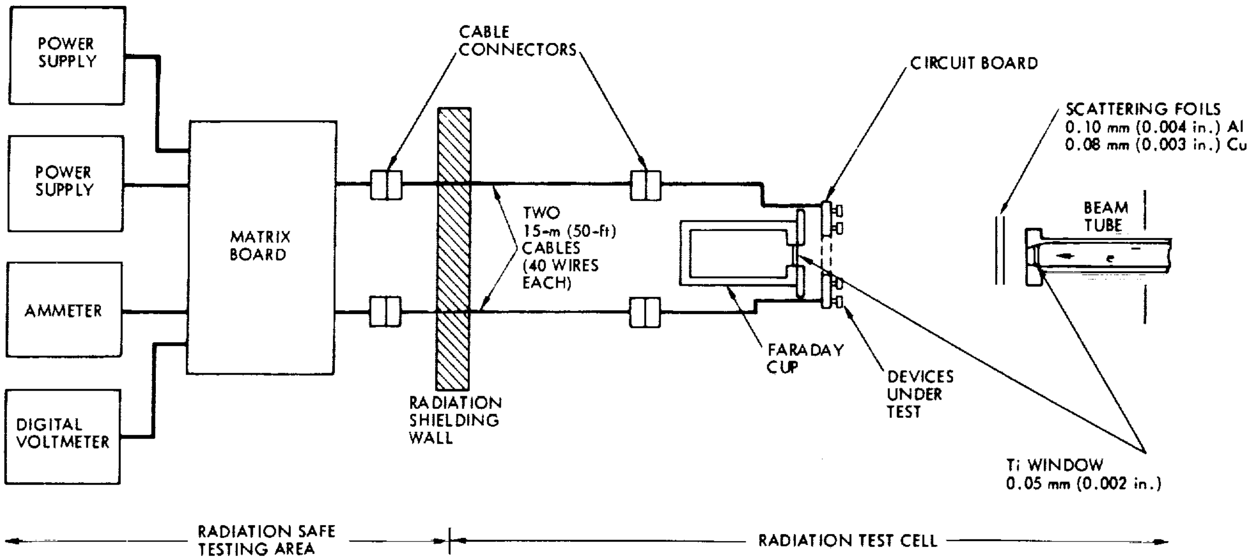


Figure 4-1. Block Diagram of the Test Setup for <u>in situ</u> Testing with the Electron Accelerator (Dynamitron)

SECTION V

DATA PRESENTATION

A. BIPOLAR TRANSISTORS

The transistor data presented in graphic format are shown in Figure 5-1. Each of the electrical parameter data plots is represented by multiple lines to represent different collector currents. A table at the bottom of each graph lists the test conditions, when applicable, and the normal standard deviations of each data point at each dose level.[1]

Date codes usually indicate when the device was packaged. For example, 8420 indicates the device was packaged in the twentieth week of 1984. If no date code is available, the space may be used for other identifying numbers such as wafer number or lot number.

For convenience, the degradation in transistor gain (h_{FE}) is plotted as $\Delta(1/h_{FE}) = 1/h_{FE\phi} - 1/h_{FEo}$, where $h_{FE\phi}$ is the value at the specified radiation level, and h_{FEo} is the initial value. Implicit in this approach is the assumption that the radiation behavior can be approximated by the well-known formula:

$$\Delta(1/h_{FE}) = K\phi$$

where ϕ is the dose (or fluence) and K is a damage constant that depends on the device type and collector current, I_C.

A method of determining the final h_{FE}, when the initial h_{FE} and postirradiation $\Delta(1/h_{FE})$ are known, is shown in the following example for a 2N2222 device type at V_{CE} of 20 V at 300 krad(Si).

1. Scale the value of $\Delta(1/h_{FE})$ from the applicable graph for a 2N2222 transistor at the stated conditions. In this example, $\Delta(1/h_{FE})$ is determined to be 0.008.

2. Determine the minimum specified preirradiation h_{FE} for this device type. In this example, the initial specified minimum h_{FE} is 100. Then proceed as follows:

$$h_{FE}(\text{final}) = \frac{1}{\Delta(1/h_{FE}) + \dfrac{1}{h_{FEo}(\text{initial})}}$$

$$h_{FE}(\text{final}) = \frac{1}{0.008 + \dfrac{1}{100}} = 55.6$$

[1]The log-normal distribution actually provides a better fit to most radiation data than the normal distribution. Hence, caution should be exercised in estimating worst-case conditions based on the limited statistical data presented herein.

Table 5-1 may also be used to determine the final h_{FE}. Locate the postirradiation $\Delta(1/h_{FE})$ value in the left-hand column, and the initial h_{FE} on the top row. The column and row intersection is the final h_{FE}.

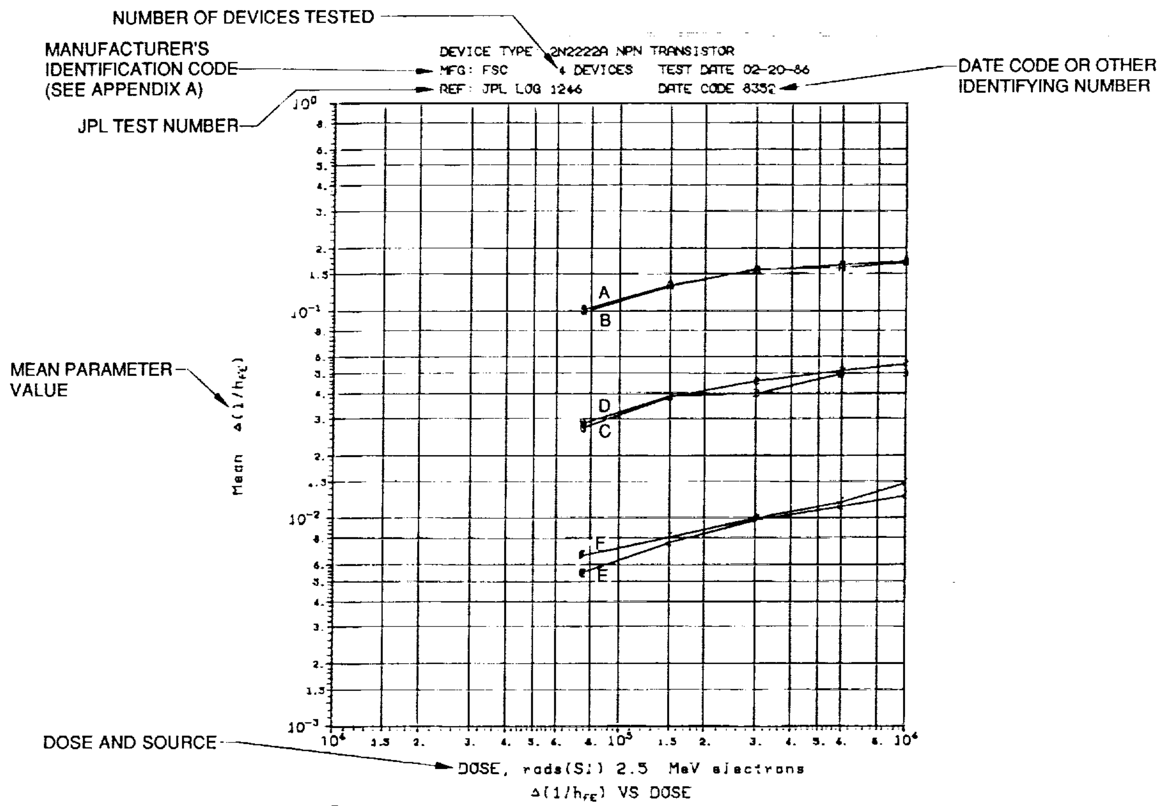


TABLE OF NORMAL STANDARD DEVIATIONS							
CURVE	I_C (mA)	V_{CE} (v)	DOSE, rads(Si) 7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
A	.1000	20.0	.0286	.0366	.0393	.0321	.0321
B	.1000	.500	.0322	.0372	.0363	.0357	.0281
C	1.000	.500	.0048	.0078	.0093	.0093	.0083
D	1.000	20.0	.0064	.0079	.0046	.0096	.0039
E	20.00	20.0	.0016	.0020	.0019	.0027	.0032
F	20.00	.500	.0006	.0018	.0016	.0024	.0011

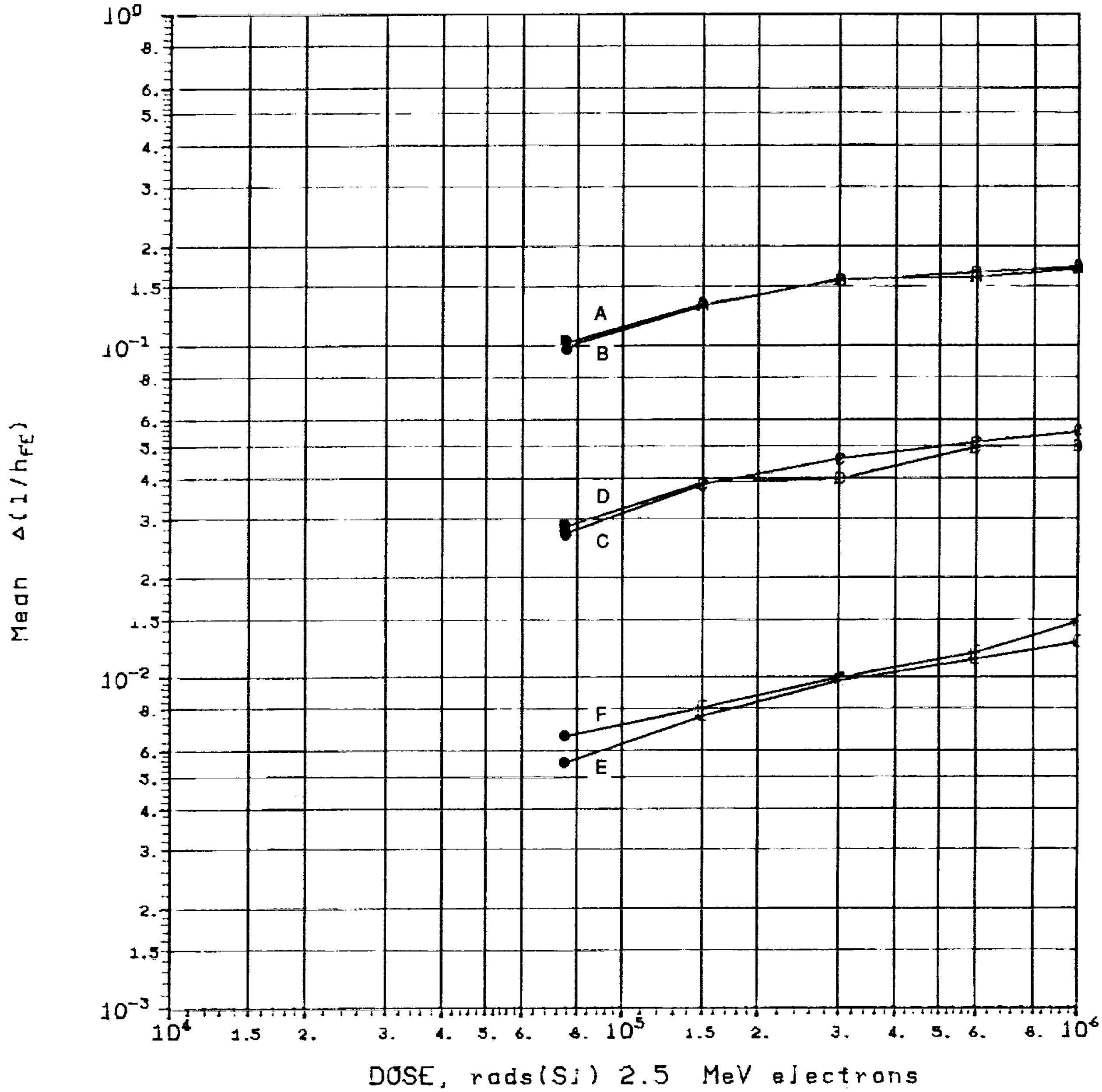
STANDARD DEVIATION VALUES FOR EACH MEASUREMENT POINT

Figure 5-1. Graph Format Description

Table 5-1. Determination of Final h_{FE}, Given Initial h_{FEo} and Postirradiation $\Delta(1/h_{FE})$

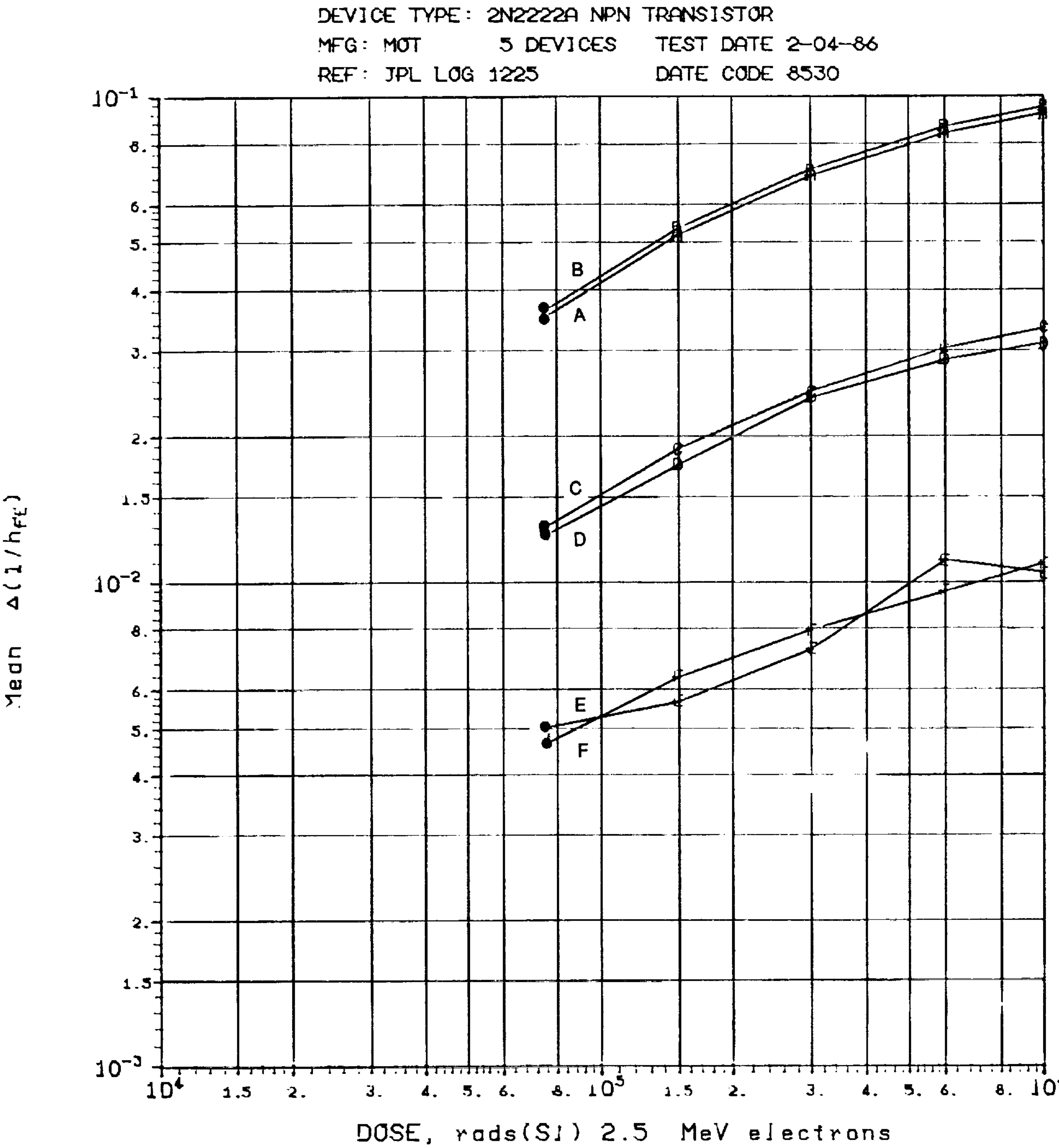
$\Delta(\frac{1}{h_{FE}})$	h_{FEo} 10	12	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	110	120	130	140	150	170	200	250	300	350	400
.0005	9.95	11.9	14.9	19.8	24.7	29.6	34.4	39.2	44.1	48.8	53.3	58.1	62.9	67.6	72.5	76.9	81.3	86.2	90.9	95.2	104	114	122	132	139	156	182	222	263	294	333
.0007	9.93	11.9	14.9	19.7	24.6	29.4	34.1	38.9	43.7	48.3	52.9	57.5	61.7	66.7	71.4	75.8	80.0	84.8	89.3	93.5	102	111	119	128	135	152	175	212	250	278	313
.001	9.90	11.9	14.8	19.6	24.4	29.2	33.8	38.5	43.1	47.6	52.1	56.6	61.0	65.4	69.9	74.1	78.1	82.6	87.0	90.9	99.0	107	115	124	130	145	167	200	233	256	286
.0015	9.85	11.8	14.7	19.4	24.1	28.7	33.2	37.7	42.2	46.5	51.8	55.0	59.2	63.4	67.6	71.4	75.2	79.4	83.3	87.0	94.3	102	109	116	122	135	154	182	208	227	250
.002	9.80	11.7	14.6	19.2	23.8	28.3	32.7	37.0	41.3	45.5	49.5	53.6	57.5	61.4	65.4	69.0	72.5	76.3	80.0	83.3	90.1	96.8	103	110	115	127	143	167	189	204	222
.0025	9.76	11.7	14.5	19.0	23.5	27.9	32.2	36.4	40.5	44.4	48.3	52.2	55.9	59.6	63.3	66.7	69.9	73.5	76.9	80.0	86.2	92.3	98.0	104	109	119	133	154	172	185	200
.003	9.71	11.6	14.3	18.9	23.3	27.5	31.7	35.7	39.7	43.5	47.2	50.8	54.4	57.9	61.4	64.5	67.6	70.9	74.1	76.9	82.6	88.2	93.5	99.0	103	112	125	143	159	170	182
.0035	9.66	11.5	14.3	18.7	23.0	27.2	31.2	35.1	38.9	42.6	46.1	49.5	52.9	56.2	59.5	62.5	65.4	68.5	71.4	74.1	79.4	84.8	89.3	94.3	98.0	106	118	133	147	156	167
.004	9.62	11.5	14.1	18.5	22.7	26.8	30.7	34.5	38.2	41.7	45.1	48.4	51.6	54.7	57.8	60.6	63.3	66.2	69.0	71.4	76.3	81.1	85.5	90.1	93.8	101	111	125	137	145	154
.005	9.52	11.3	13.9	18.2	22.2	26.1	29.9	33.3	36.8	40.0	43.1	46.2	49.0	51.9	54.6	57.1	59.5	62.1	64.5	66.7	70.9	75.0	78.7	82.6	85.7	91.7	100	111	121	127	133
.006	9.43	11.2	13.8	17.9	21.7	25.4	28.9	32.3	35.5	38.5	41.3	44.1	46.7	49.3	51.8	54.1	56.2	58.5	60.6	62.5	66.2	69.8	73.0	76.3	79.0	84.0	90.9	100	108	112	118
.007	9.35	11.1	13.6	17.5	21.3	24.8	28.1	31.3	34.3	37.0	39.7	42.3	44.6	47.0	49.3	51.3	53.2	55.2	57.1	58.8	62.1	65.2	68.0	70.9	73.2	77.5	83.3	90.9	97.1	101	105
.008	9.26	11.0	13.4	17.2	20.8	24.2	27.4	30.3	33.1	35.7	38.2	40.5	42.7	44.9	47.0	48.8	50.5	52.4	54.1	55.6	58.5	61.2	63.7	66.2	68.2	71.9	76.9	83.3	88.5	91.7	95.2
.009	9.17	10.8	13.2	16.9	20.4	23.6	26.6	29.4	32.1	34.5	36.8	39.0	41.0	42.9	44.8	46.5	48.1	49.8	51.3	52.6	55.3	57.7	60.0	62.1	63.8	67.1	71.4	76.9	81.3	84.0	87.0
.010	9.09	10.7	13.0	16.7	20.0	23.1	26.0	28.6	31.1	33.3	35.5	37.5	39.4	41.2	42.9	44.4	45.9	47.4	48.8	50.0	52.4	54.5	56.5	58.5	60.0	62.9	66.7	71.4	75.2	77.5	80.0
.011	9.01	10.6	12.9	16.4	19.6	22.6	25.3	27.7	30.1	32.3	34.3	36.1	37.4	39.5	41.1	42.6	43.4	45.3	46.5	47.6	49.7	51.2	53.5	55.3	56.5	59.2	62.5	66.7	69.9	71.9	74.1
.012	8.93	10.5	12.7	16.1	19.2	22.1	24.7	27.0	29.2	31.3	33.1	34.9	36.5	38.1	39.5	40.8	42.0	43.3	44.4	45.5	47.4	49.2	50.8	52.4	53.6	55.9	58.8	62.5	65.4	47.1	69.0
.013	8.85	10.4	12.6	15.9	18.9	21.6	24.1	26.3	28.4	30.3	32.1	33.7	35.2	36.6	38.0	39.2	40.3	42.5	42.6	43.5	45.3	47.0	48.3	49.8	50.8	52.9	55.6	58.8	61.4	62.9	64.5
.014	8.77	10.3	12.4	15.6	18.5	21.1	23.5	25.6	27.6	29.4	31.1	32.6	34.0	35.1	36.6	37.7	38.8	39.8	40.8	41.7	43.3	44.8	46.1	47.4	48.3	50.3	52.6	55.6	57.8	59.2	60.6
.015	8.70	10.1	12.2	15.4	18.2	20.7	23.0	25.0	26.9	28.6	30.1	31.6	32.9	34.1	35.3	36.4	37.3	38.3	39.2	40.0	41.5	42.9	44.1	45.3	46.2	47.9	50.0	52.6	54.6	55.9	57.1
.017	8.62	10.0	12.0	14.9	17.5	19.9	21.9	23.8	25.5	27.0	28.4	29.7	30.9	32.0	33.0	33.9	34.7	35.6	36.4	37.0	38.3	39.5	40.5	41.5	42.2	43.7	45.5	47.6	49.3	50.3	51.3
.020	8.33	9.67	11.5	14.3	16.7	18.8	20.6	22.2	23.7	25.0	26.2	27.3	28.3	29.2	30.0	30.8	31.5	32.2	32.8	33.3	34.4	35.3	36.1	36.9	37.5	38.6	40.0	41.7	42.9	43.7	44.4
.025	8.00	9.23	10.9	13.3	15.4	17.2	18.7	20.0	21.2	22.2	23.2	24.0	24.7	25.5	29.6	26.7	27.2	27.7	28.2	28.6	29.3	30.0	30.6	31.2	31.6	32.4	33.3	34.5	35.3	35.8	36.4
.030	7.69	8.82	10.3	12.5	14.3	15.8	17.1	18.2	19.2	20.0	20.8	21.4	22.0	22.6	23.1	23.5	23.9	24.3	24.7	25.0	25.6	26.1	26.5	27.0	27.3	27.9	28.6	29.4	29.9	30.4	30.8
.035	7.41	8.48	9.83	11.8	13.3	14.6	15.8	16.7	17.5	18.2	18.7	19.3	19.8	20.3	22.8	21.0	21.4	21.7	22.0	22.2	22.7	23.0	23.4	23.8	24.0	24.5	25.0	25.6	26.1	26.4	26.7
.040	7.14	8.11	9.38	11.1	12.5	13.6	14.6	15.4	16.1	16.7	17.2	17.6	18.0	18.4	18.8	19.0	19.3	19.6	19.8	20.0	20.4	20.7	21.0	21.2	21.4	21.8	22.2	22.7	23.1	23.3	23.5
.050	6.67	7.50	8.57	10.0	11.1	12.0	12.7	13.3	13.9	14.3	14.7	15.0	15.3	15.6	15.8	16.0	16.2	16.4	16.5	16.7	16.9	17.2	17.3	17.8	17.6	17.9	18.2	18.5	18.8	18.9	19.1
.060	6.25	6.98	7.89	9.09	10.0	10.7	11.3	11.8	12.2	12.5	12.8	13.0	13.3	13.5	13.6	13.8	13.9	14.1	14.2	14.3	14.5	14.6	14.8	14.9	15.0	15.2	15.4	15.6	15.8	15.9	16.0
.070	5.88	6.52	7.32	8.33	9.09	9.71	10.1	10.5	10.8	11.1	11.3	11.5	11.7	11.8	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.8	12.9	13.0	13.0	13.2	13.3	13.5	13.6	13.7	13.8
.080	5.56	6.12	6.82	7.69	8.33	8.85	9.21	9.52	9.8	10.0	10.2	10.3	10.5	10.6	10.7	10.8	10.9	11.0	11.1	11.1	11.2	11.3	11.4	11.5	11.5	11.6	11.8	11.9	12.0	12.1	12.1
.090	5.26	5.77	6.38	7.14	7.69	8.13	8.42	8.70	8.9	9.09	9.25	9.38	9.49	9.59	9.68	9.76	9.68	9.89	9.95	10.0	10.1	10.2	10.2	10.3	10.3	10.4	10.5	10.6	10.7	10.8	10.8
.100	5.00	5.45	6.00	6.67	7.14	7.52	7.81	8.00	8.2	8.33	8.46	8.57	8.67	8.75	8.83	8.89	8.95	9.00	9.05	9.09	9.17	9.23	9.29	9.34	9.28	9.44	9.52	9.62	9.68	9.72	9.76

DEVICE TYPE: 2N2222A NPN TRANSISTOR
MFG: FSC 4 DEVICES TEST DATE 02-20-86
REF: JPL LOG 1246 DATE CODE 8352



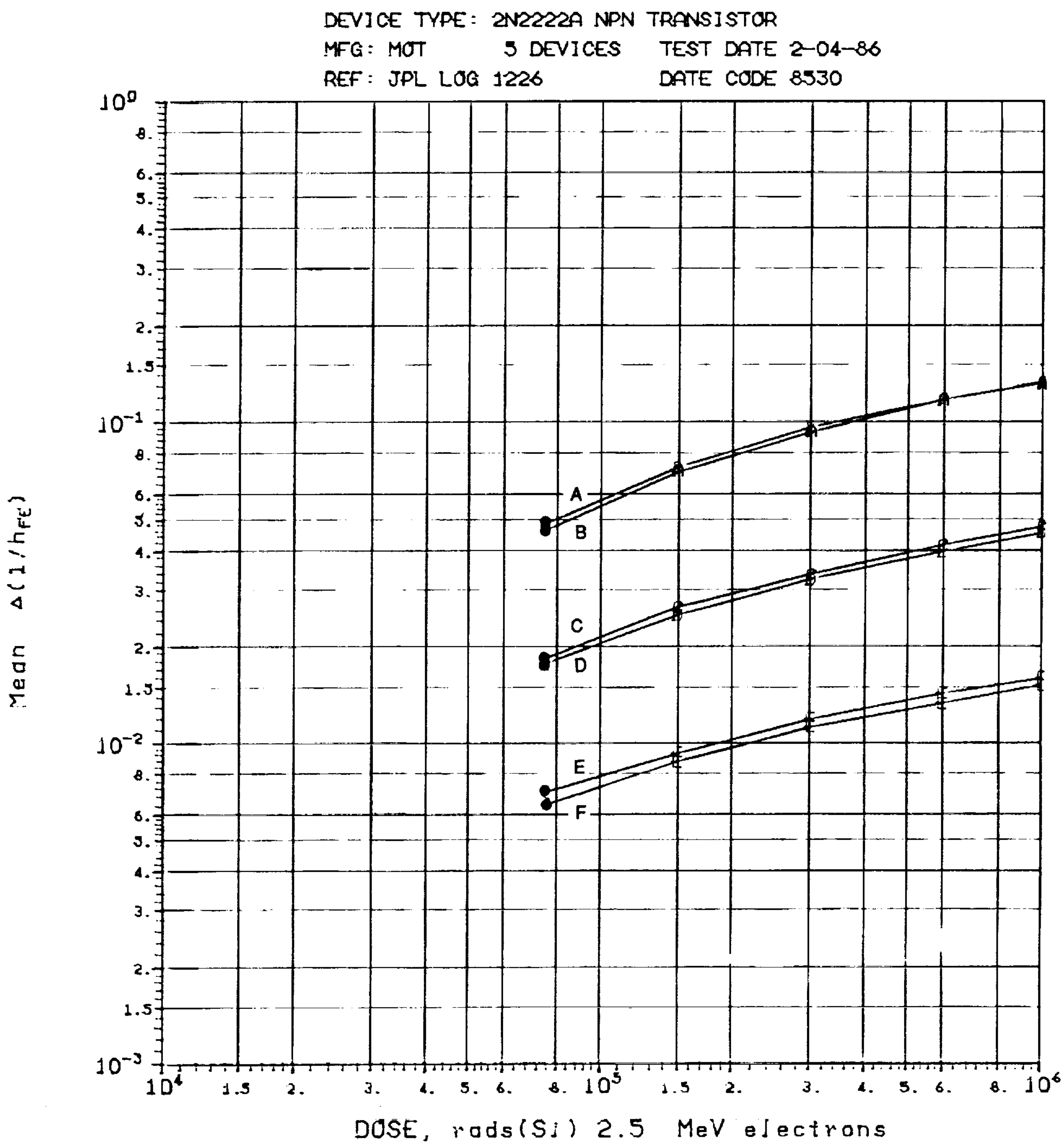
$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS							
CURVE	I_C	V_{CC}	DOSE, rads(Si)				
	(mA)	(v)	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
A	.1000	20.0	.0286	.0366	.0393	.0321	.0321
B	.1000	.500	.0322	.0372	.0363	.0357	.0281
C	1.000	.500	.0048	.0078	.0093	.0093	.0083
D	1.000	20.0	.0064	.0079	.0046	.0096	.0039
E	20.00	20.0	.0016	.0020	.0019	.0027	.0032
F	20.00	.500	.0006	.0018	.0016	.0024	.0011



Δ(1/h_{FE}) VS DOSE

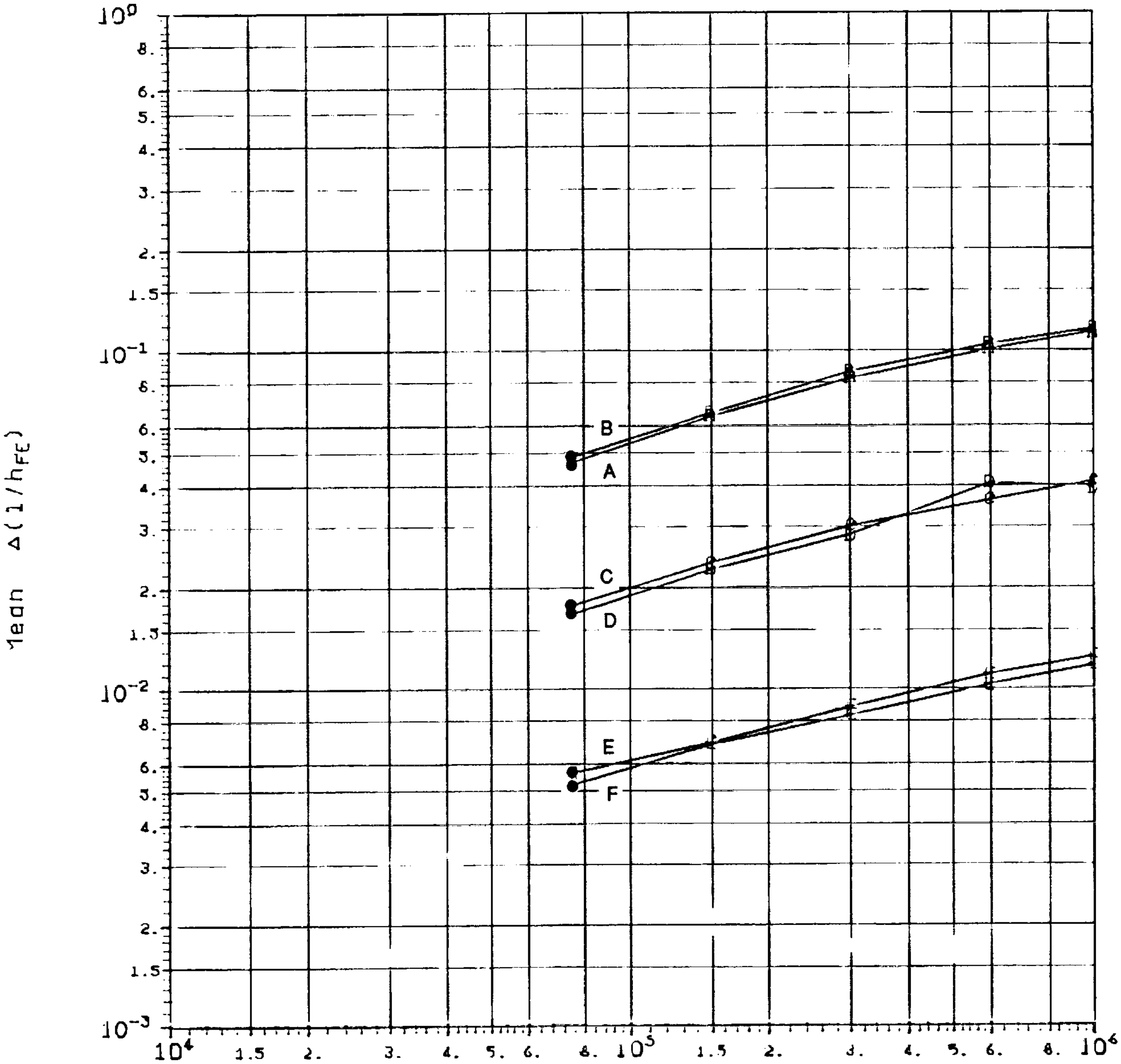
TABLE OF NORMAL STANDARD DEVIATIONS							
CURVE	I_C (mA)	V_{CE} (v)	DOSE, rads(Si) 7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
A	.1000	20.0	.0066	.0085	.0108	.0127	.0157
B	.1000	.500	.0061	.0087	.0105	.0132	.0171
C	1.000	.500	.0023	.0031	.0039	.0038	.0060
D	1.000	20.0	.0019	.0025	.0036	.0040	.0049
E	20.00	20.0	.0014	.0004	.0010	.0020	.0005
F	20.00	.500	.0007	.0010	.0010	.0014	.0015



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS							
CURVE	I_C (mA)	V_{CE} (v)	DOSE, rads(Si) 7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
A	.1000	20.0	.0040	.0047	.0060	.0082	.0065
B	.1000	.500	.0039	.0046	.0057	.0065	.0065
C	1.000	.500	.0012	.0020	.0017	.0022	.0022
D	1.000	20.0	.0013	.0014	.0020	.0018	.0017
E	20.00	20.0	.0005	.0006	.0006	.0006	.0006
F	20.00	.500	.0005	.0007	.0006	.0005	.0006

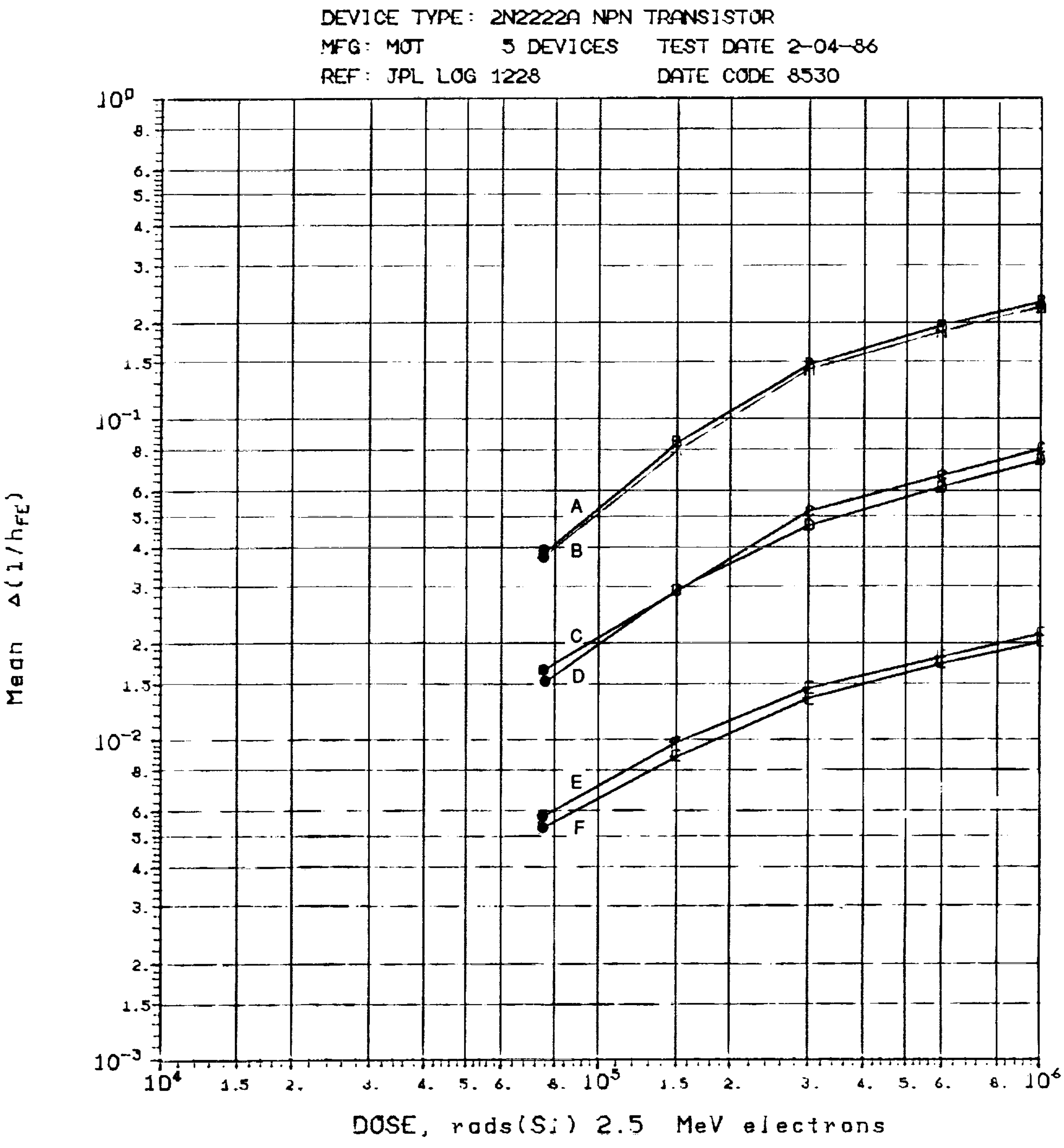
DEVICE TYPE: 2N2222A NPN TRANSISTOR
MFG: MOT 5 DEVICES TEST DATE 2-04-86
REF: JPL LOG 1227 DATE CODE 8530



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS

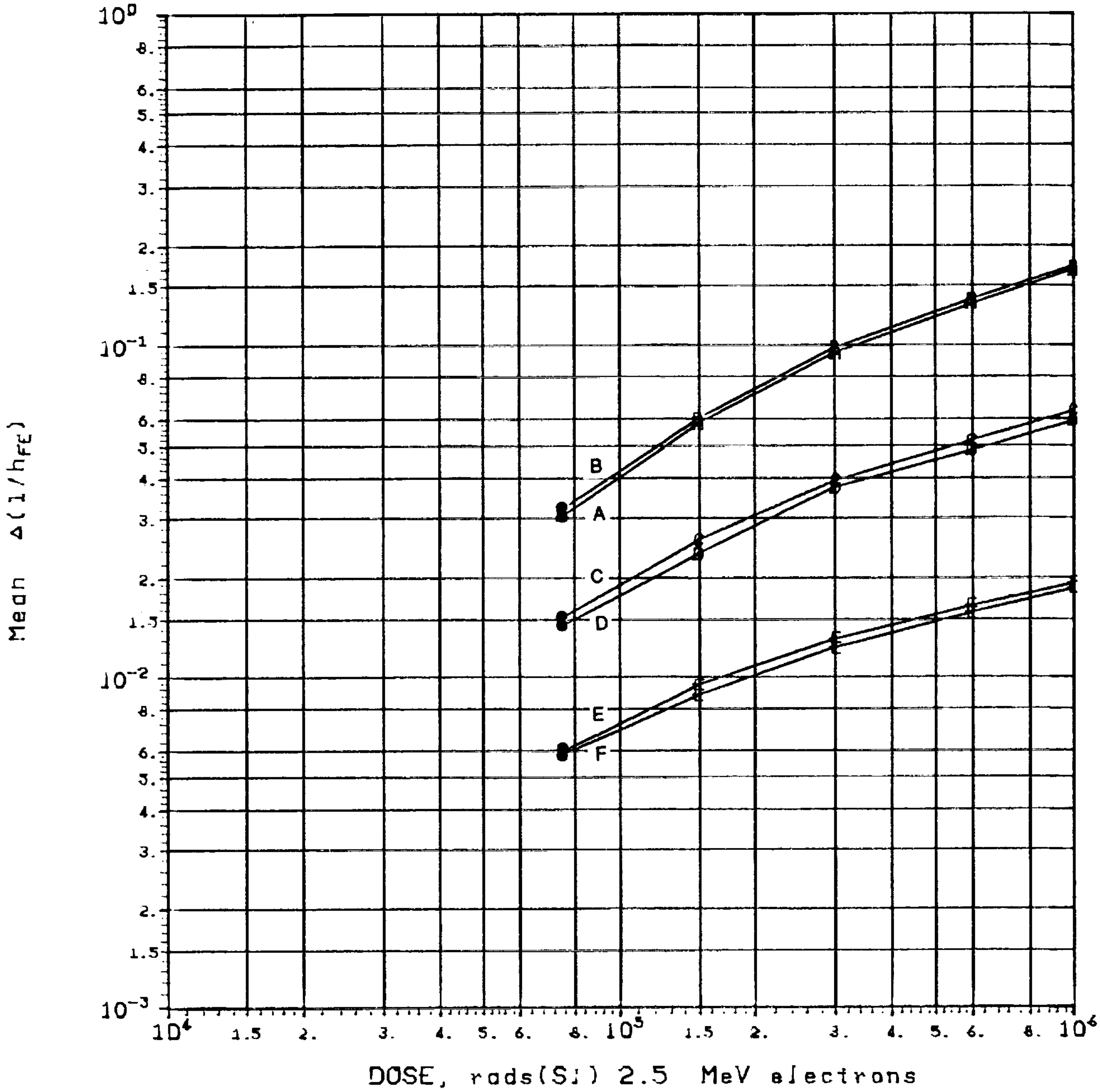
CURVE	I_C (mA)	V_{CE} (v)	DOSE, rads(Si) 7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
A	.1000	20.0	.0030	.0034	.0028	.0026	.0048
B	.1000	.500	.0029	.0026	.0023	.0022	.0039
C	1.000	.500	.0008	.0012	.0010	.0008	.0013
D	1.000	20.0	.0011	.0007	.0008	.0047	.0010
E	20.00	20.0	.0003	.0002	.0002	.0002	.0003
F	20.00	.500	.0003	.0007	.0002	.0003	.0003



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS							
CURVE	I_C (mA)	V_{CE} (v)	DOSE, rads(Si) 7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
A	.1000	20.0	.0026	.0305	.0158	.0102	.0126
B	.1000	.500	.0026	.0302	.0153	.0108	.0104
C	1.000	.500	.0011	.0152	.0054	.0035	.0031
D	1.000	20.0	.0009	.0091	.0075	.0045	.0032
E	20.00	20.0	.0003	.0020	.0012	.0010	.0011
F	20.00	.500	.0003	.0023	.0012	.0008	.0011

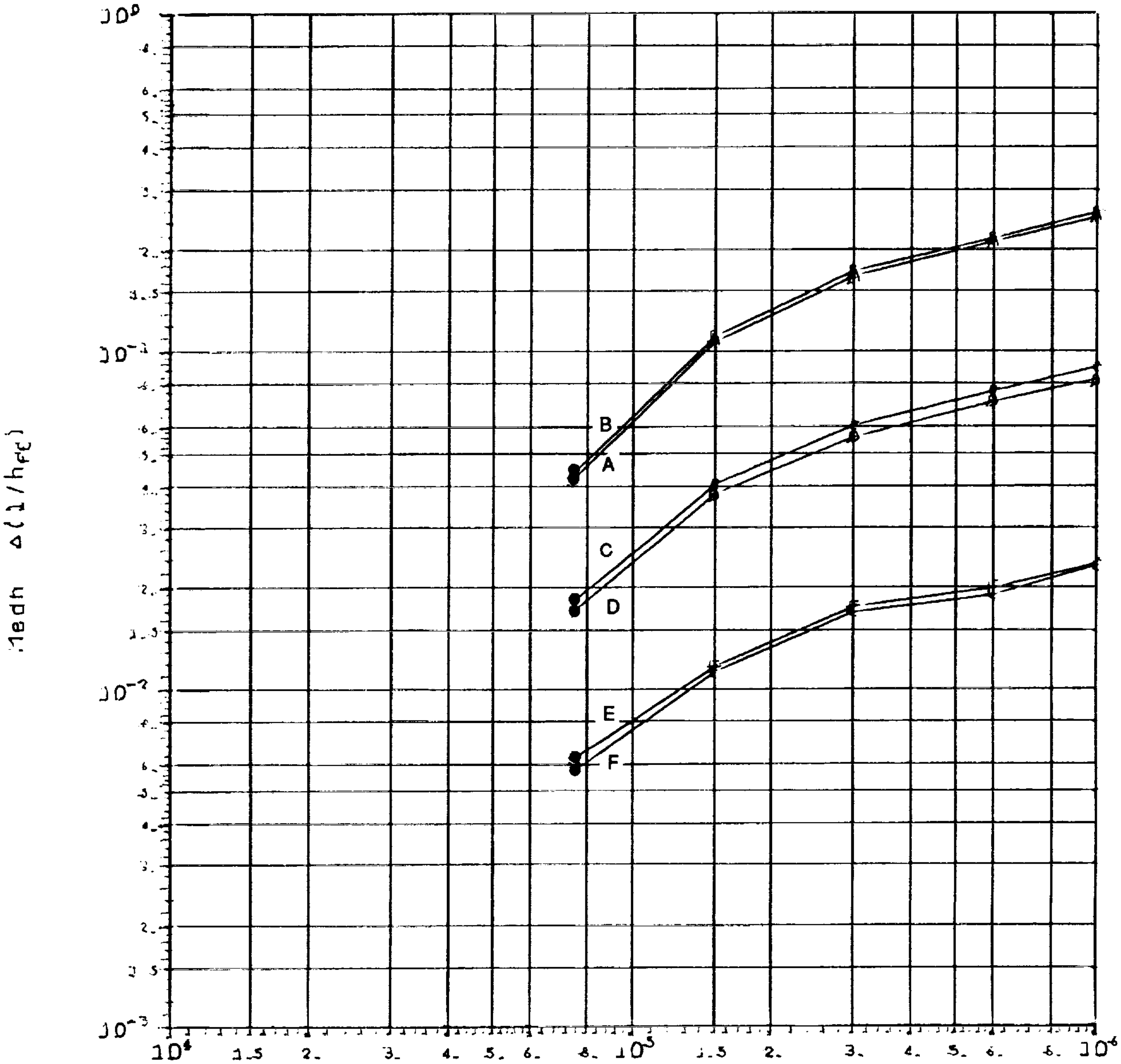
DEVICE TYPE: 2N2222A NPN TRANSISTOR
MFG: MOT 5 DEVICES TEST DATE 2-04-86
REF: JPL LOG 1229 DATE CODE 8530



Δ(1/hFE) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS							
CURVE	Ic (mA)	Vcc (v)	DOSE, rads(Si) 7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
A	.1000	20.0	.0015	.0017	.0022	.0067	.0023
B	.1000	.500	.0014	.0022	.0029	.0056	.0029
C	1.000	.500	.0006	.0007	.0008	.0017	.0009
D	1.000	20.0	.0005	.0025	.0009	.0009	.0007
E	20.00	20.0	.0004	.0002	.0003	.0003	.0002
F	20.00	.500	.0002	.0002	.0003	.0003	.0005

DEVICE TYPE: 2N2222A NPN TRANSISTOR
MFG: MOT 5 DEVICES TEST DATE 02-04-86
REF: JPL LOG 1230 DATE CODE 8530

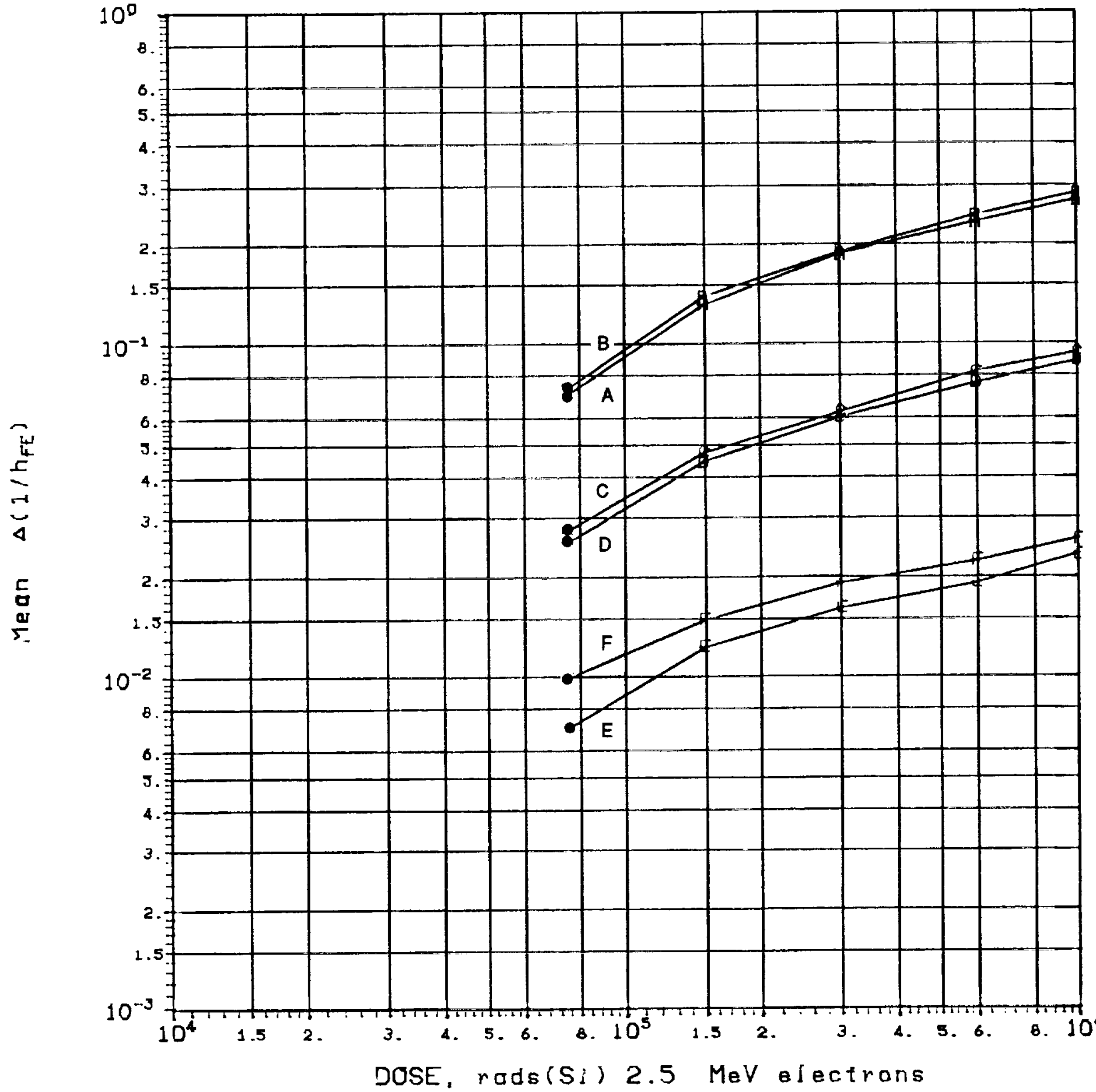


DOSE, rads(Si) 2.5 MeV electrons

Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS							
CURVE	I_C (mA)	V_{CE} (v)	DOSE, rads(Si) 7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
A	.1000	20.0	.0012	.0017	.0031	.0045	.0043
B	.1000	.500	.0013	.0020	.0017	.0062	.0041
C	1.000	.500	.0006	.0006	.0011	.0013	.0019
D	20.00	20.0	.0006	.0009	.0009	.0004	.0016
E	20.00	.500	.0002	.0002	.0008	.0003	.0003
F	.0000	.000	.0001	.0003	.0007	.0003	.0004

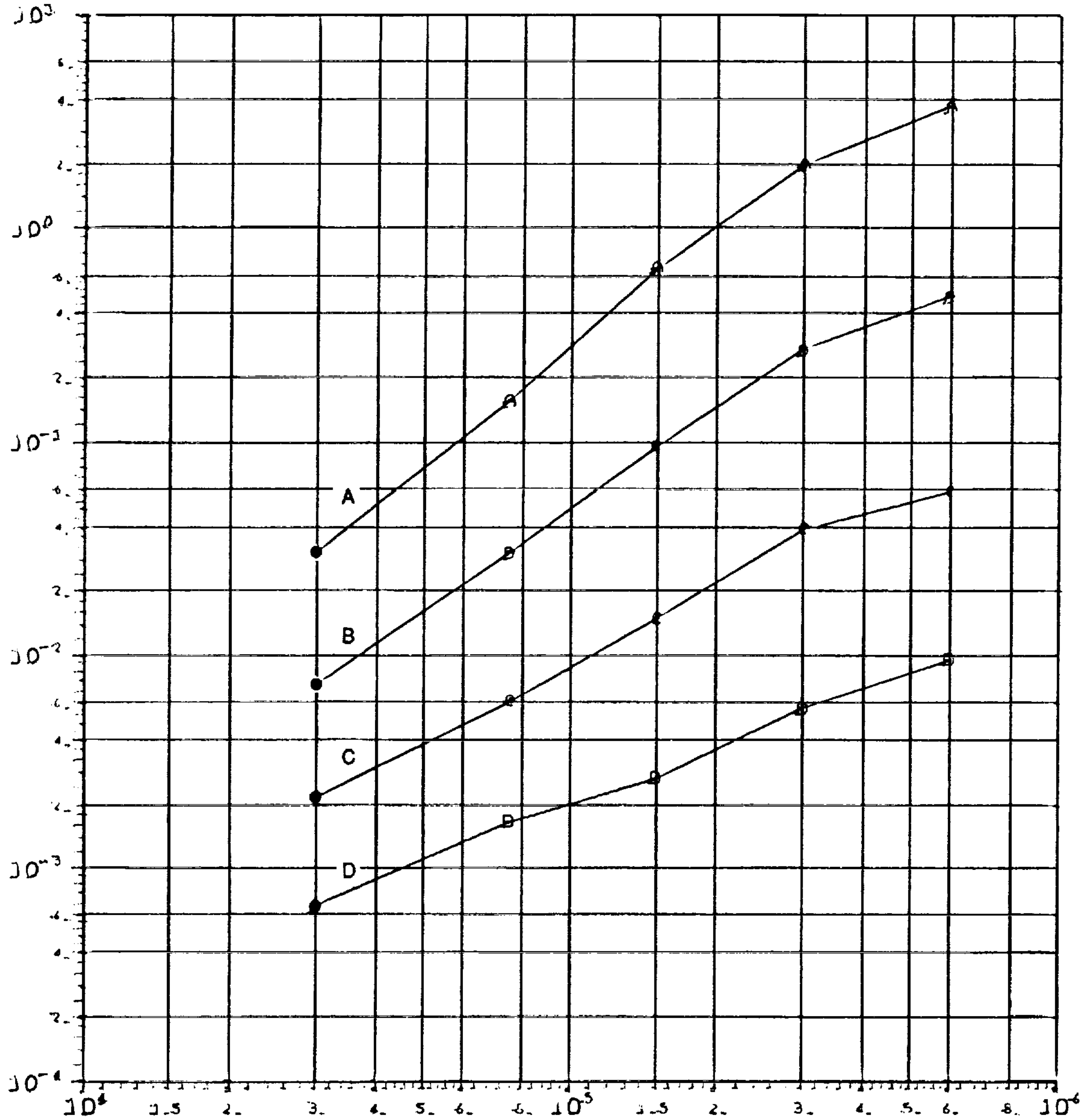
DEVICE TYPE: 2N2222A NPN TRANSISTOR
MFG: MOT 5 DEVICES TEST DATE 02-05-86
REF: JPL LOG 1231 DATE CODE 8530



$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS							
CURVE	I_C	V_{CE}	DOSE, rads(Si)				
	(mA)	(v)	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
A	.1000	20.0	.0049	.0082	.0072	.0062	.0065
B	.1000	.500	.0056	.0091	.0036	.0086	.0078
C	1.000	.500	.0016	.0039	.0044	.0020	.0024
D	1.000	20.0	.0016	.0029	.0025	.0025	.0020
E	20.00	20.0	.0003	.0002	.0004	.0008	.0003
F	20.00	.500	.0003	.0005	.0006	.0011	.0006

DEVICE TYPE: 2N3749 NPN POWER TRANSISTOR
MFG: APC 3 DEVICES TEST DATE 12-19-85
REF: JPL LOG 1211 DATE CODE 8510



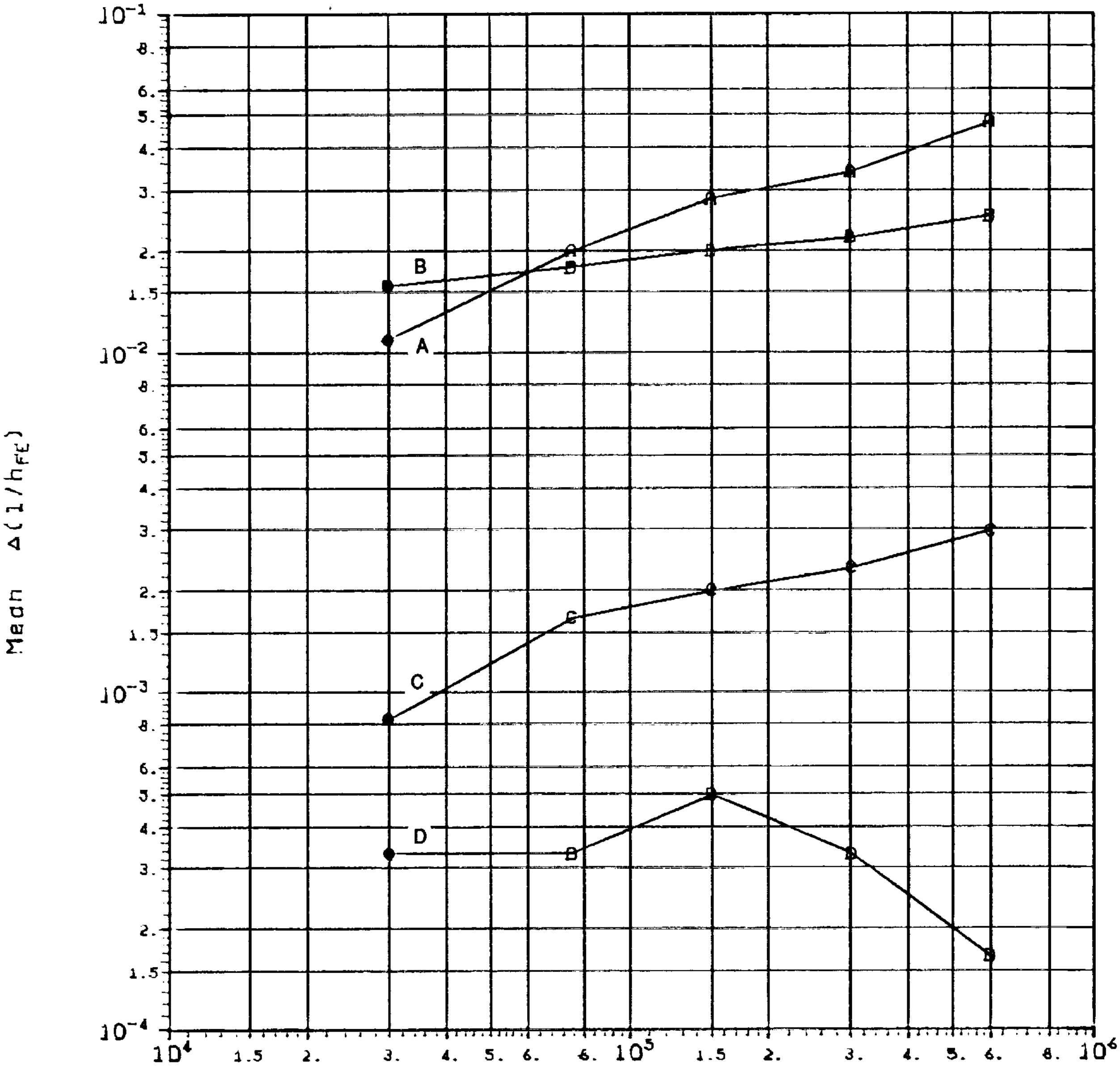
Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS							
CURVE	I_C (mA)	V_{CE} (v)	DOSE, rads(Si) 3.0E4	7.5E4	1.5E5	3.0E5	6.0E5
A	1.000	5.00	.0402	.2381	.8168	1.062	1.034
B	10.00	5.00	.0110	.0429	.1044	.1250	.1457
C	100.0	5.00	.0025	.0073	.0136	.0154	.0141
D	1000.	5.00	.0008	.0013	.0013	.0023	.0038

DEVICE TYPE: 2N3749 NPN

MFG: PPC 3 DEVICES TEST DATE 01-08-86

REF: JPL LOG 1212 DATE CODE 8515

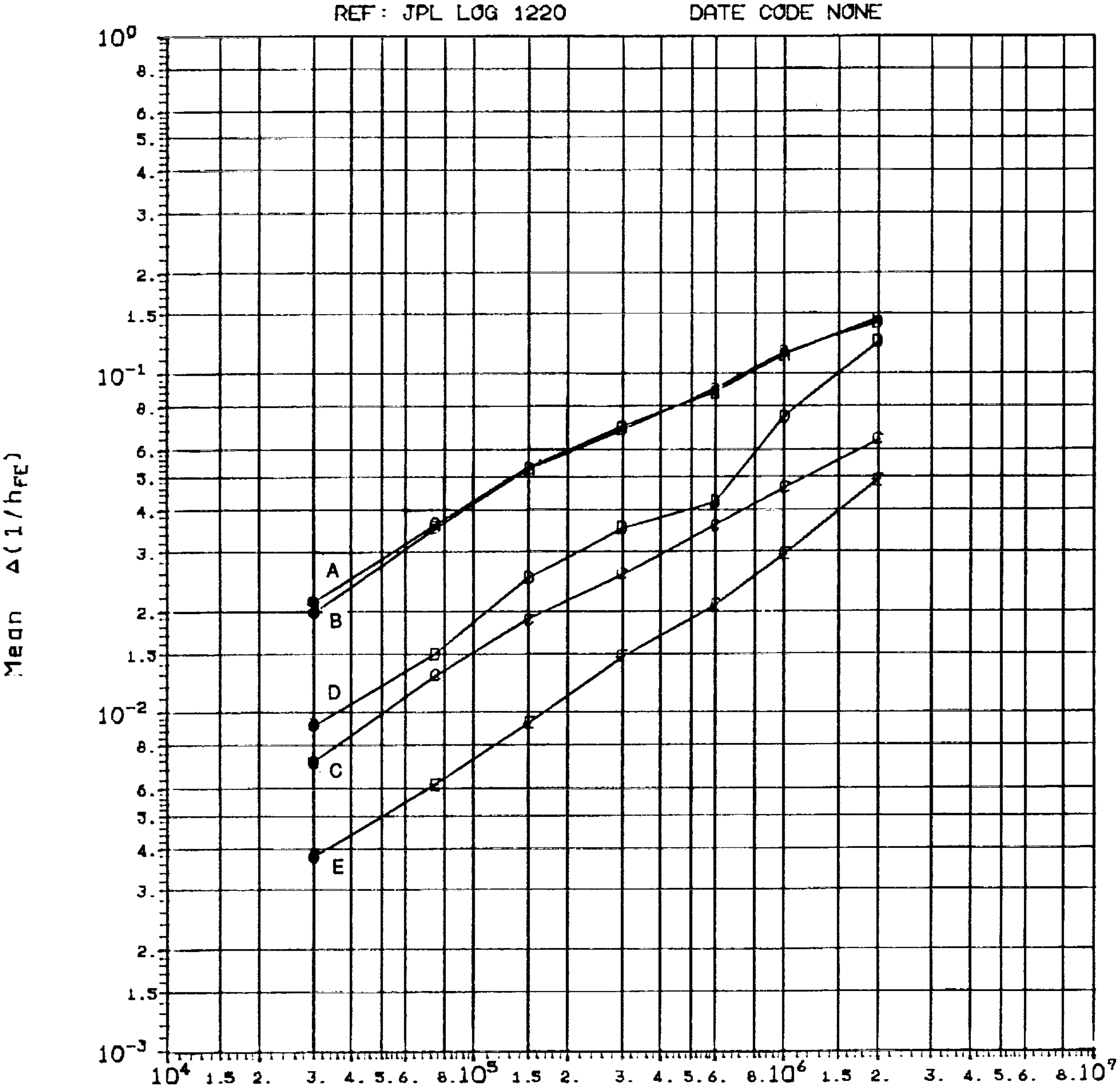


DOSE, rads(Si) Co^{60} Gammas

$\Delta(1/h_{FE})$ VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS							
CURVE	I_c (mA)	V_{CE} (v)	DOSE, rads(Si) 3.0E4	7.5E4	1.5E5	3.0E5	6.0E5
A	1.000	5.00	.0018	.0038	.0040	.0045	.0045
B	10.00	5.00	.0022	.0028	.0028	.0027	.0031
C	100.0	5.00	.0003	.0003	.0005	.0003	.0005
D	1000.	5.00	.0003	.0003	.0000	.0003	.0003

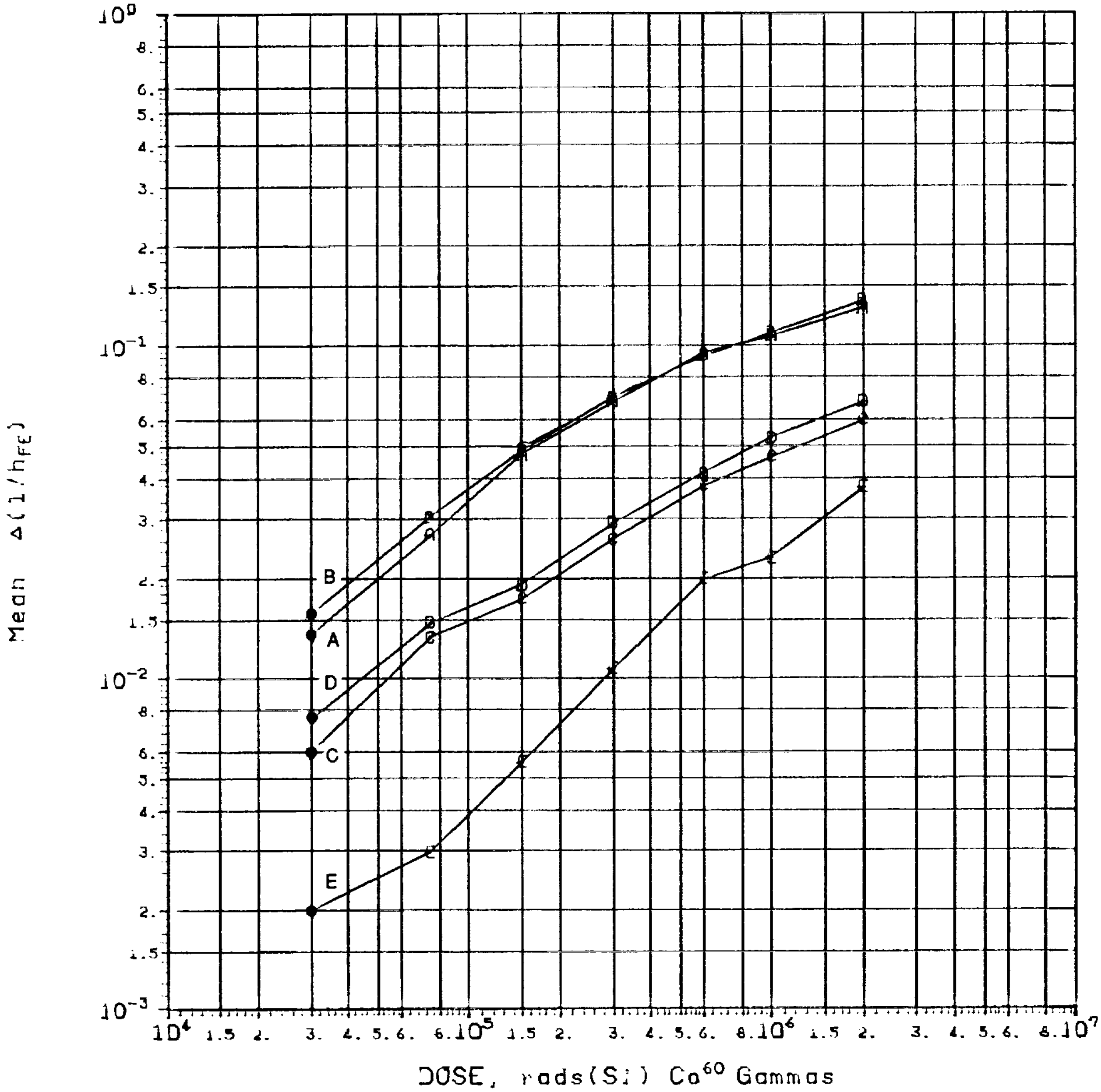
DEVICE TYPE: MJ16012 NPN POWER TRANSISTOR
MFG: MOT 5 DEVICES TEST DATE 12-17-85
REF: JPL LOG 1220 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS									
CURVE	I_C (mA)	V_{CE} (v)	DOSE, rads(Si) 3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6
A	100.0	50.0	.0072	.0127	.0164	.0219	.0373	.0319	.0312
B	100.0	.500	.0063	.0114	.0169	.0226	.0373	.0285	.0247
C	1000.	50.0	.0025	.0050	.0077	.0103	.0168	.0119	.0135
D	1000.	.500	.0029	.0062	.0071	.0093	.0102	.0121	.0174
E	10000.	50.0	.0013	.0019	.0036	.0041	.0090	.0068	.0067

DEVICE TYPE: MJ16012 NPN POWER TRANSISTOR
MFG: MOT 5 DEVICES TEST DATE 12-12-85
REF: JPL LOG 1221 DATE CODE NONE



Δ(1/h_{FE}) VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS									
CURVE	I_c (mA)	V_{ce} (v)	DOSE, rads(Si) 3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6
A	100.0	50.0	.0043	.0074	.0118	.0136	.0156	.0173	.0288
B	100.0	.500	.0048	.0089	.0129	.0145	.0190	.0211	.0334
C	1000.	50.0	.0016	.0052	.0045	.0053	.0065	.0062	.0082
D	1000.	.500	.0025	.0078	.0061	.0067	.0081	.0086	.0105
E	10000.	50.0	.0034	.0051	.0017	.0030	.0035	.0048	.0046

B. OPTICAL DEVICES

The optical data are presented in a combined narrative, tabular, and graphic format.

The TIL24 devices were measured using a TIL604 photo transistor as a reference sensor, placed 1/4 in. from the source being measured. The TIL604 devices were measured using a single TIL24 near-infrared-emitting diode as the light source, placed 1/4 in. away from the base of the photo transistor.

Device Type: TIL24 BIPOLAR PN GaAs INFRARED-EMITTING DIODES
Manufacturer: Texas Instruments Inc. (TIX)
Date Code:
Package Type: PILL
No. of Devices Tested: 2 LOG 1261; 7 (6 + Control) LOG 1260
Radiation Test Requirement (RTR) S/N: 100 C
Log No.: 1260, 1261
Radiation Test Date: 10-July-86
Facility: DYNAMITRON
Energy: 2.5 MeV
Dose Rate: 1.3E08, 4.0E08, 4.0E09, increasing with dose (see RTR 100C)
Dose: 4.0E10 to 2.0E12 [e/cm^2] or 1.0E3 to 5.0E5 [rad(Si)]

In the discussion below, only the parameters that failed are discussed; all other parameters met the manufacturers' specifications out to 50 krad(Si). It is recommended that this device not be used above 10 krad(Si) at the 50 mA drive level unless special design considerations are made to account for the observed failures. Postirradiation measurements were made at 2, 20, and 100 hours after irradiation. The annealing behavior should be taken into account, because the extremely low dose rates in space will allow significant annealing and possibly permit use of this part up to the 30 krad(Si) dose level, based on the specification of 1 mW at 50 mA drive. Use at current drives lower than 50 mA should be done with extreme caution, because the nonlinearity in the power curve with current indicates the possibility of premature failure at low current drives (power output is below 1 mW at 40 mA preirradiation and decreases exponentially with lower currents).

The TIL24 bipolar pn GaAs infrared-emitting diode is designed to emit near-infrared radiation spectrally compatible with silicon sensors. It is designed to have high power efficiency, high power output, and to permit matrix assembly directly to printed circuit boards.

Failure levels are taken as parameter changes exceeding the manufacturers' specifications or reasonable preset changes, even though it is realized that some failures to meet specifications can be overcome by clever design.

These devices were irradiated according to RTR S/N 100 C, which gives the bias conditions during irradiation and lists the parameters measured and the measurement conditions. All measurements of light output from the TIL24 were relative measurements, using a single TIL604 phototransistor as a reference sensor placed a fixed distance (1/4 in.) from the source being measured. The RTR and the data are available, if required.

The TIL24 GaAs infrared-emitting diodes were kept under radiation bias after completion of irradiation to 50 krad(Si), and were measured at 2, 20, and 100 hours of anneal time. The TIL24 showed significant recovery of output power for all tested conditions.

Device Type: TIL24 BIPOLAR PN GaAs INFRARED-EMITTING DIODES

Failure Summary:

The mean light emitted in response to various inputs as a function of dose is shown in Table 1 for the preirradiation, 10, 20, 50 krad(Si) levels as well as for the 2, 20, and 100 hours anneal time measurements. While the TIL24 remained functional out to the 50 krad(Si) dose level, the light output had fallen by roughly a factor of two at the 20 krad(Si) dose level and continued to degrade with increasing dose.

Table 1. Output Power at Various Currents Versus Dose Level with Input Light Reference Current (IF) as a Parameter.

Po @ IF(mA)	PRE	krad(Si) 10	20	50	2 hr	20 hr	100 hr
20	390.0	256.3	176.3	63.8	108.8	218.8	260.0 mW
40	971.1	692.5	496.2	195.0	320.0	580.0	672.5 mW
60	1558.0	1163.0	868.8	368.8	568.8	977.5	1114.0 mW
80	2112.0	1629.0	1250.0	565.0	833.8	1366.0	1548.0 mW
100	2623.0	2623.0	1620.0	772.5	1097.0	1741.0	1954.0 mW

These data are plotted in the following graph, which shows output phototransistor current versus LOG(Dose and Time), with the drive current of the light source and/or the incident light energy as a parameter.

The other parameters were measured as a function of dose level and did not exceed the manufacturers' specifications or change significantly with dose up to the 50 krad(Si) dose level.

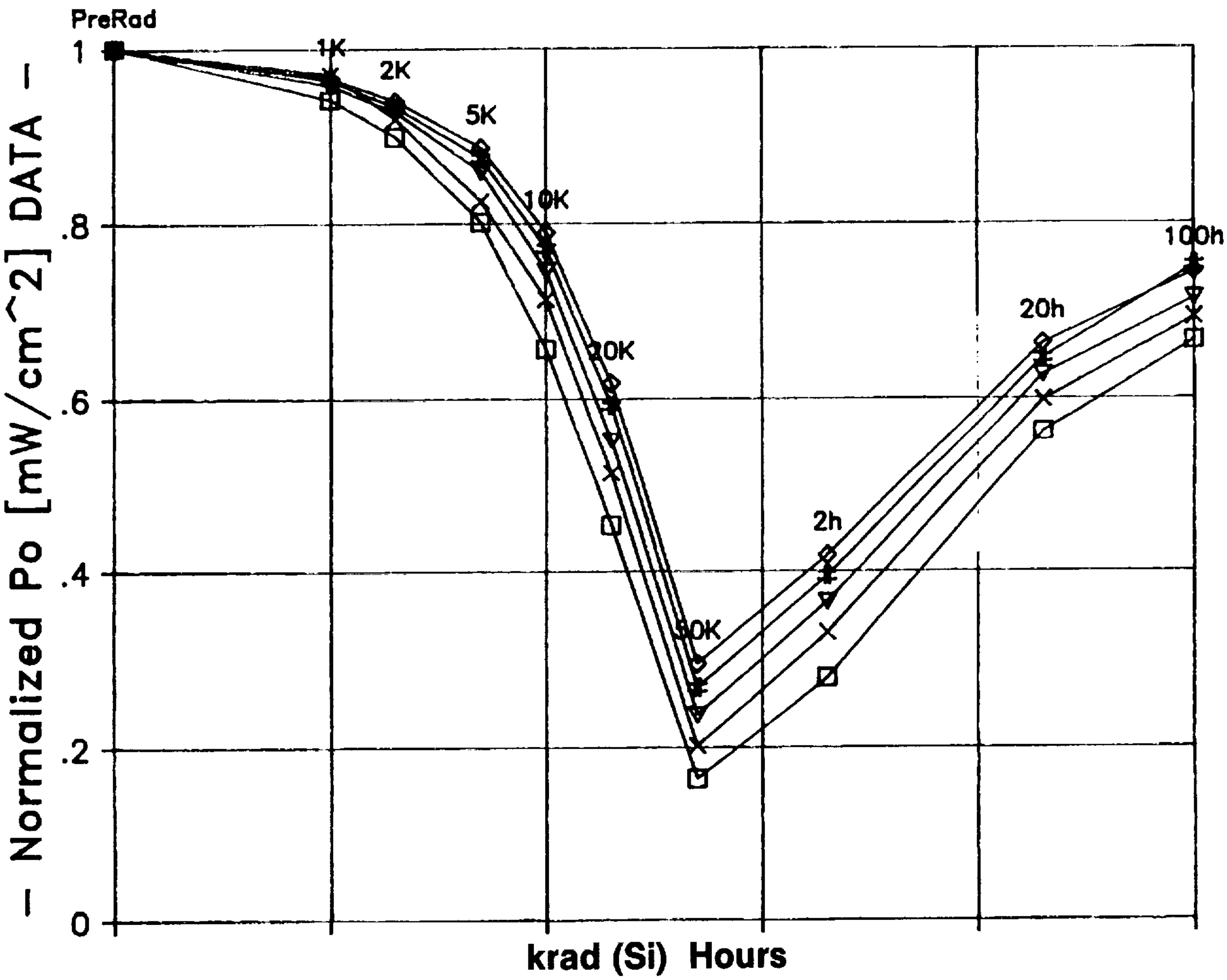
These devices were irradiated according to RTR S/N 100 C which gives the bias conditions during irradiation and lists the parameters measured and the measurement conditions. The RTR and the data are available if required.

The parameters measured were (RTR 100 C):

Test No.	Symbol	Test Name	Conditions (Reference sensor is a TIL604 @ (VCE=5V)
1	VF-1	FORWARD VOLTAGE	IF = 20 mA
2	VF-2	FORWARD VOLTAGE	IF = 40 mA
3	VF-3	FORWARD VOLTAGE	IF = 60 mA
4	VF-4	FORWARD VOLTAGE	IF = 80 mA
5	VF-5	FORWARD VOLTAGE	IF = 100 mA
6	Po-1	RELATIVE OUTPUT POWER	IF = 20 mA
7	Po-2	RELATIVE OUTPUT POWER	IF = 40 mA
8	Po-3	RELATIVE OUTPUT POWER	IF = 60 mA
9	Po-4	RELATIVE OUTPUT POWER	IF = 80 mA
10	Po-5	RELATIVE OUTPUT POWER	IF = 100 mA

– Normalized Po [mW/cm^2] DATA –

4/27/87



LOG1260:Data TIX TIL24 Bipolar PN GaAs
Infrared–Emitting Diodes

- Po @ IF =20mA
- Po @ IF =40mA
- Po @ IF =60mA
- Po @ IF =80mA
- Po @ IF =100mA

Device Type: TIL604 BIPOLAR NPN PLANAR SILICON PHOTOTRANSISTOR
Manufacturer: Texas Instruments Inc. (TIX)
Date Code: 8507
Package Type: PILL
No. of Devices Tested: 2 LOG 1258; 7 (6 + Control) LOG 1259
Radiation Test Requirement (RTR) S/N: 412
Log No.: 1258, 1259
Radiation Test Date: 09-July-86
Facility: DYNAMITRON
Energy: 2.5 MeV
Dose Rate: 1.3E08, 4.0E08, 4.0E08, increasing with level (see RTR 412)
Dose: 4.0E10 to 2.0E12 [e/cm^2] or 1.0E3 to 5.0E5 [rad(Si)]

In the discussion below, only the parameters that failed are discussed; all other tested parameters met the manufacturers' specifications out to 50 krad(Si). It is recommended that this device not be used above 10 krad(Si) unless special design considerations to account for the observed degradations are made.

The TIL604 is a bipolar, nonplanar silicon phototransistor in a hermetically sealed pill package that can be assembled into printed circuit boards. The TIL604 is recommended for applications in character recognition, tape and card readers, velocity indicators, and encoders.

Failure levels are taken at parameter changes exceeding the manufacturers' specifications or reasonable preset changes, even though it is realized that some failures to meet specifications can be overcome by clever design.

These devices were irradiated according to RTR S/N 412, which gives the bias conditions during irradiation and lists the parameters measured and the measurement conditions. The TIL604 phototransistors were tested using a single TIL near-infrared-emitting diode as the light source a fixed distance (1/4 in.) away. The current for the reference diode was varied to give a reasonable range of collector currents values in the tested phototransistor, prior to radiation exposure. The RTR and the data are available, if required.

The TIL604 phototransistors were kept under the radiation bias after completion of irradiation to 50 krad(Si), and were measured at 16 and 120 hours of anneal time. No significant annealing of the TIL604 was observed.

Failure Summary:

The mean light current response to various light inputs as a function of dose level is shown in Table 1 for the preirradiation, 10, 20, and 50 krad(Si) levels, as well as for the 16- and 120-hour anneal time measurements. While the TIL604 phototransistors remained functional out to the 50 krad(Si) dose level, the light current had fallen by roughly a factor of two at the 10 krad(Si) level, and continued to degrade with increasing dose levels.

Device Type: TIL604 BIPOLAR NPN PLANAR SILICON PHOTOTRANSISTOR

Failure Summary (Cont):

Table 1. I-LITE Versus Dose Level with Input Light Reference Current (IF) as a Parameter

I-LITE(mA) @ IF=20 mA	PRE	krad(Si) 10	20	50	16 hr	120 hr
20 mA (7mW/cm^2)	4.070	1.927	1.426	0.845	0.920	0.883 mA
40 mA (17mW/cm^2)	9.001	5.170	4.197	2.784	2.957	2.951 mA
60 mA (20mW/cm^2)	13.170	7.782	6.547	4.579	4.819	4.874 mA
80 mA (27mW/cm^2)	16.410	10.290	8.824	6.254	6.548	6.671 mA
100 mA (100mW/cm^2)	18.850	12.490	10.810	7.713	8.042	8.225 mA

These data are plotted in the following graph, which shows output phototransistor current versus LOG (Dose and Time), with the drive current of the light source and/or the incident light energy as a parameter.

The other parameters were measured as a function of dose level and did not exceed the manufacturers' specifications or change significantly with dose up to the 50 krad(Si) dose level.

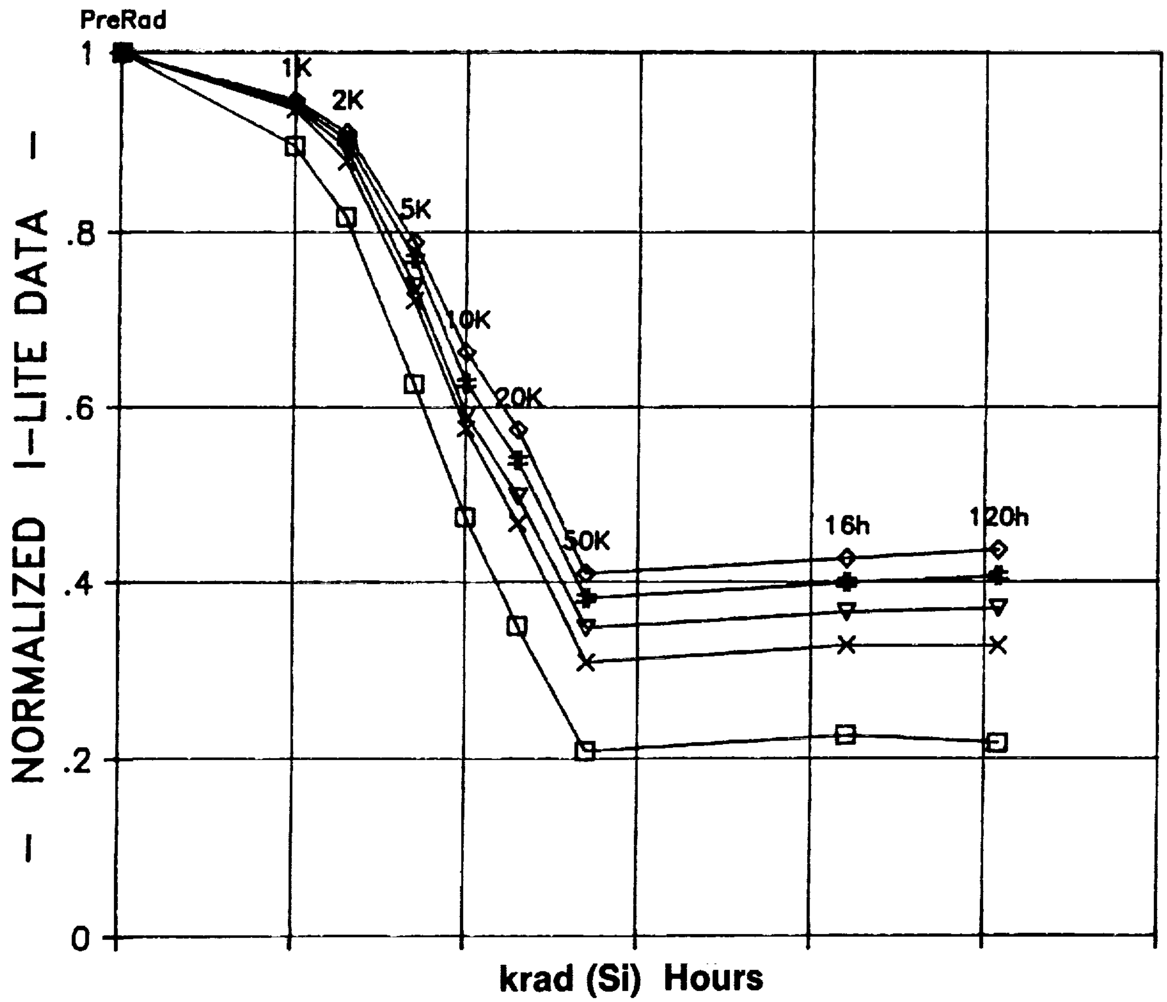
These devices were irradiated according to RTR S/N 412 which gives the bias conditions during irradiation and lists the parameters measured and the measurement conditions. The RTR and the data are available, if required.

The parameters measured were (RTR 412):

Test No.	Symbol	Test Name	Conditions (Reference source is a TIL24)
1	BVCEO	REVERSE BREAKDOWN VOLTAGE	IC = 100 μA
2	I-DARK	DARK CURRENT	VCE = 30 V
3	I-LITE1	LIGHT CURRENT 7 mW/cm^2	VCE = 5V, IF = 20 mA from reference source
4	I-LITE2	LIGHT CURRENT 17 mW/cm^2	VCE = 5V, IF = 40 mA from reference source
5	I-LITE3	LIGHT CURRENT 20 mW/cm^2	VCE = 5V, IF = 60 mA from reference source
6	I-LITE4	LIGHT CURRENT 27 mW/cm^2	VCE = 5V, IF = 80 mA from reference source
7	I-LITE5	LIGHT CURRENT 33 mW/cm^2	VCE = 5V, IF = 100 mA from reference source
8	VCE(SAT)	OUTPUT SATURATION VOLTAGE	IC = 0.4 mA, IF = 70 mA from reference source

– NORMALIZED I–LITE DATA –

4/27/87



LOG1258:Data TIX TIL604 NPN Planar Silicon Phototransistor

C. INTEGRATED CIRCUITS

The data are presented in graphic format using the normal distribution.[2] The graph format varies depending on the test requirements. Some graphs present a table of standard deviations at the bottom (Figure 5-2), others have more than one plot per paragraph, with or without post irradiation effects (PIE) data in hours following end of radiation (EOR) plots (Figure 5-3). Tests investigating dose rate effects indicate the test dose rate on the graph.

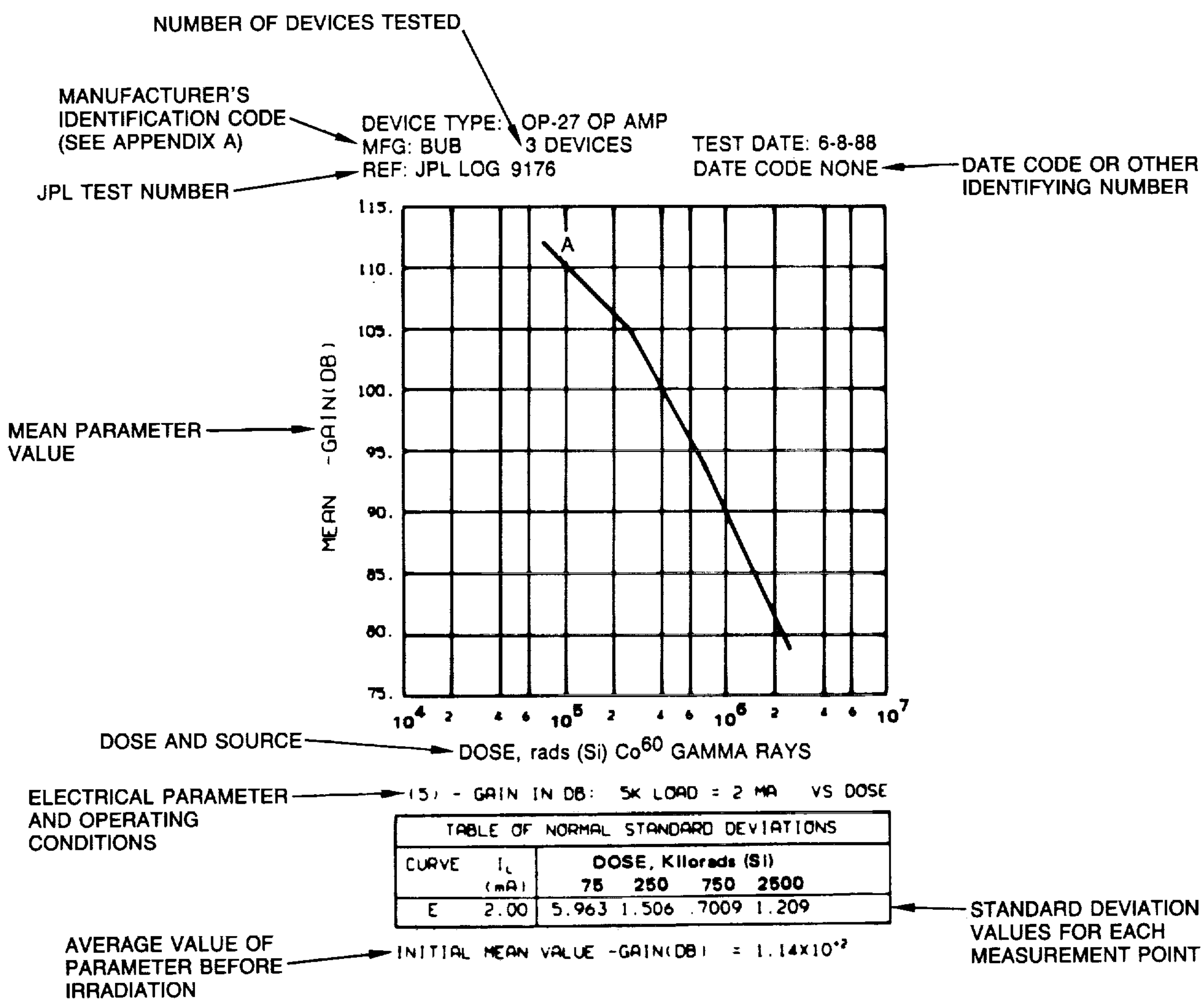


Figure 5-2. Typical Integrated Circuit Graph Format Example

[2] The log-normal or other types of distributions may provide a better fit for some radiation data than the normal distribution. Hence, caution should be exercised in estimating worst-case conditions based on the limited statistical data presented here.

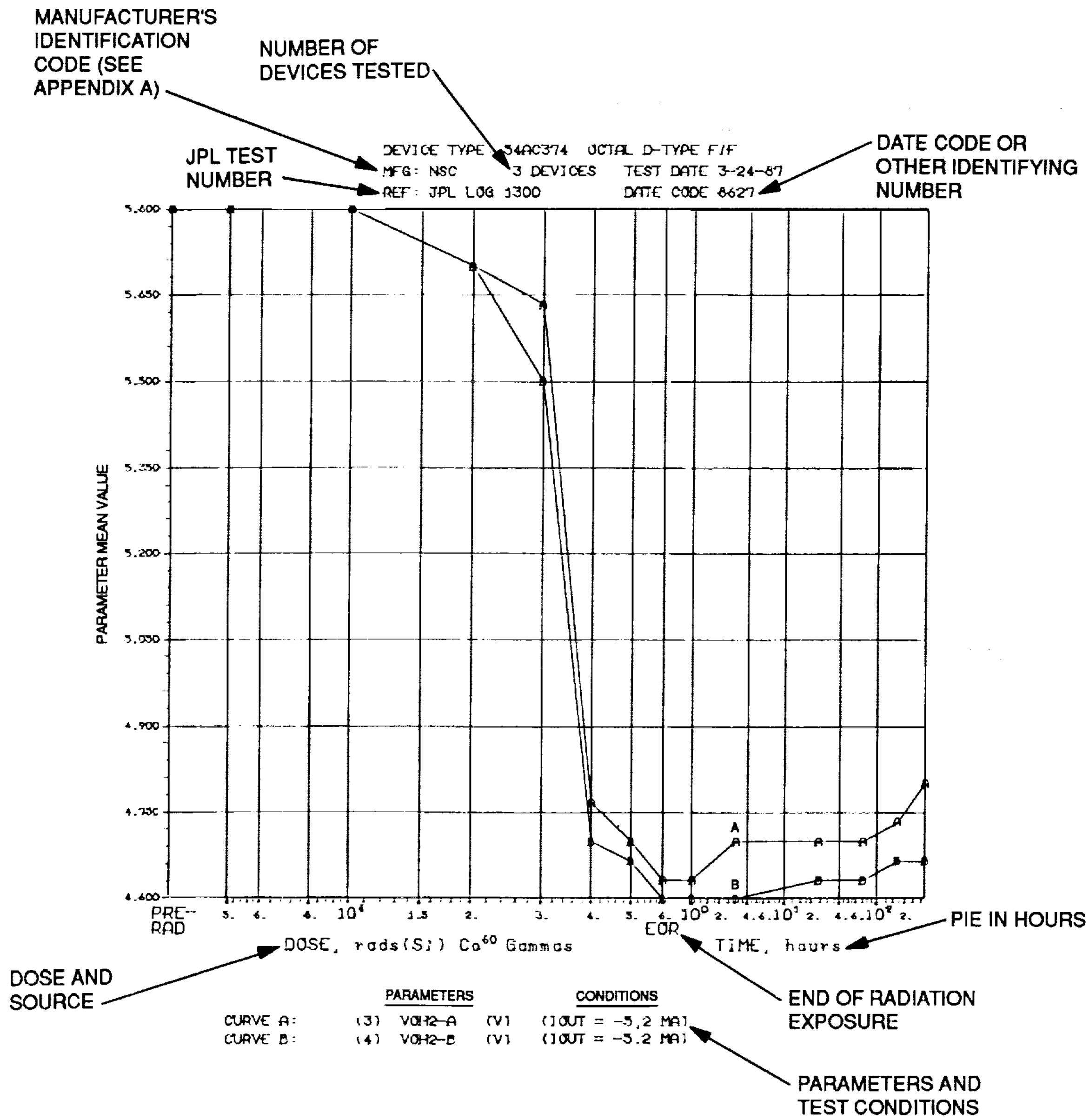
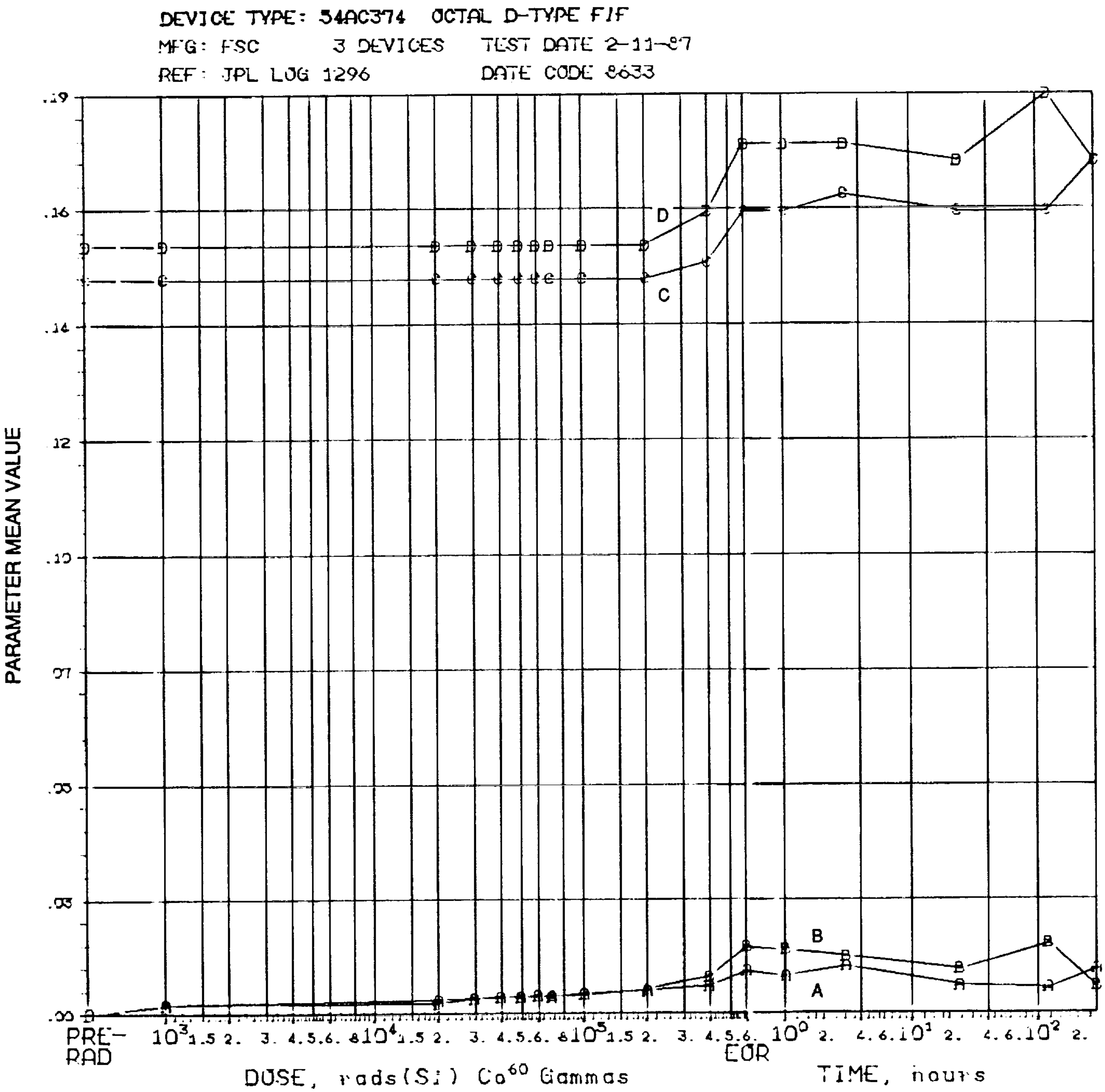
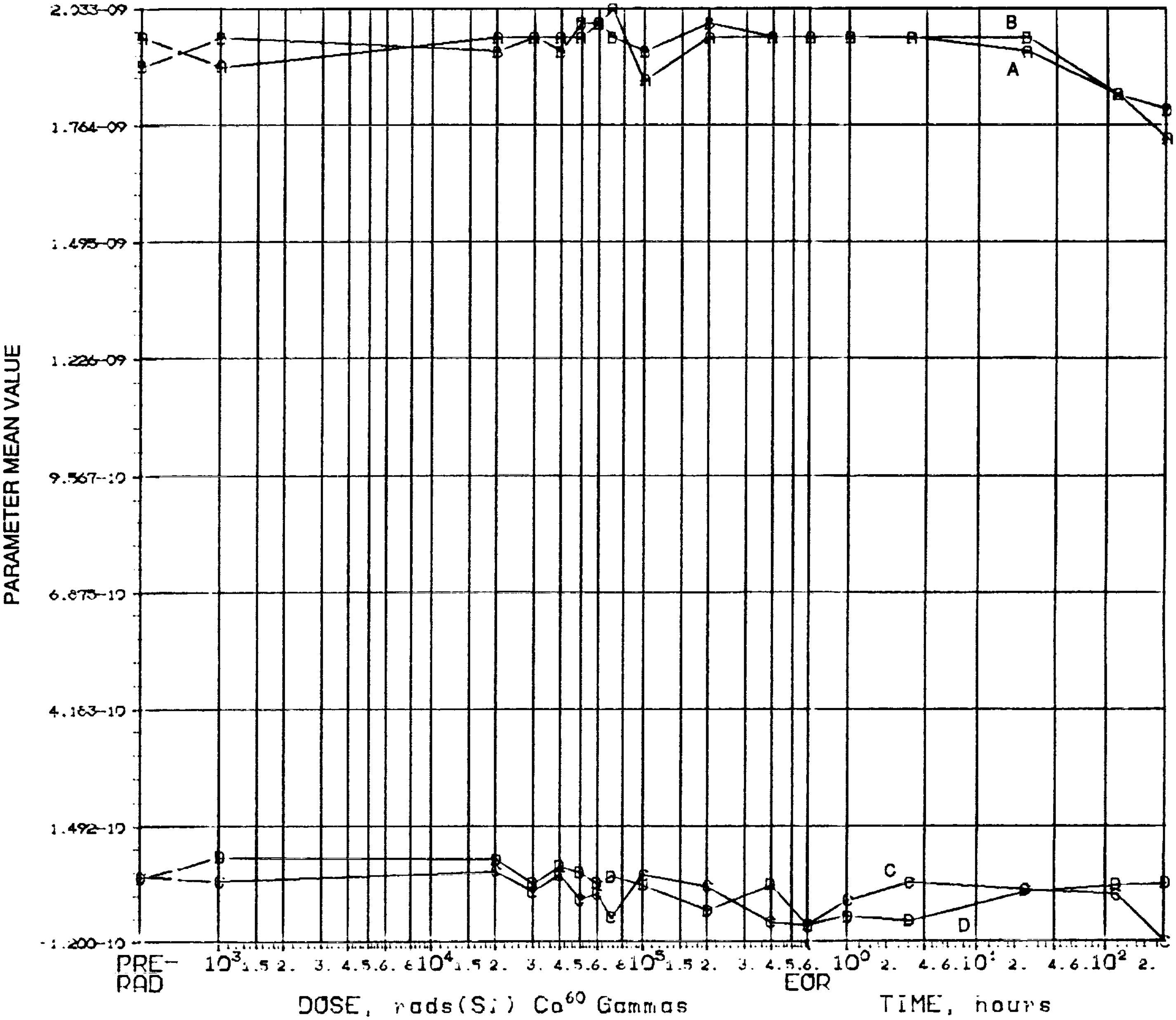


Figure 5-3. Alternate Integrated Circuit Graph Format Example



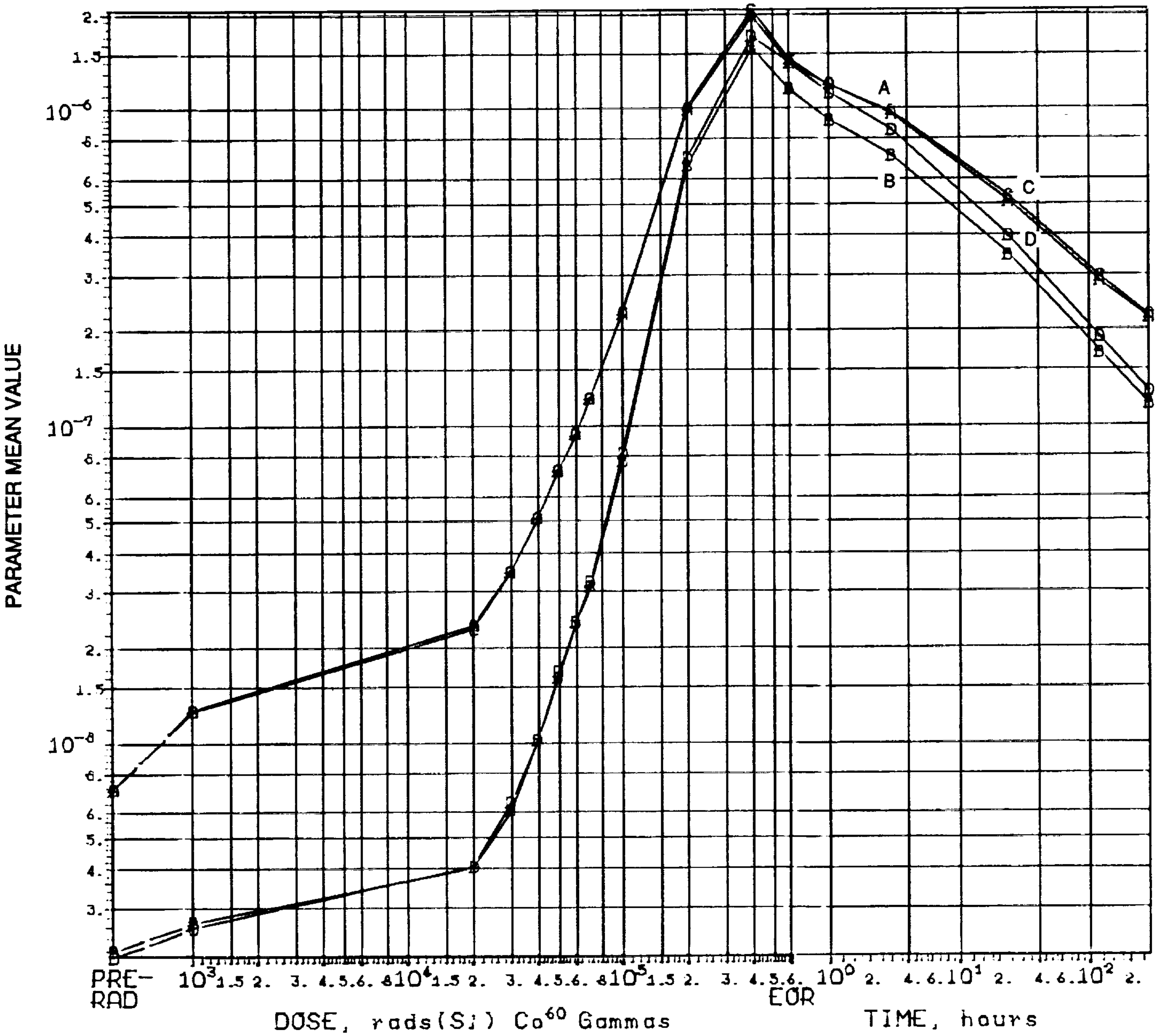
PARAMETERS				CONDITIONS
CURVE A:	(5)	VOL1-A	(V)	(IOUT = 20 UA)
CURVE B:	(6)	VOL1-B	(V)	" "
CURVE C:	(7)	VOL2-A	(V)	(IOUT = 24 MA)
CURVE D:	(8)	VOL2-B	(V)	" "

DEVICE TYPE: 54AC374 OCTAL D-TYPE F/F
MFG: FSC 3 DEVICES TEST DATE 2-11-87
REF: JPL LOG 1296 DATE CODE 8633



	PARAMETERS	CONDITIONS
CURVE A:	(9) IIH-A	(A) (VIN = VCC)
CURVE B:	(10) IIH-B	(A) " "
CURVE C:	(11) IIL-A	(A) (VIN = GRD)
CURVE D:	(12) IIL-B	(A) " "

DEVICE TYPE: 54AC374 OCTAL D-TYPE F/F
MFG: FSC 3 DEVICES TEST DATE 2-11-87
REF: JPL LOG 1296 DATE CODE 8633

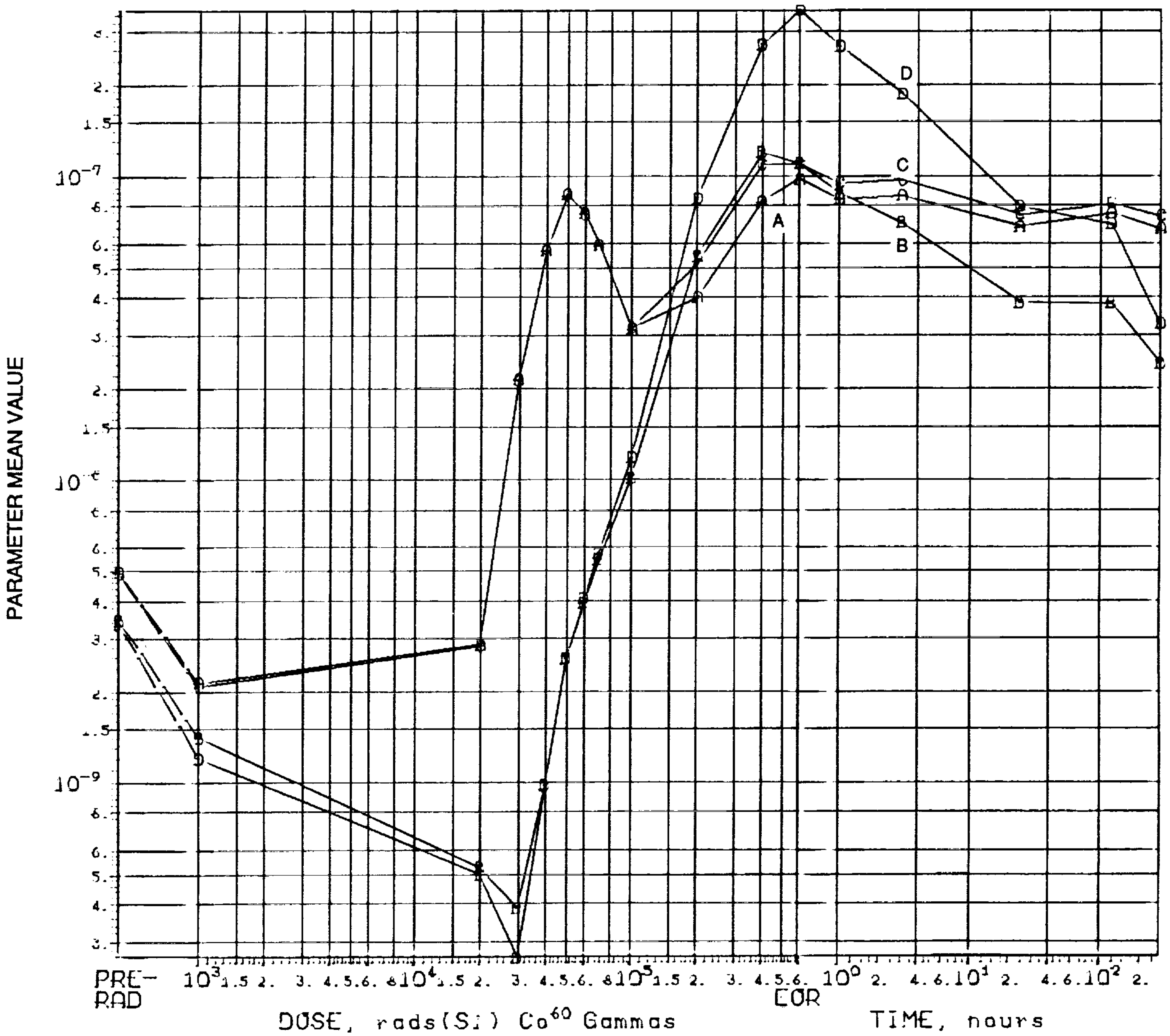


	PARAMETERS	CONDITIONS
CURVE A:	(13) IOZH1-A (A)	(VIN = 3.86 V)
CURVE B:	(14) IOZH1-B (A)	" "
CURVE C:	(15) IOZH2-A (A)	(VIN = 1.64 V)
CURVE D:	(16) IOZH2-B (A)	" "

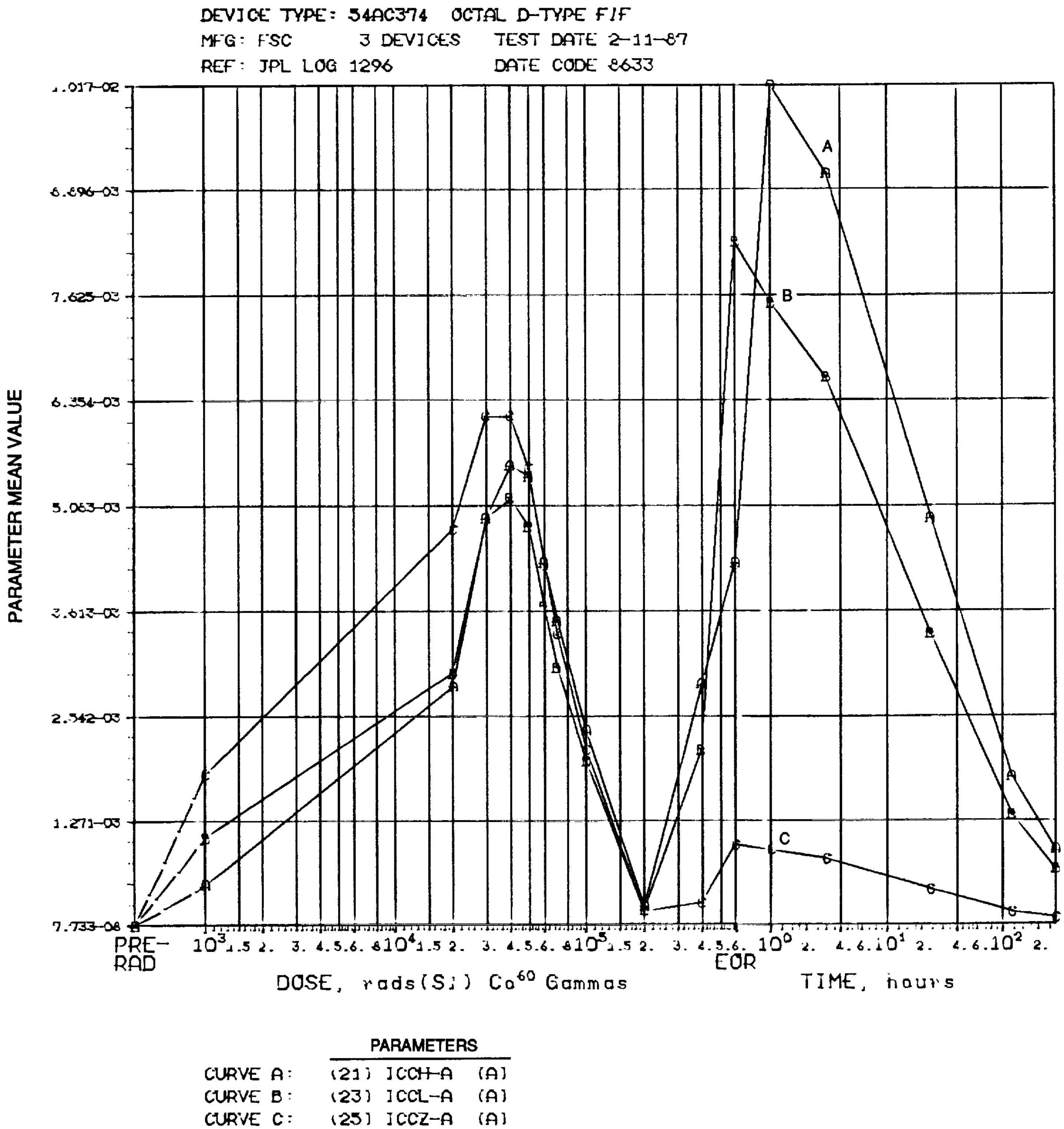
DEVICE TYPE: 54AC374 OCTAL D-TYPE F/F

MFG: FSC 3 DEVICES TEST DATE 2-11-87

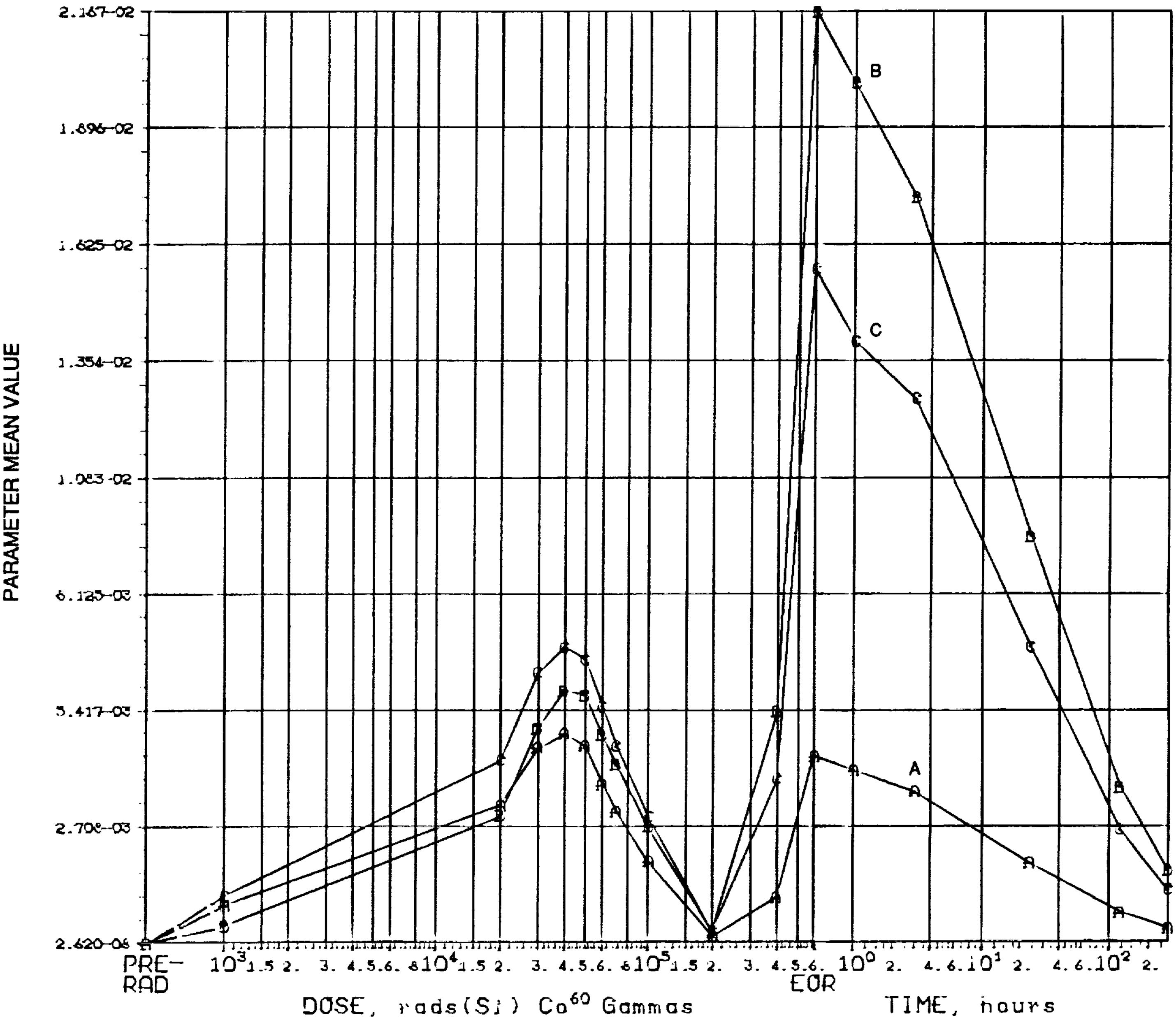
REF: JPL LOG 1296 DATE CODE 8633



	PARAMETERS	CONDITIONS
CURVE A:	(17) IOZL1-A (A)	(VIN = 3.66 V)
CURVE B:	(18) IOZL1-B (A)	" "
CURVE C:	(19) IOZL2-A (A)	(VIN = 1.64 V)
CURVE D:	(20) IOZL2-B (A)	" "


DEVICE TYPE: 54AC374 OCTAL D-TYPE F/F
MFG: FSC 3 DEVICES TEST DATE 2-11-87
REF: JPL LOG 1296 DATE CODE 8633
PARAMETER MEAN VALUE
1.017-02
8.896-03
7.625-03
6.354-03
5.083-03
3.813-03
2.542-03
1.271-03
7.733-08
PRE-RAD
EOR
DOSE, rads(Si) Co60 Gammas
TIME, hours
PARAMETERS
CURVE A: (21) ICCH-A (A)
CURVE B: (23) ICCL-A (A)
CURVE C: (25) ICCZ-A (A)

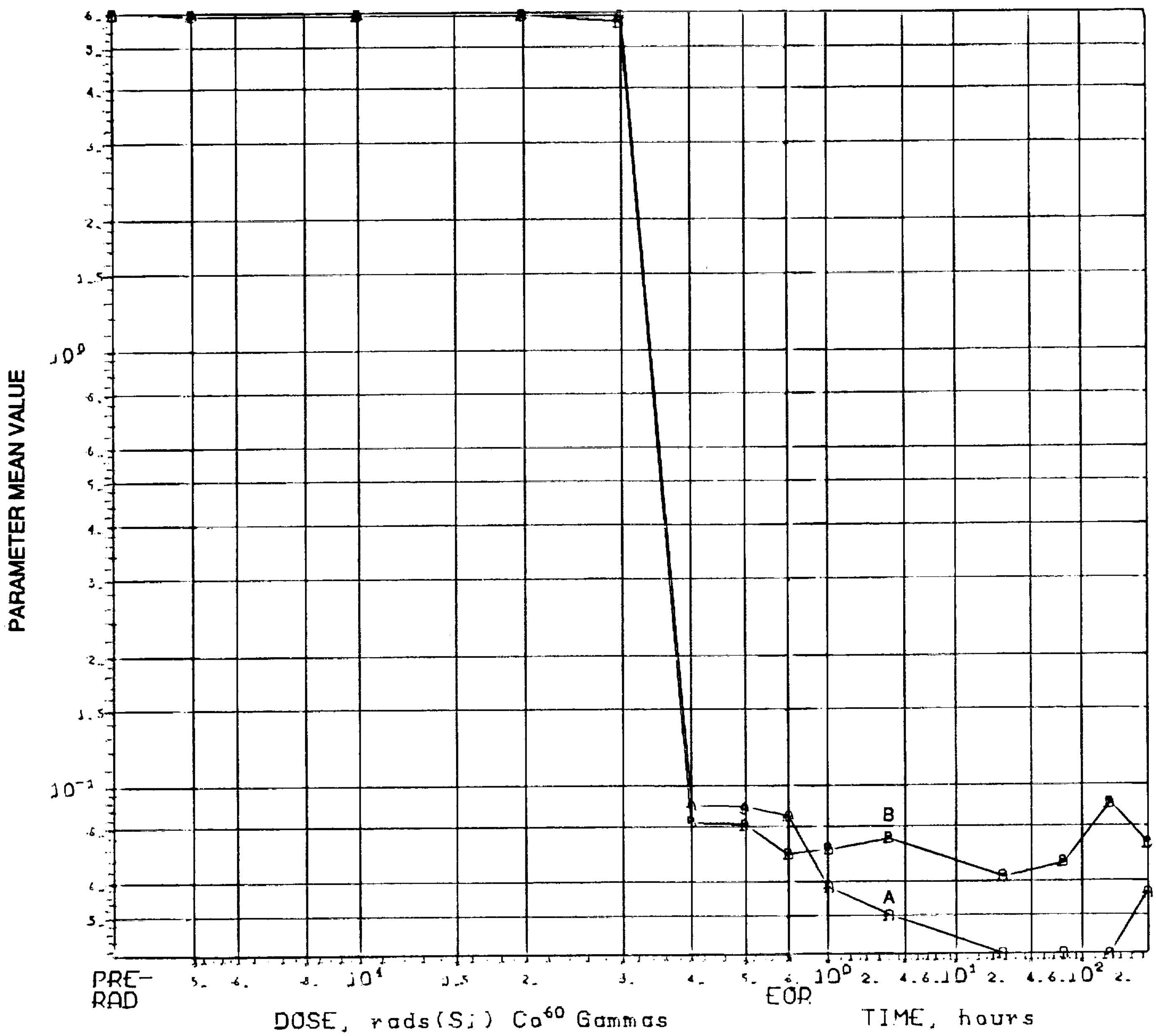
DEVICE TYPE: 54AC374 OCTAL D-TYPE F/F
MFG: FSC 3 DEVICES TEST DATE 2-11-87
REF: JPL LOG 1296 DATE CODE 8633



PARAMETERS

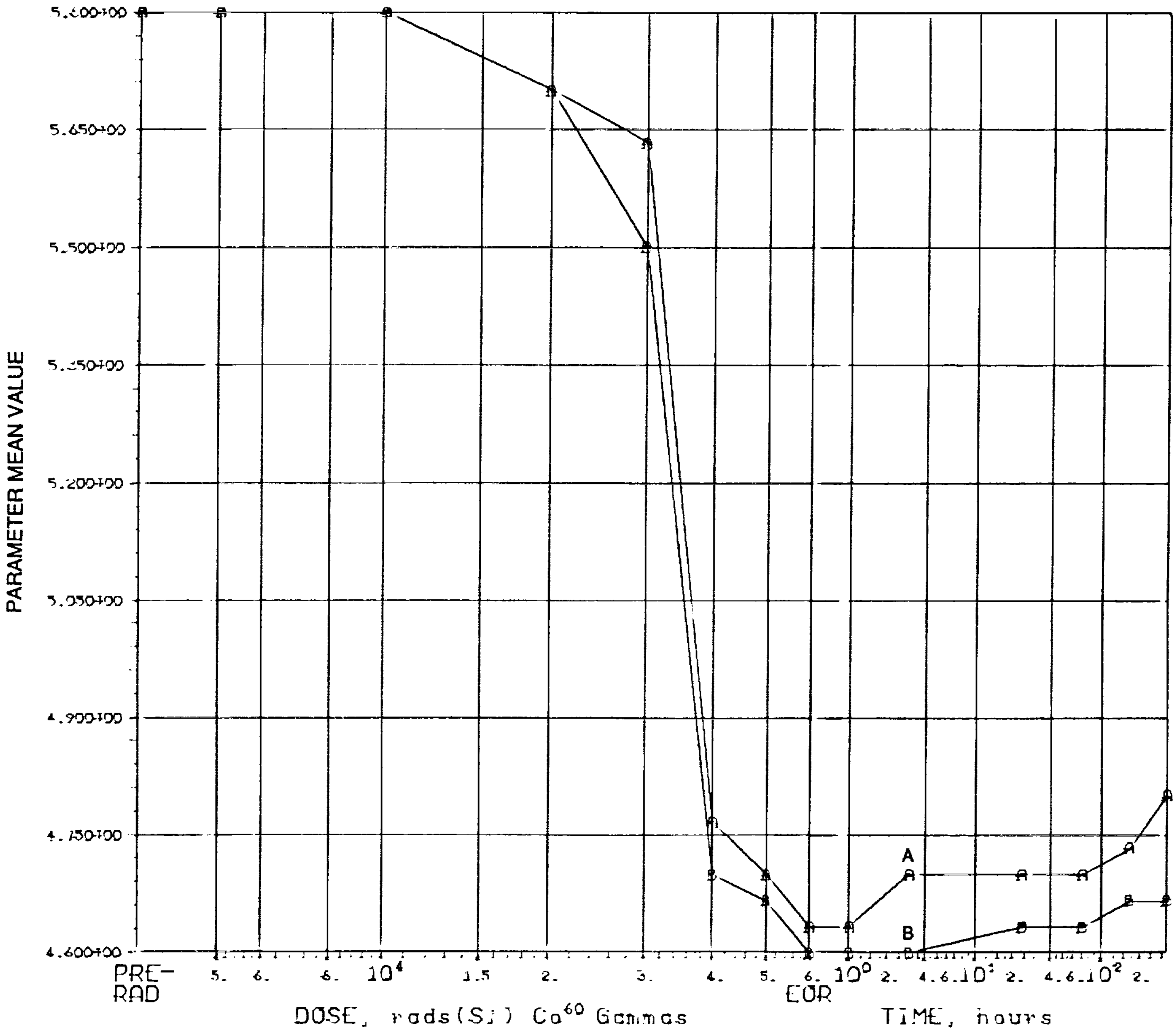
CURVE A: (22) ICCH-B (A)
CURVE B: (24) ICCL-B (A)
CURVE C: (26) ICCZ-B (A)

DEVICE TYPE: 54AC374 OCTAL D-TYPE F/F
MFG: NSC 3 DEVICES TEST DATE 3-24-87
REF: JPL LOG 1300 DATE CODE 8627



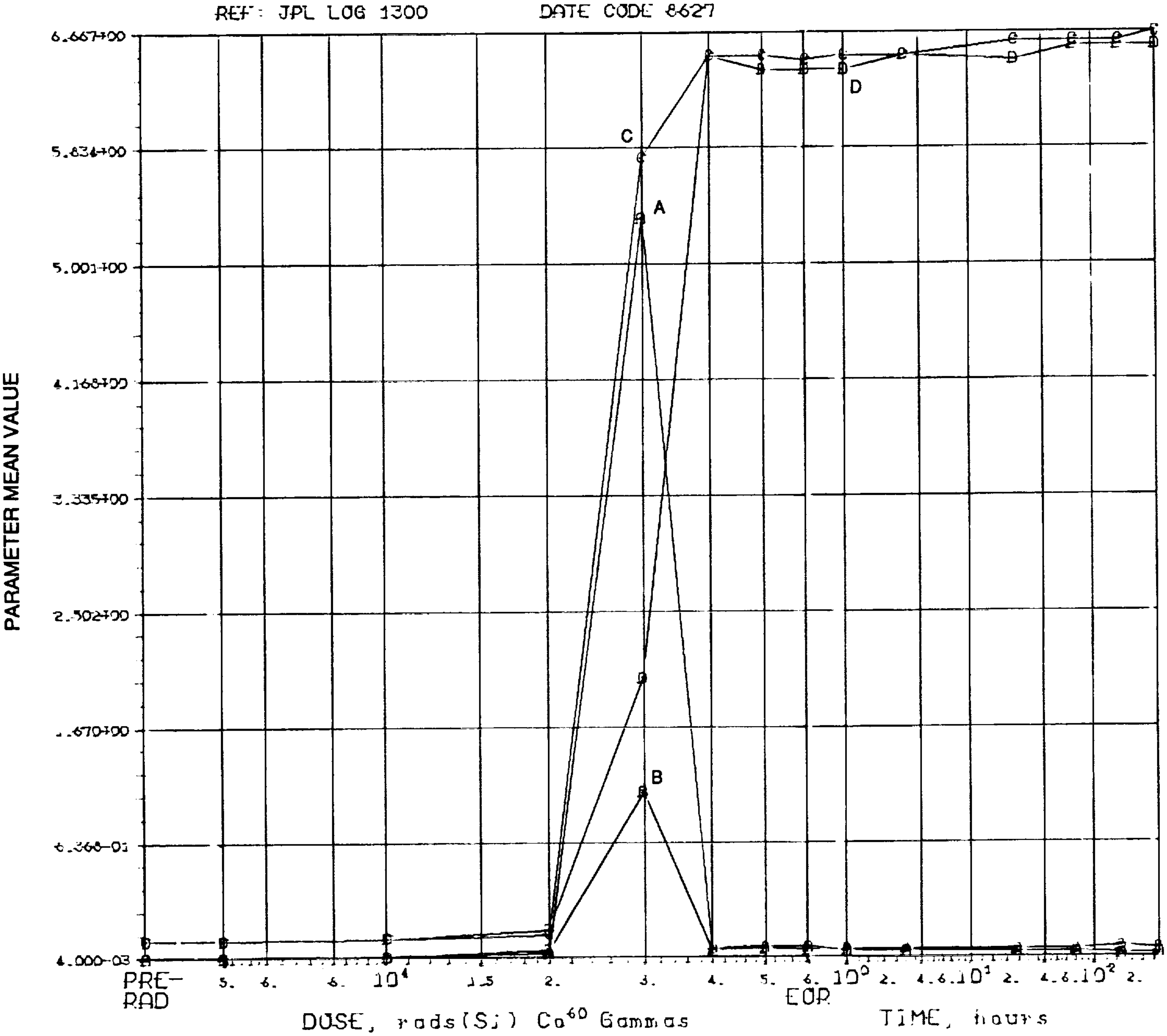
	PARAMETERS			CONDITIONS
CURVE A:	(1)	VOH1-A	(V)	(IOUT = -20 UA)
CURVE B:	(2)	VOH1-B	(V)	" "

DEVICE TYPE: 54AC374 OCTAL D-TYPE F/F
MFG: NSC 3 DEVICES TEST DATE 3-24-87
REF: JPL LOG 1300 DATE CODE 8627



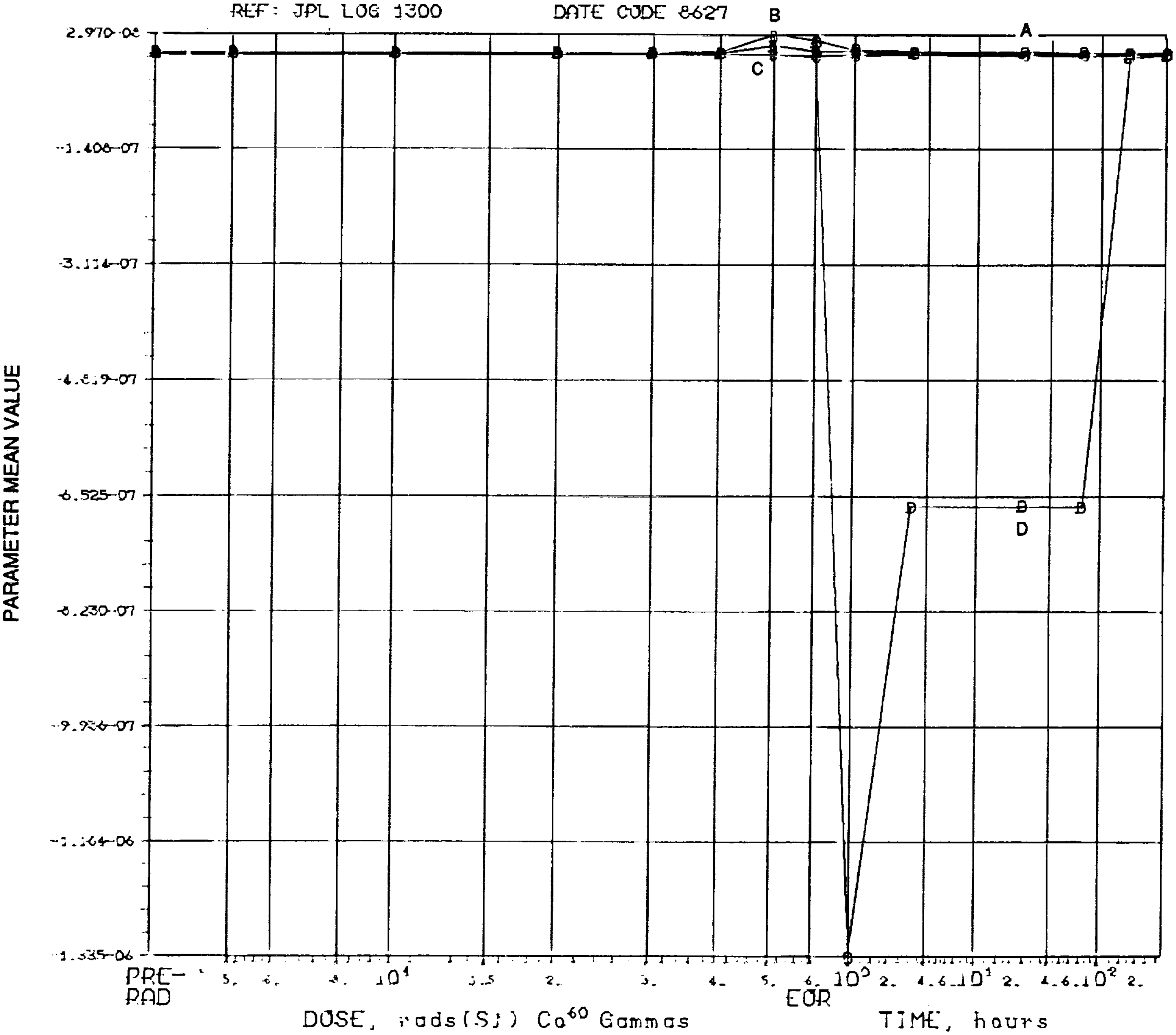
	PARAMETERS			CONDITIONS
CURVE A:	(3)	VOH2-A	(V)	(IOUT = -5.2 MA)
CURVE B:	(4)	VOH2-B	(V)	" "

DEVICE TYPE: 54AC374 OCTAL D-TYPE F/F
MFG: NSC 3 DEVICES TEST DATE 3-24-87
REF: JPL LOG 1300 DATE CODE 8627



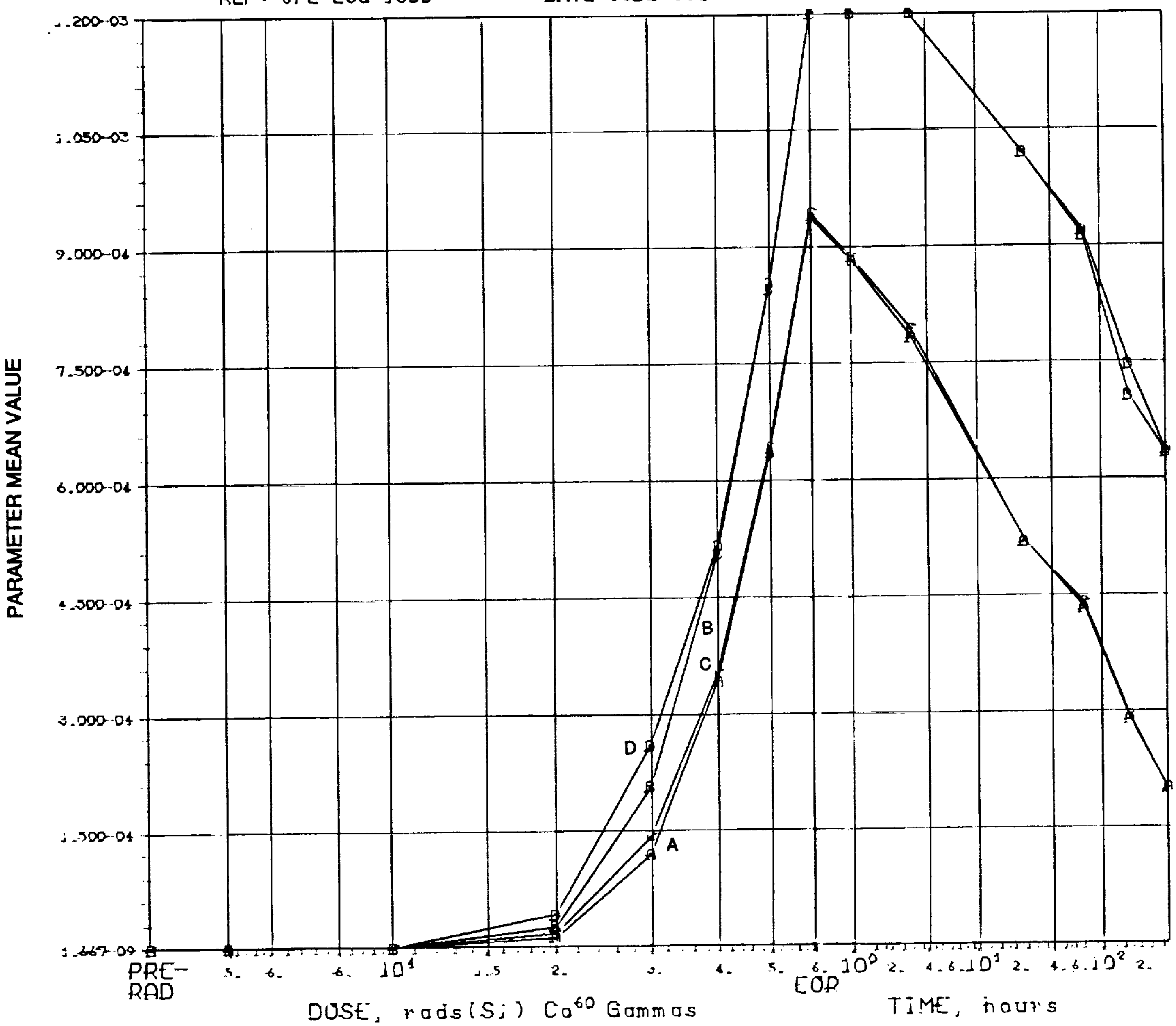
	PARAMETERS			CONDITIONS
CURVE A:	(5)	VOL1-A	(V)	(IOUT = 20 UA)
CURVE B:	(6)	VOL1-B	(V)	" "
CURVE C:	(7)	VOL2-A	(V)	(IOUT = 5.2 MA)
CURVE D:	(8)	VOL2-B	(V)	" "

DEVICE TYPE: 54AC374 OCTAL D-TYPE F/F
MFG: NSC 3 DEVICES TEST DATE 3-24-87
REF: JPL LOG 1300 DATE CODE 8627



	PARAMETERS		CONDITIONS
CURVE A:	(9) IIH-A	(A)	(VIN = VCC)
CURVE B:	(10) IIH-B	(A)	" "
CURVE C:	(11) IIL-A	(A)	((VIN = GND)
CURVE D:	(12) IIL-B	(A)	" "

DEVICE TYPE: 54AC374 OCTAL D-TYPE F/F
MFG: NSC 3 DEVICES TEST DATE 3-24-87
REF: JPL LOG 1300 DATE CODE 8627

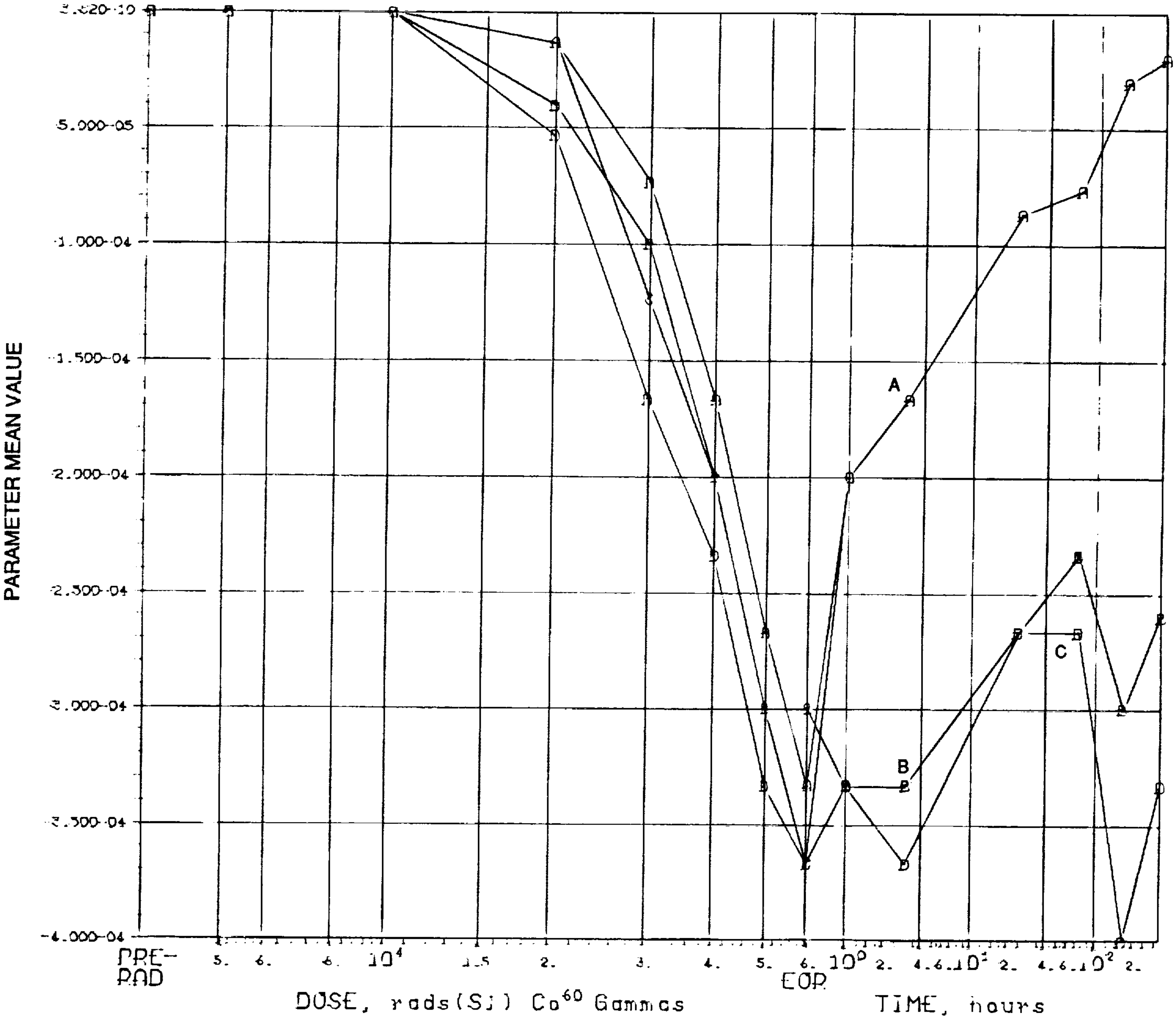


	PARAMETERS	CONDITIONS
CURVE A:	(13) IOZH1--A (A)	(VIN = 4.2 V)
CURVE B:	(14) IOZH1--B (A)	" "
CURVE C:	(15) IOZH2--A (A)	(VIN = 1.2 V)
CURVE D:	(16) IOZH2--B (A)	" "

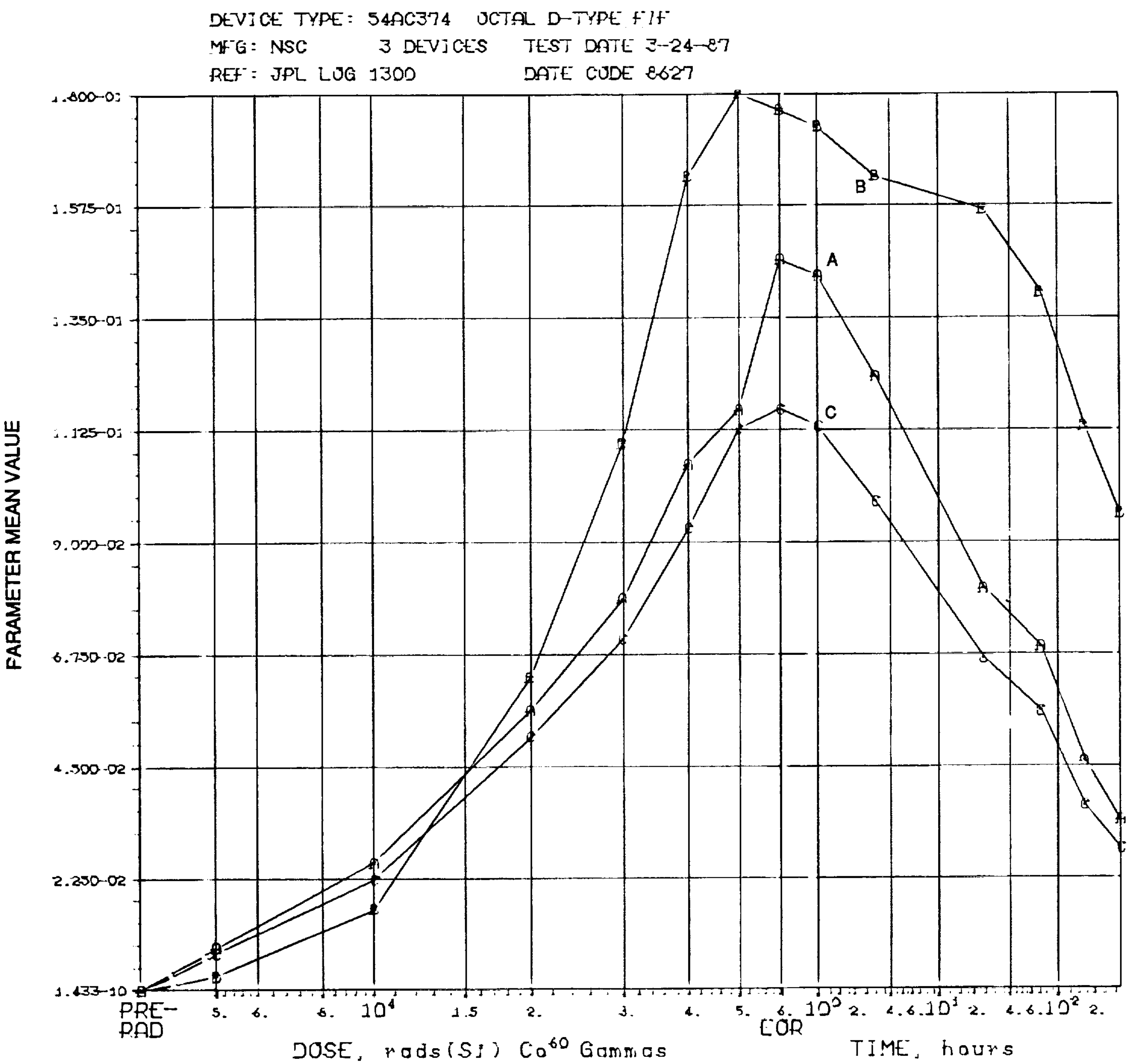
DEVICE TYPE: 54AC374 OCTAL D-TYPE F/F

MFG: NSC 3 DEVICES TEST DATE 3-24-87

REF: JPL LOG 1300 DATE CODE 8627



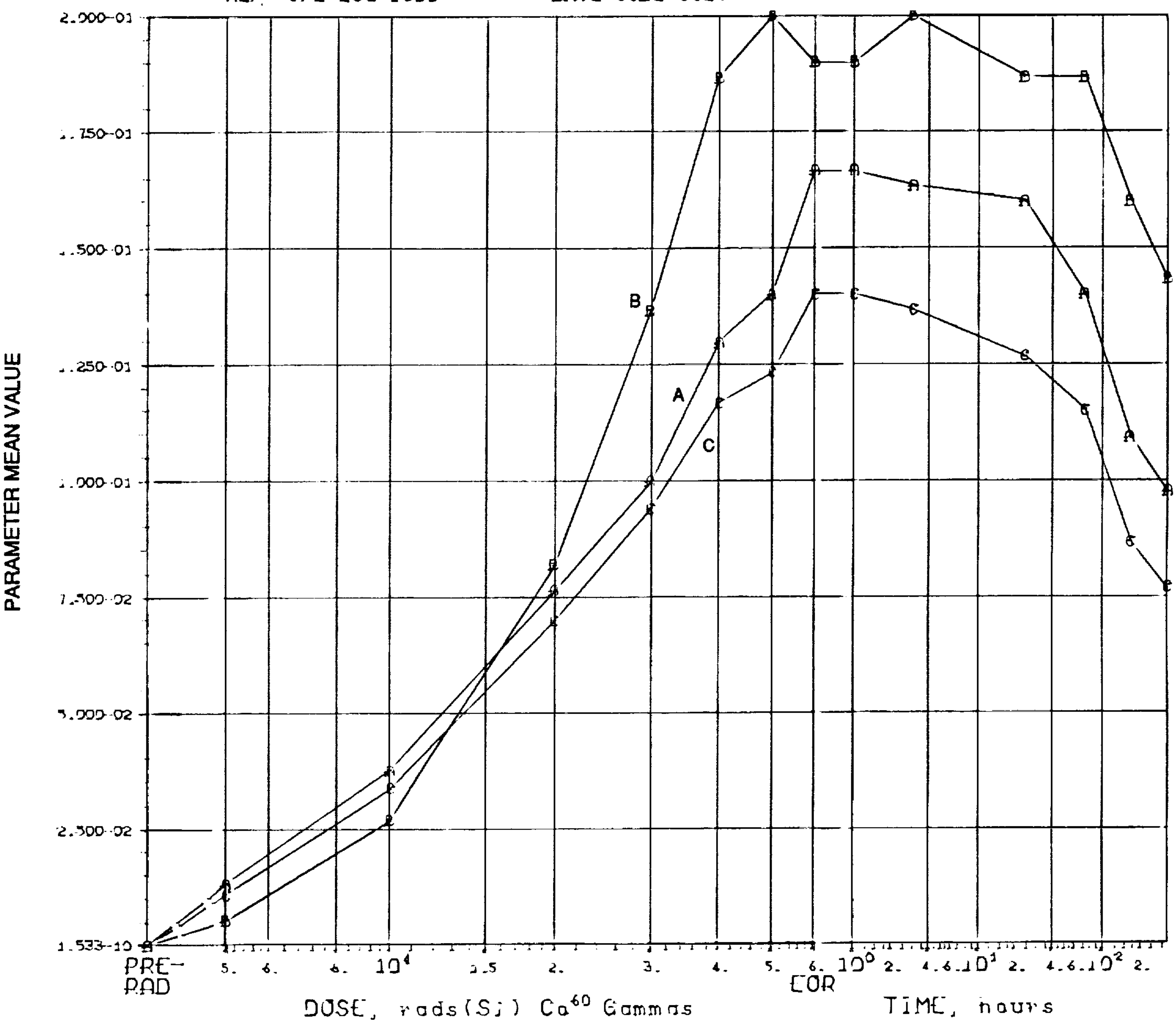
	PARAMETERS	CONDITIONS
CURVE A:	(17) IOZL1-A (A)	(VIN = 4.2 V)
CURVE B:	(18) IOZL1-B (A)	" "
CURVE C:	(20) IOZL2-B (A)	(VIN = 1.2 V)



PARAMETERS

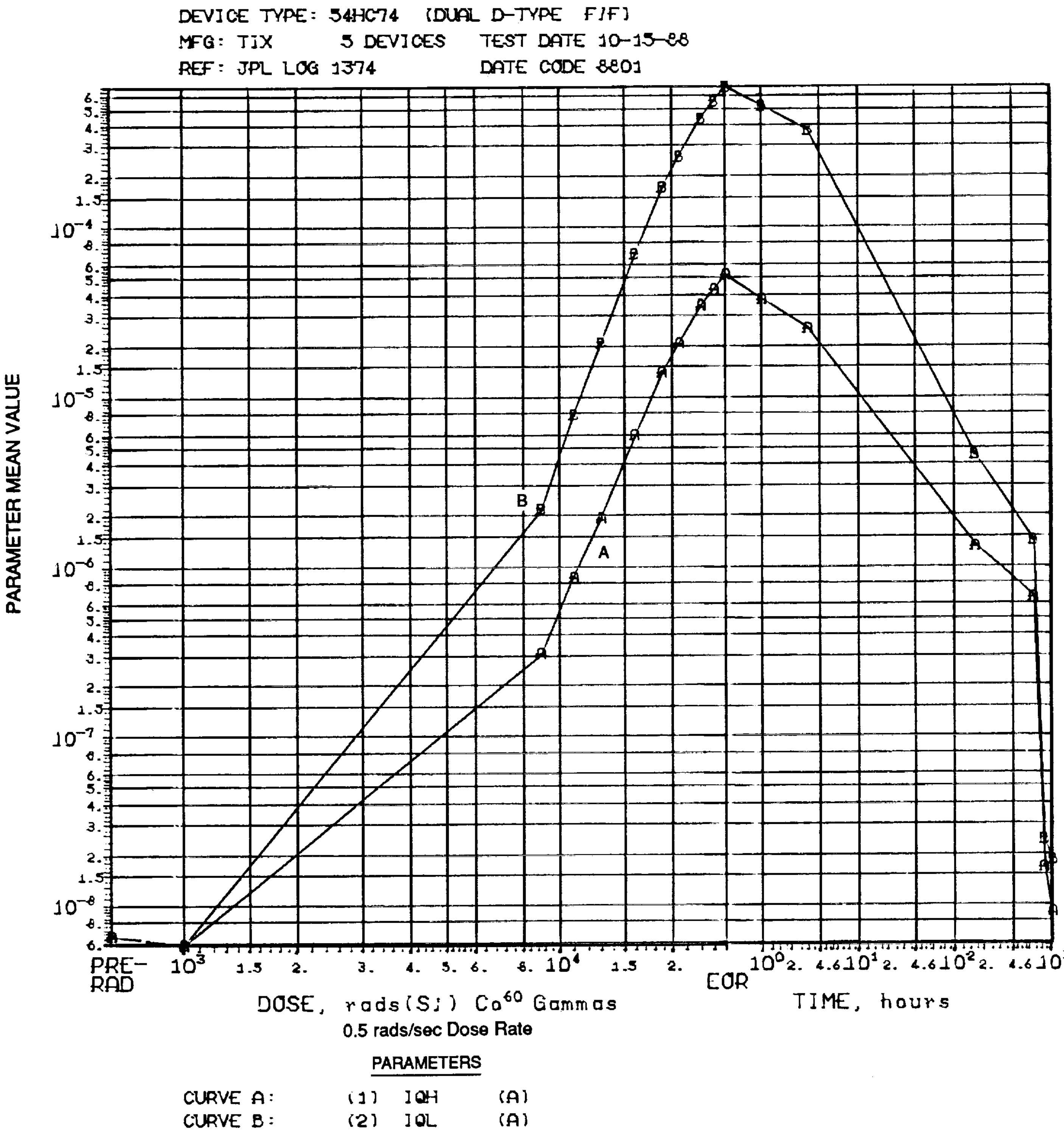
CURVE A:	(21) ICCH-A	(A)
CURVE B:	(23) ICCL-A	(A)
CURVE C:	(25) ICCZ-A	(A)

DEVICE TYPE: 54AC374 OCTAL D-TYPE F/F
MFG: NSC 3 DEVICES TEST DATE 3-24-87
REF: JPL LOG 1300 DATE CODE 8627

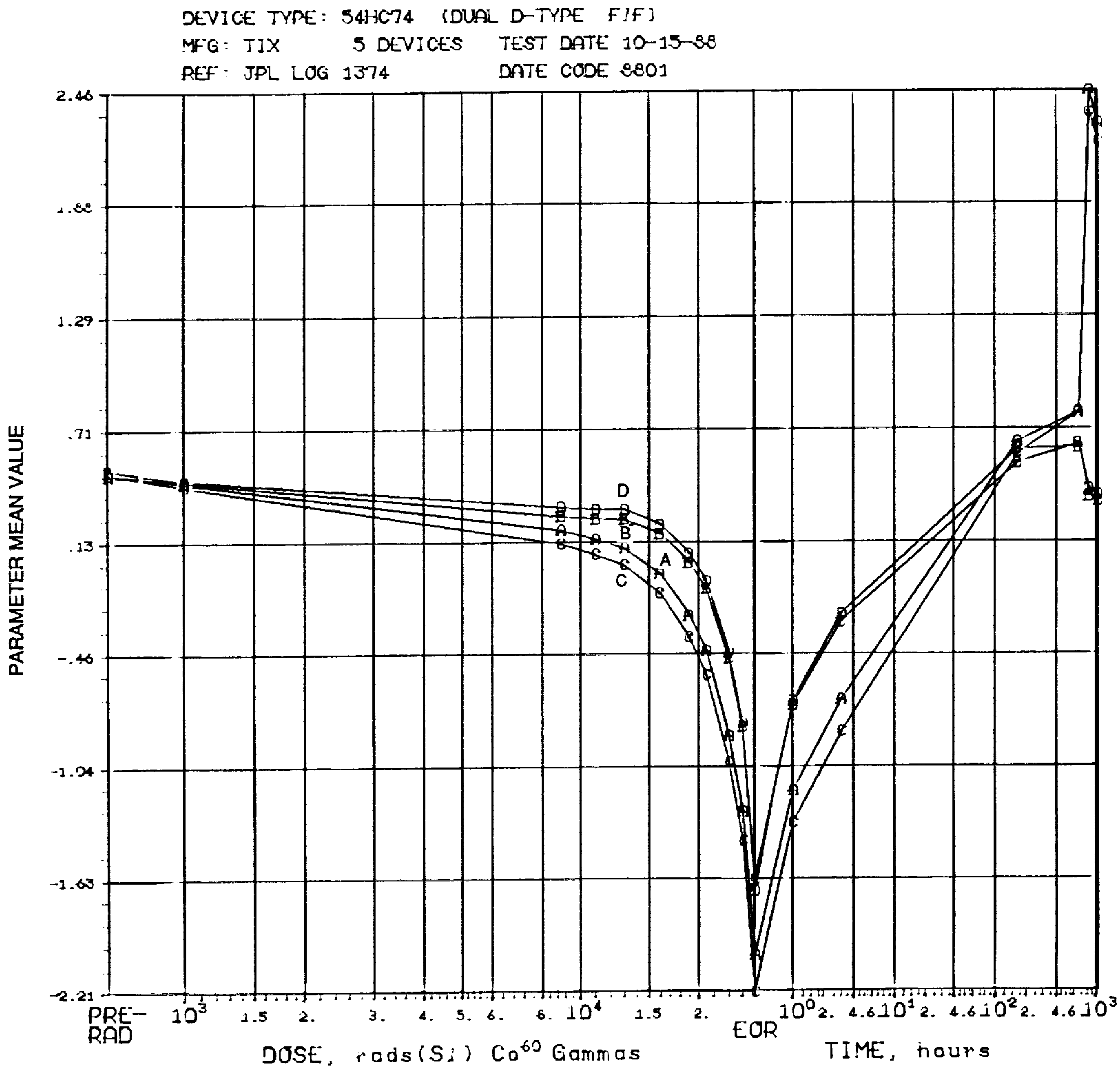


PARAMETERS

CURVE A:	(22)	ICCH-B	(A)
CURVE B:	(24)	ICCL-B	(A)
CURVE C:	(26)	ICCZ-B	(A)



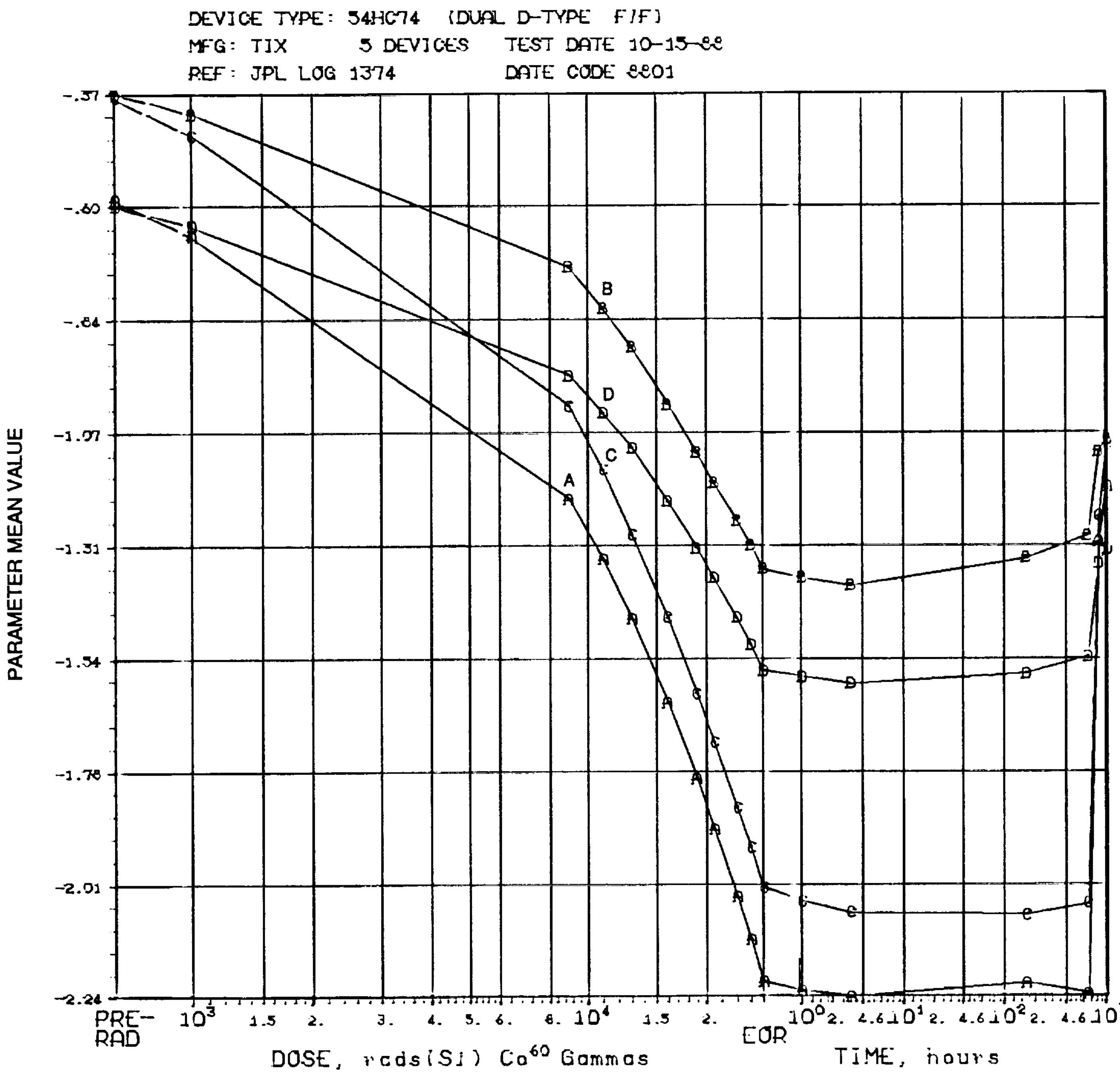
DEVICE TYPE: 54HC74 (DUAL D-TYPE F/F)
MFG: TIX 5 DEVICES TEST DATE 10-15-88
REF: JPL LOG 1374 DATE CODE 8801
PARAMETER MEAN VALUE
PRE-RAD
EOR
DOSE, rads(Si) Co60 Gammas
TIME, hours
0.5 rads/sec Dose Rate
PARAMETERS
CURVE A: (1) IQH (A)
CURVE B: (2) IQL (A)



0.5 rads/sec Dose Rate

PARAMETERS

CURVE A:	(3)	VTN(3)-ON	(V)
CURVE B:	(4)	VTN(6)-ON	(V)
CURVE C:	(5)	VTN(8)-OFF	(V)
CURVE D:	(6)	VTN(11)-OFF	(V)

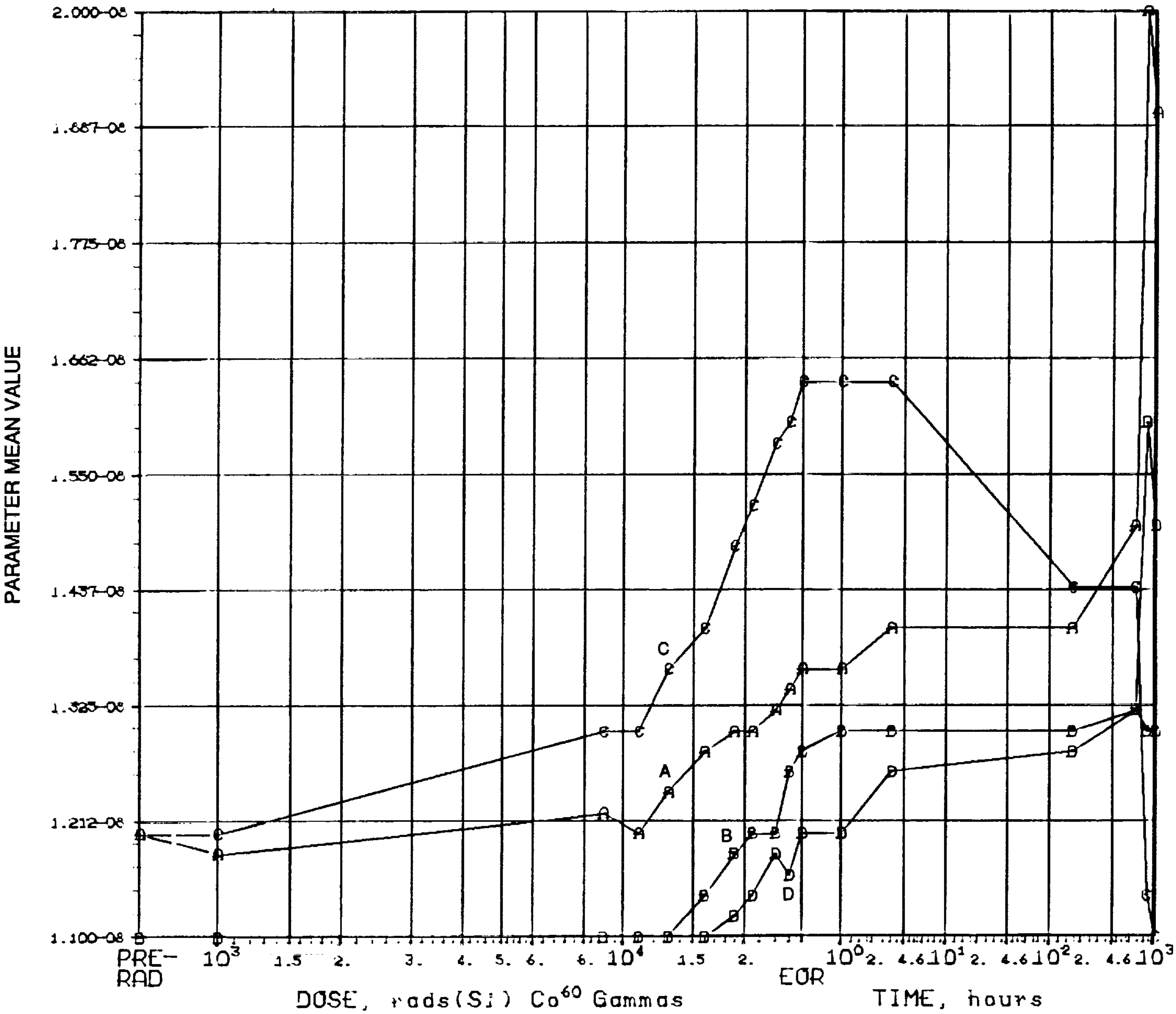


0.5 rads/sec Dose Rate

PARAMETERS

CURVE A:	(7)	VTP(3)-ON (V)
CURVE B:	(8)	VTP(6)-ON (V)
CURVE C:	(9)	VTP(8)-OFF (V)
CURVE D:	(10)	VTP(11)-OFF (V)

DEVICE TYPE: 54HC74 (DUAL D-TYPE F/F)
MFG: TIX 5 DEVICES TEST DATE 10-15-88
REF: JPL LOG 1374 DATE CODE 8801

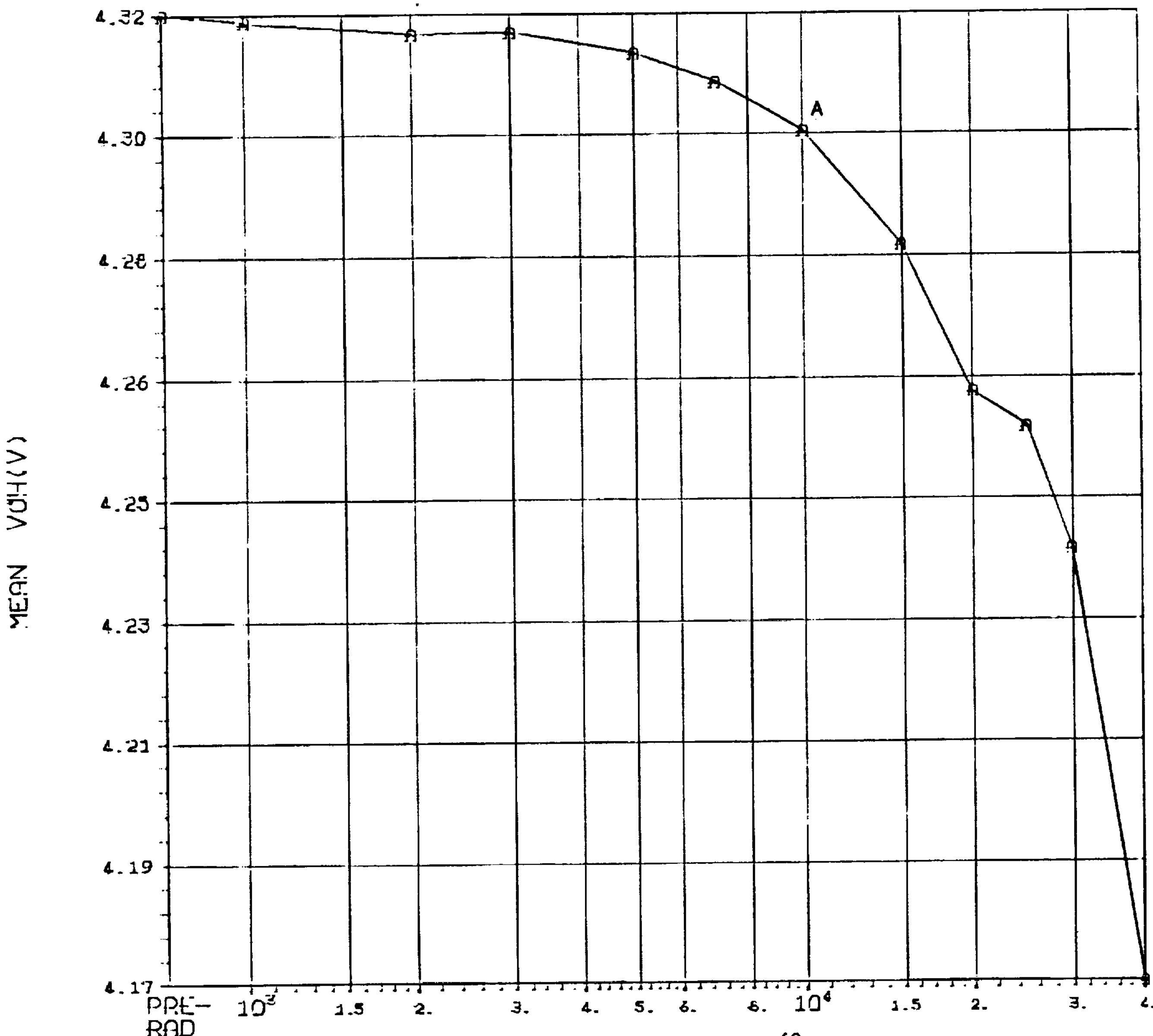


0.5 rads/sec Dose Rate

PARAMETERS

CURVE A:	(11) TPLHQ1	(S)
CURVE B:	(12) TPHLQ1	(S)
CURVE C:	(13) TPLHQ2	(S)
CURVE D:	(14) TPHLQ2	(S)

DEVICE TYPE: 54HC374 CMOS OCTAL D-TYPE F/F
MFG: NSC 5 DEVICES TEST DATE 11-13-85
REF: JPL LOG 1215 DATE CODE A8520

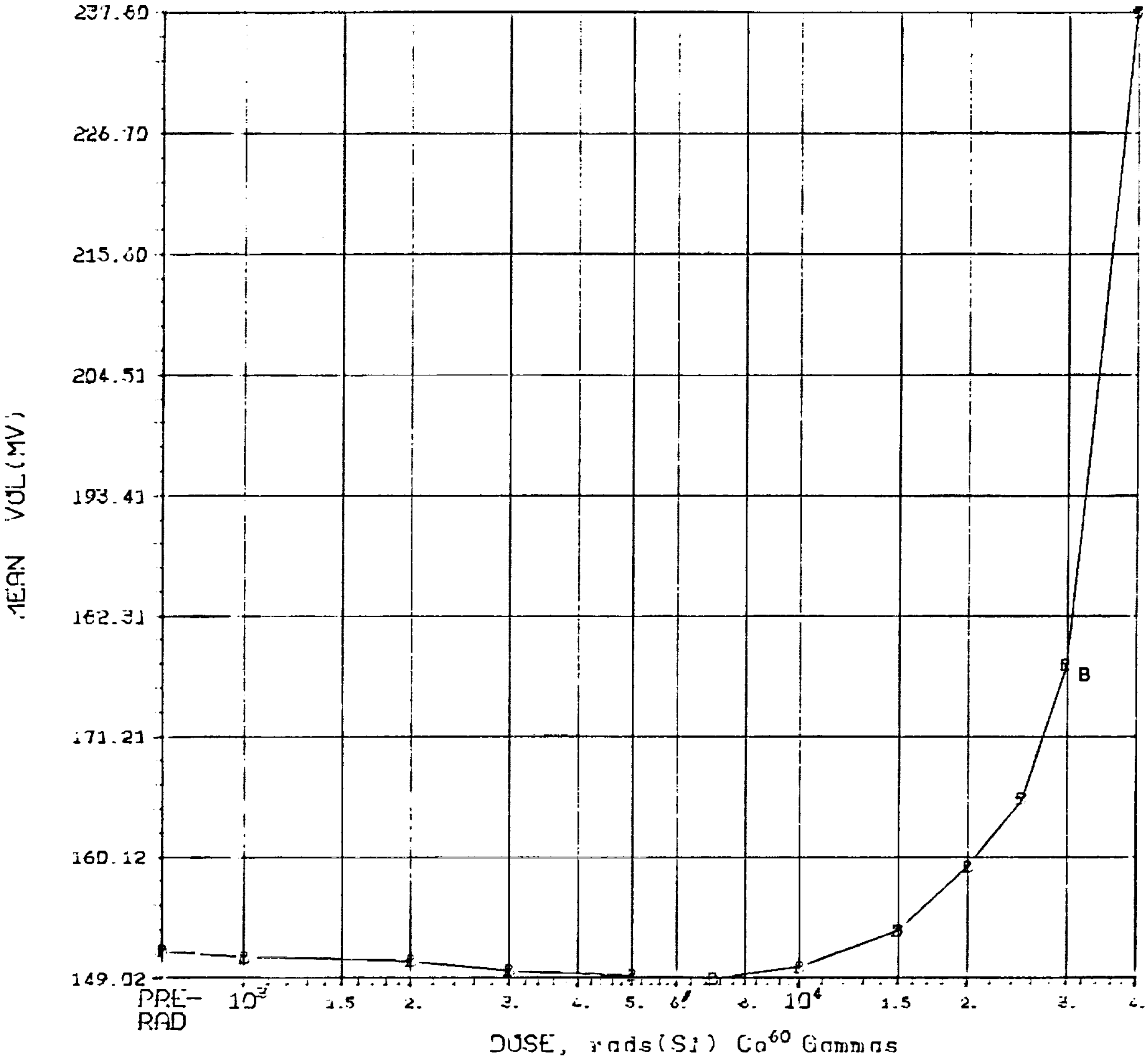


(1) VOH (VCC=4.5V,IO=-6MA) IN V. VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
CURVE	DOSE, rads(Si)										
DOSE	0.0E0	1.0E3	2.0E3	3.0E3	5.0E3	7.0E3	1.0E4	1.5E4	2.0E4	2.5E4	3.0E4
STD. DEV.	.0025	.0022	.0028	.0026	.0029	.0040	.0072	.0176	.0334	.0312	.0374
DOSE	4.0E4										
STD. DEV.	.0919										

INITIAL MEAN VALUE VOH(V) = +4.32X10^{+0}

DEVICE TYPE: 54HC374 CMOS OCTAL D-TYPE F/F
MFG: NSC 5 DEVICES TEST DATE 11-13-85
REF: JPL LOG 1215 DATE CODE R8520

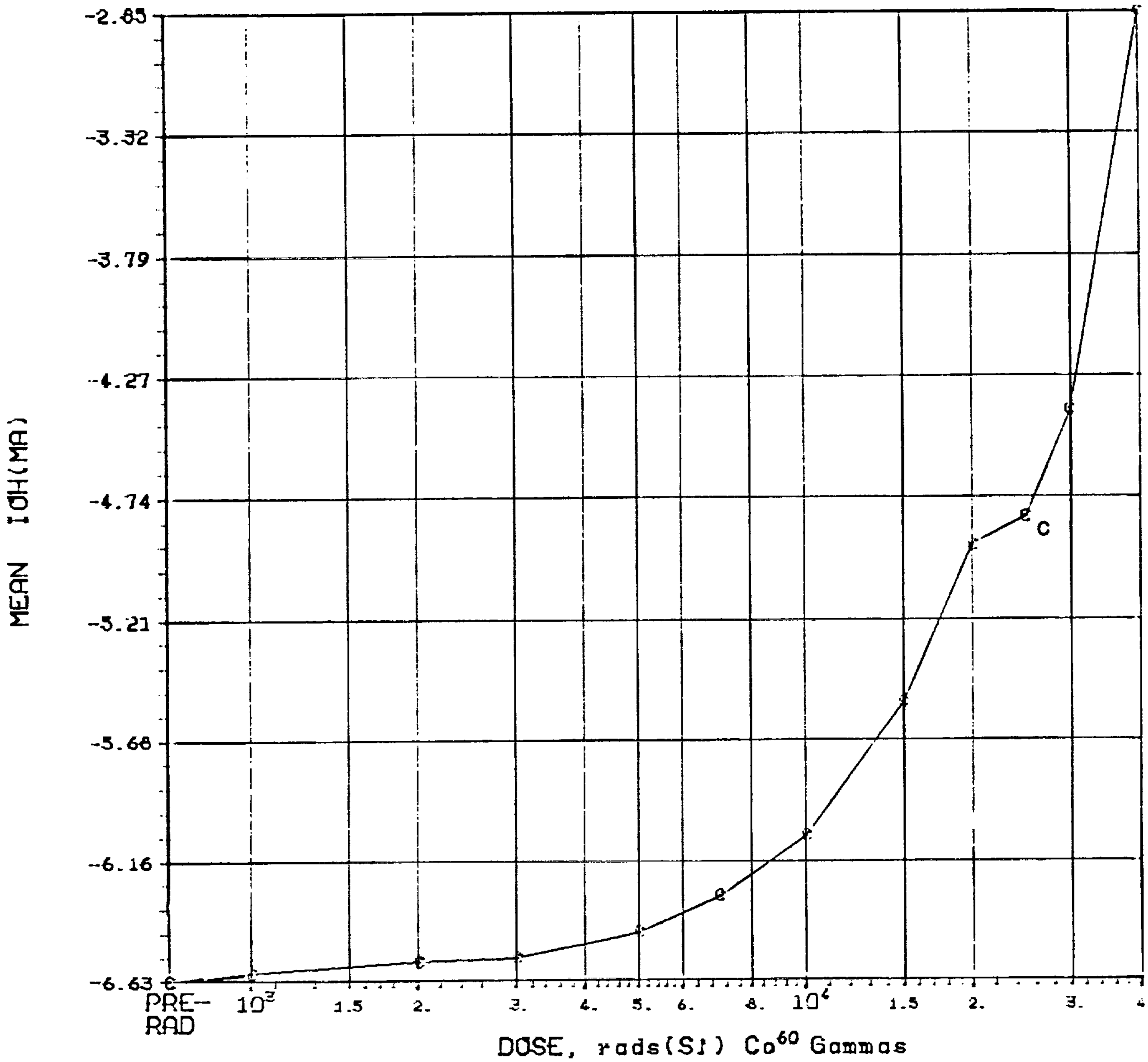


(2) VOL (VCC=4.5V,IO=6MA) IN MV: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, rads(Si)
DOSE	0.0E0 1.0E3 2.0E3 3.0E3 5.0E3 7.0E3 1.0E4 1.5E4 2.0E4 2.5E4 3.0E4
STD. DEV.	3.466 3.116 3.241 2.972 3.232 3.339 4.398 6.707 10.39 13.35 19.64
DOSE	4.0E4
STD. DEV.	65.26

INITIAL MEAN VALUE VOL(MV) = $+1.52X10^{12}$

DEVICE TYPE: 54HC374 CMOS OCTAL D-TYPE F/F
MFG: NSC 5 DEVICES TEST DATE 11-13-85
REF: JPL LOG 1215 DATE CODE A8520

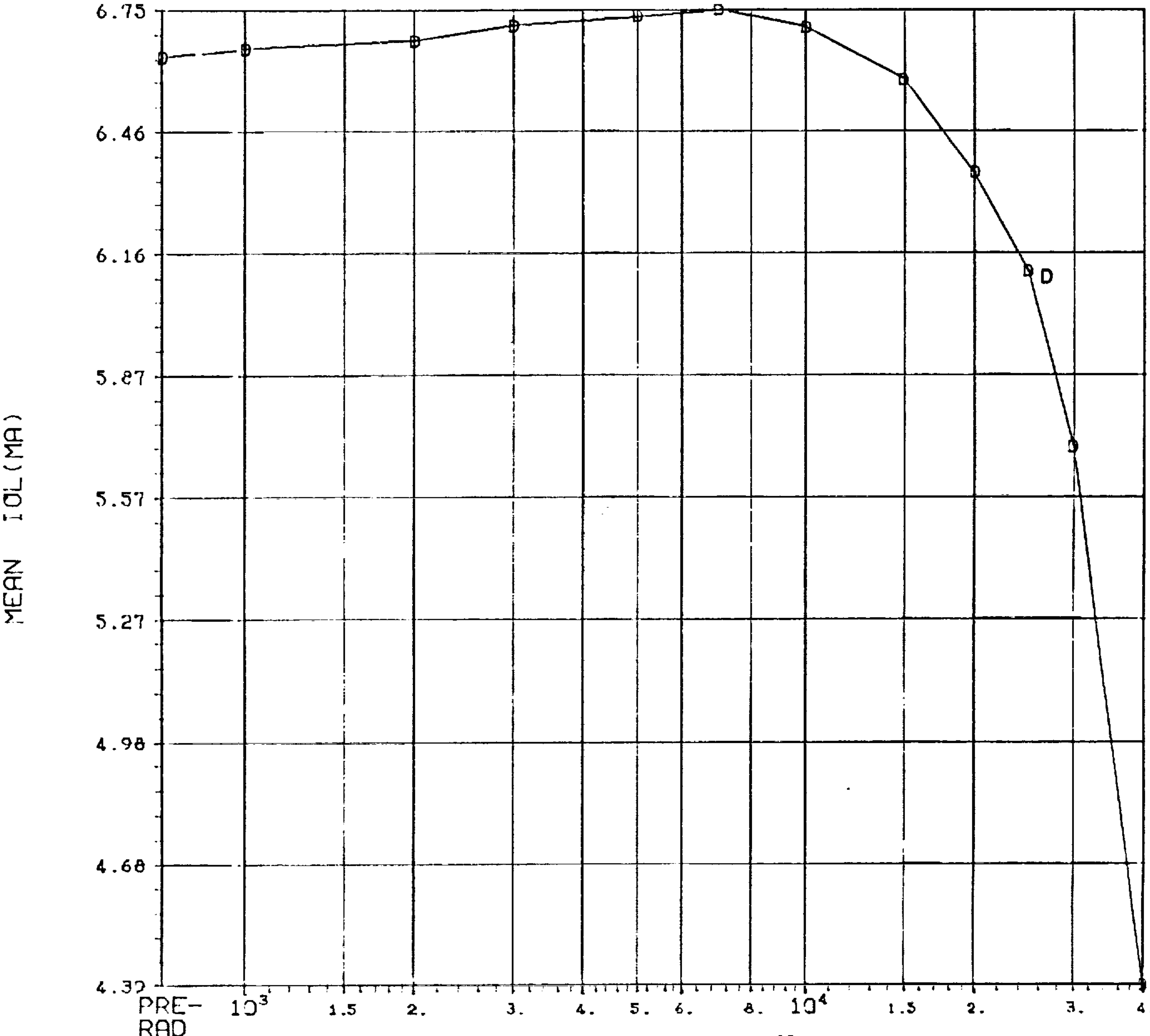


(3) IOH (VCC=4.5V,VO=4.3V) IN MA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
CURVE	DOSE, rads(Si)										
DOSE	0.0E0	1.0E3	2.0E3	3.0E3	5.0E3	7.0E3	1.0E4	1.5E4	2.0E4	2.5E4	3.0E4
STD. DEV.	.0872	.0760	.0786	.0772	.0877	.1290	.2191	.5019	.9302	.8016	.9459
DOSE	4.0E4										
STD. DEV.	2.063										

INITIAL MEAN VALUE IOH(MA) $= -6.63X10^{-0}$

DEVICE TYPE: 54HC374 CMOS OCTAL D-TYPE F/F
MFG: NSC 5 DEVICES TEST DATE 11-13-85
REF: JPL LOG 1215 DATE CODE R8520

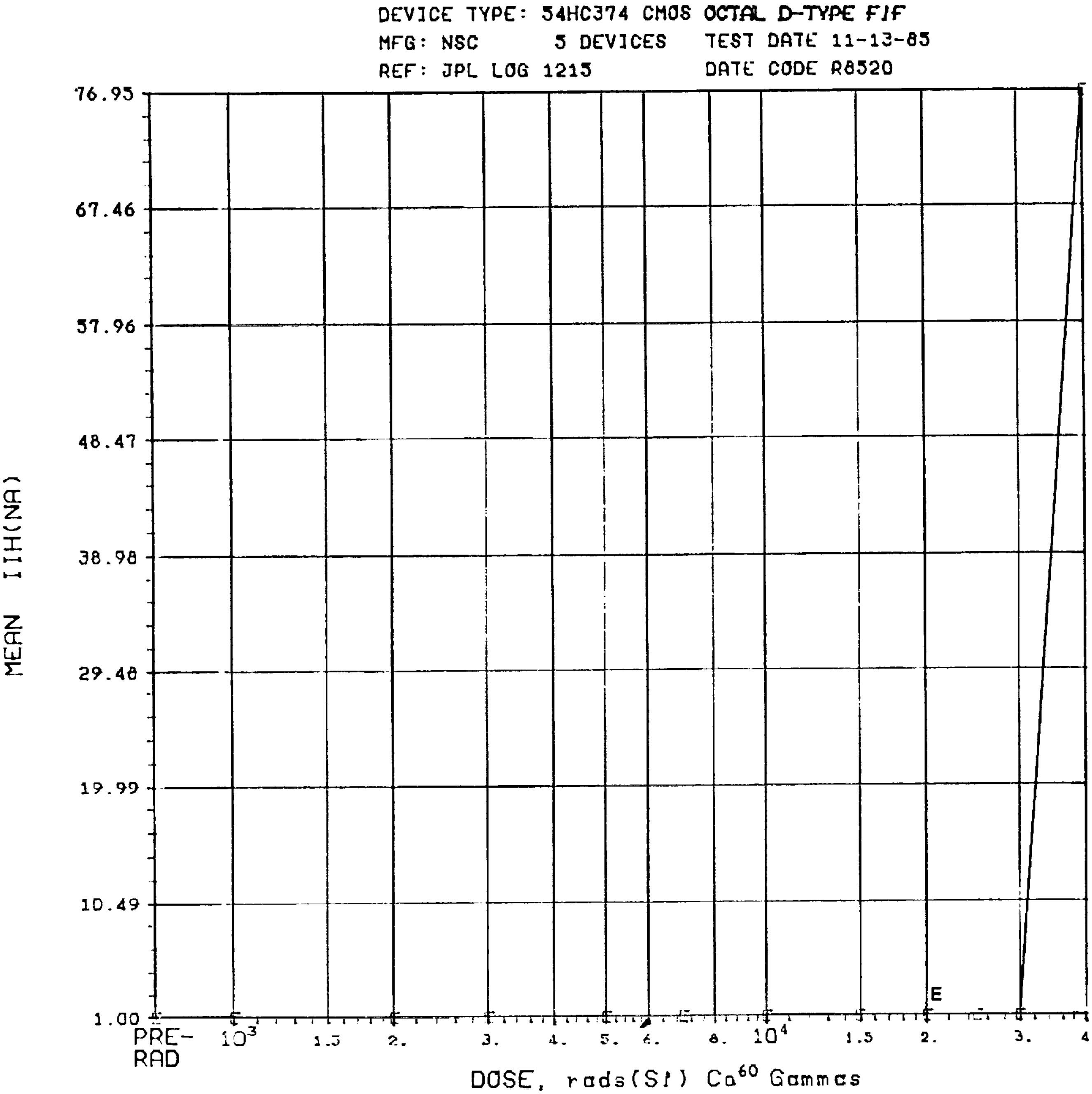


(4) IOL (VCC=4.5V,VO=.1MV) IN MA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
CURVE	DOSE, rads(Si)										
DOSE	0.0E0	1.0E3	2.0E3	3.0E3	5.0E3	7.0E3	1.0E4	1.5E4	2.0E4	2.5E4	3.0E4
STD. DEV.	.1513	.1359	.1442	.1347	.1396	.1473	.1916	.2912	.4325	.5371	.7346

DOSE	4.0E4
STD. DEV.	1.440

INITIAL MEAN VALUE IOL(MA) = +6.64X10^+0



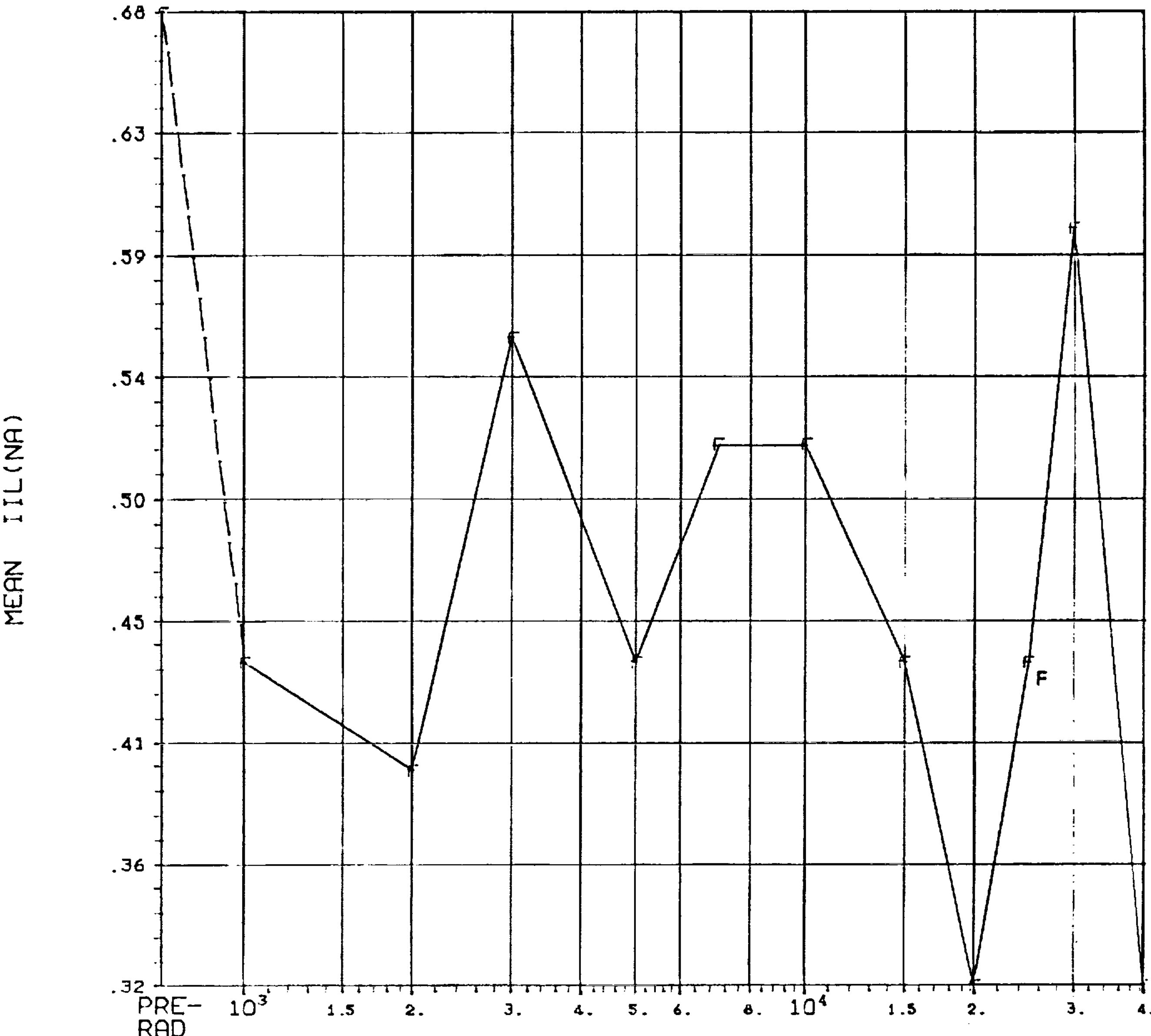
(5) IIH (VCC=6V,VIN=6V) IN NA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
CURVE	DOSE, rads(Si)										
DOSE	0.0E0	1.0E3	2.0E3	3.0E3	5.0E3	7.0E3	1.0E4	1.5E4	2.0E4	2.5E4	3.0E4
STD. DEV.	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

DOSE	4.0E4
STD. DEV.	128.9

INITIAL MEAN VALUE IIH(NA) = $+9.99\times10^{-1}$

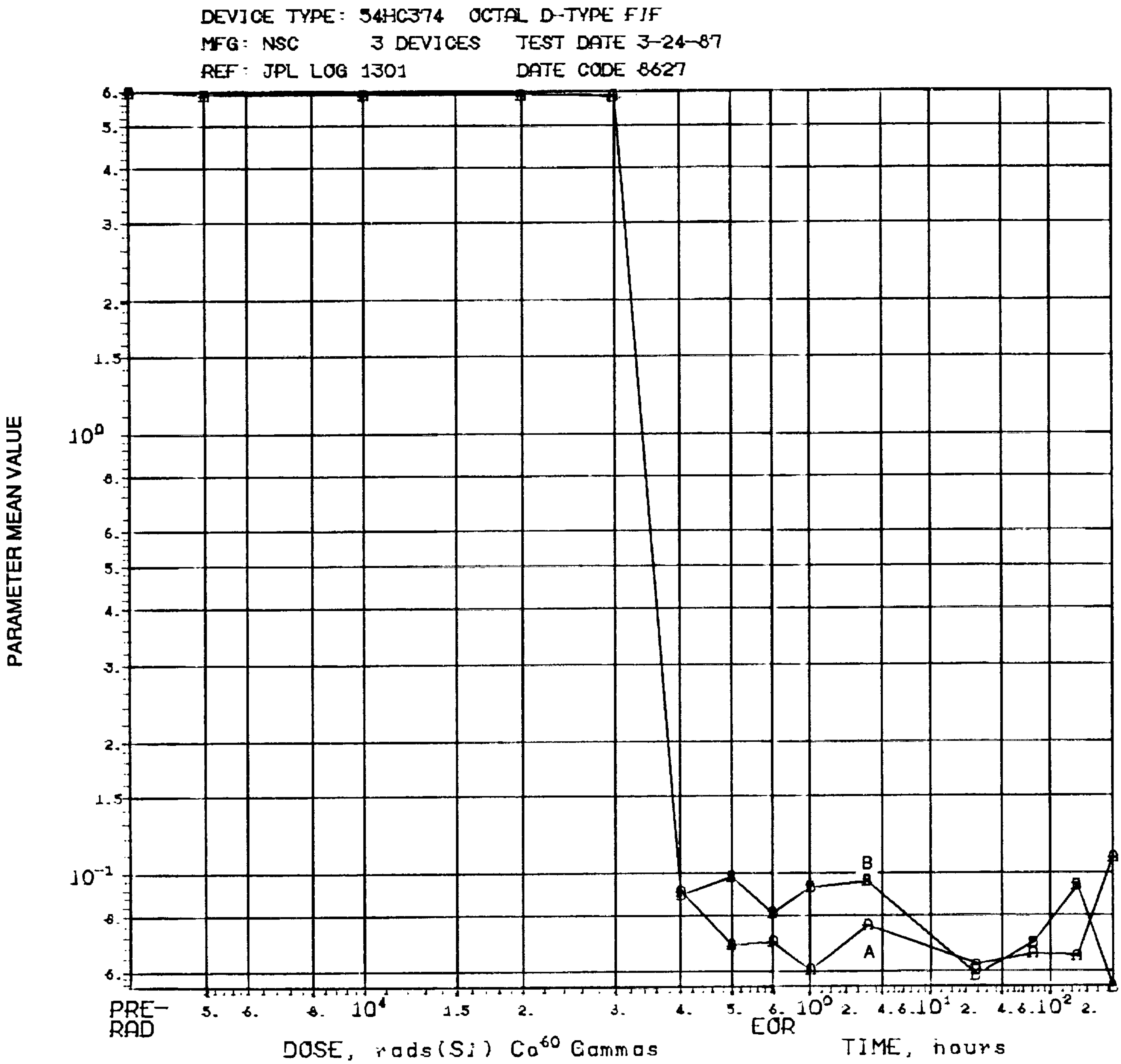
DEVICE TYPE: 54HC374 CMOS OCTAL D-TYPE F/F
MFG: NSC 5 DEVICES TEST DATE 11-13-85
REF: JPL LOG 1215 DATE CODE R8520



(6) IIL (VCC=6V,VIN=0V) IN NA: VS DOSE

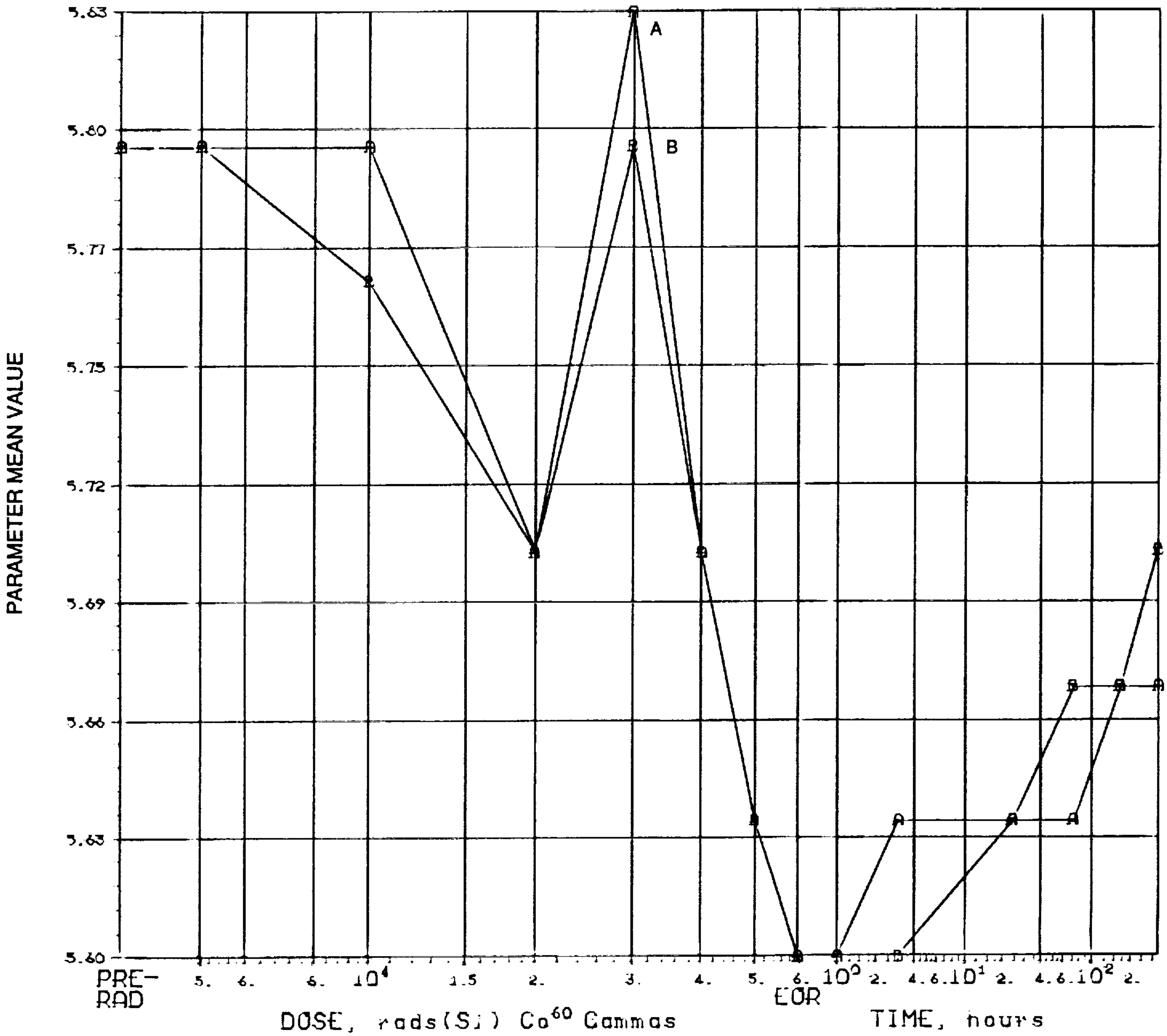
TABLE OF NORMAL STANDARD DEVIATIONS											
CURVE	DOSE, rads(Si)										
DOSE	0.0E0	1.0E3	2.0E3	3.0E3	5.0E3	7.0E3	1.0E4	1.5E4	2.0E4	2.5E4	3.0E4
STD. DEV.	.1789	.2608	.1414	.1673	.1673	.1095	.1789	.1673	.2280	.3847	.2000
DOSE	4.0E4										
STD. DEV.	.2280										

INITIAL MEAN VALUE IIL(NA) = +6.80X10^{-1}



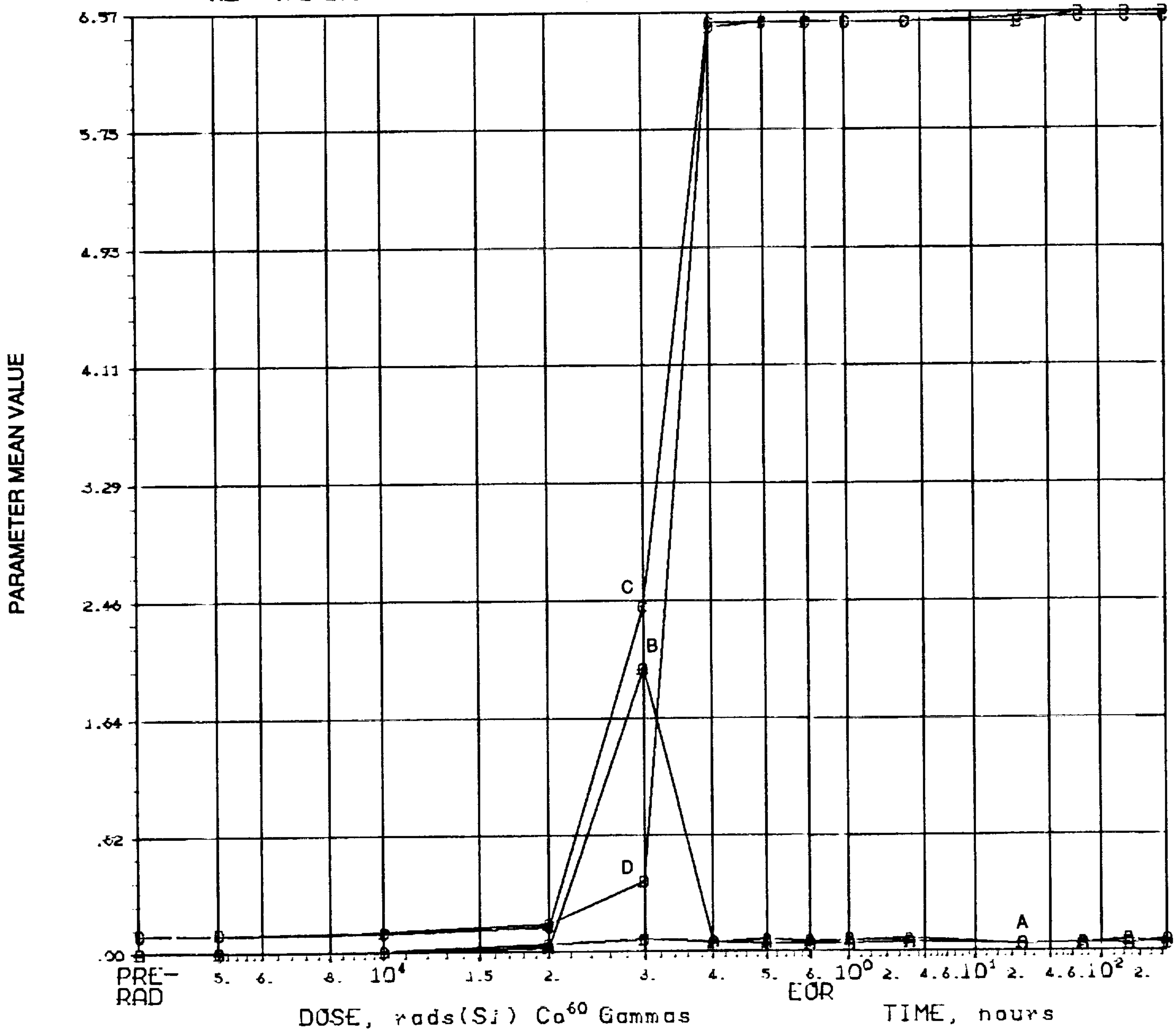
	PARAMETERS		CONDITIONS
CURVE A:	(1) VOH1-A	(V)	(IOUT = -20 UA)
CURVE B:	(2) VOH1-B	(V)	" "

DEVICE TYPE: 54HC374 OCTAL D-TYPE F/F
MFG: NSC 3 DEVICES TEST DATE 3-24-87
REF: JPL LOG 1301 DATE CODE 8627

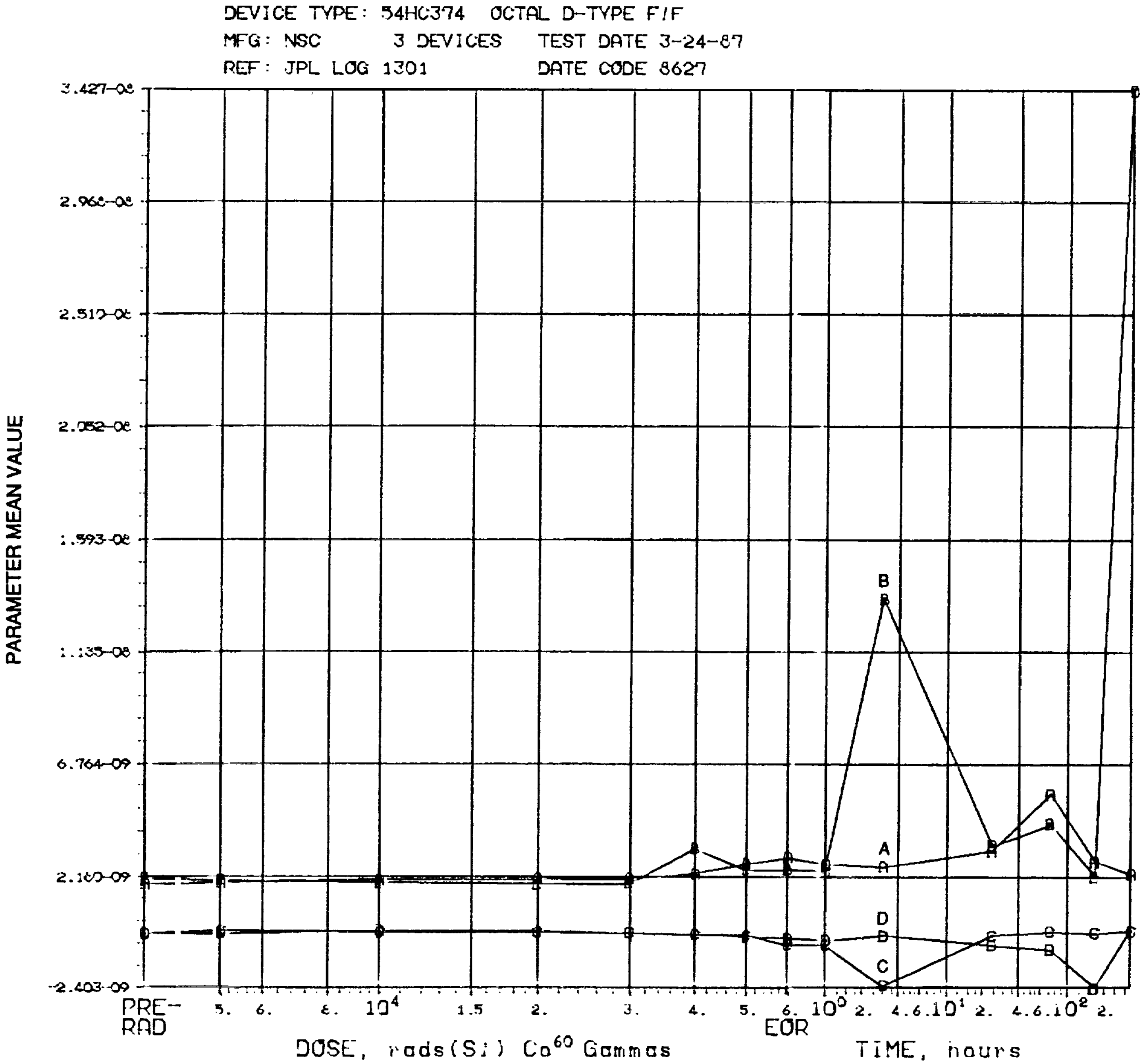


	PARAMETERS			CONDITIONS
CURVE A:	(3)	VOH2-A	(V)	(IOUT = -5.2 MA)
CURVE B:	(4)	VOH2-B	(V)	" "

DEVICE TYPE: 54HC374 OCTAL D-TYPE F/F
MFG: NSC 3 DEVICES TEST DATE 3-24-87
REF: JPL LOG 1301 DATE CODE 8627

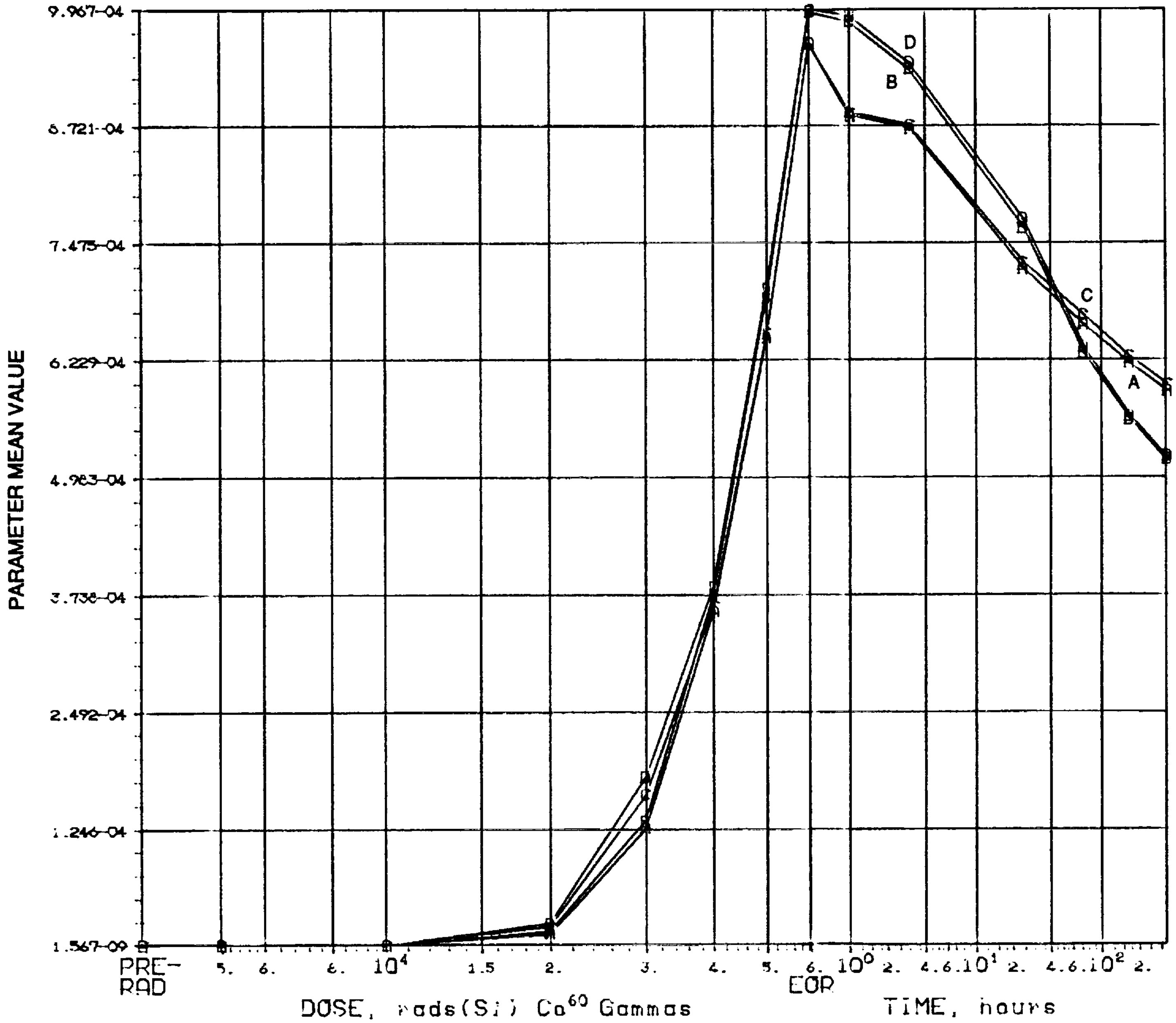


	PARAMETERS			CONDITIONS
CURVE A:	(5)	VOL1--A	(V)	(IOUT = 20 UA)
CURVE B:	(6)	VOL1--B	(V)	" "
CURVE C:	(7)	VOL2--A	(V)	(IOUT = 5.2 MA)
CURVE D:	(8)	VOL2--B	(V)	" "



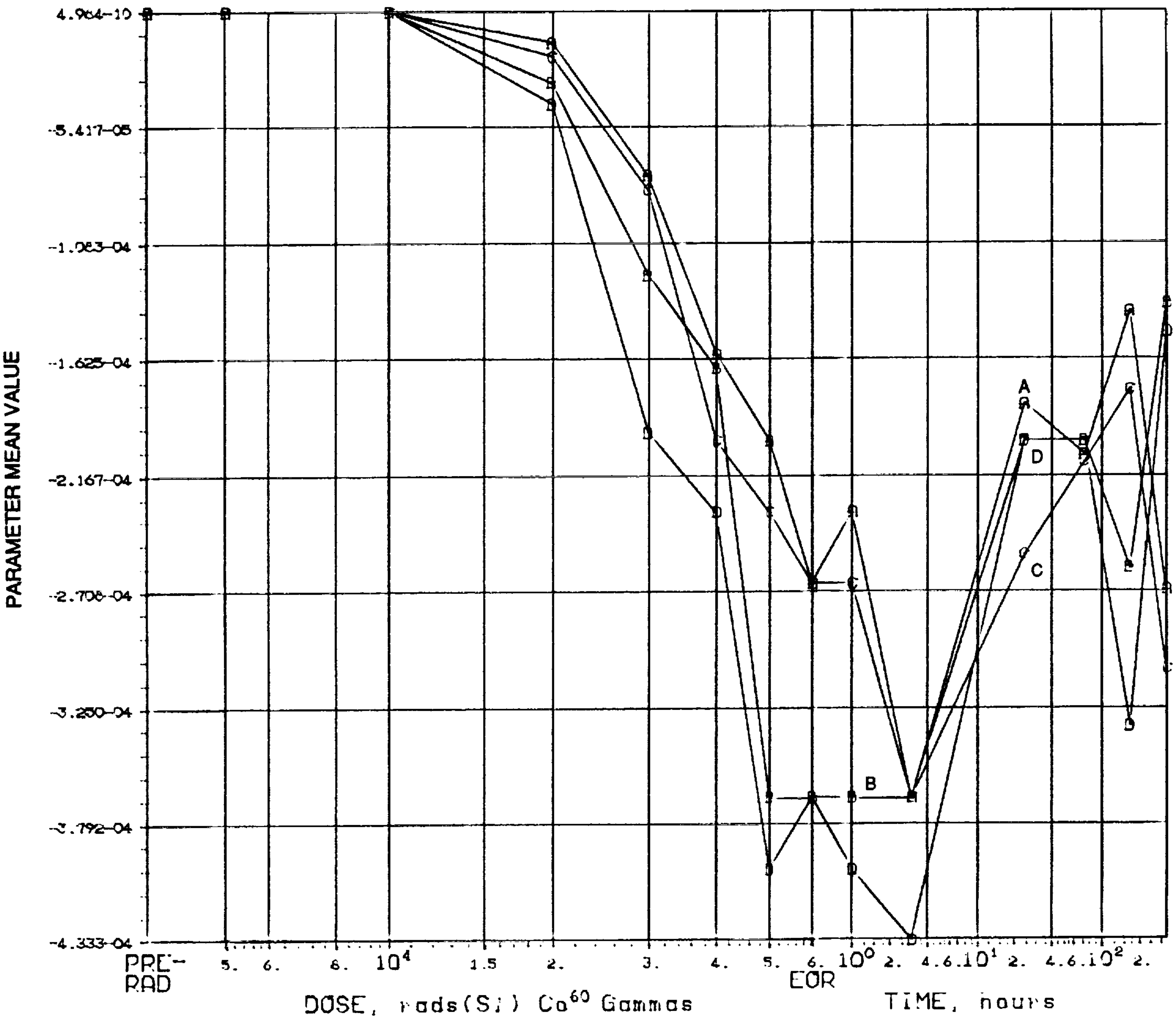
	PARAMETERS		CONDITIONS
CURVE A:	(9) IIH-A	(A)	(VIN = VCC)
CURVE B:	(10) IIH-B	(A)	" "
CURVE C:	(11) IIL-A	(A)	((VIN = GND)
CURVE D:	(12) IIL-B	(A)	" "

DEVICE TYPE: 54HC374 OCTAL D-TYPE F/F
MFG: NSC 3 DEVICES TEST DATE 3-24-87
REF: JPL LOG 1301 DATE CODE 8627

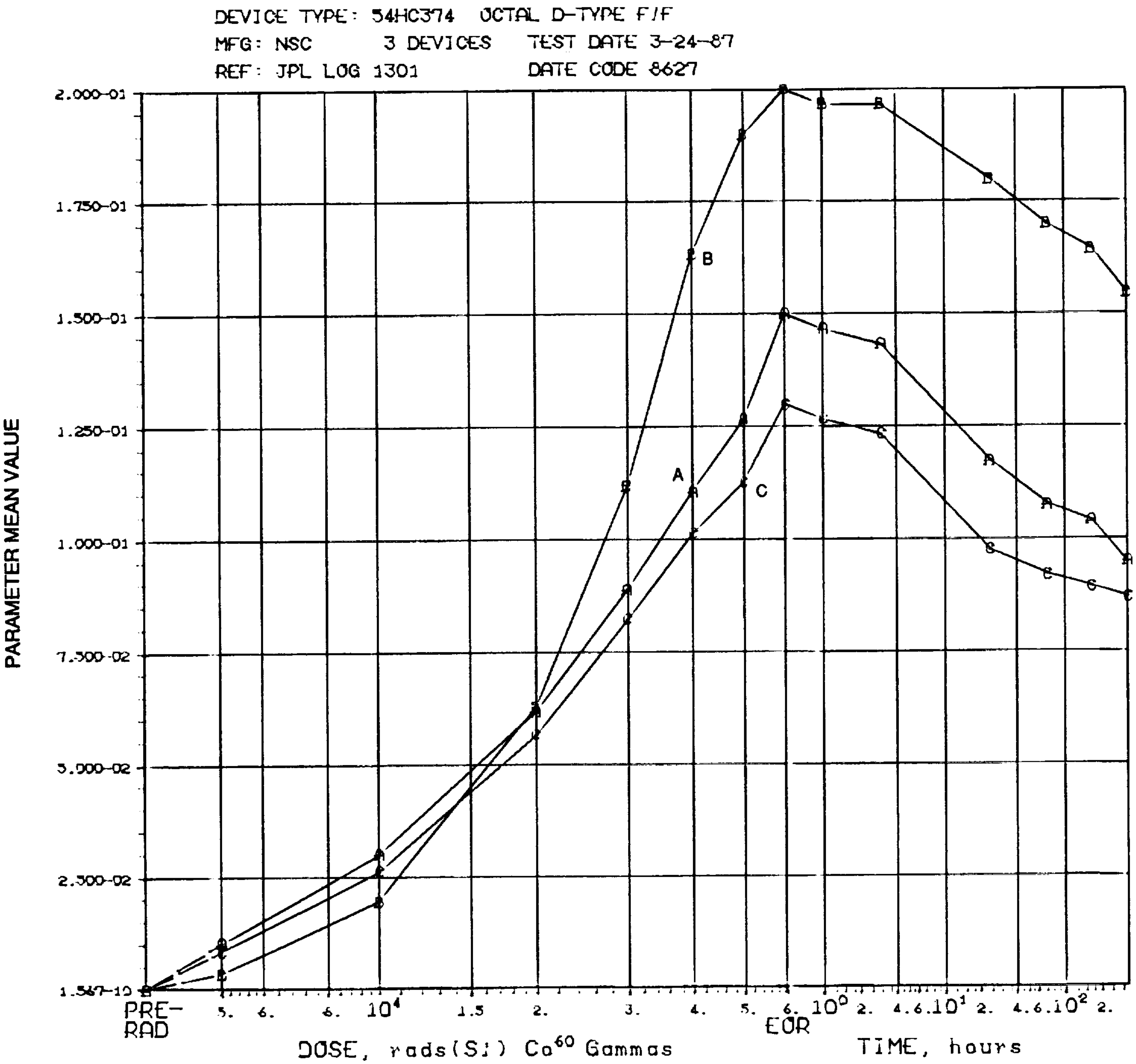


	PARAMETERS	CONDITIONS
CURVE A:	(13) IOZH1--A (A)	(VIN = 4.2 V)
CURVE B:	(14) IOZH1--B (A)	" "
CURVE C:	(15) IOZH2--A (A)	(VIN = 1.2 V)
CURVE D:	(16) IOZH2--B (A)	" "

DEVICE TYPE: 54HC374 OCTAL D-TYPE F/F
MFG: NSC 3 DEVICES TEST DATE 3-24-87
REF: JPL LOG 1301 DATE CODE 8627



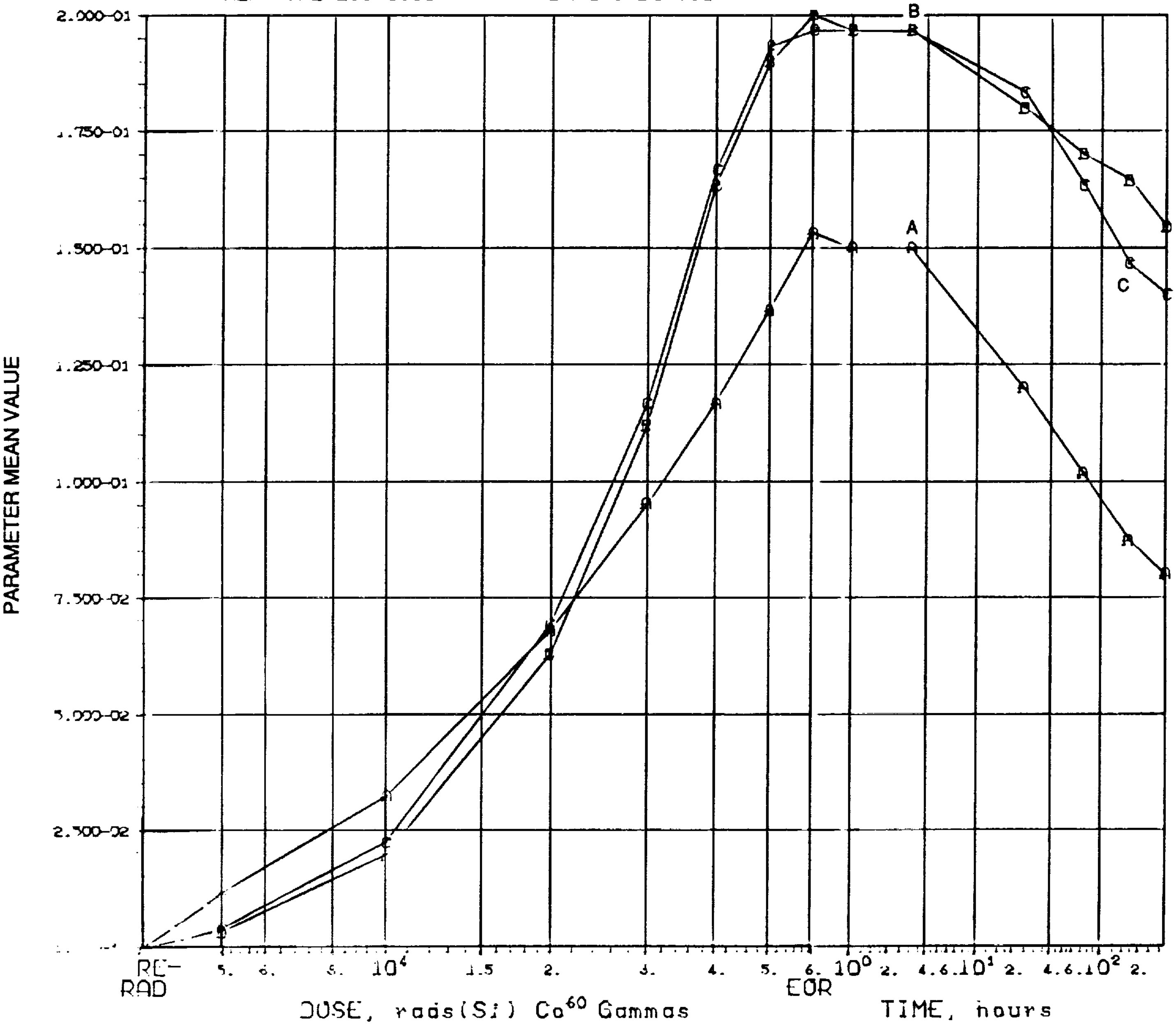
	PARAMETERS	CONDITIONS
CURVE A:	(17) IOZL1-A (A)	(VIN = 4.2 V)
CURVE B:	(18) IOZL-B1 (A)	" "
CURVE C:	(19) IOZL2-A (A)	(VIN = 1.2 V)
CURVE D:	(20) IOZL2-B (A)	" "



PARAMETERS

CURVE A:	(21) ICCH-A	(A)
CURVE B:	(23) ICCL-A	(A)
CURVE C:	(25) ICCZ-A	(A)

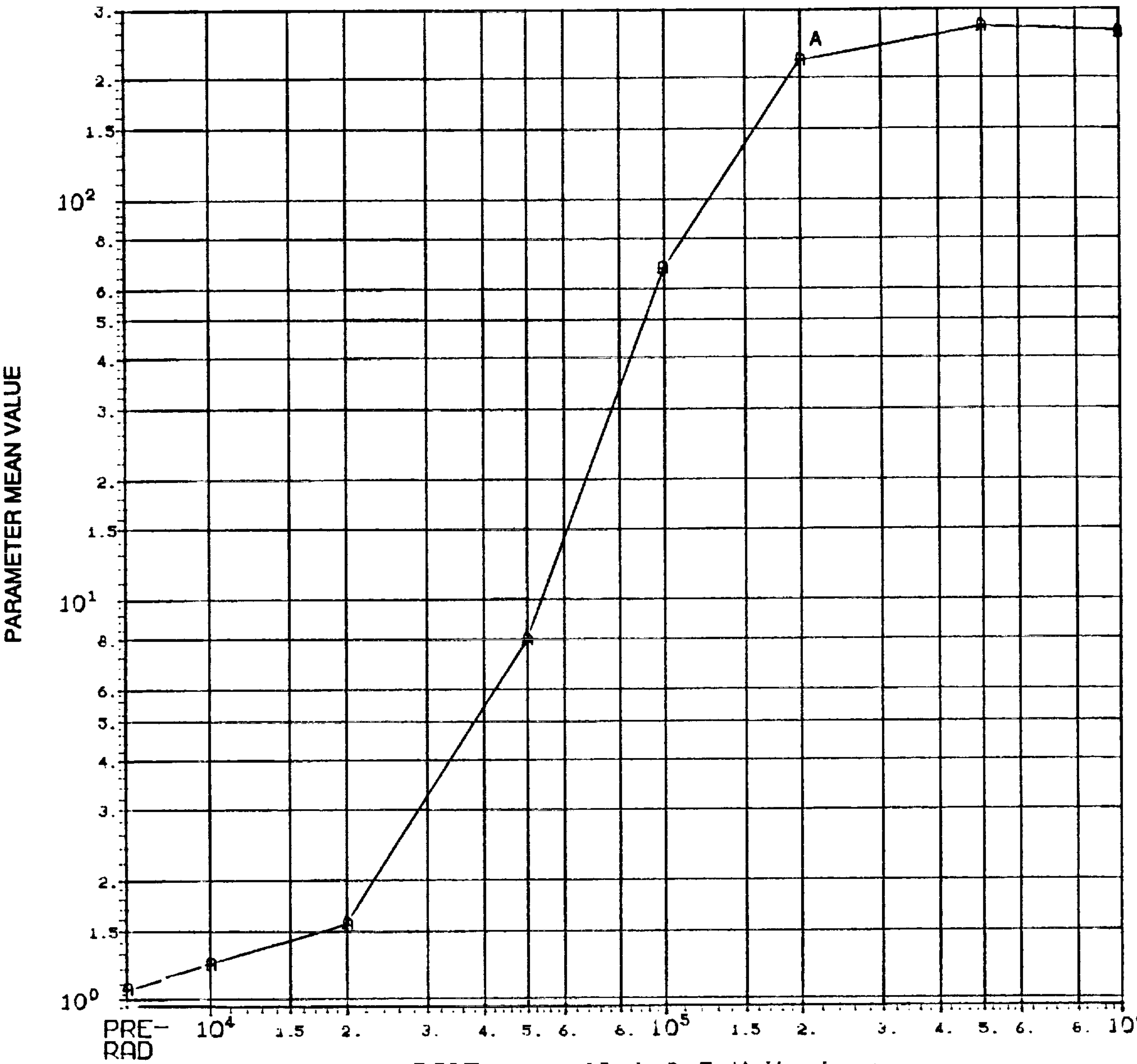
DEVICE TYPE: 54HC374 OCTAL D-TYPE F/F
MFG: NSC 3 DEVICES TEST DATE 3-24-87
REF: JPL LOG 1301 DATE CODE 8627



PARAMETERS

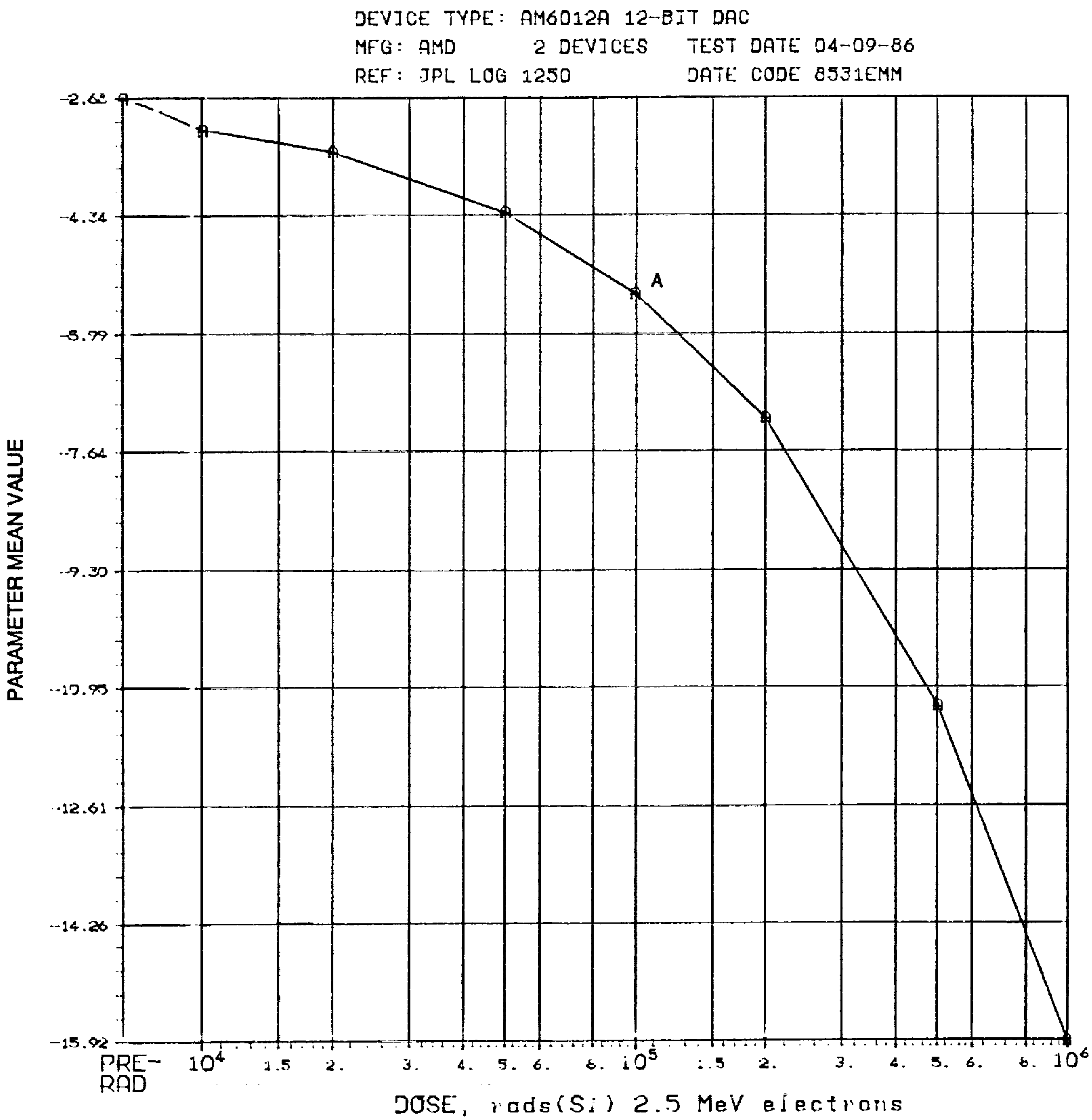
CURVE A:	(22) ICCH-B	(A)
CURVE B:	(23) ICCL-A	(A)
CURVE C:	(24) ICCL-B	(A)

DEVICE TYPE: AM6012A 12-BIT DAC
MFG: AMD 2 DEVICES TEST DATE 04-09-86
REF: JPL LOG 1250 DATE CODE 8531EMM



PARAMETERS

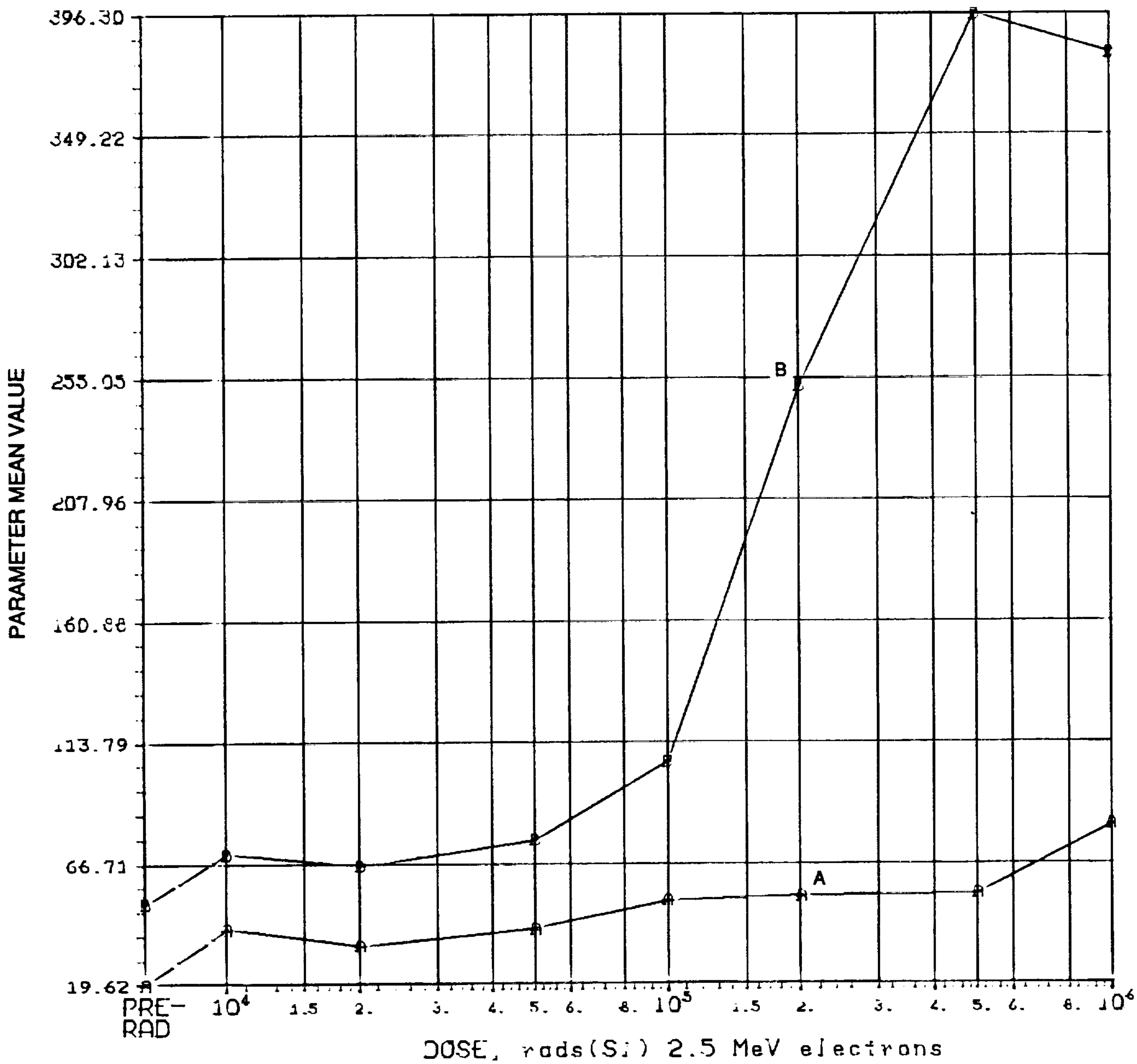
CURVE A: (1) IIH (VIH=15V) IN NA:



PARAMETERS

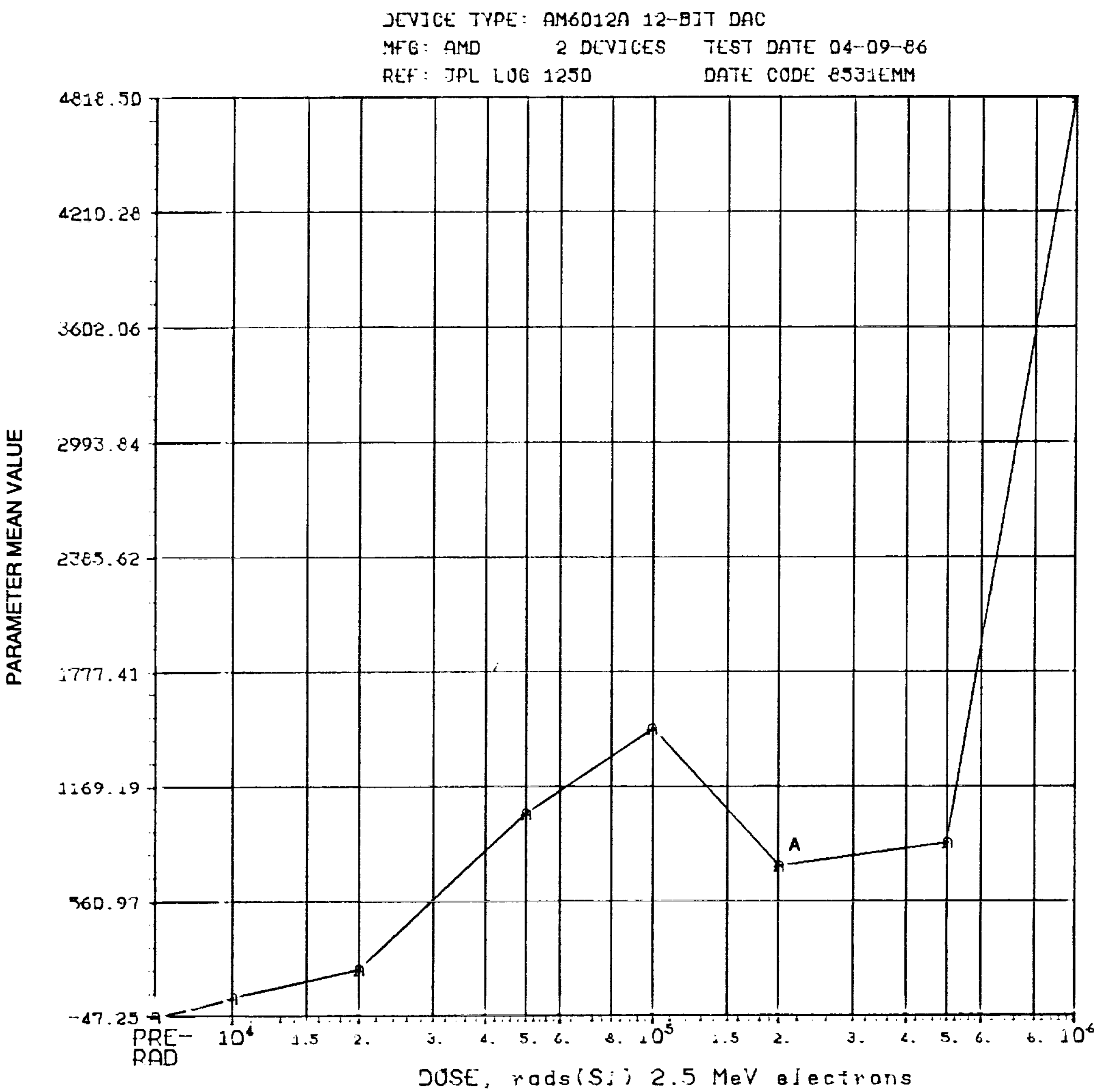
CURVE A: (2) IIL (VIL=0V) IN UA:

DEVICE TYPE: AM6012A 12-BIT DAC
MFG: AMD 2 DEVICES TEST DATE 04-09-86
REF: JPL LOG 1250 DATE CODE 8531EMM



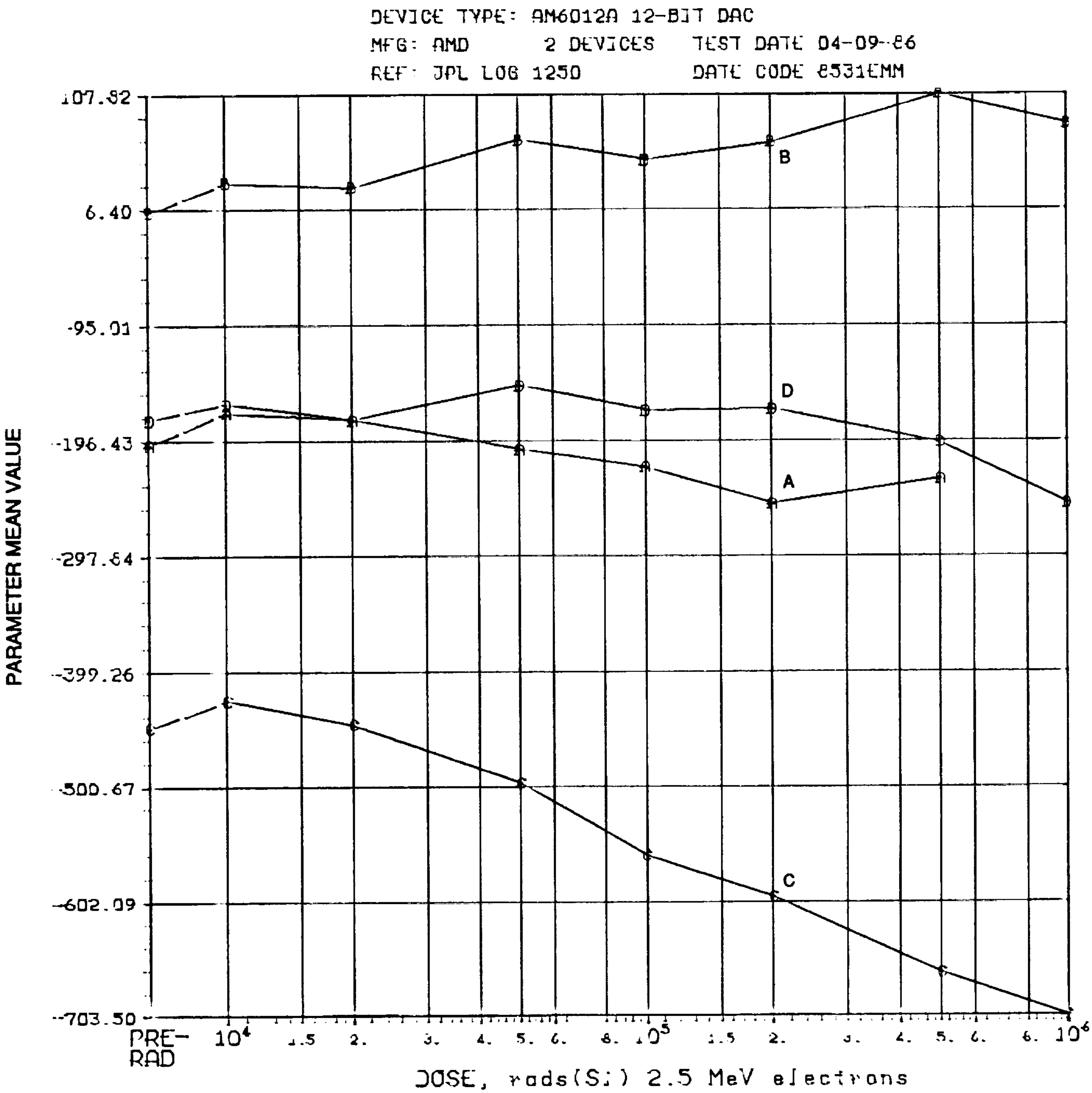
PARAMETERS

CURVE A: (3) IZS1 (INPUTS HIGH,IO MEASURED) IN NA:
CURVE B: (4) IZS2 (INPUTS LOW,IO MEASURED) IN NA:



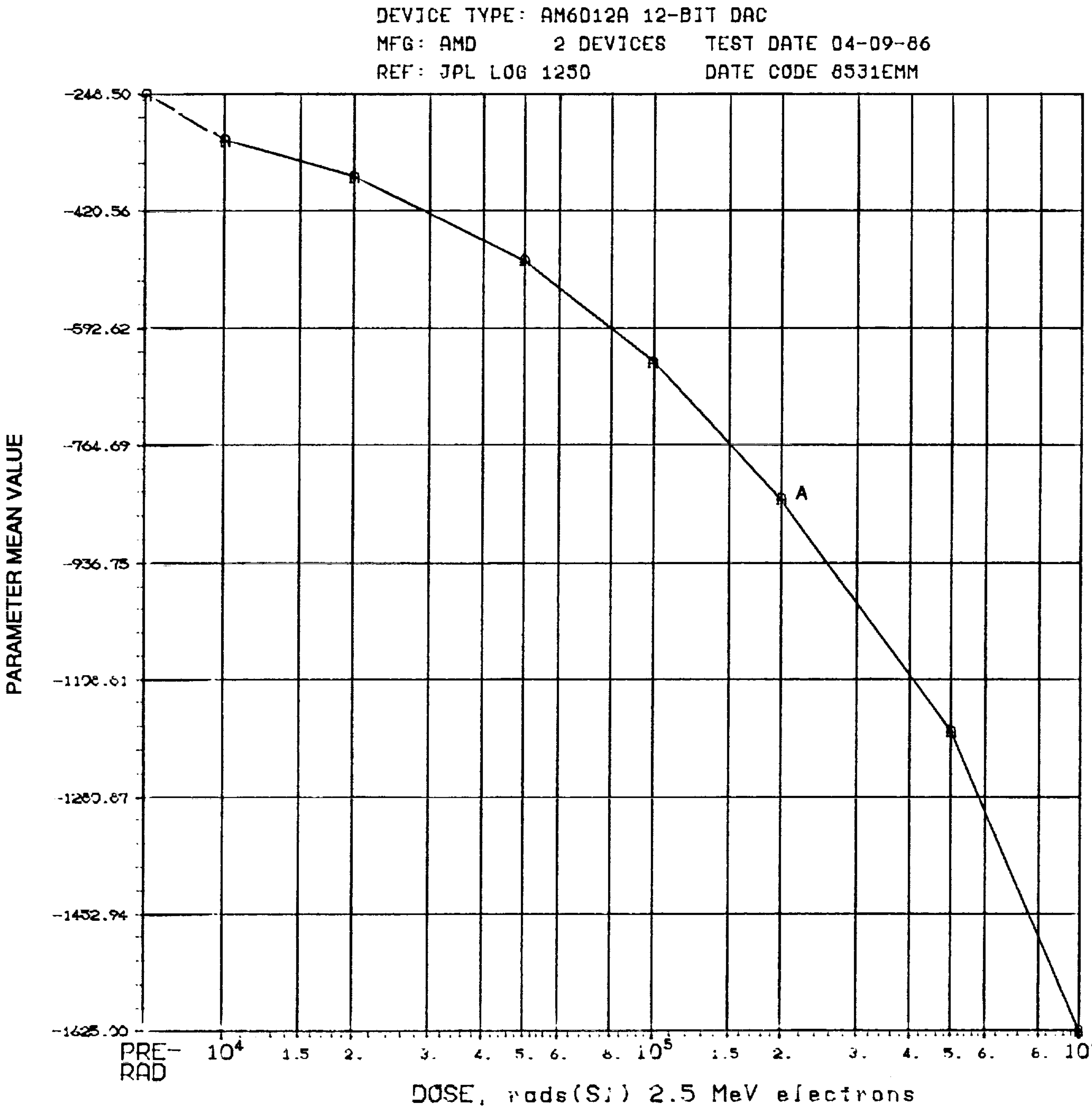
PARAMETERS

CURVE A: (5) IFSS (IFS3-IFS4) IN NA:



PARAMETERS

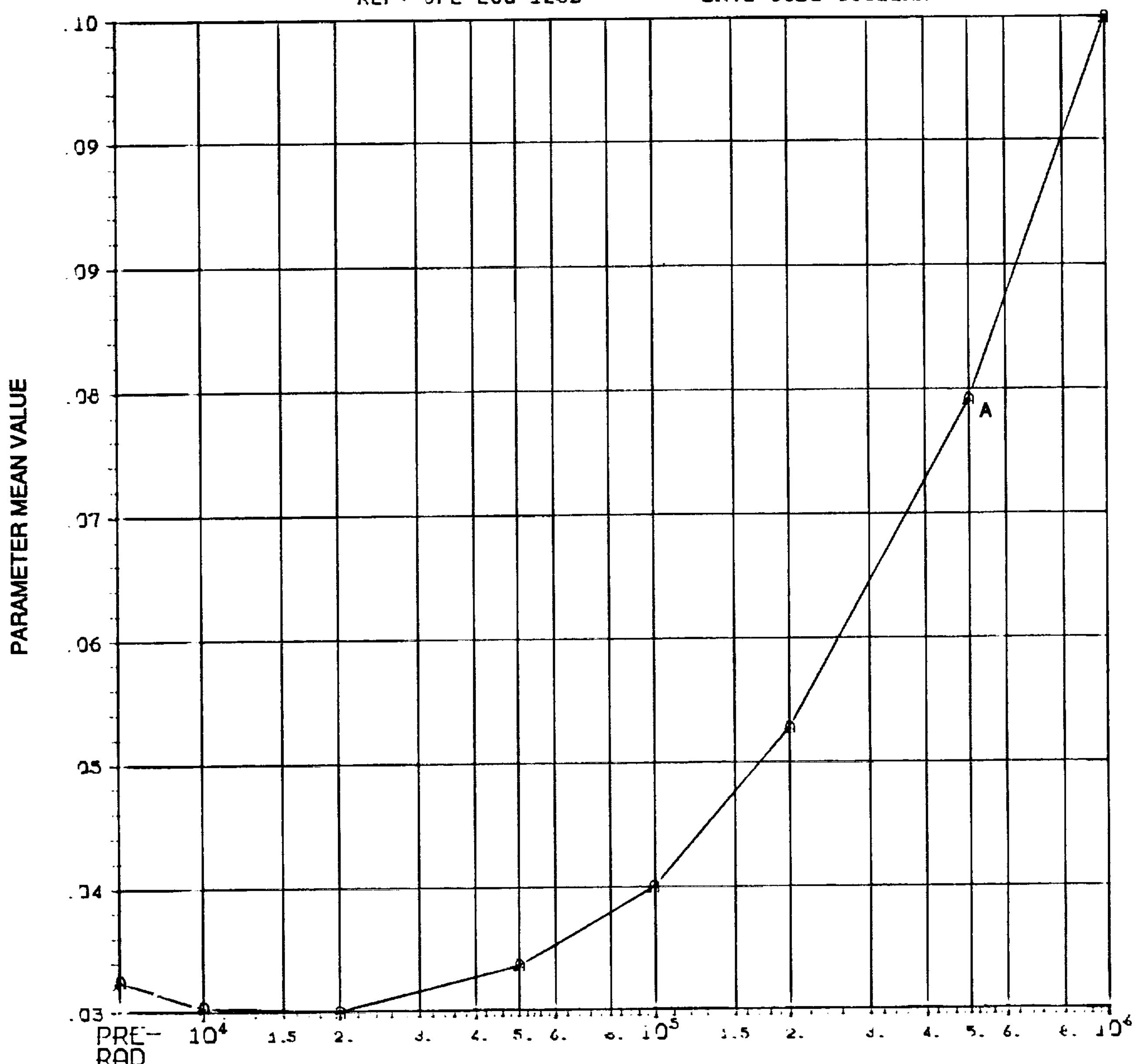
CURVE A: (6) PSS+1 (15V>VCC>4.5V,DELTA IO MEASURED) IN NA:
CURVE B: (7) PSS+2 (15V>VCC>18V,DELTA IO MEASURED IN NA:
CURVE C: (8) PSS-1 (-10.8V>VEE>-15V,DELTA IO MEASURED) IN NA:
CURVE D: (9) PSS-2 (-15V>VEE>-18V,DELTA IO MEASURED) IN NA:



PARAMETERS

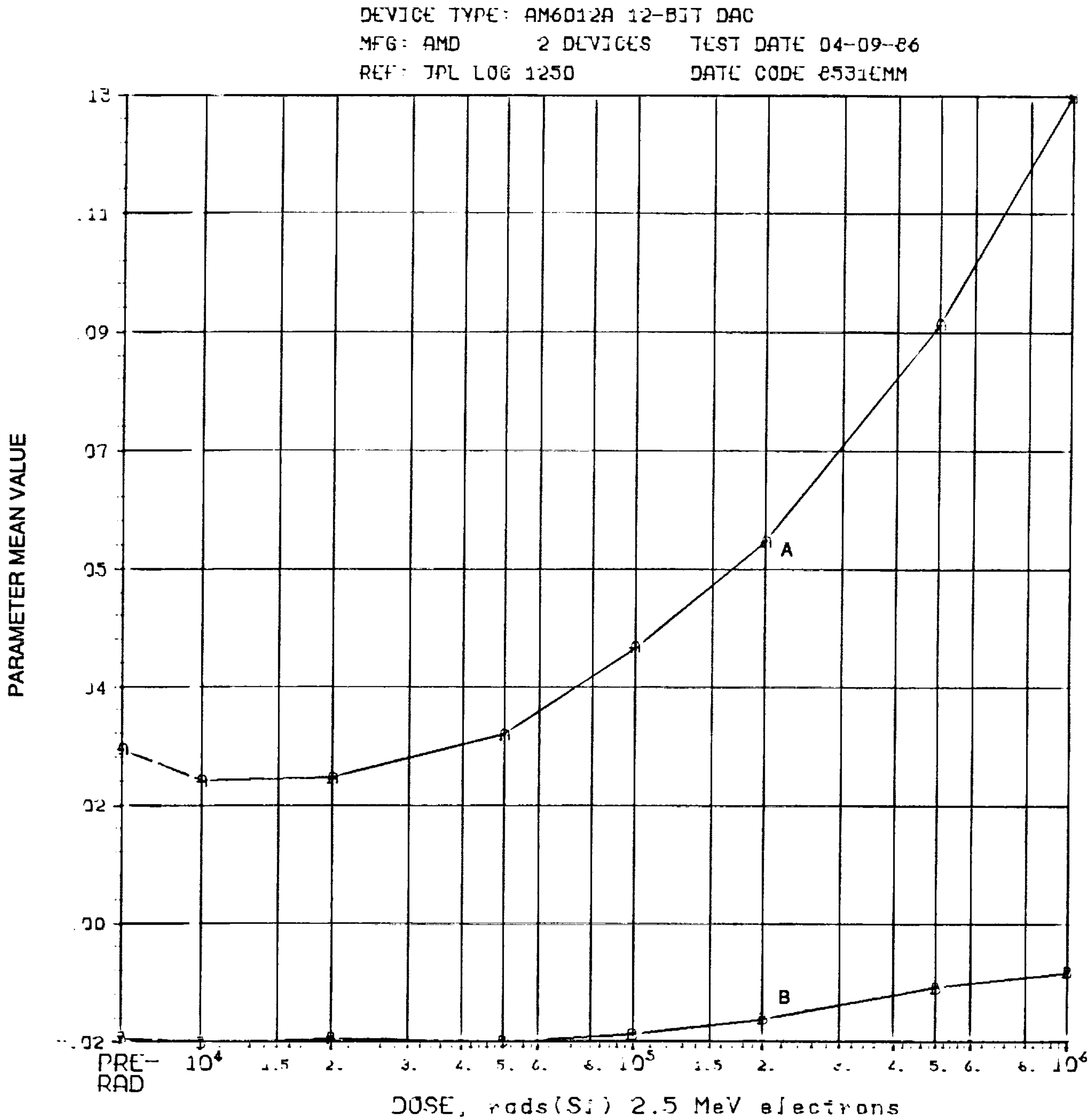
CURVE A: (10) IREF (VREF=0V) IN NA:

DEVICE TYPE: AM6012A 12-BIT DAC
MFG: AMD 2 DEVICES TEST DATE 04-09-86
REF: JPL LOG 1250 DATE CODE 8531EMM



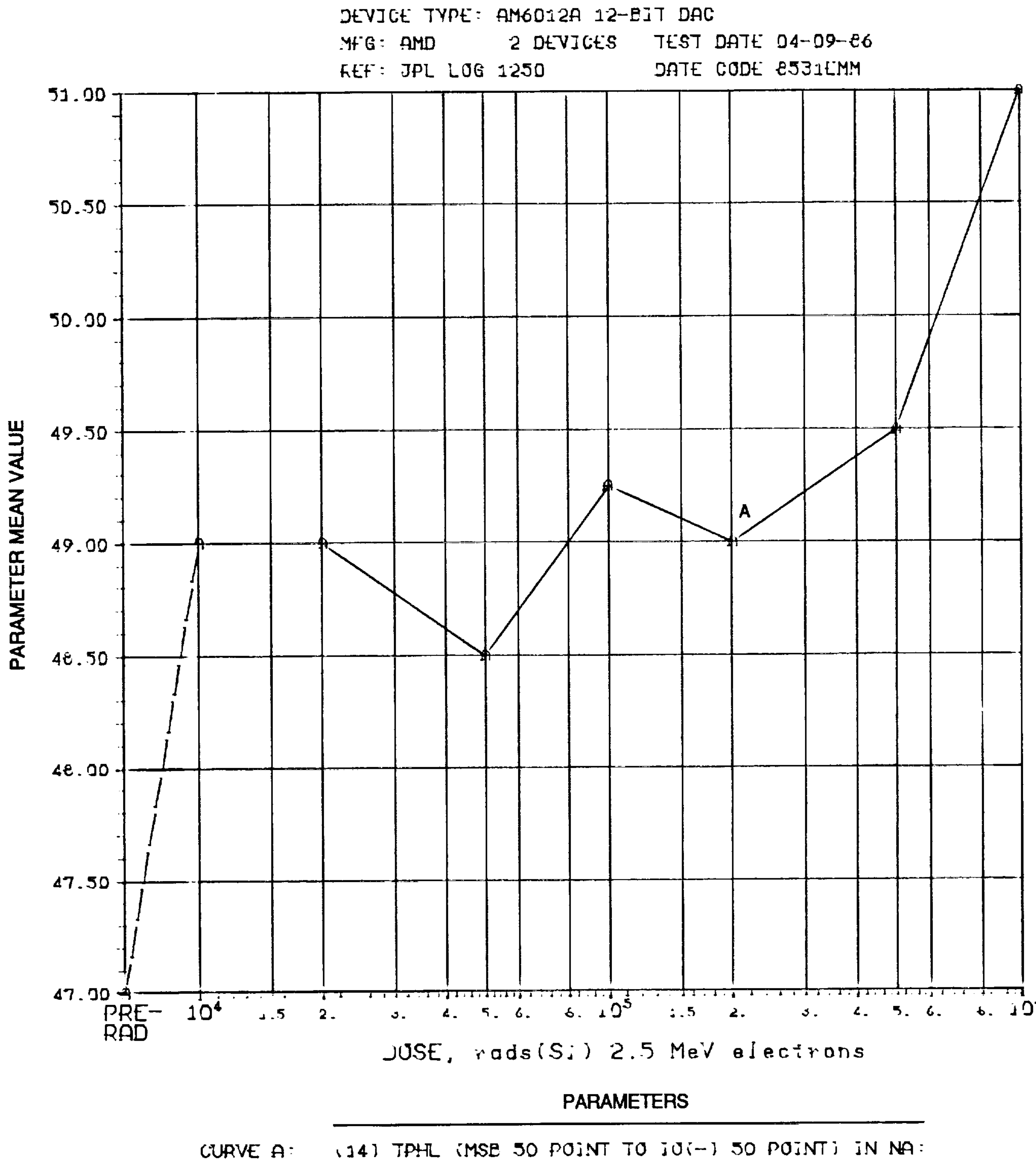
PARAMETERS

CURVE A: (11) NONLIN (MEAS'D DEV. FROM END-POINT CURVE FIT) IN FS:

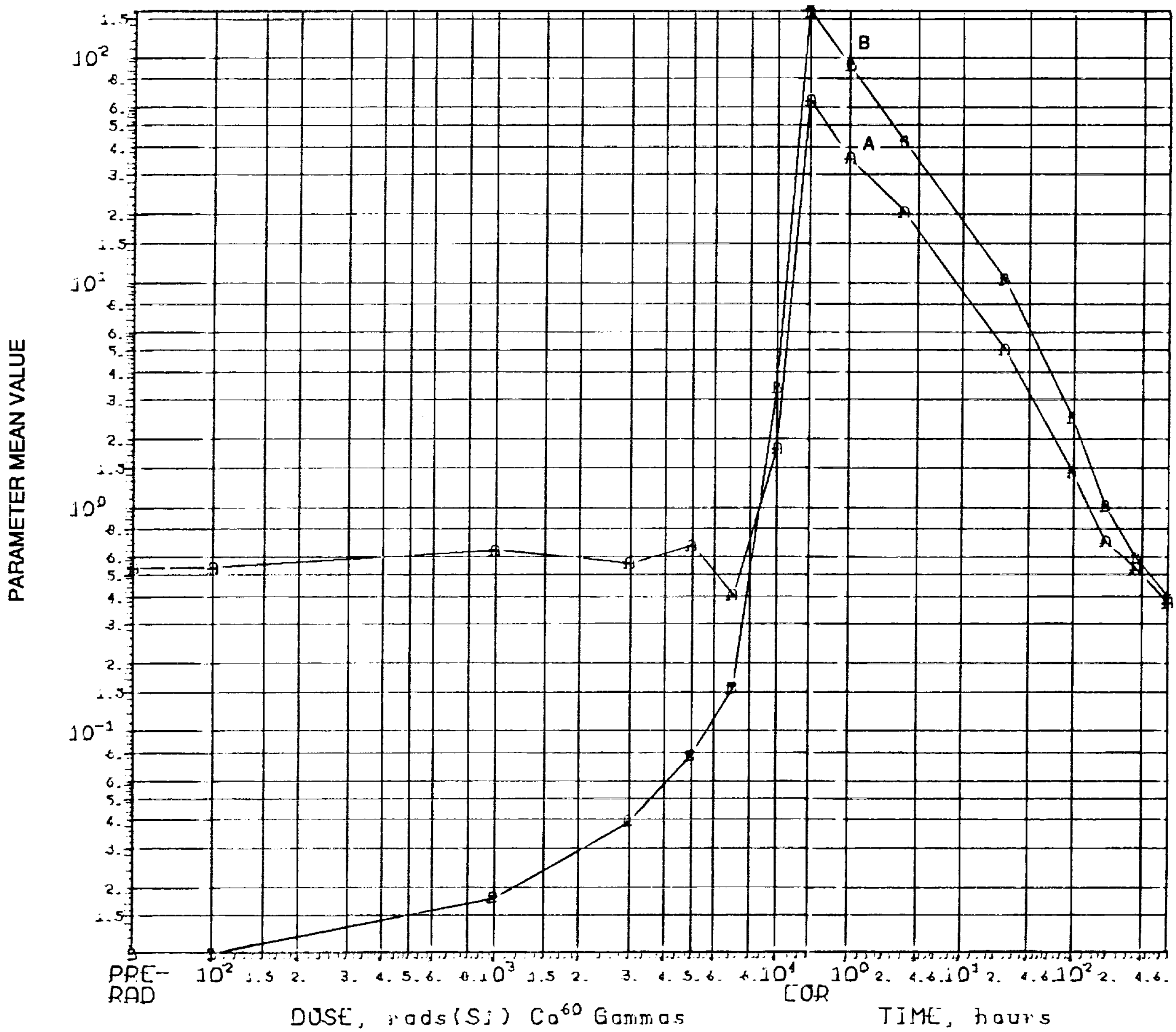


PARAMETERS

CURVE A:	(12) DNL+ (CALC. FROM MEAS'D BIT WEIGHTS IN TEST #46) FS:
CURVE B:	(13) DNL- (CALC. FROM MEAS'D BIT WEIGHTS IN TEST #46) FS:


DEVICE TYPE: AM6012A 12-BIT DAC
MFG: AMD 2 DEVICES TEST DATE 04-09-86
REF: JPL LOG 1250 DATE CODE 8531EMM
PARAMETER MEAN VALUE
51.00
50.50
50.00
49.50
49.00
48.50
48.00
47.50
47.00
A
PRE-RAD
DOSE, rads(Si) 2.5 MeV electrons
PARAMETERS
CURVE A: (14) TPHL (MSB 50 POINT TO IO(-) 50 POINT) IN NA:

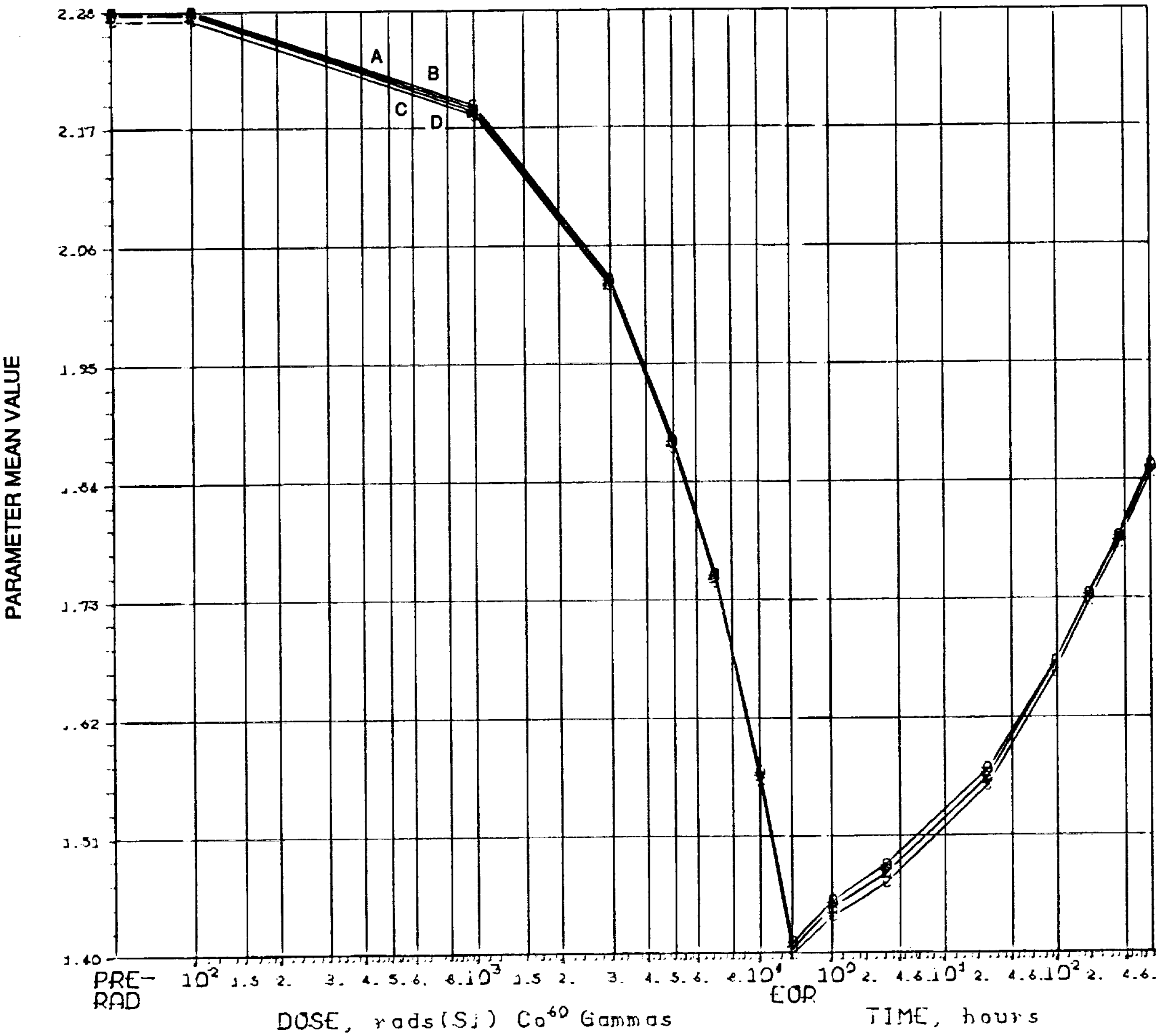
DEVICE TYPE: CD4011 QUAD NAND GATE
MFG: RCA 5 DEVICES TEST DATE 09-15-86
REF: JPL LOG 1173 DATE CODE D407



PARAMETERS

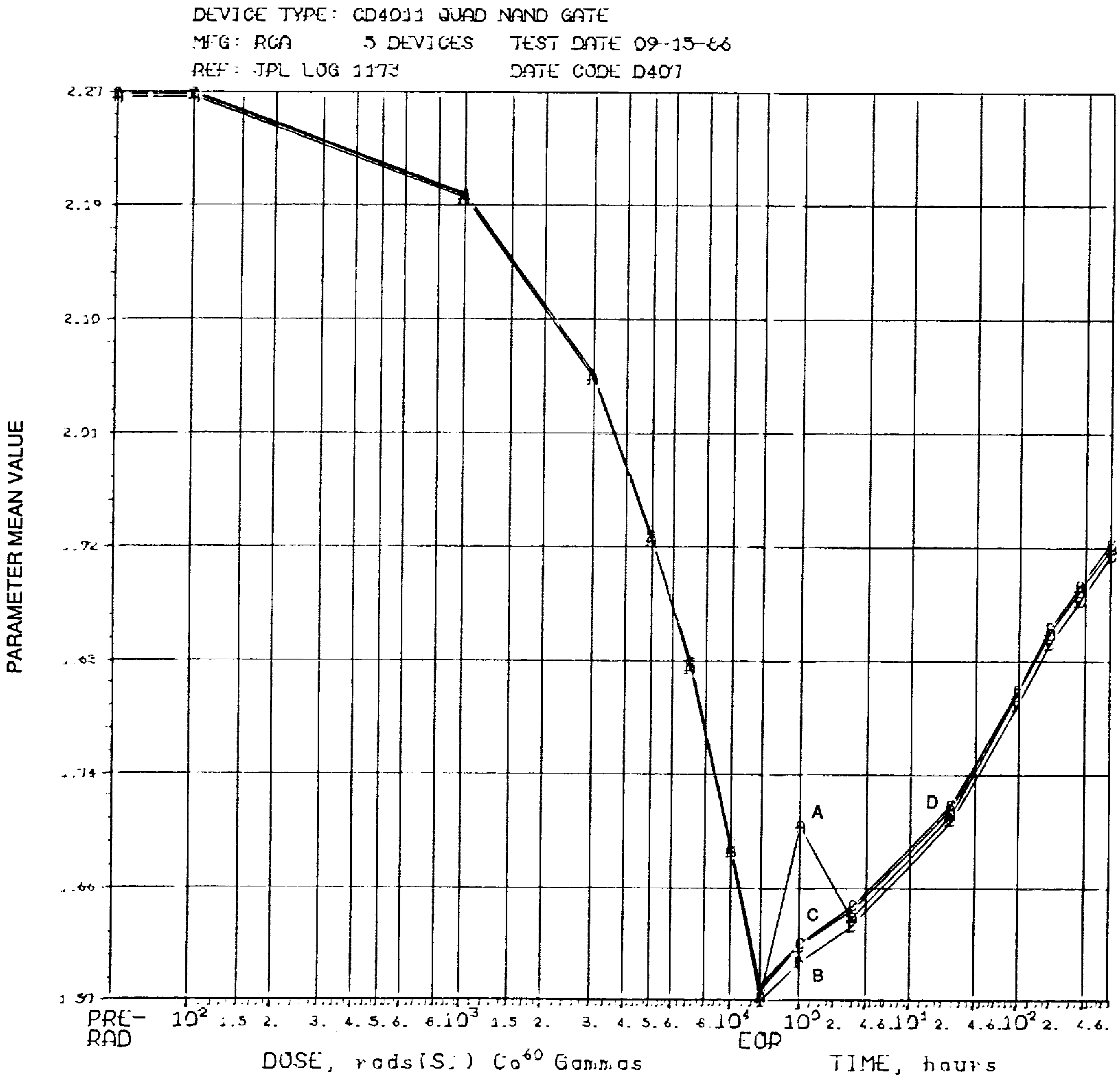
CURVE A: (1) IQH (NA)
CURVE B: (2) IQL (NA)

DEVICE TYPE: CD4011 QUAD NAND GATE
MFG: RCA 5 DEVICES TEST DATE 09-15-86
REF: JPL LOG 1173 DATE CODE D407



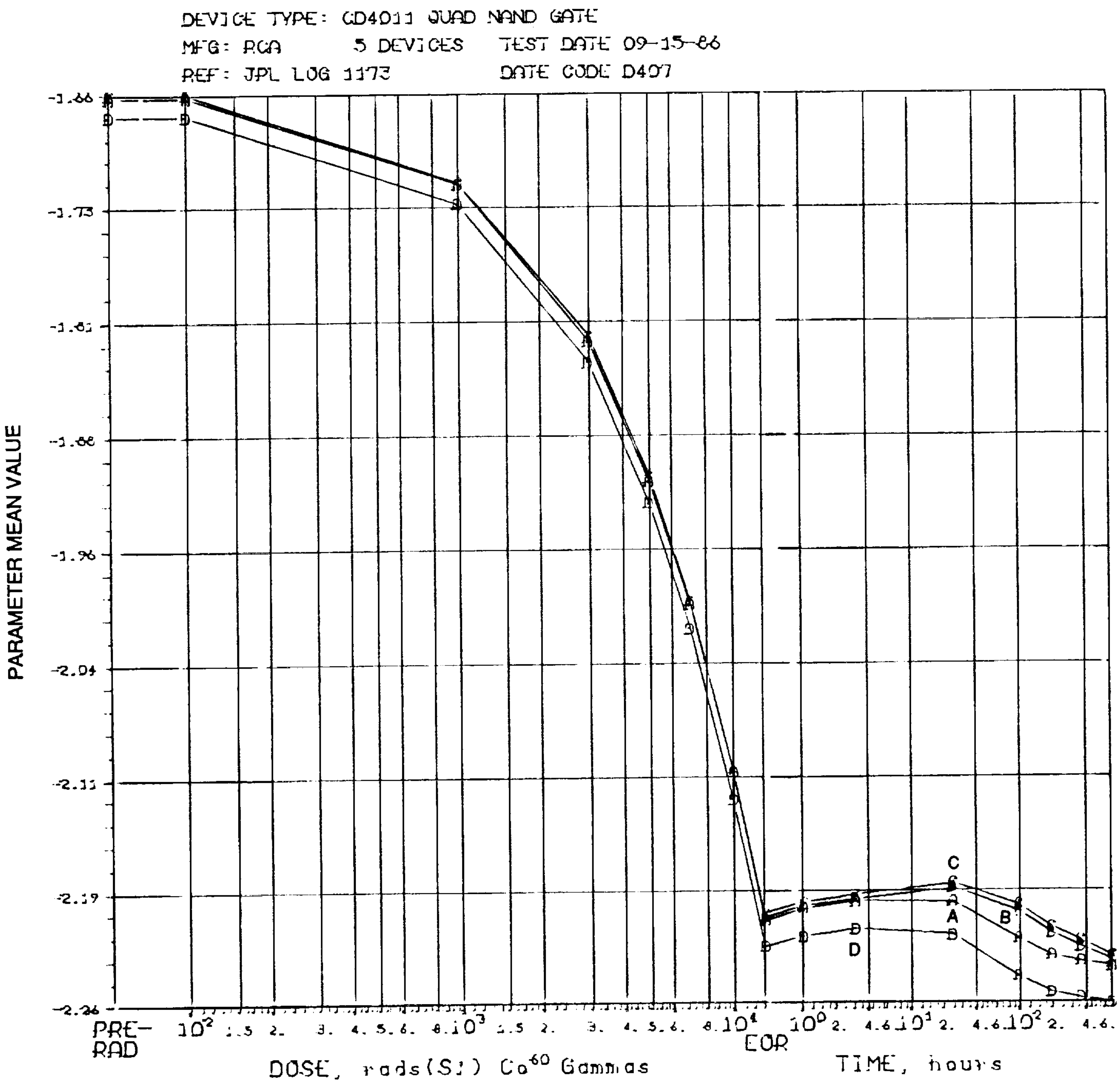
PARAMETERS

CURVE A:	(3)	VTN1--ON	(V)
CURVE B:	(4)	VTN2-ON	(V)
CURVE C:	(7)	VTN8-ON	(V)
CURVE D:	(8)	VTN9-ON	(V)



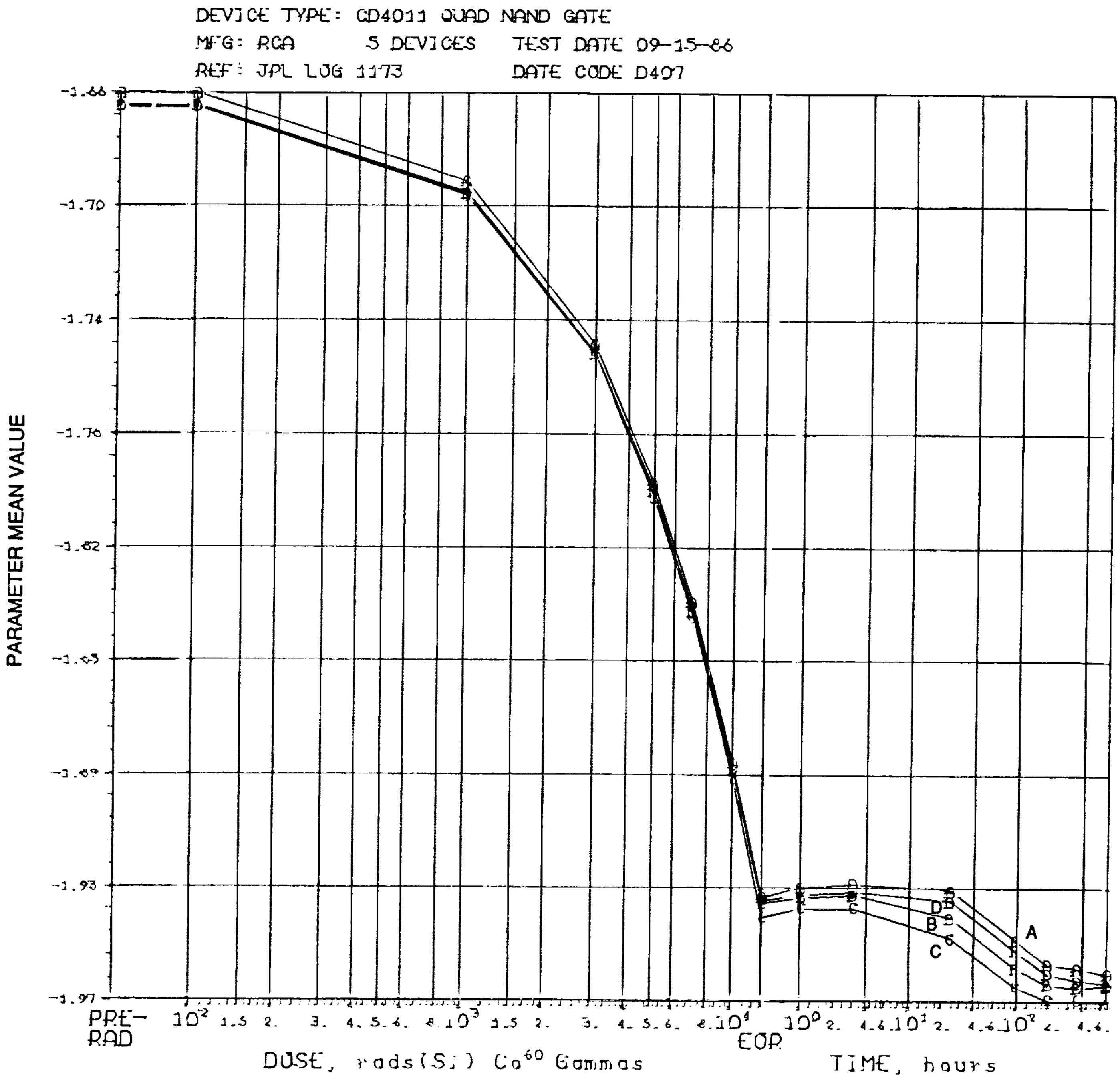
PARAMETERS

CURVE A:	(5)	VTN5-OFF	(V)
CURVE B:	(6)	VTN6-OFF	(V)
CURVE C:	(9)	VTN12-OFF	(V)
CURVE D:	(10)	VTN13-OFF	(V)



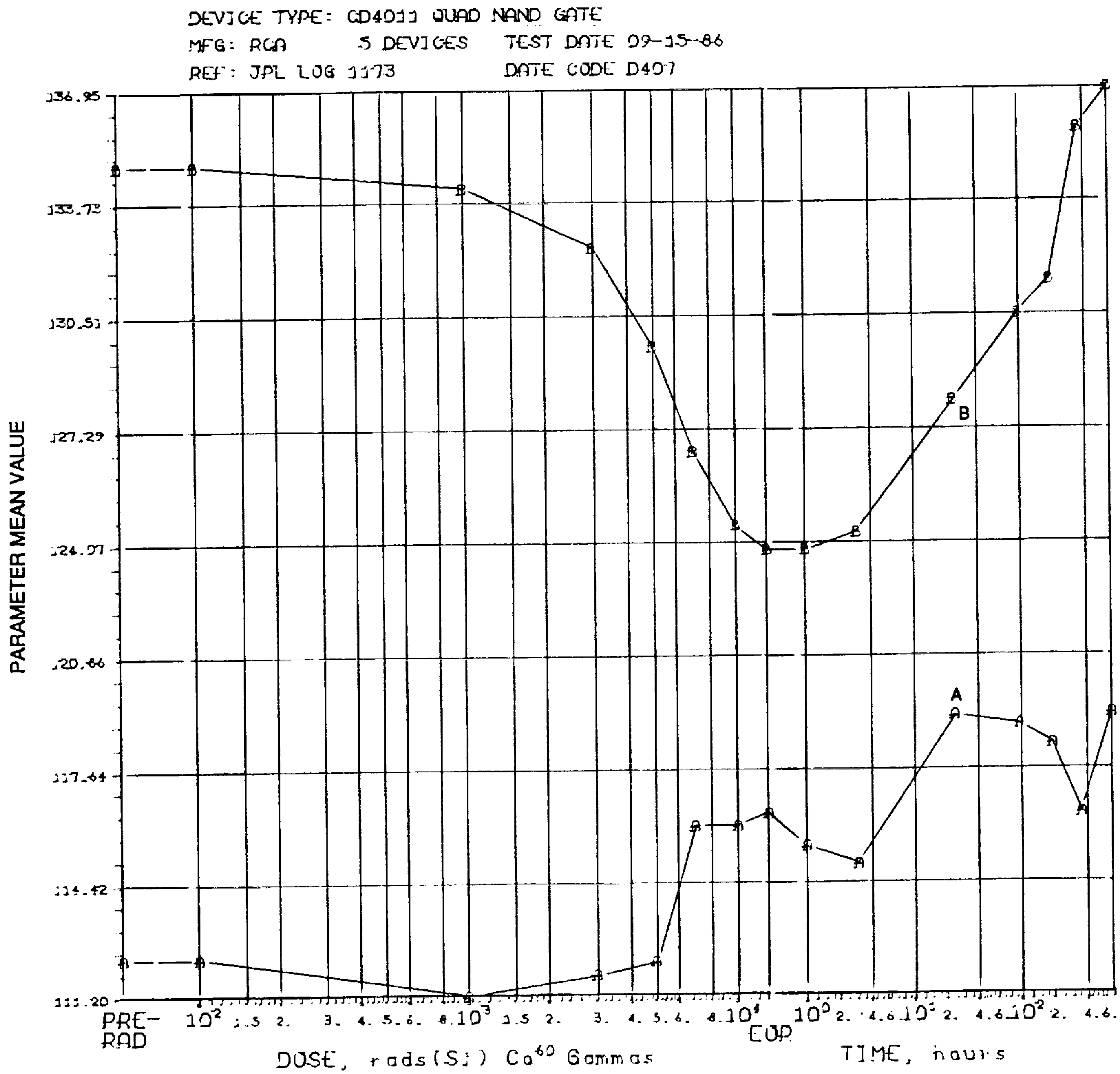
PARAMETERS

CURVE A:	(11) VTP1-OFF	(V)
CURVE B:	(12) VTP2-OFF	(V)
CURVE C:	(15) VTP8-OFF	(V)
CURVE D:	(16) VTP9-OFF	(V)



PARAMETERS

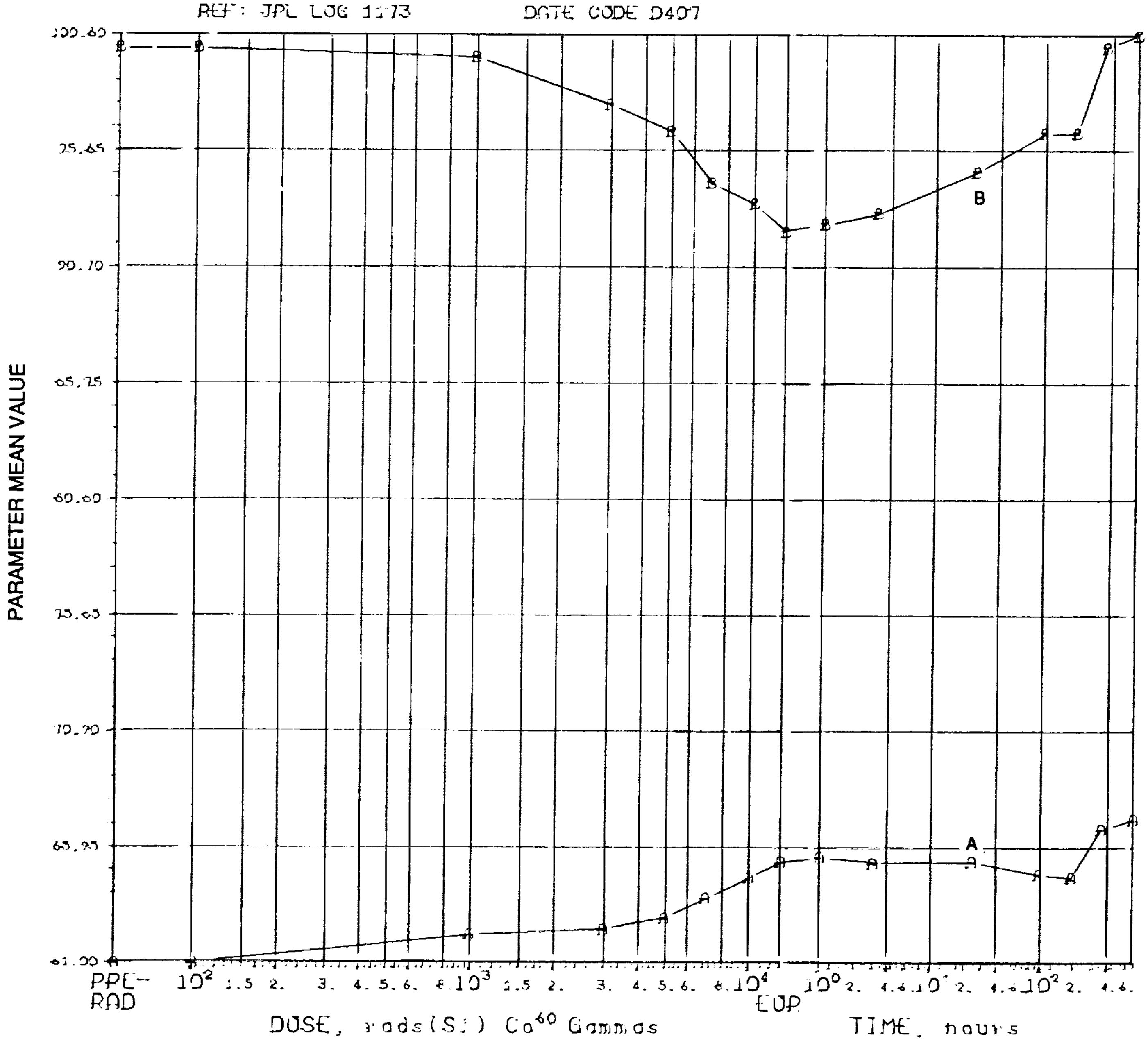
CURVE A:	(13)	VTP5-ON	(V)
CURVE B:	(14)	VTP6-ON	(V)
CURVE C:	(17)	VTP12-ON	(V)
CURVE D:	(16)	VTP13-ON	(V)



PARAMETERS

CURVE A: (19) TR (NS)
CURVE B: (20) TF (NS)

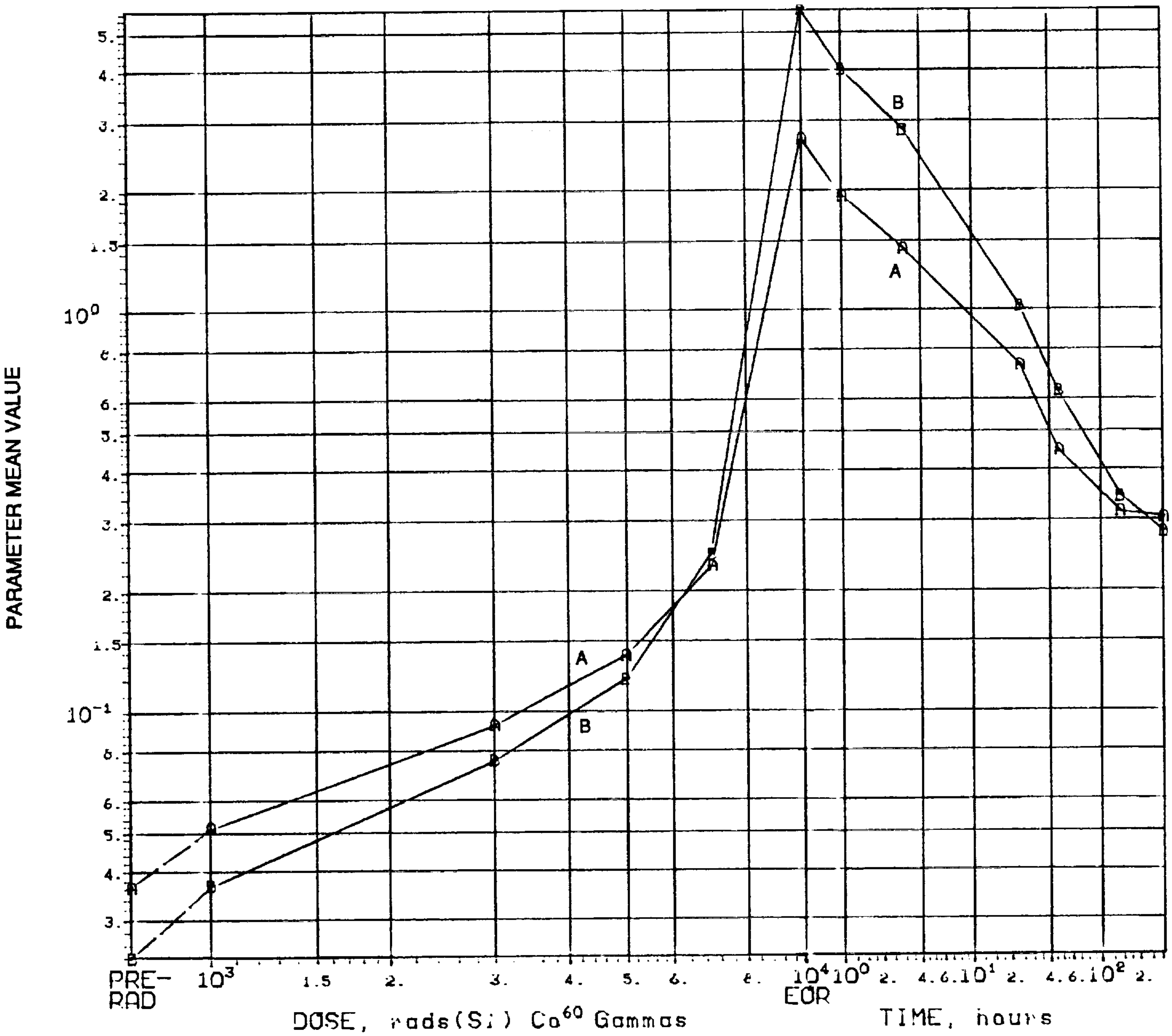
DEVICE TYPE: CD4011 QUAD NAND GATE
MFG: RCA 5 DEVICES TEST DATE 09-15-86
REF: JPL LOG 1173 DATE CODE D407



PARAMETERS

CURVE A:	(21) TPLH	(NS)
CURVE B:	(22) TPHL	(NS)

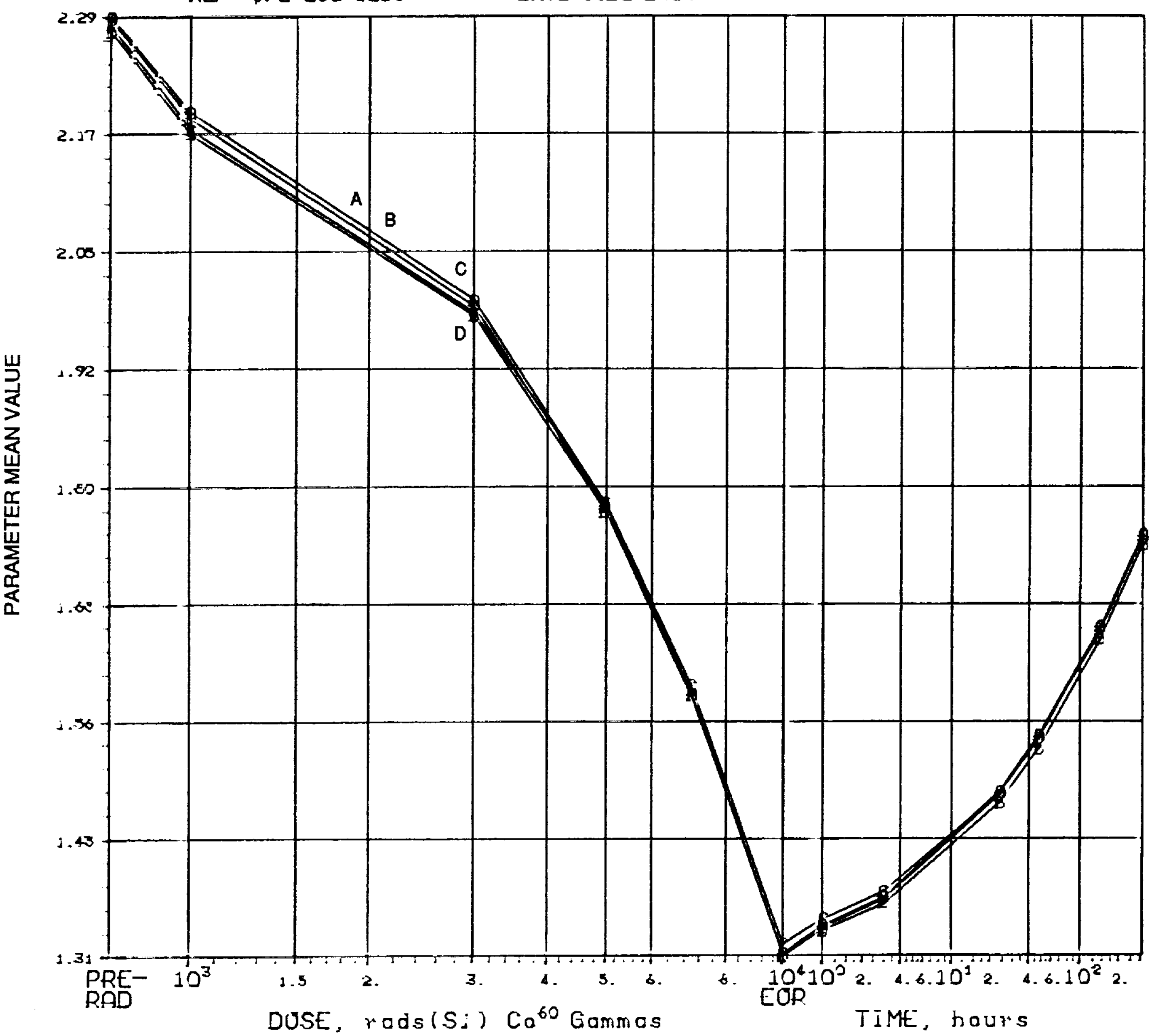
DEVICE TYPE: CD4011 QUAD NAND GATE
MFG: RCA 5 DEVICES TEST DATE 09-17-86
REF: JPL LOG 1203 DATE CODE D407



PARAMETERS

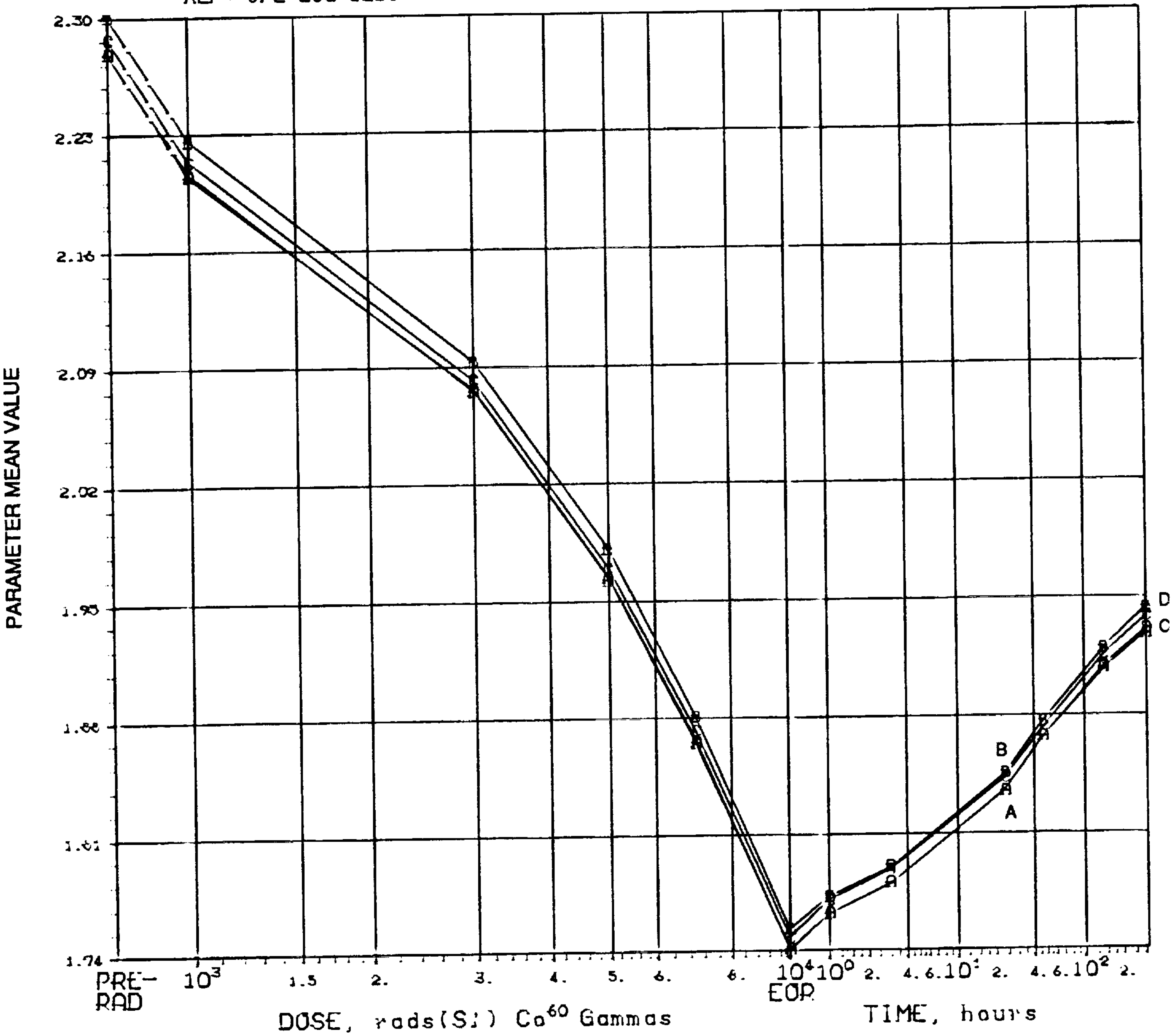
CURVE A: (1) IQH IN NA:
CURVE B: (2) IQL IN NA:

DEVICE TYPE: CD4011 QUAD NAND GATE
MFG: RCA 5 DEVICES TEST DATE 09-17-86
REF: JPL LOG 1203 DATE CODE D407

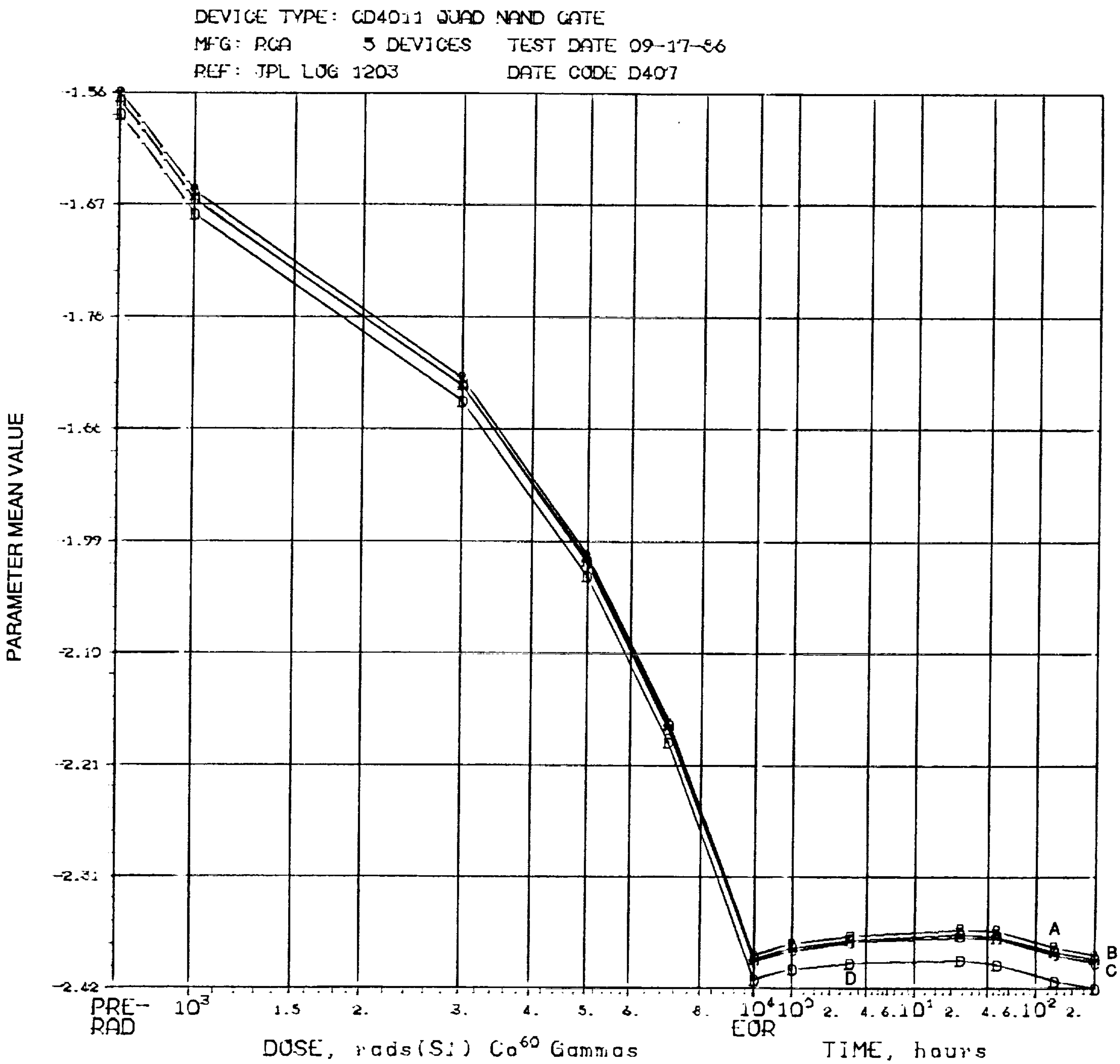


	PARAMETERS			CONDITIONS	
CURVE A:	(3)	VTN 1-ON	(V)	(BIAS	15V)
CURVE B:	(4)	VTN 2-ON	(V)	"	"
CURVE C:	(7)	VTN 8-ON	(V)	"	"
CURVE D:	(8)	VTN 9-ON	(V)	"	"

DEVICE TYPE: CD4011 QUAD NAND GATE
MFG: RCA 5 DEVICES TEST DATE 09-17-86
REF: JPL LOG 1203 DATE CODE D407



	PARAMETERS	CONDITIONS
CURVE A:	(5) VTN 5-OFF (V)	(BIAS GND)
CURVE B:	(6) VTN 6-OFF (V)	" "
CURVE C:	(9) VTN12-OFF (V)	" "
CURVE D:	(10) VTN13-OFF (V)	" "

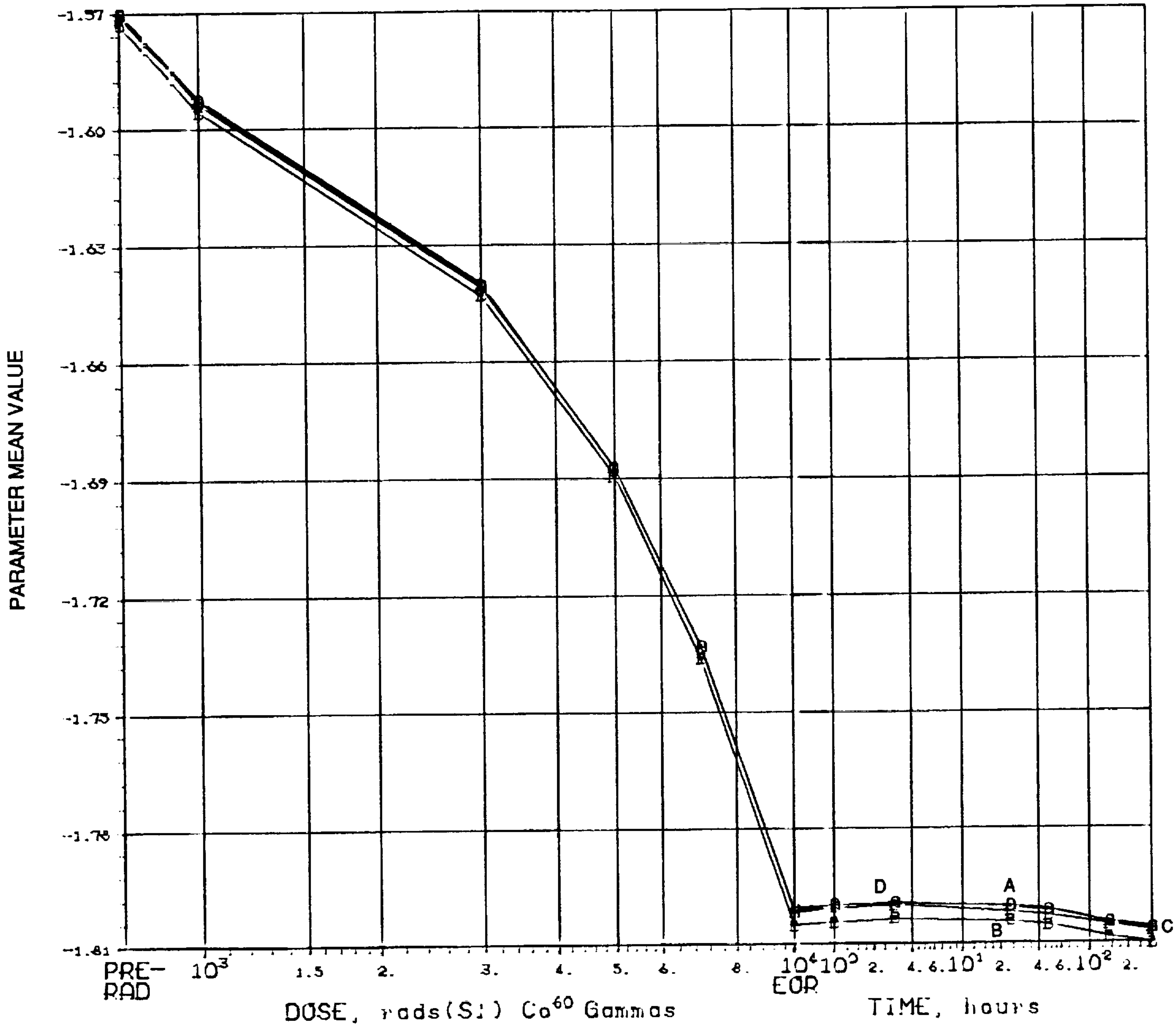


	PARAMETERS	CONDITIONS
CURVE A:	(11) VTP 1-OFF (V)	(BIAS 15V)
CURVE B:	(12) VTP 2-OFF (V)	" "
CURVE C:	(15) VTP 8-OFF (V)	" "
CURVE D:	(16) VTP 9-OFF (V)	" "

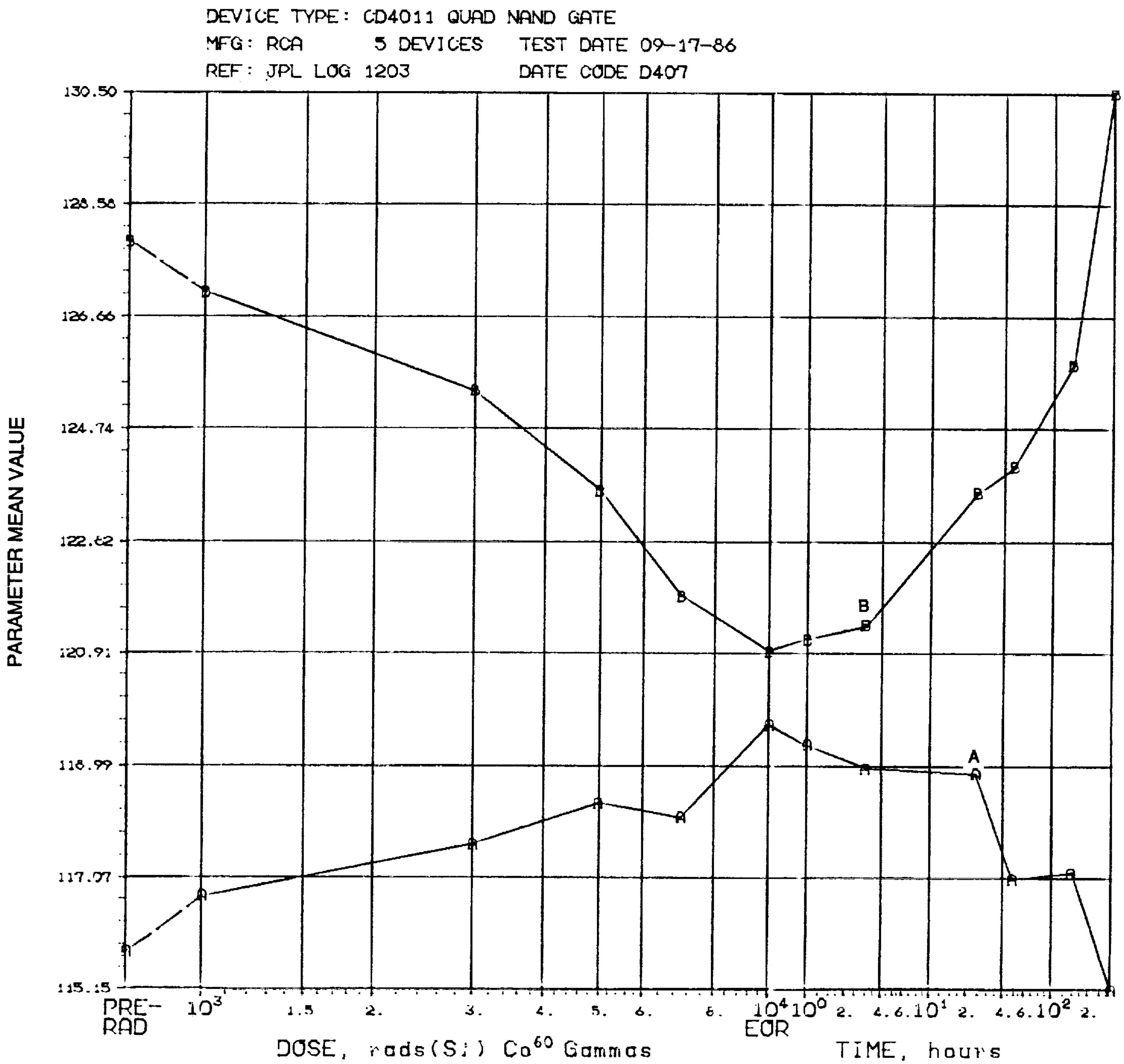
DEVICE TYPE: CD4011 QUAD NAND GATE

MFG: RCA 5 DEVICES TEST DATE 09-17-86

REF: JPL LOG 1203 DATE CODE D407

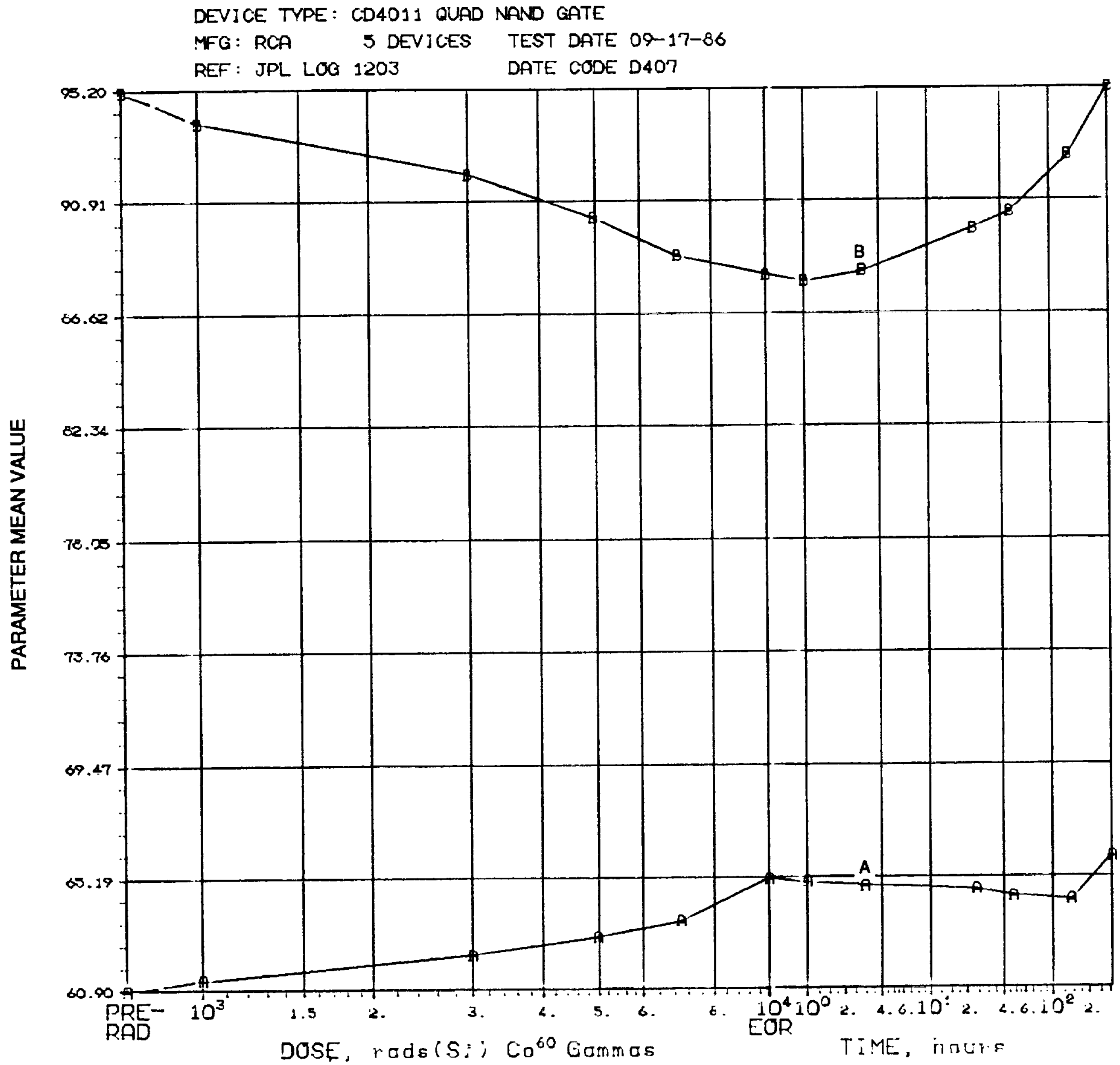


	PARAMETERS	CONDITIONS
CURVE A:	(13) VTP 5-ON (V)	(BIAS GND)
CURVE B:	(14) VTP 6-ON (V)	" "
CURVE C:	(17) VTP12-ON (V)	" "
CURVE D:	(18) VTP13-ON (V)	" "



PARAMETERS

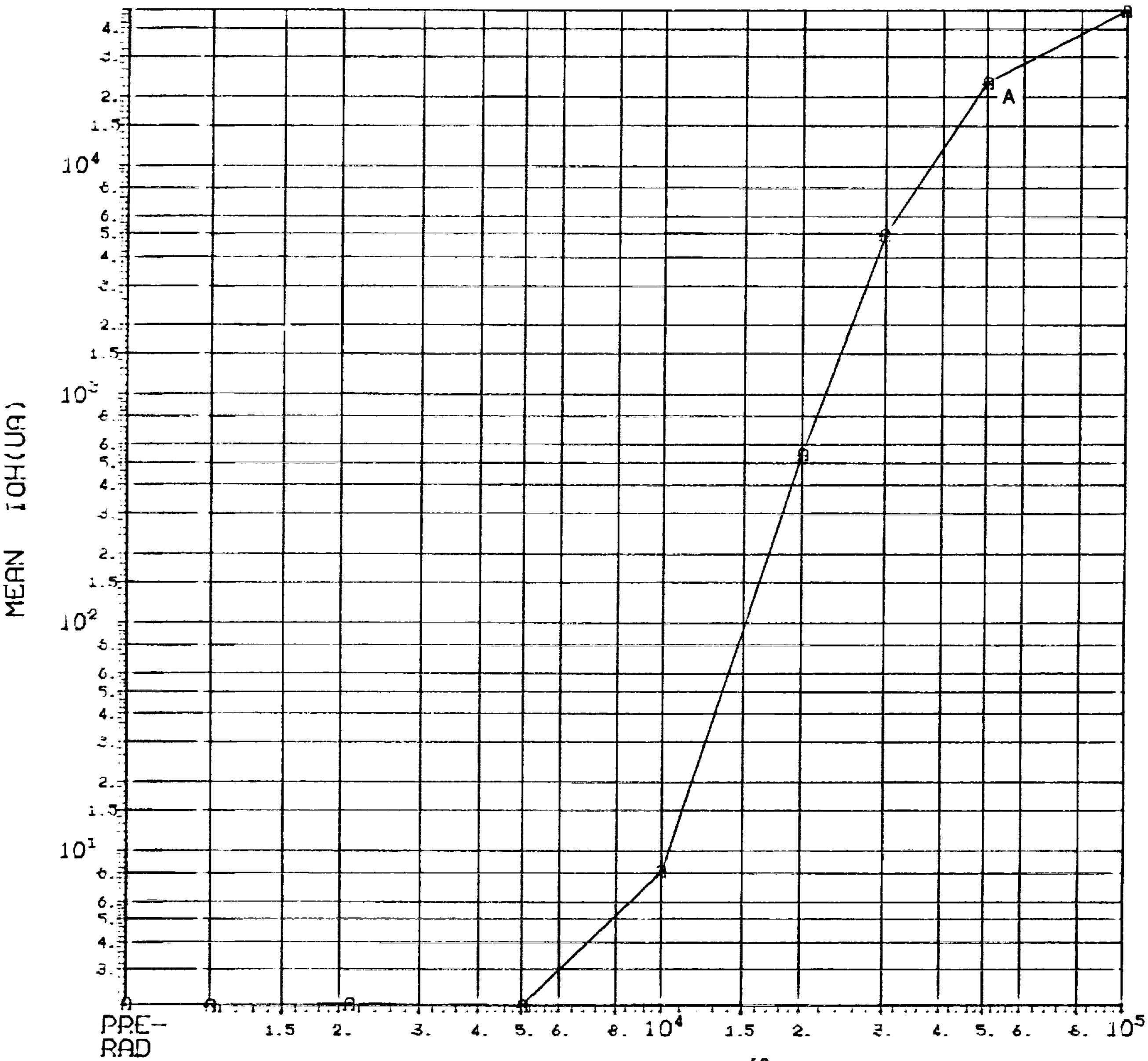
CURVE A: (19) TR IN NS:
CURVE B: (20) TF IN NS:



PARAMETERS

CURVE A: (21) TPLH IN NS:
CURVE B: (22) TPHL IN NS:

DEVICE TYPE: CD4013 CMOS DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 06-22-85
REF: JPL LOG 1176 DATE CODE 352Y



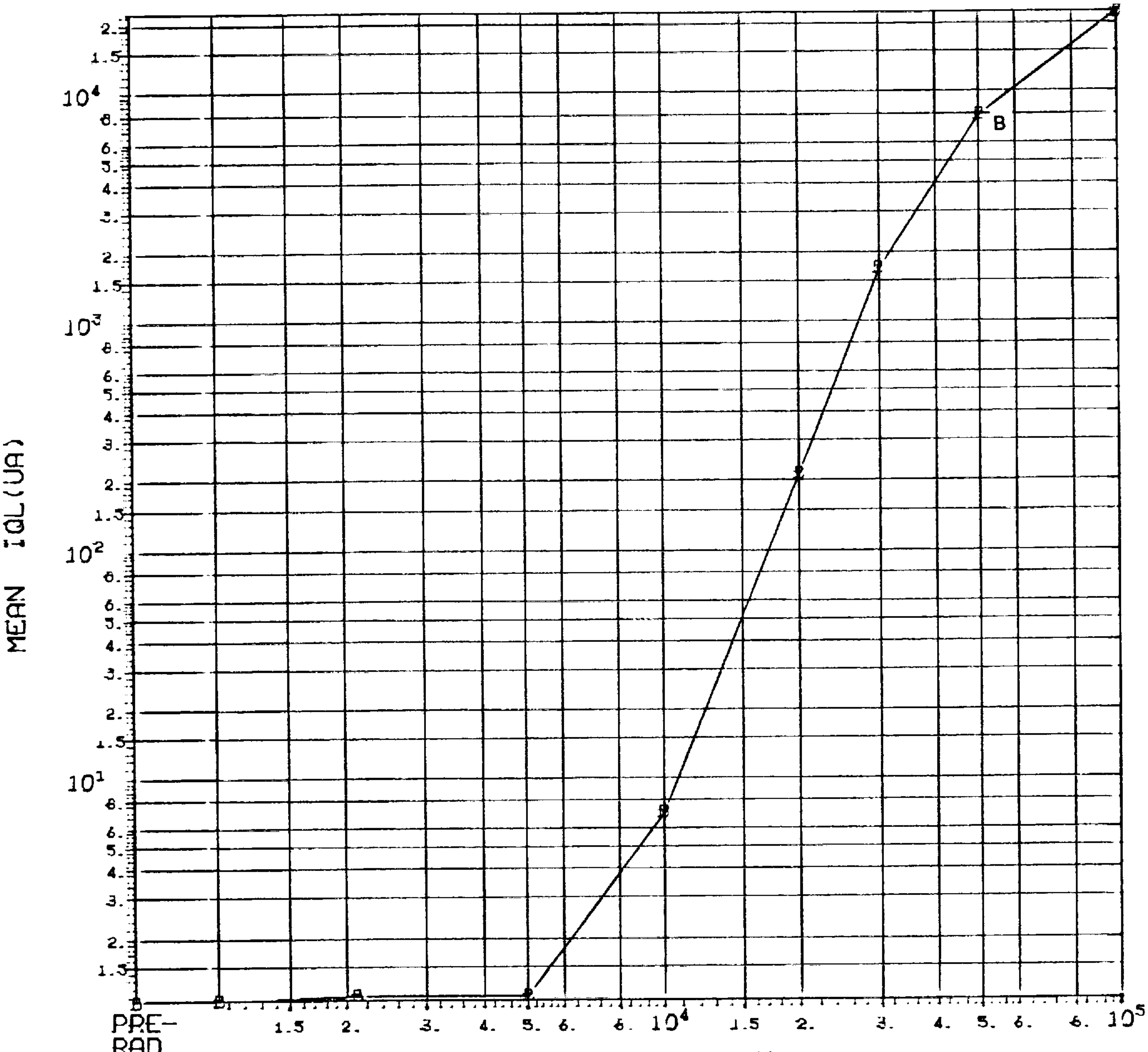
DOSE, rads(Si) Co^{60} Gammas

(1)IOH (VDD=15V) IN UA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS									
CURVE	DOSE, rads(Si)								
DOSE	0.0E0	1.0E3	2.1E3	5.0E3	1.0E4	2.0E4	3.0E4	5.0E4	1.0E5
STD. DEV.	.0908	.2770	.2345	.2596	7.456	479.4	3272.	9417.	*****

INITIAL MEAN VALUE IOH(UA) = +2.13X10^00

DEVICE TYPE: CD4013 CMOS DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 08-22-85
REF: JPL LOG 1176 DATE CODE 352Y

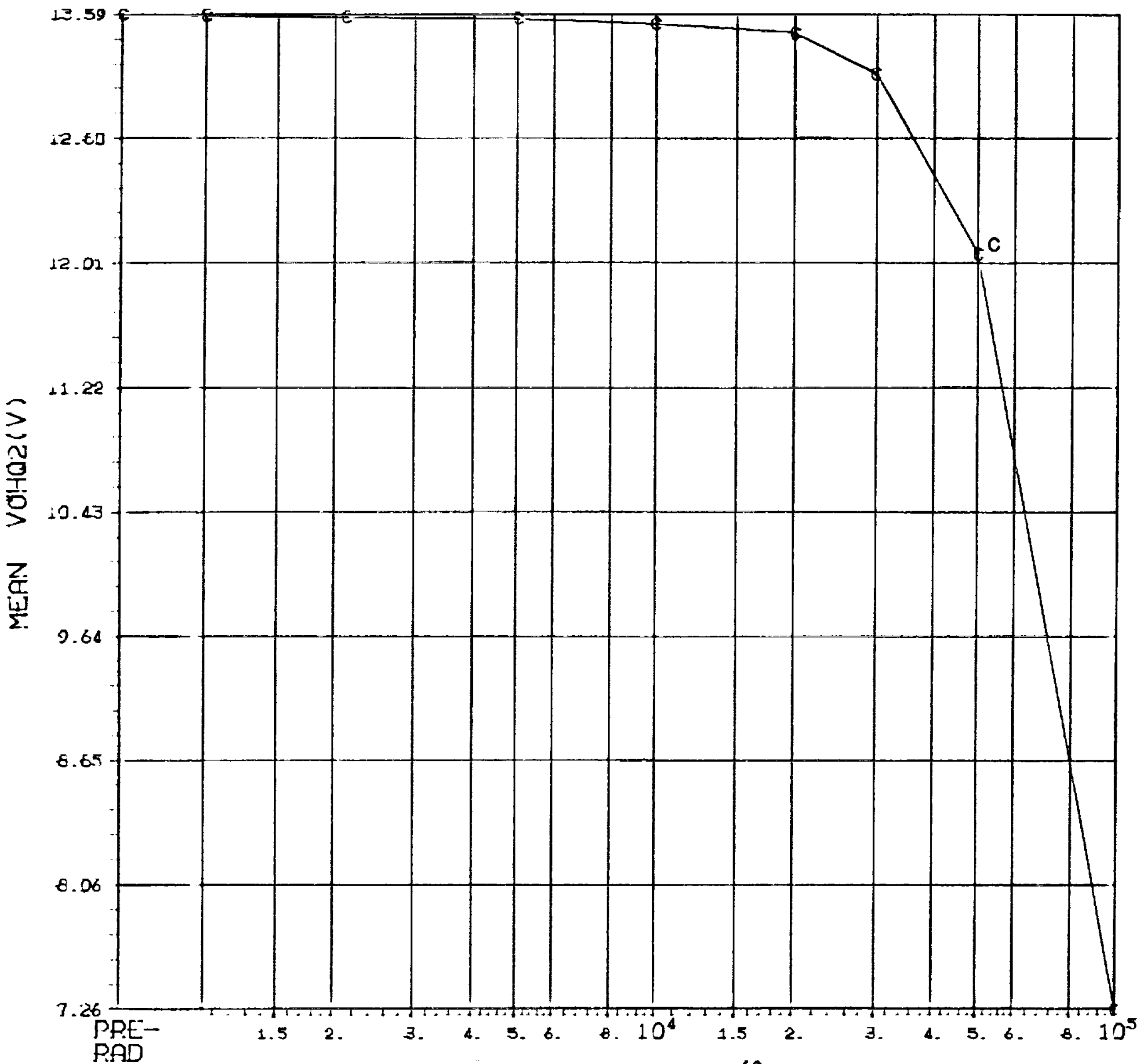


(2)IQL (VDD=15V) IN UA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS									
CURVE	DOSE, rads(Si)								
DOSE	0.0E0	1.0E3	2.1E3	5.0E3	1.0E4	2.0E4	3.0E4	5.0E4	1.0E5
STD. DEV.	.0685	.1636	.1561	.2874	7.621	176.1	1102.	3267.	1572.

INITIAL MEAN VALUE IQL(UA) = +1.05X10^00

DEVICE TYPE: CD4013 CMOS DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 06-22-85
REF: JPL LOG 1176 DATE CODE 352Y

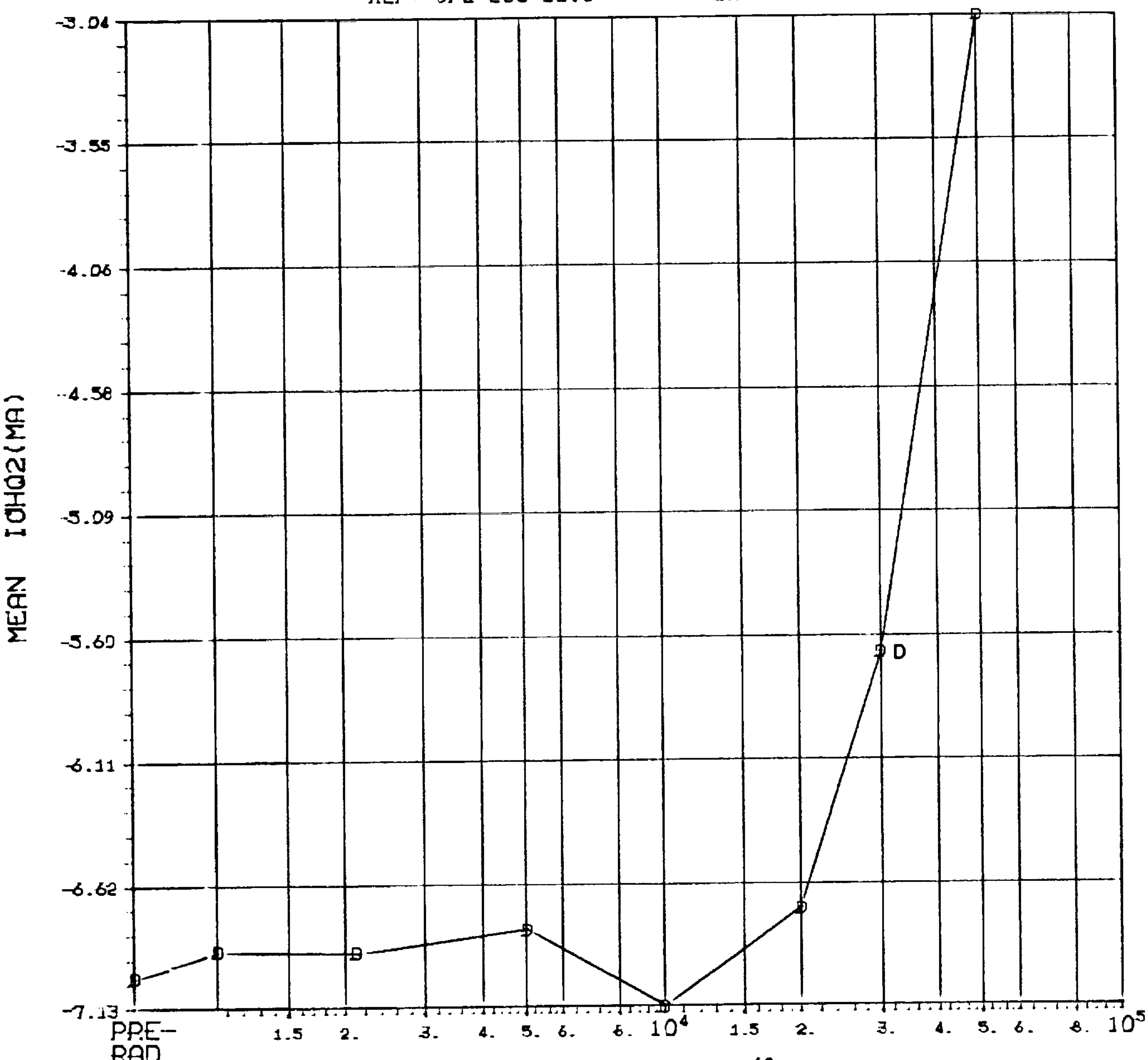


(3)VOHO2 (IO=-6.6MA) IN V: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE DOSE	DOSE, rads(Si) 0.0E0 1.0E3 2.1E3 5.0E3 1.0E4 2.0E4 3.0E4 5.0E4 1.0E5
STD. DEV.	.0416 .0447 .0570 .0652 .0447 .0570 .2162 .6544 XXXXX

INITIAL MEAN VALUE VOHO2(V) = $+1.36X10^{+1}$

DEVICE TYPE: CD4013 CMOS DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 06-22-85
REF: JPL LOG 1176 DATE CODE 352Y

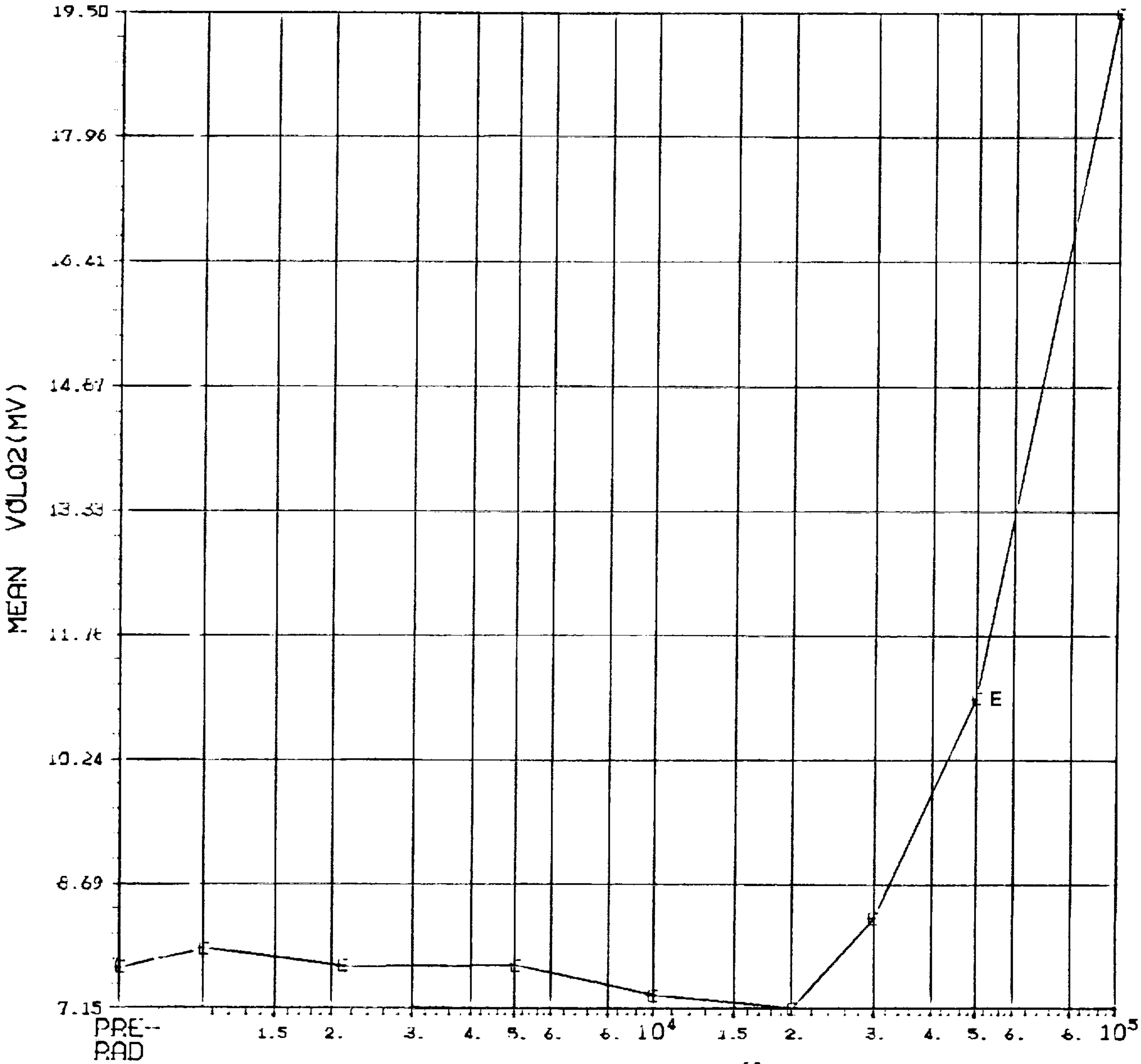


(4)IOH02 (VO=13.5V) IN MA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS									
CURVE DOSE	DOSE, rads(Si) 0.0E0	1.0E3	2.1E3	5.0E3	1.0E4	2.0E4	3.0E4	5.0E4	1.0E5
STD. DEV.	.3385	.3402	.3385	.3539	*****	.2783	.8789	1.729	*****

INITIAL MEAN VALUE IOHO2(MA) = $-7.01 \times 10^{+0}$

DEVICE TYPE: CD4013 **CMOS DUAL D F/F**
MFG: SGS 5 DEVICES TEST DATE 06-22-85
REF: JPL LOG 1176 DATE CODE 352Y

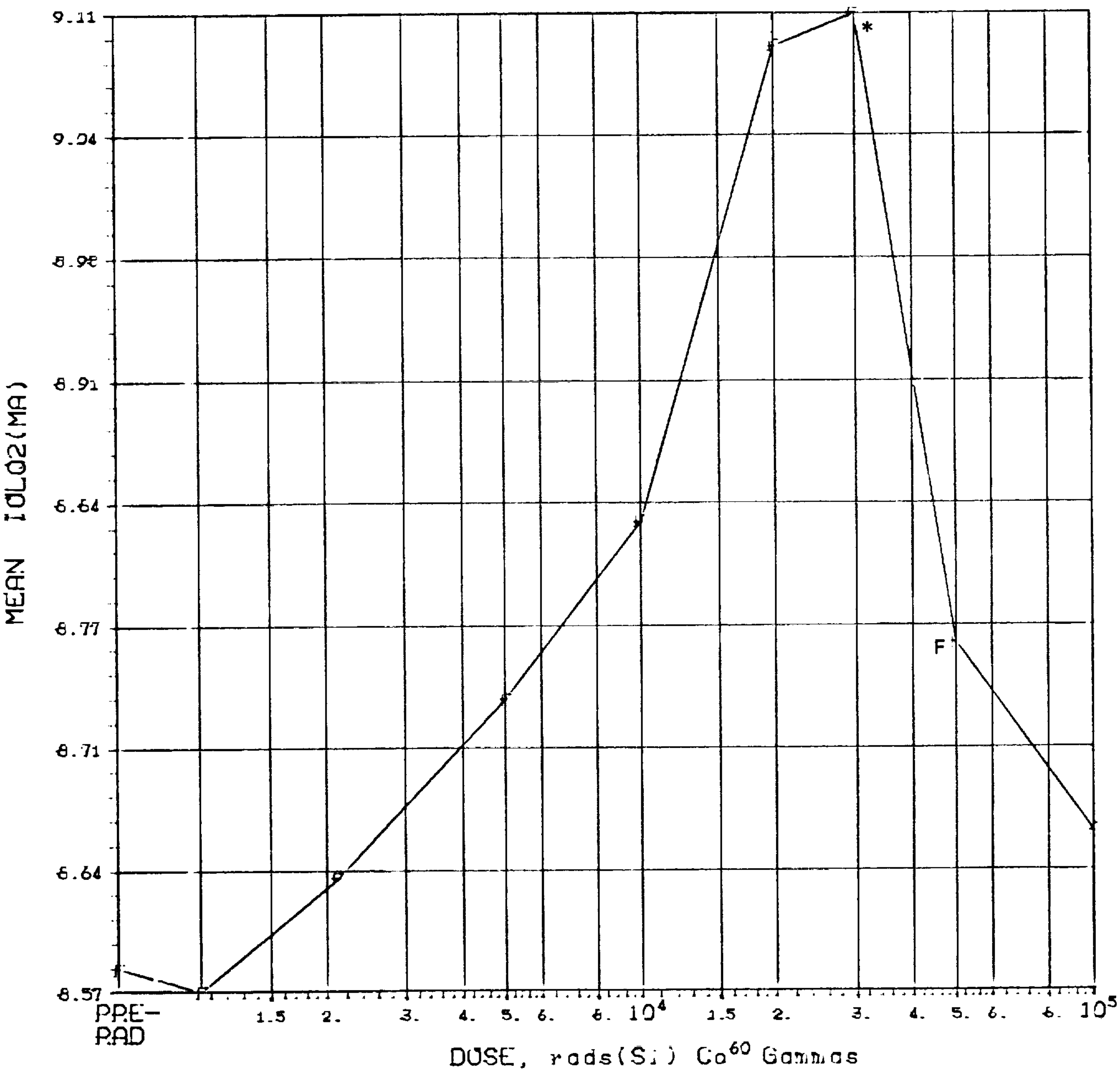


(5)VOLO2 (IO=50UA) IN MV: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS									
CURVE	DOSE, rads(Si)								
DOSE	0.0E0	1.0E3	2.1E3	5.0E3	1.0E4	2.0E4	3.0E4	5.0E4	1.0E5
STD. DEV.	.2706	.2987	.5910	.4077	.1255	.3791	.5357	2.065	2.538

INITIAL MEAN VALUE VOLO2(MV) = $+7.67\times10^{+0}$

DEVICE TYPE: CD4013 CMOS DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 06-22-85
REF: JPL LOG 1176 DATE CODE 352Y



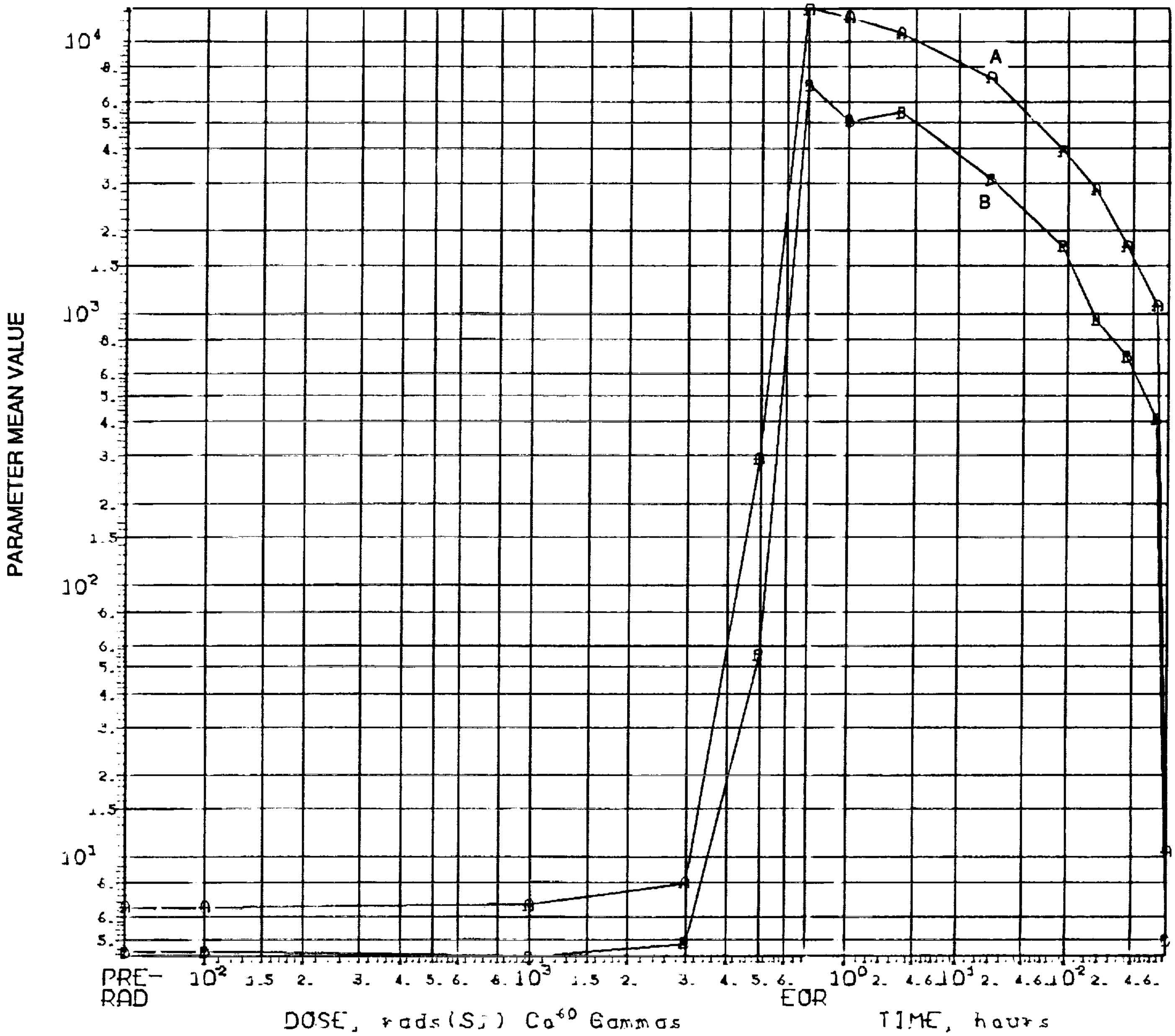
(6)IOL02 (VO=1.5V) IN MA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE DOSE	DOSE, rads(Si) 0.0E0 1.0E3 2.1E3 5.0E3 1.0E4 2.0E4 3.0E4 5.0E4 1.0E5
STD. DEV.	.2359 .2301 .2327 .2450 .1717 .1769 .1460 .3857 .4016

INITIAL MEAN VALUE IOLO2(MA) = $+8.59X10^{+0}$

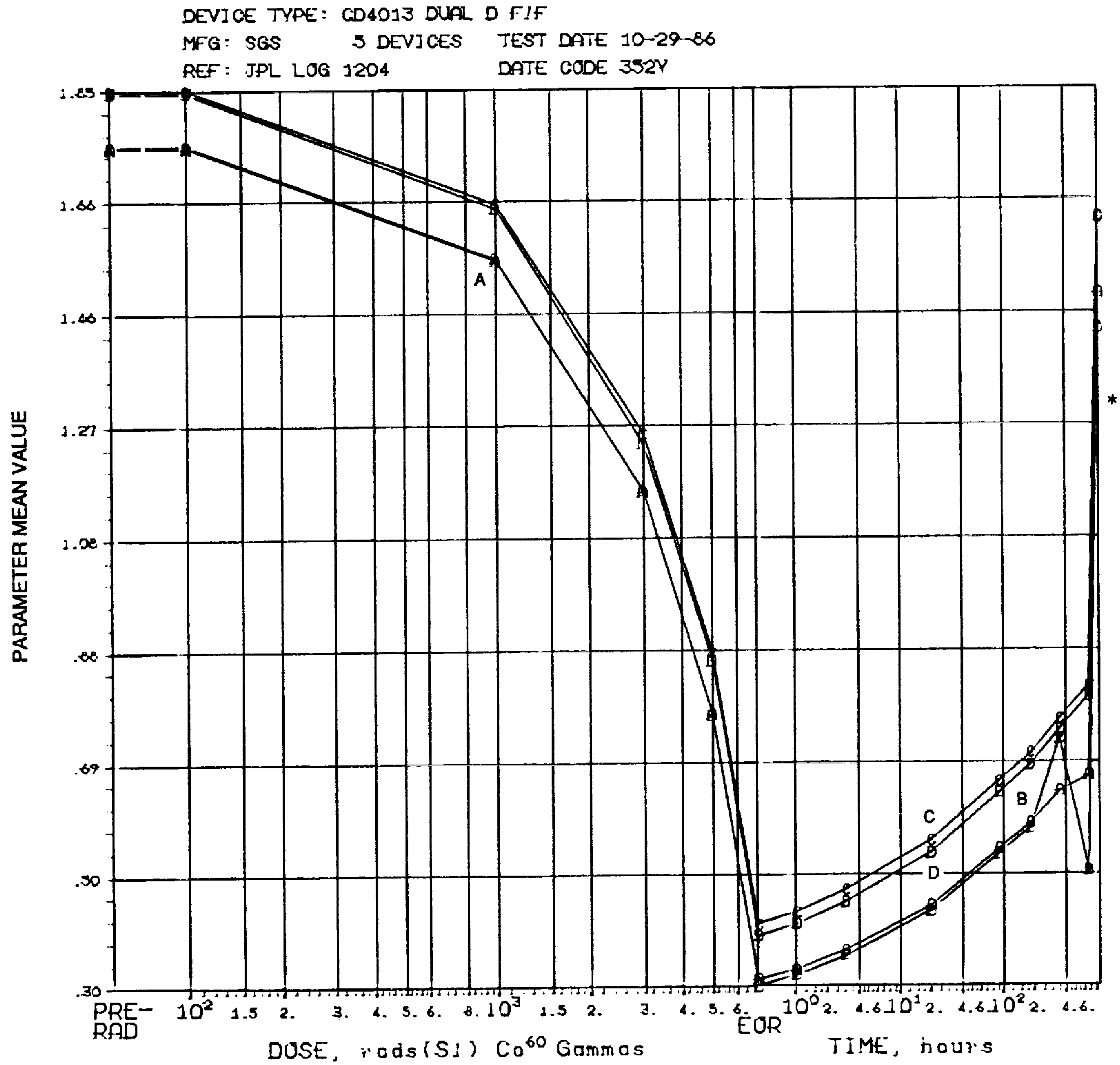
* DEVICE PARAMETER FAILURE

DEVICE TYPE: CD4013 DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 10-29-86
REF: JPL LOG 1204 DATE CODE 352Y



PARAMETERS

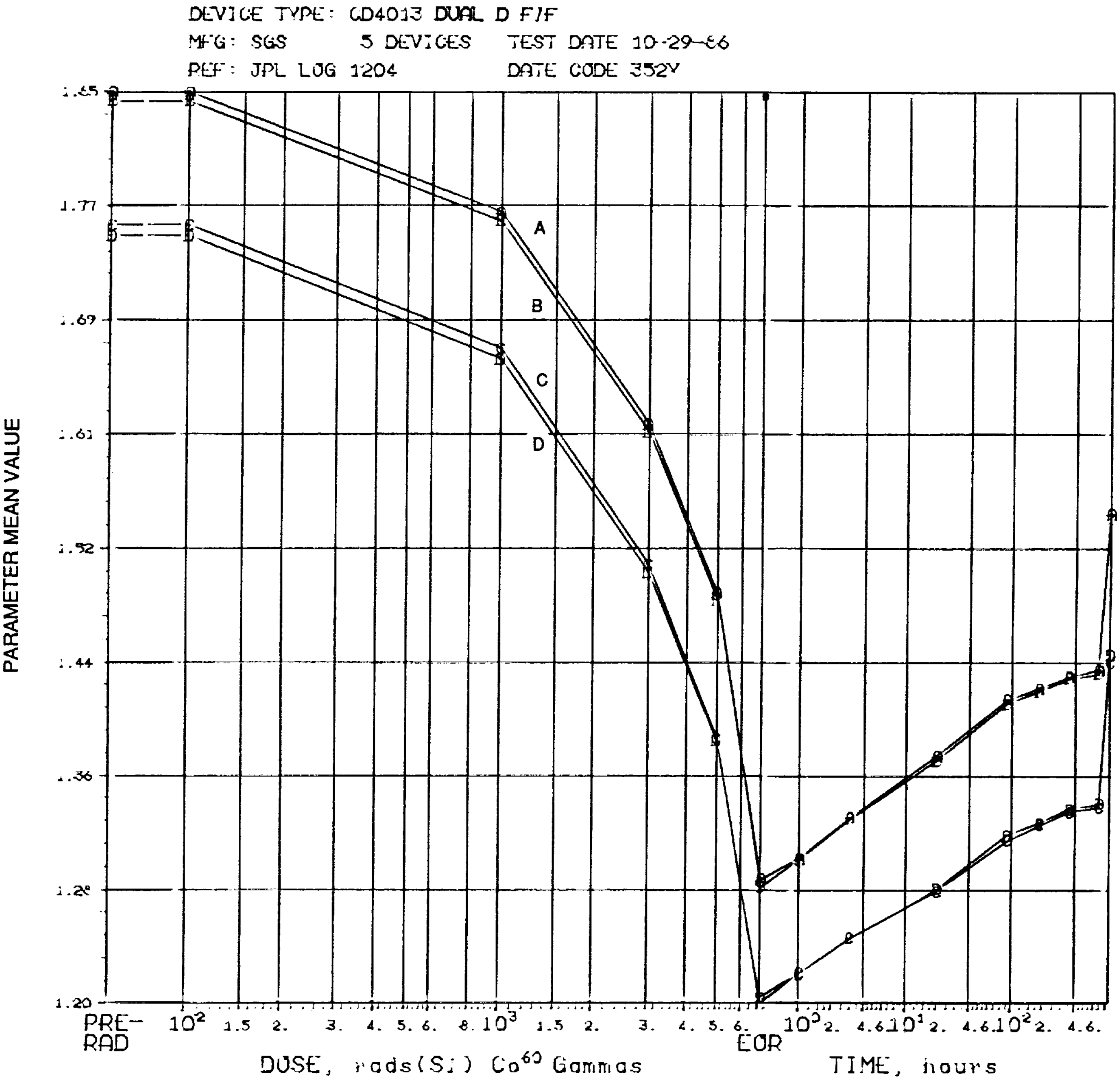
CURVE A: (1)IOH(NA)
CURVE B: (2)IOL(NA)



PARAMETERS

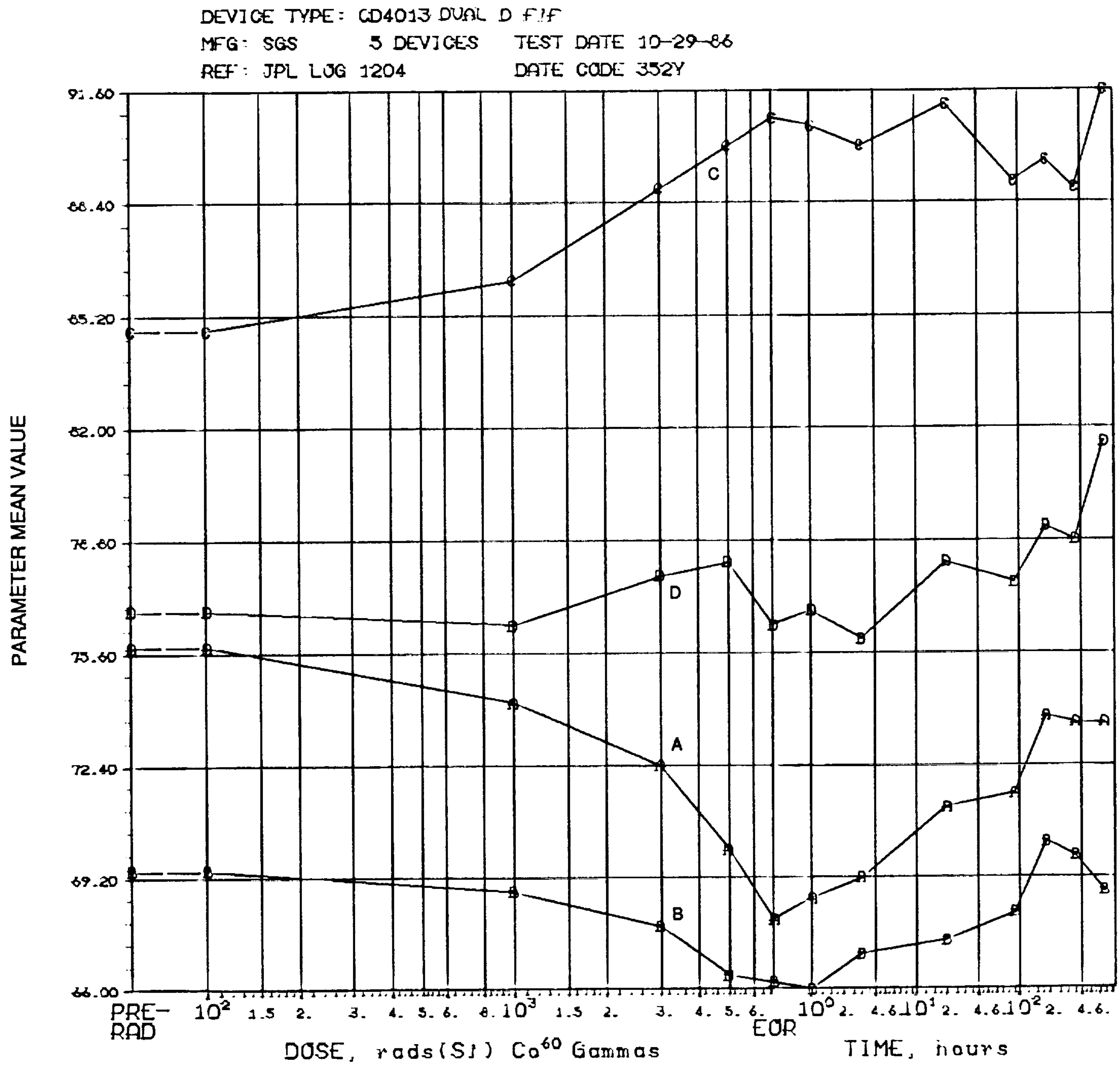
CURVE A:	(3)	VTN3-ON	(V)
CURVE B:	(5)	VTN5-ON	(V)
CURVE C:	(6)	VTN6-ON	(V)
CURVE D:	(9)	VTN10-ON	(V)

* ANNEAL



PARAMETERS

CURVE A:	(4)	VTN4-OFF	(V)
CURVE B:	(7)	VTN8-OFF	(V)
CURVE C:	(8)	VTN9-OFF	(V)
CURVE D:	(10)	VTN11-OFF	(V)



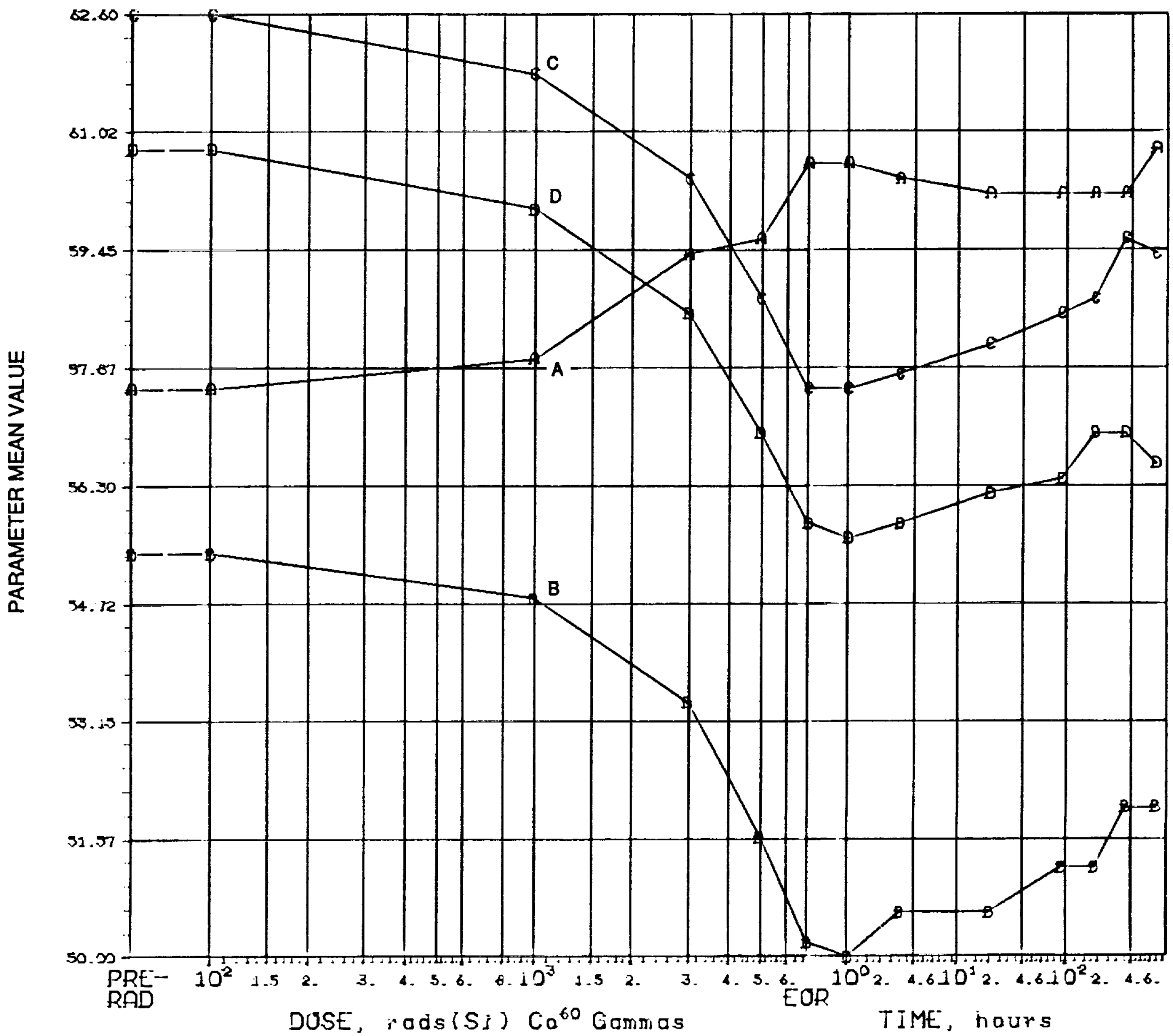
PARAMETERS

CURVE A: (19)TFQ1(NS)
CURVE B: (20)TFQ2(NS)
CURVE C: (21)TRQ1(NS)
CURVE D: (22)TRQ2(NS)

DEVICE TYPE: CD4013 DUAL D F/F

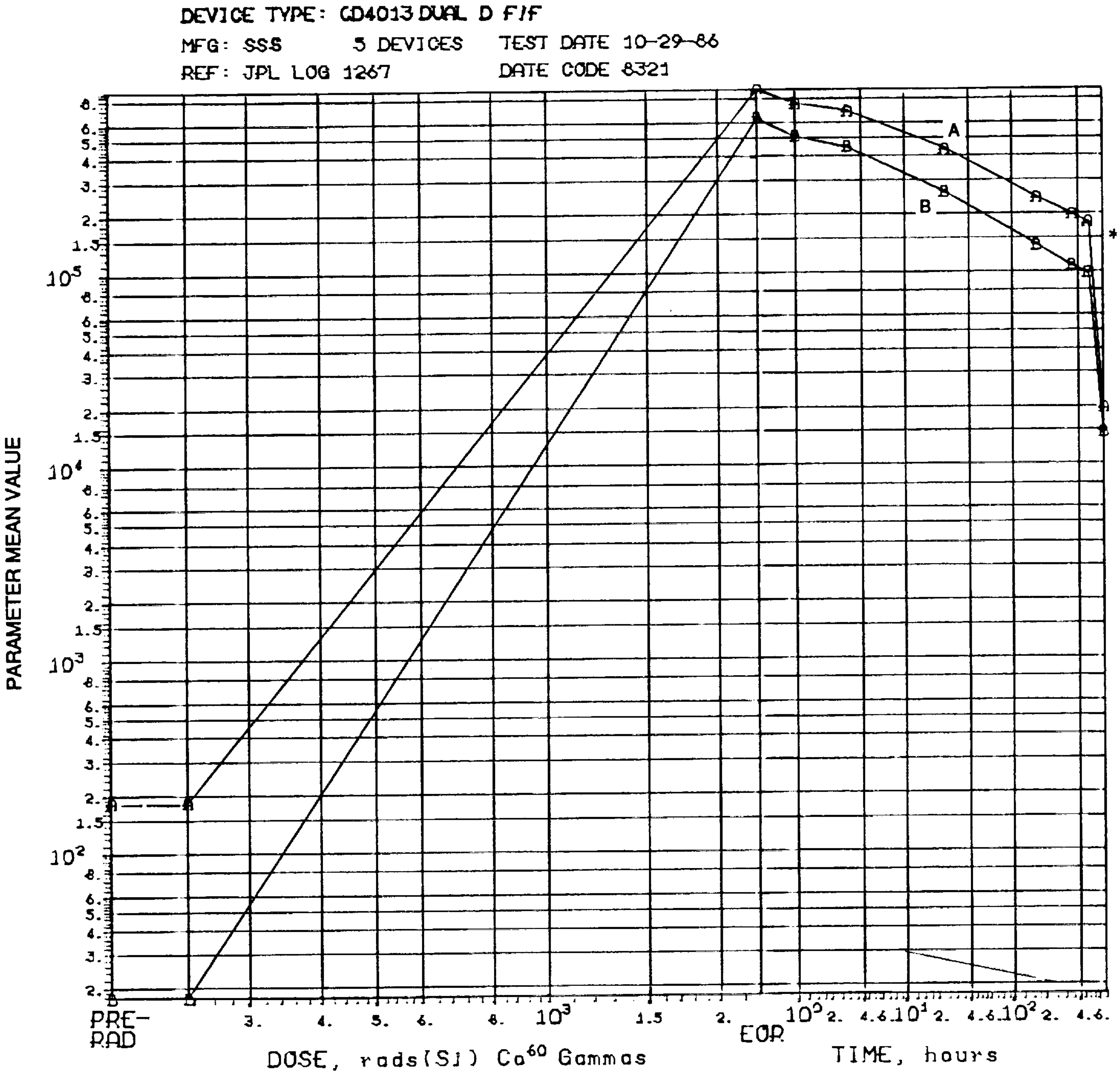
MFG: SGS 5 DEVICES TEST DATE 10-29-86

REF: JPL LOG 1204 DATE CODE 352Y



PARAMETERS

CURVE A: (23)TPLH01(NS)
CURVE B: (24)TPLH02(NS)
CURVE C: (25)TPHL01(NS)
CURVE D: (26)TPHL02(NS)

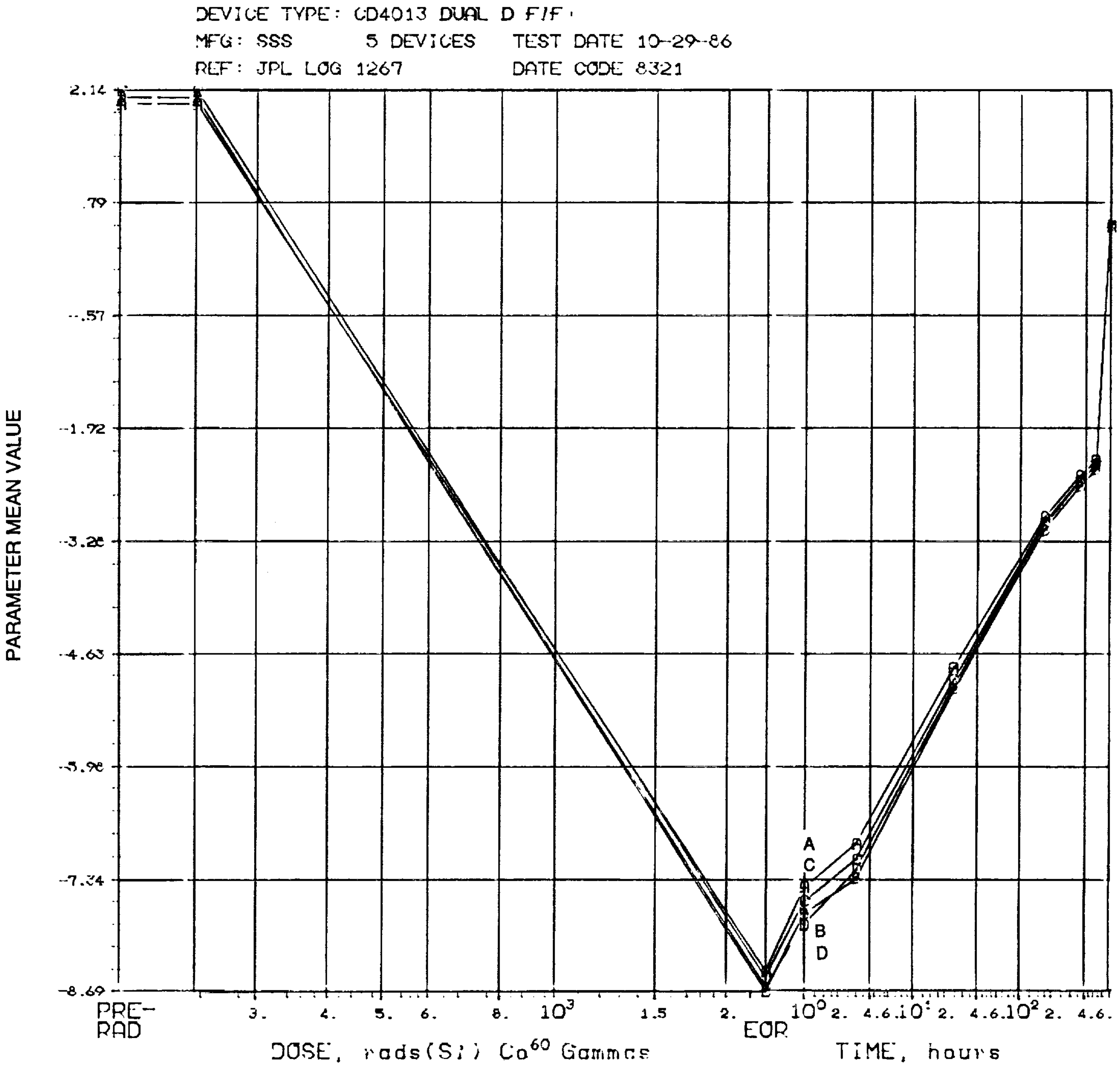


PARAMETERS

CURVE A: (1)IQH(NA)

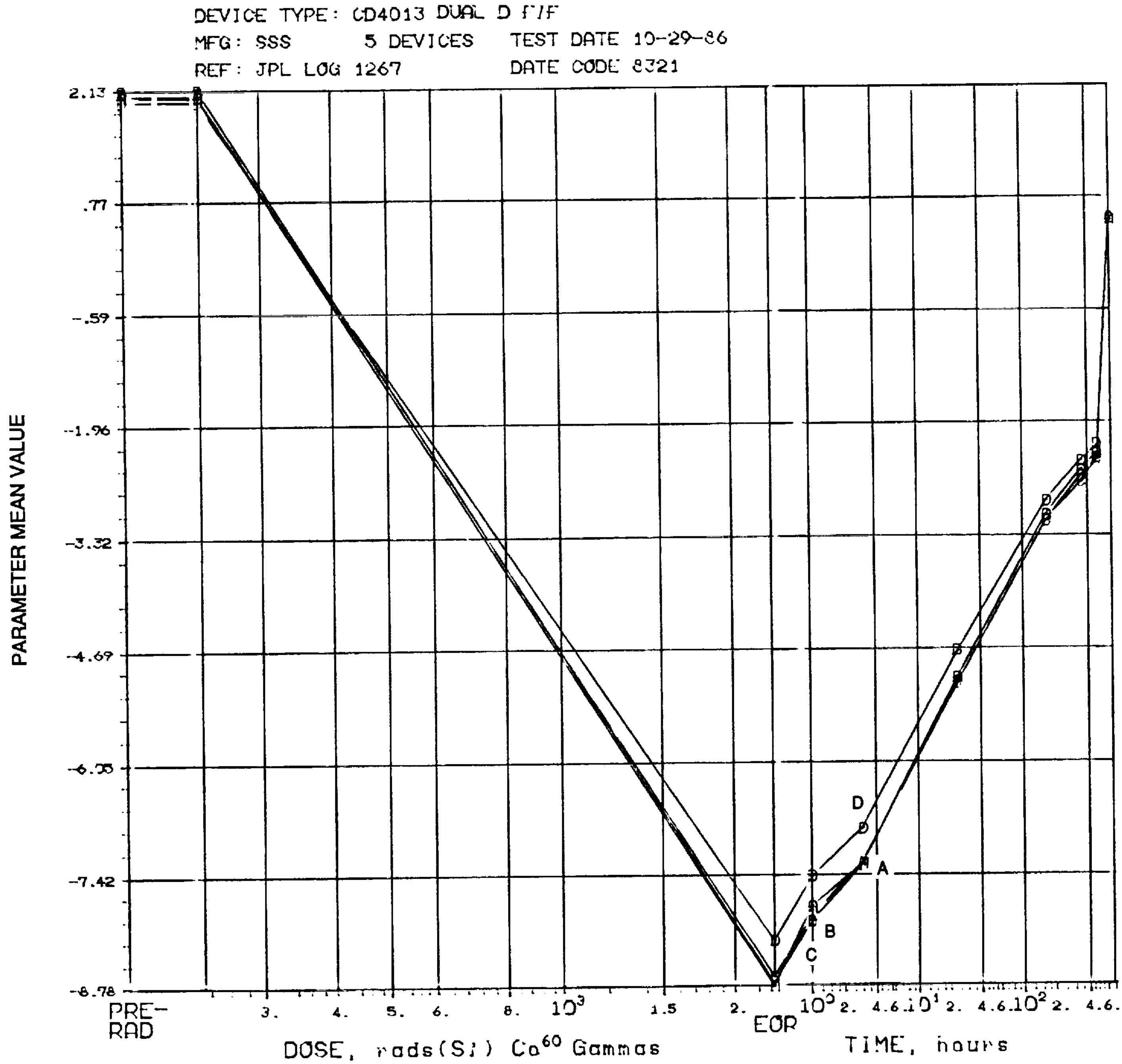
CURVE B: (2)IQL(NA)

* ACCELERATED ANNEAL



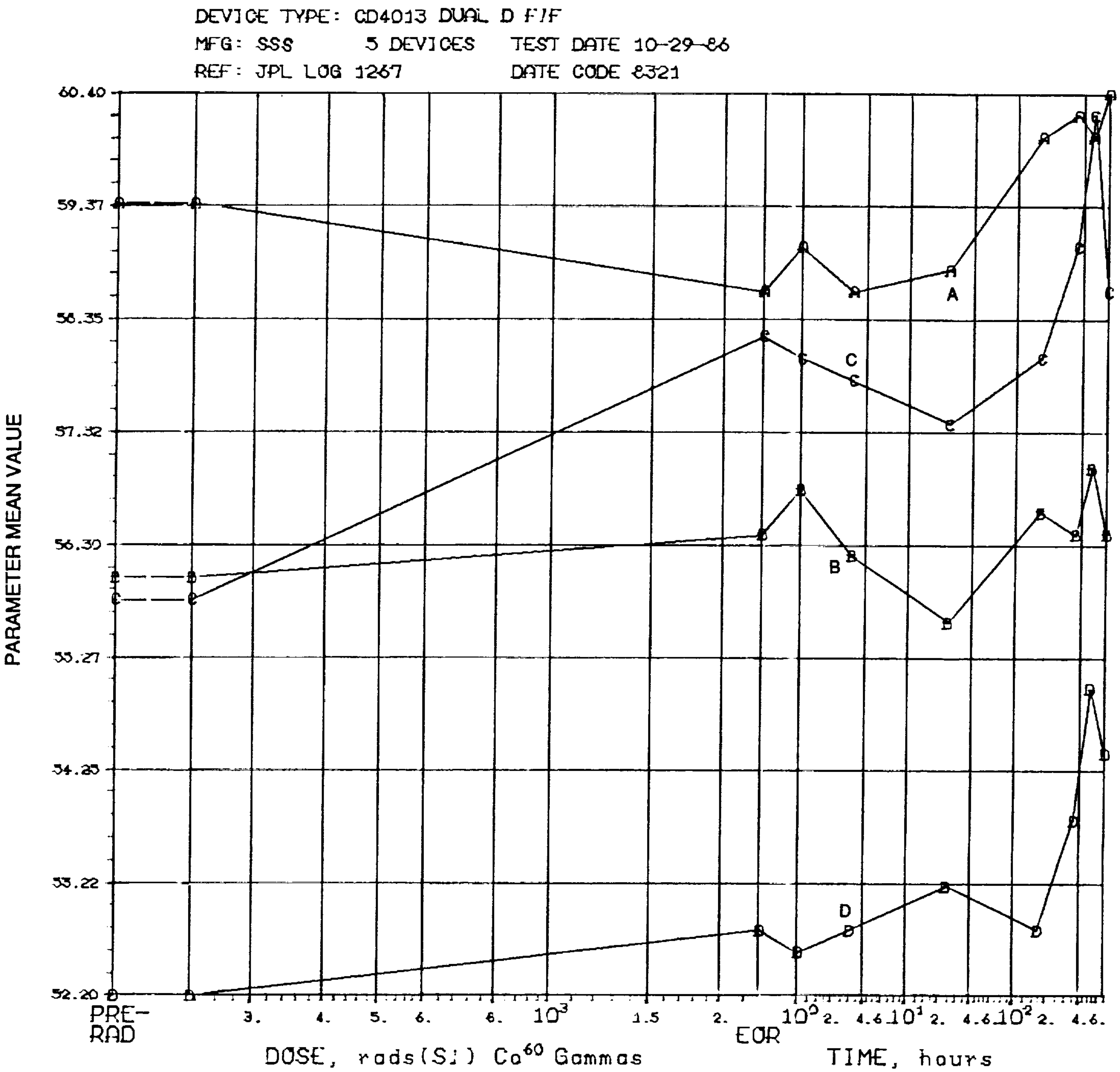
PARAMETERS

CURVE A:	(3) VTN3-ON	(V)
CURVE B:	(5) VTN5-ON	(V)
CURVE C:	(6) VTN6-ON	(V)
CURVE D:	(9) VTN10-ON	(V)



PARAMETERS

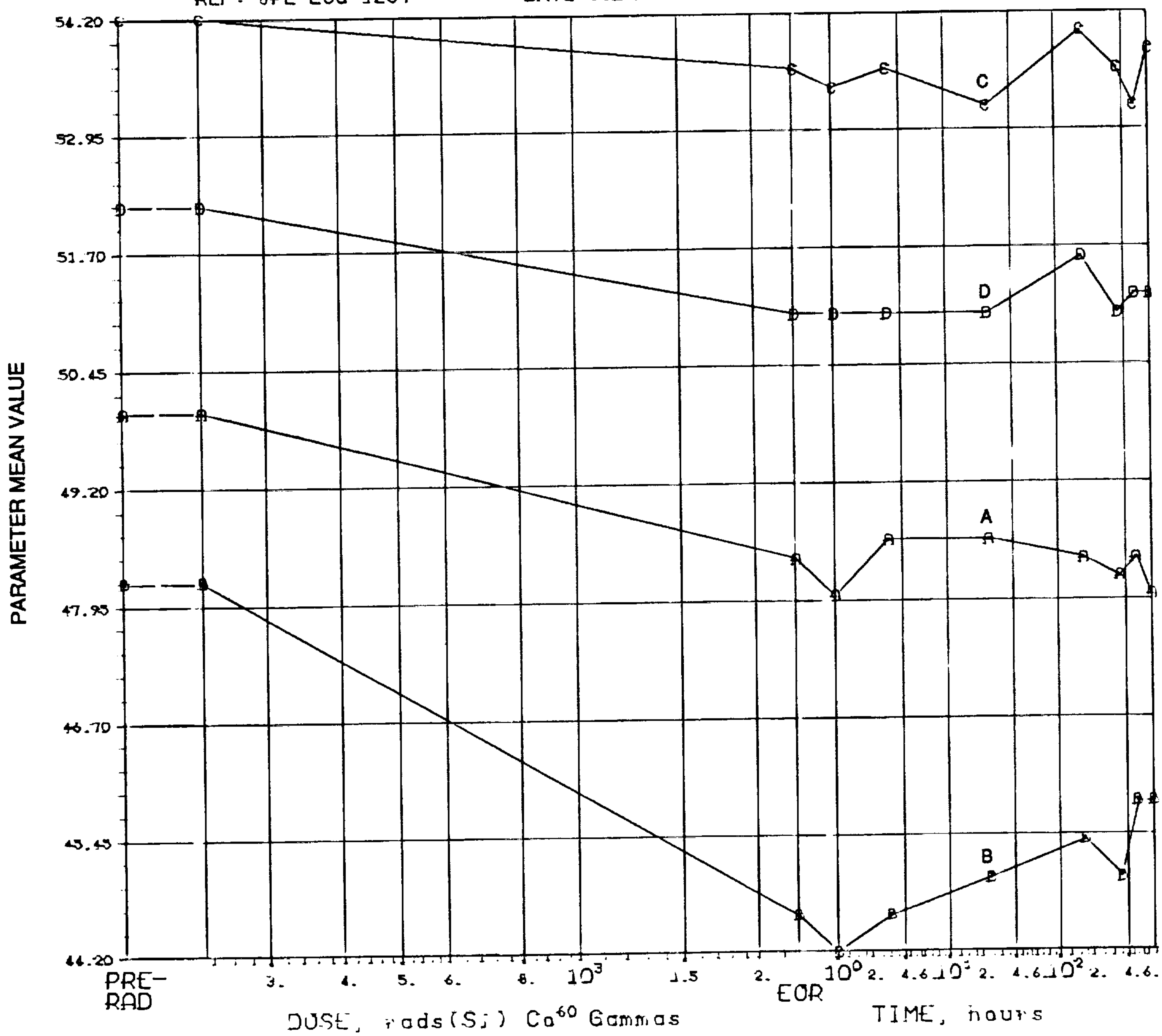
CURVE A:	(4)	VTN4-OFF	(V)
CURVE B:	(7)	VTN8-OFF	(V)
CURVE C:	(8)	VTN9-OFF	(V)
CURVE D:	(10)	VTN11-OFF	(V)



PARAMETERS

CURVE A: (19)TFQ1(NS)
CURVE B: (20)TFQ2(NS)
CURVE C: (21)TRQ1(NS)
CURVE D: (22)TRQ2(NS)

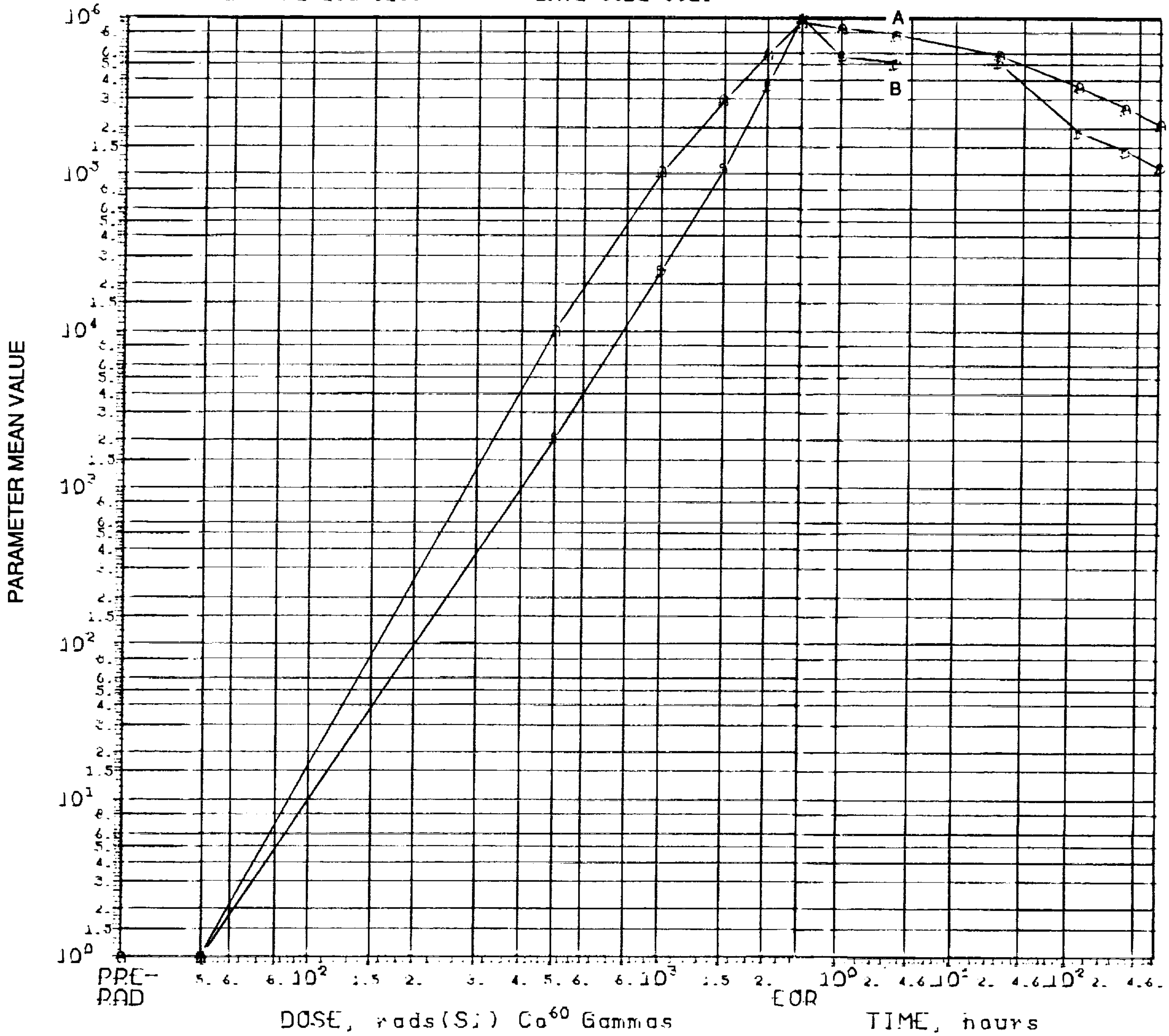
DEVICE TYPE: CD4013 DUAL D F/F
MFG: SSS 5 DEVICES TEST DATE 10-29-86
REF: JPL LOG 1267 DATE CODE 8321



PARAMETERS

CURVE A: (23)TPLHQ1(NS)
CURVE B: (24)TPLHQ2(NS)
CURVE C: (25)TPHLQ1(NS)
CURVE D: (26)TPHLQ2(NS)

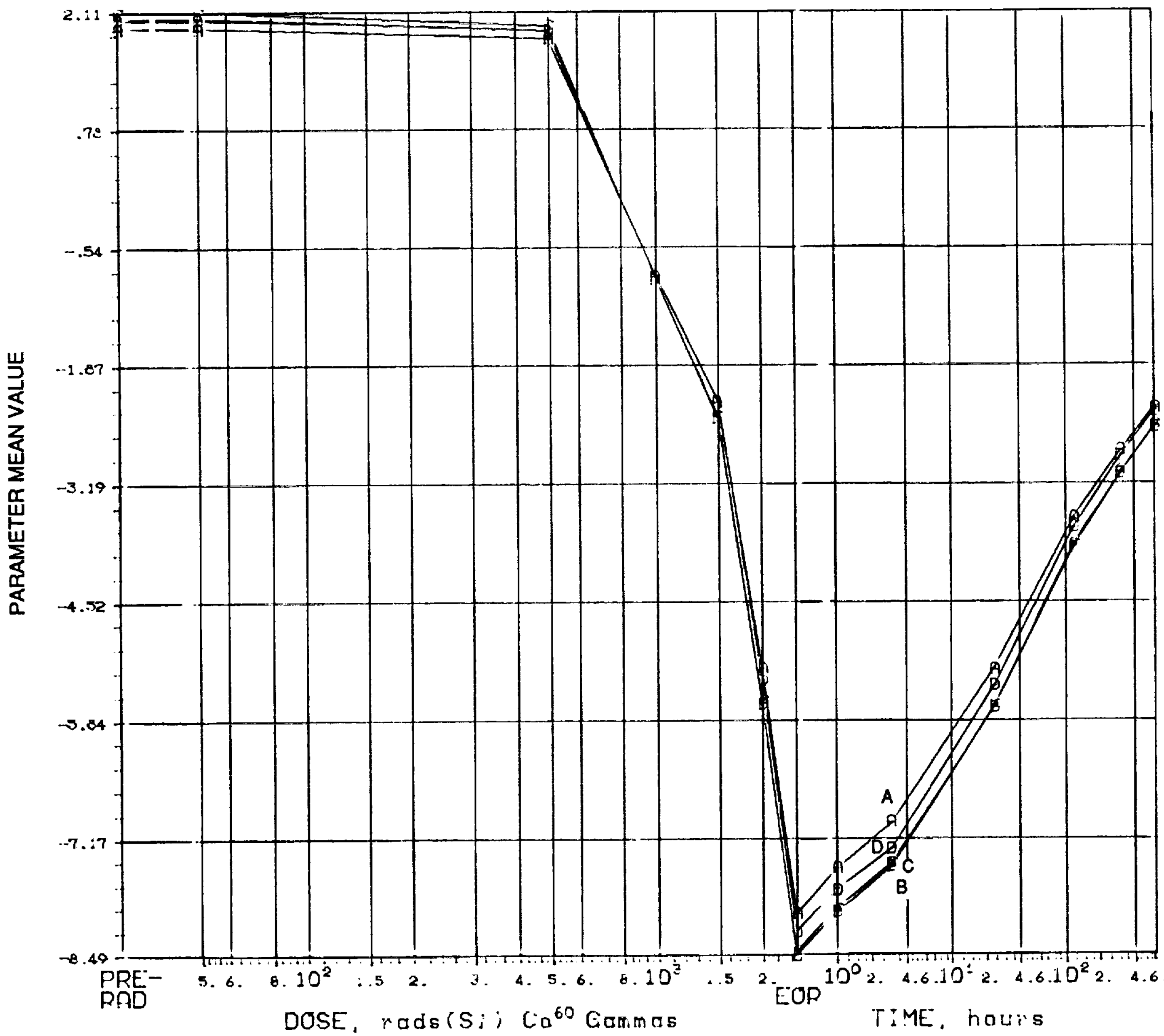
DEVICE TYPE: CD4013 DUAL D F/F
MFG: SSS 5 DEVICES TEST DATE 10-29-86
REF: JPL LOG 1268 DATE CODE 8321



PARAMETERS

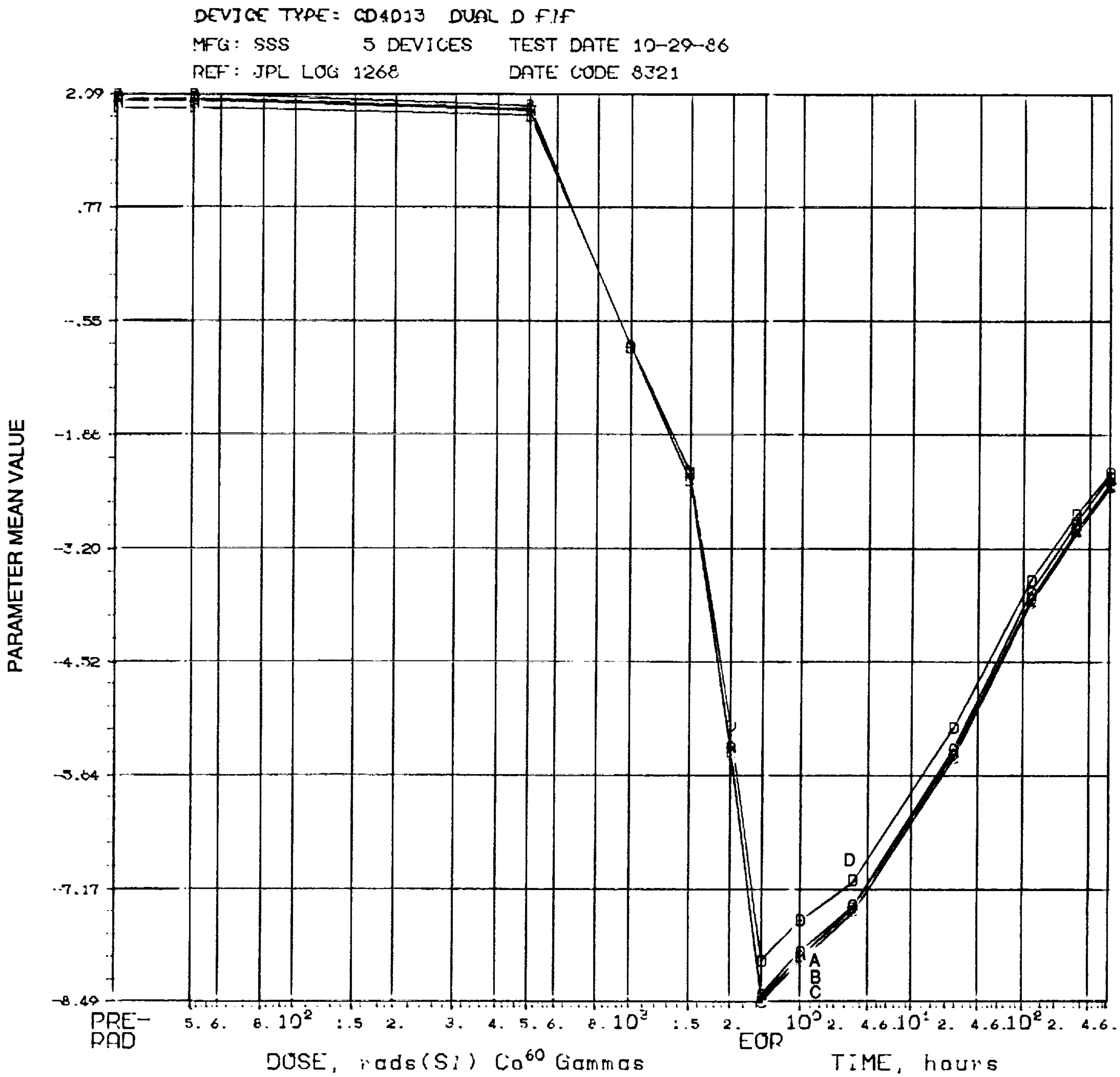
CURVE A: (1)IDH(NA)
CURVE B: (2)IDL(NA)

DEVICE TYPE: CD4013 DUAL D F/F
MFG: SSS 5 DEVICES TEST DATE 10-29-86
REF: JPL LOG 1268 DATE CODE 8321



PARAMETERS

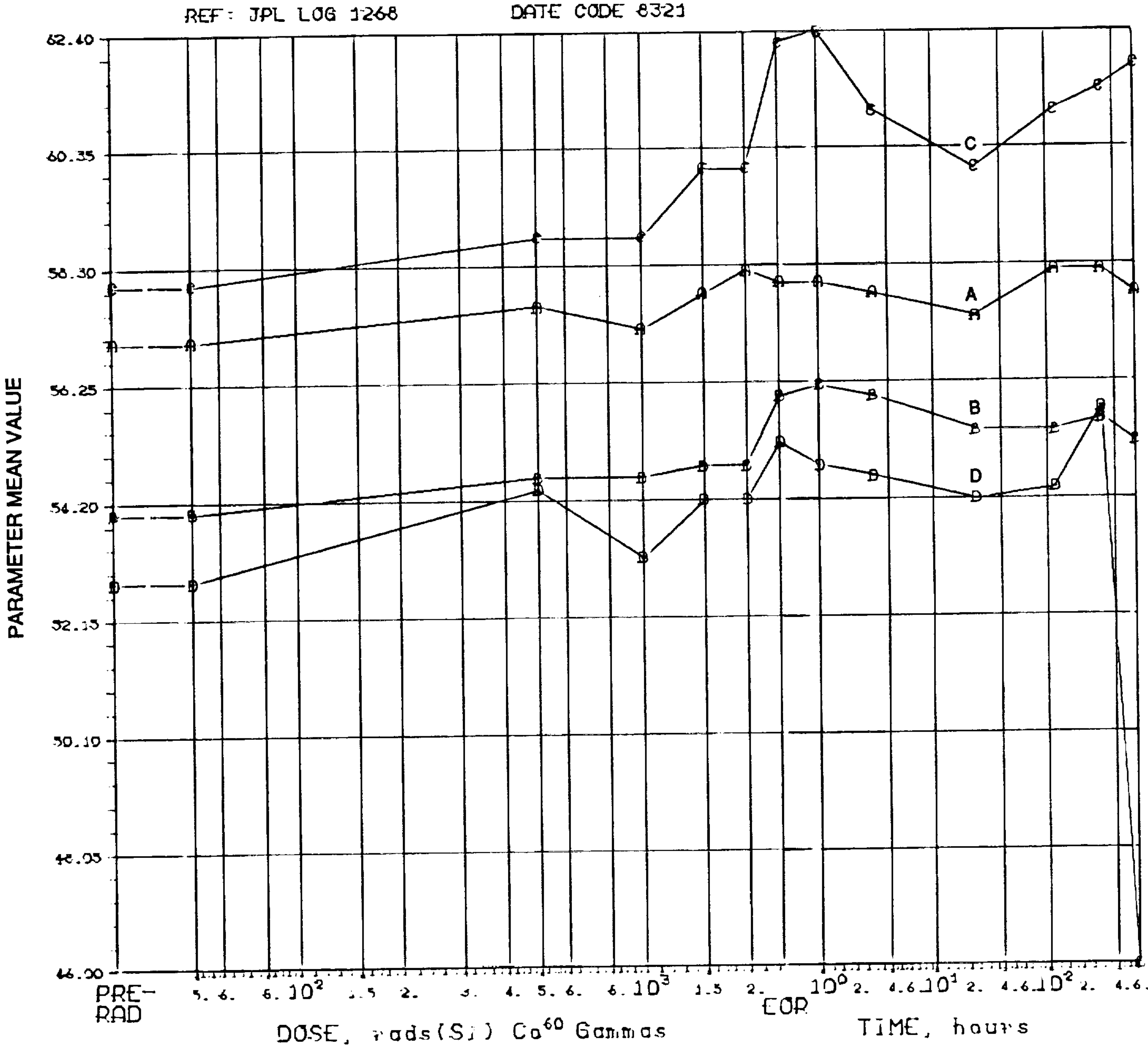
CURVE A:	(3) VTN3--ON	(V)
CURVE B:	(5) VTN5--ON	(V)
CURVE C:	(6) VTN6--ON	(V)
CURVE D:	(9) VTN10--ON	(V)



PARAMETERS

CURVE A:	(4)	VTN4--OFF	(V)
CURVE B:	(7)	VTN8--OFF	(V)
CURVE C:	(8)	VTN9--OFF	(V)
CURVE D:	(10)	VTN11-OFF	(V)

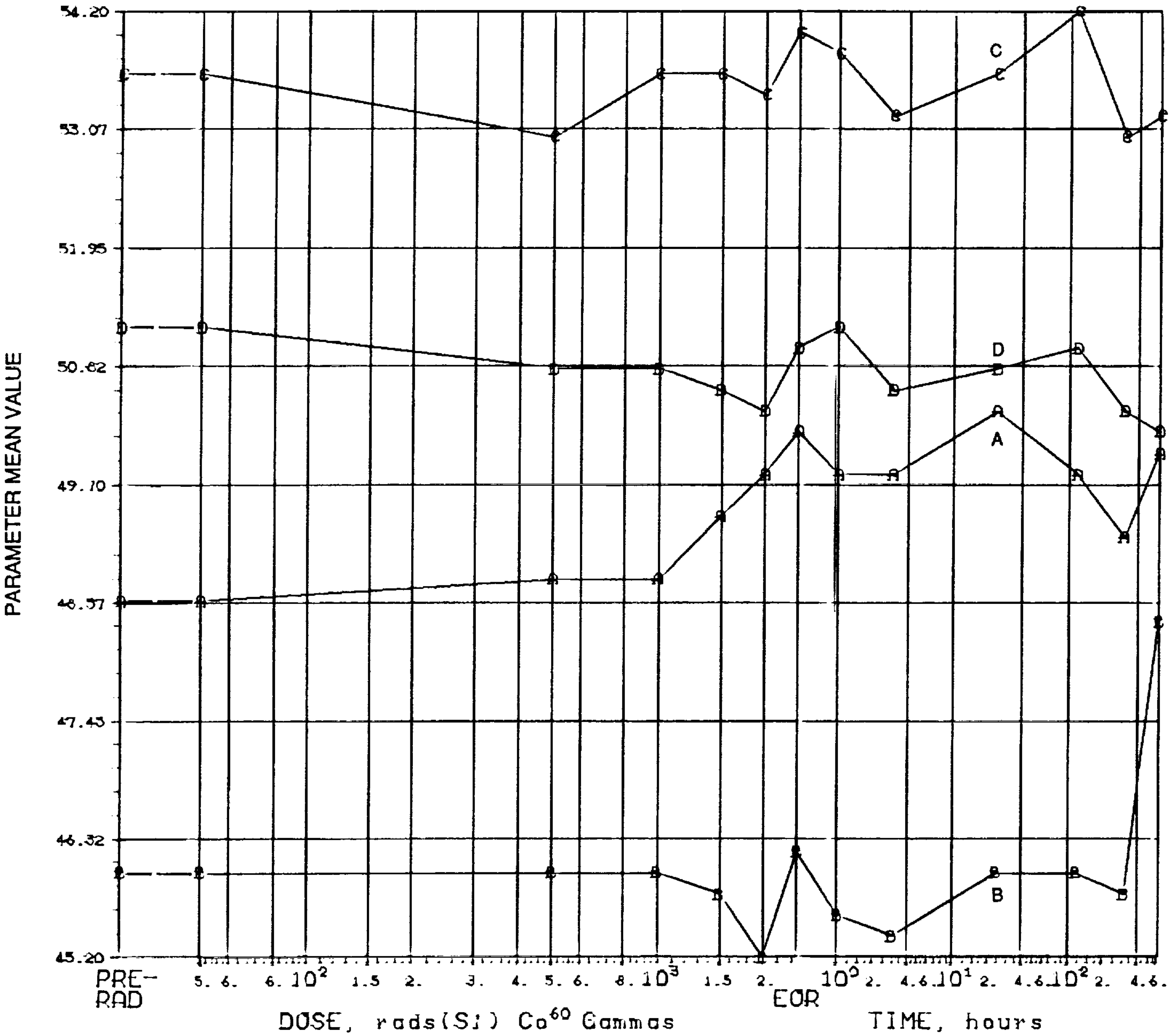
DEVICE TYPE: CD4013 DUAL D F/F
MFG: SSS 5 DEVICES TEST DATE 10-29-86
REF: JPL LOG 1268 DATE CODE 8321



PARAMETERS

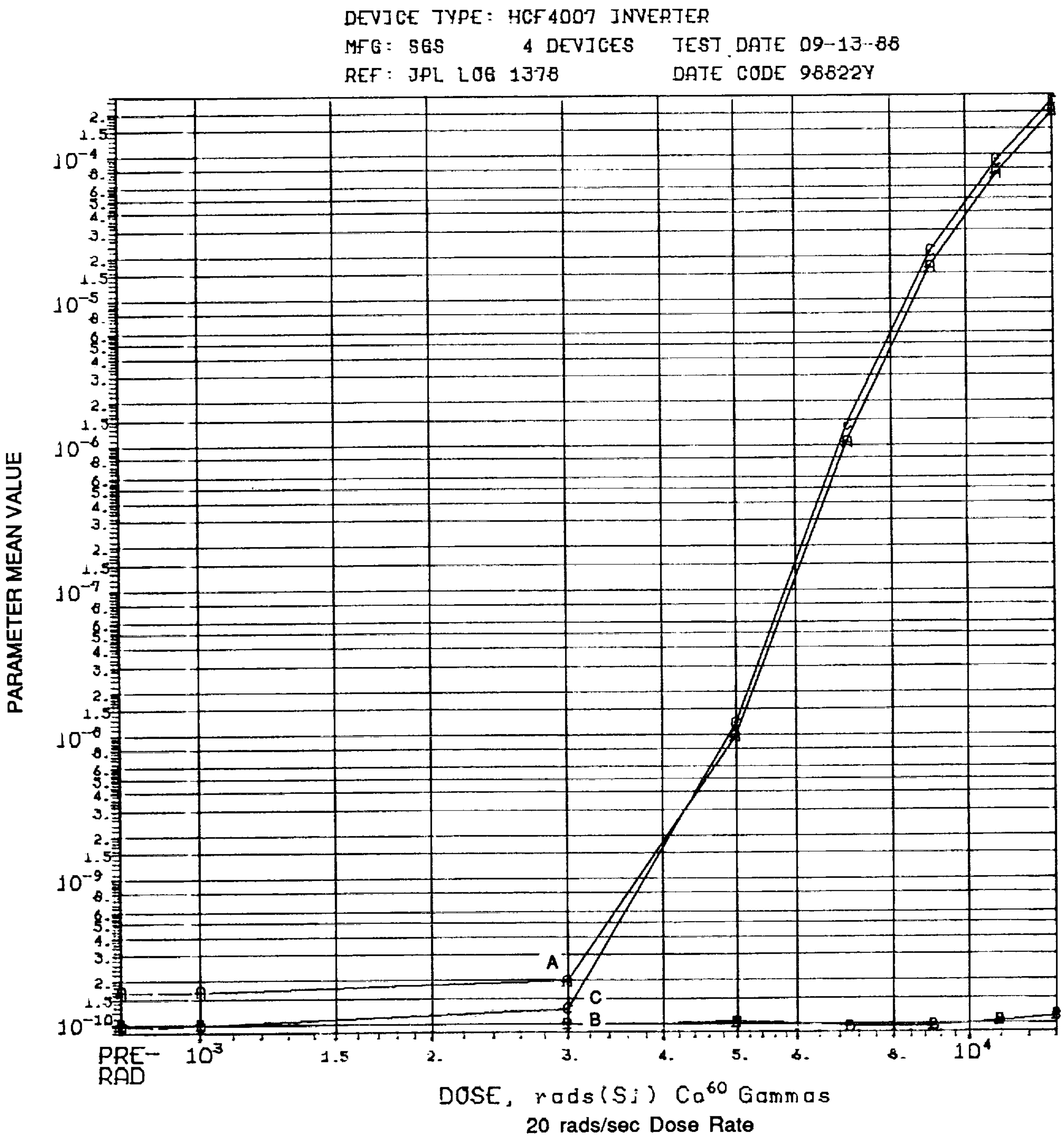
CURVE A: (19)TF01(NS)
CURVE B: (20)TF02(NS)
CURVE C: (21)TR01(NS)
CURVE D: (22)TR02(NS)

DEVICE TYPE: CD4013 DUAL D F/F
MFG: SSS 5 DEVICES TEST DATE 10-29-86
REF: JPL LOG 1268 DATE CODE 8321



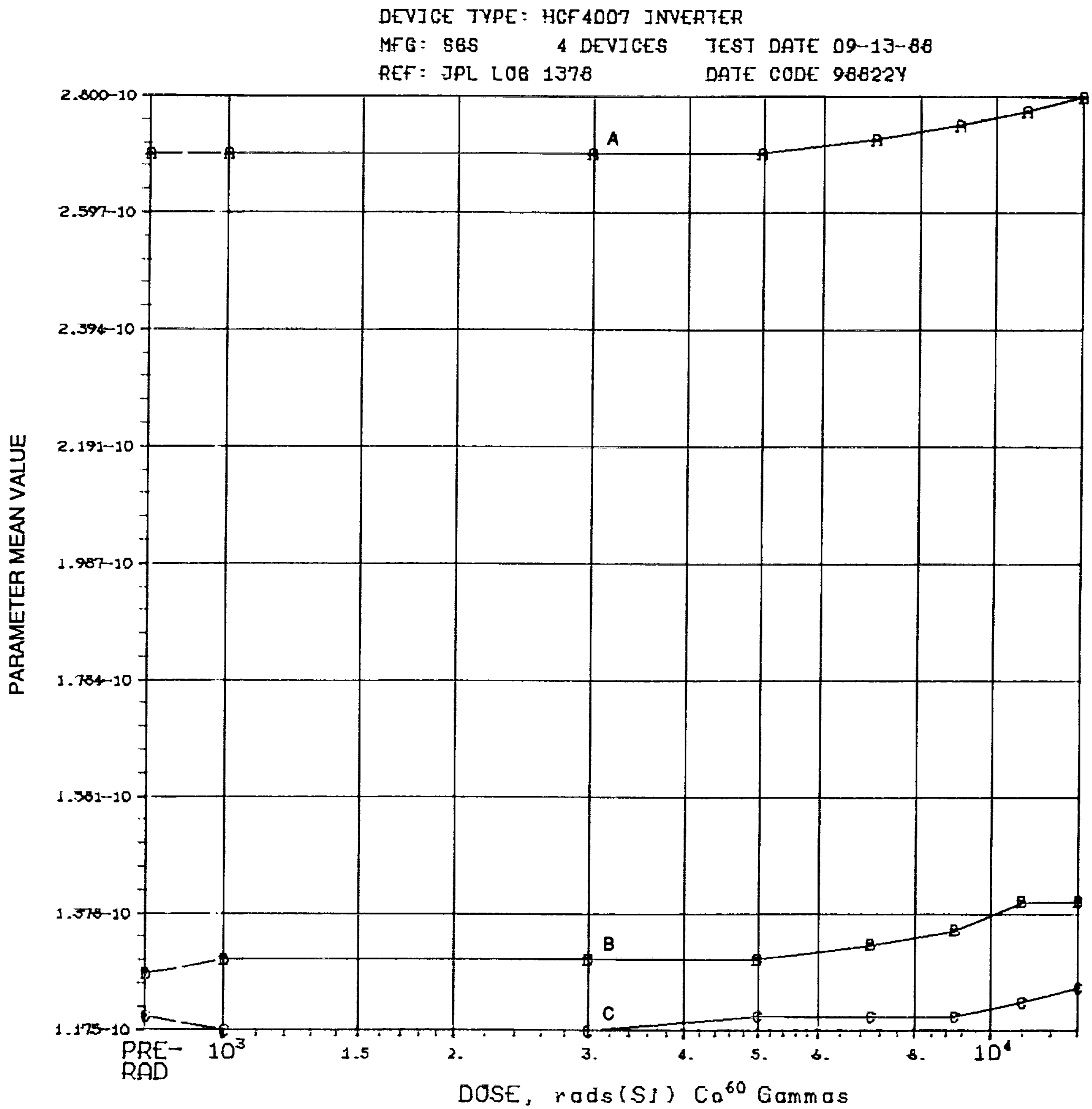
PARAMETERS

CURVE A: (23)TPLHQ1(NS)
CURVE B: (24)TPLHQ2(NS)
CURVE C: (25)TPHLQ1(NS)
CURVE D: (26)TPHLQ2(NS)



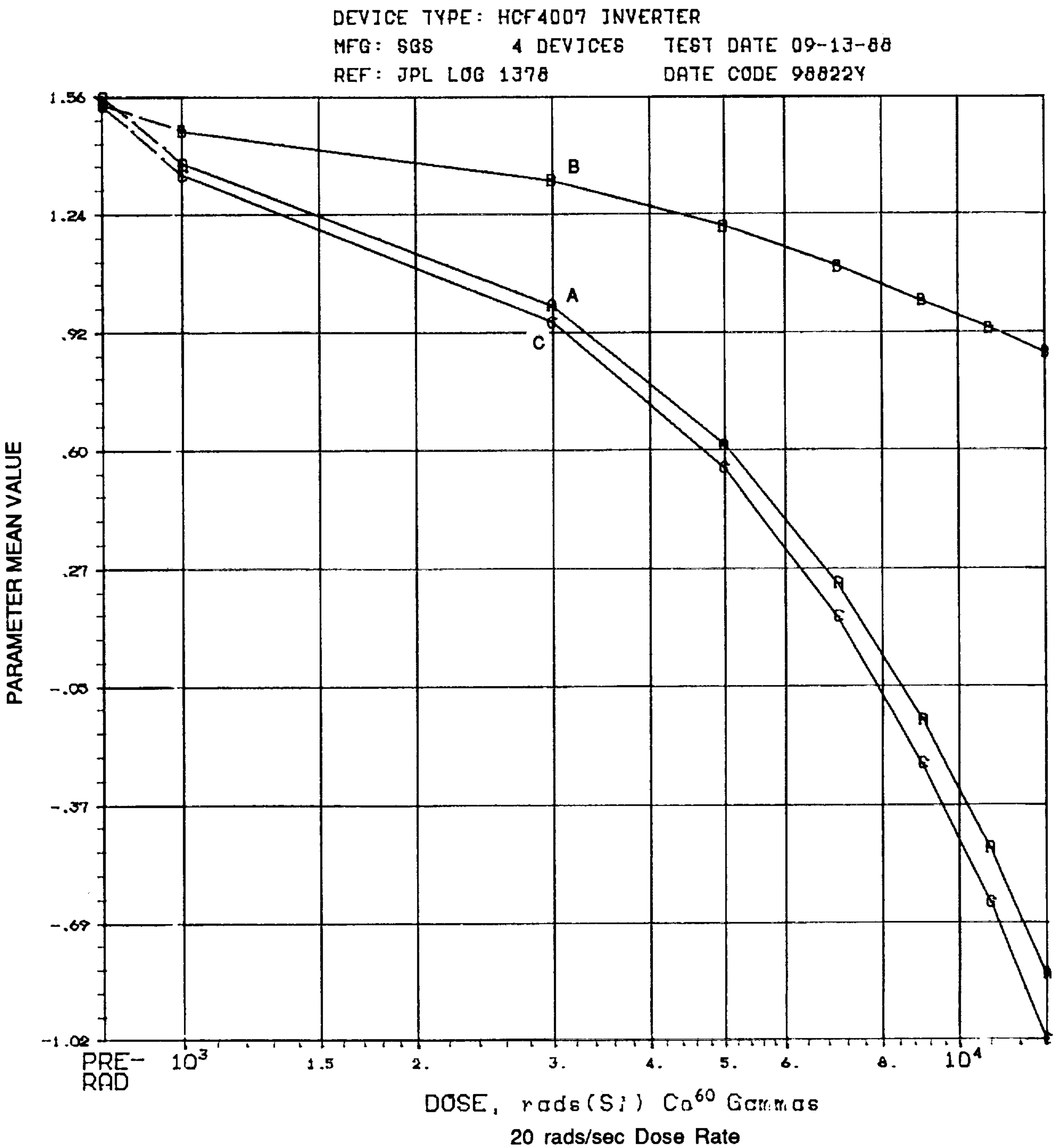
PARAMETERS

CURVE A:	(1)	IDSN(6)-ON	(A)
CURVE B:	(2)	IDSN(6)-OFF	(A)
CURVE C:	(3)	IDSN(10)-ON	(A)



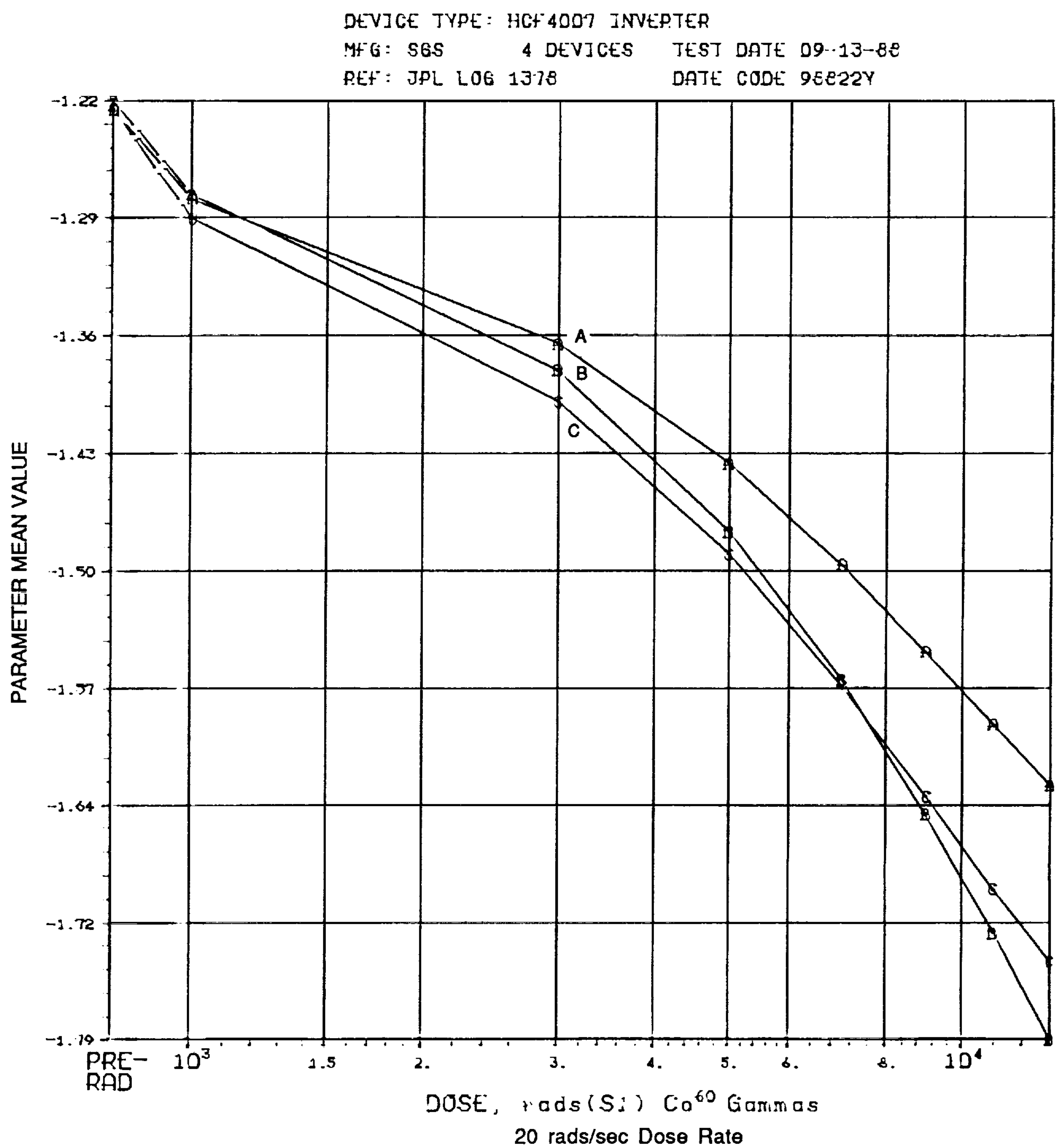
20 rads/sec Dose Rate

	PARAMETERS		
CURVE A:	(4)	IDSP(6)-OFF	(A)
CURVE B:	(5)	IDSP(6)-ON	(A)
CURVE C:	(6)	IDSP(10)-OFF	(A)



PARAMETERS

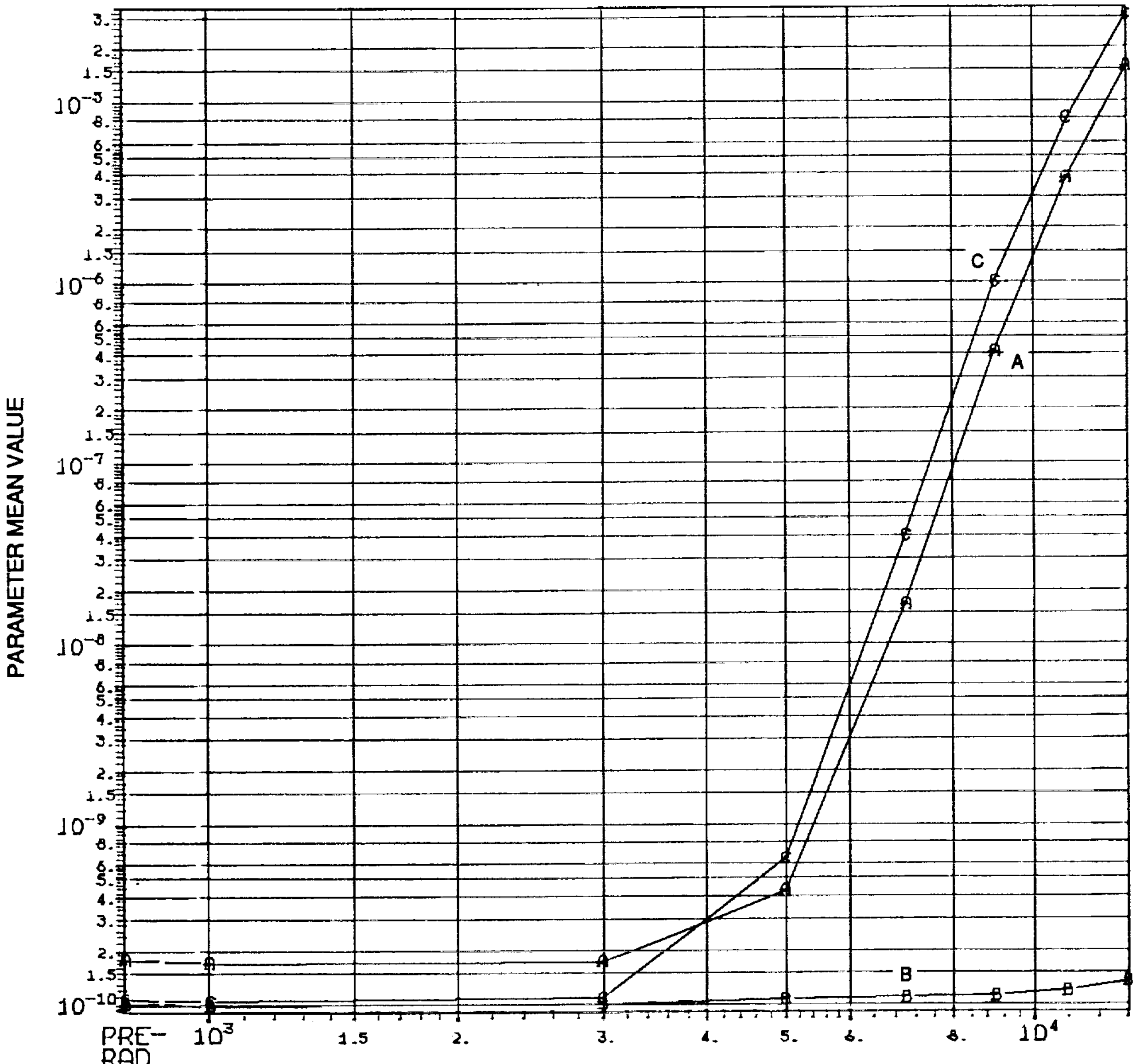
CURVE A:	(7)	VTN(6)-ON (V)
CURVE B:	(8)	VTN(3)-OFF (V)
CURVE C:	(9)	VTP(10)-ON (V)



PARAMETERS

CURVE A:	(10) VTP(6)-OFF (V)
CURVE B:	(11) VTP(3)-ON (V)
CURVE C:	(12) VTP(10)-OFF(V)

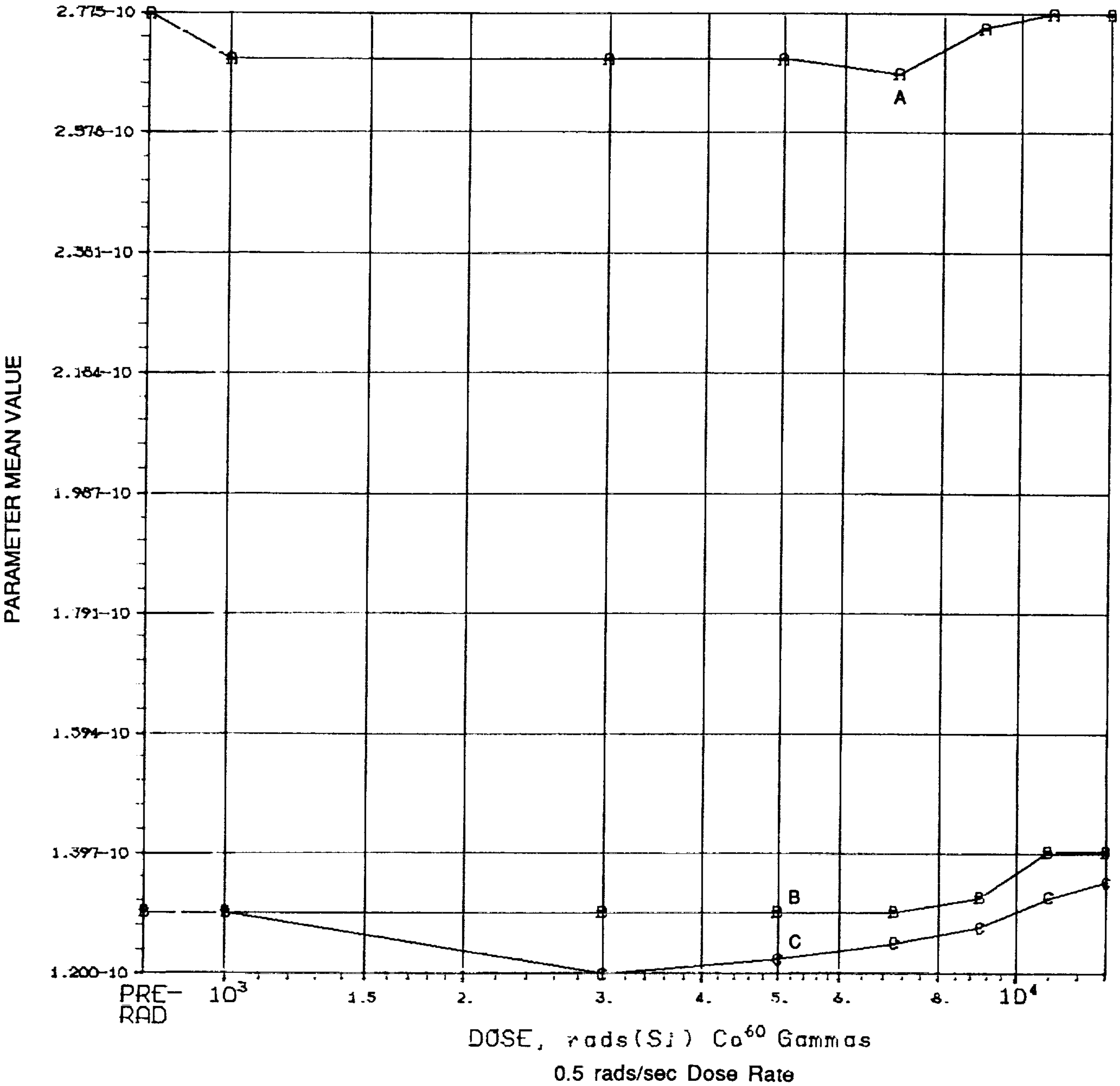
DEVICE TYPE: HCF4007 INVERTER
MFG: SGS 4 DEVICES TEST DATE 09-15-88
REF: JPL LOG 1379 DATE CODE 98822Y



0.5 rads/sec Dose Rate

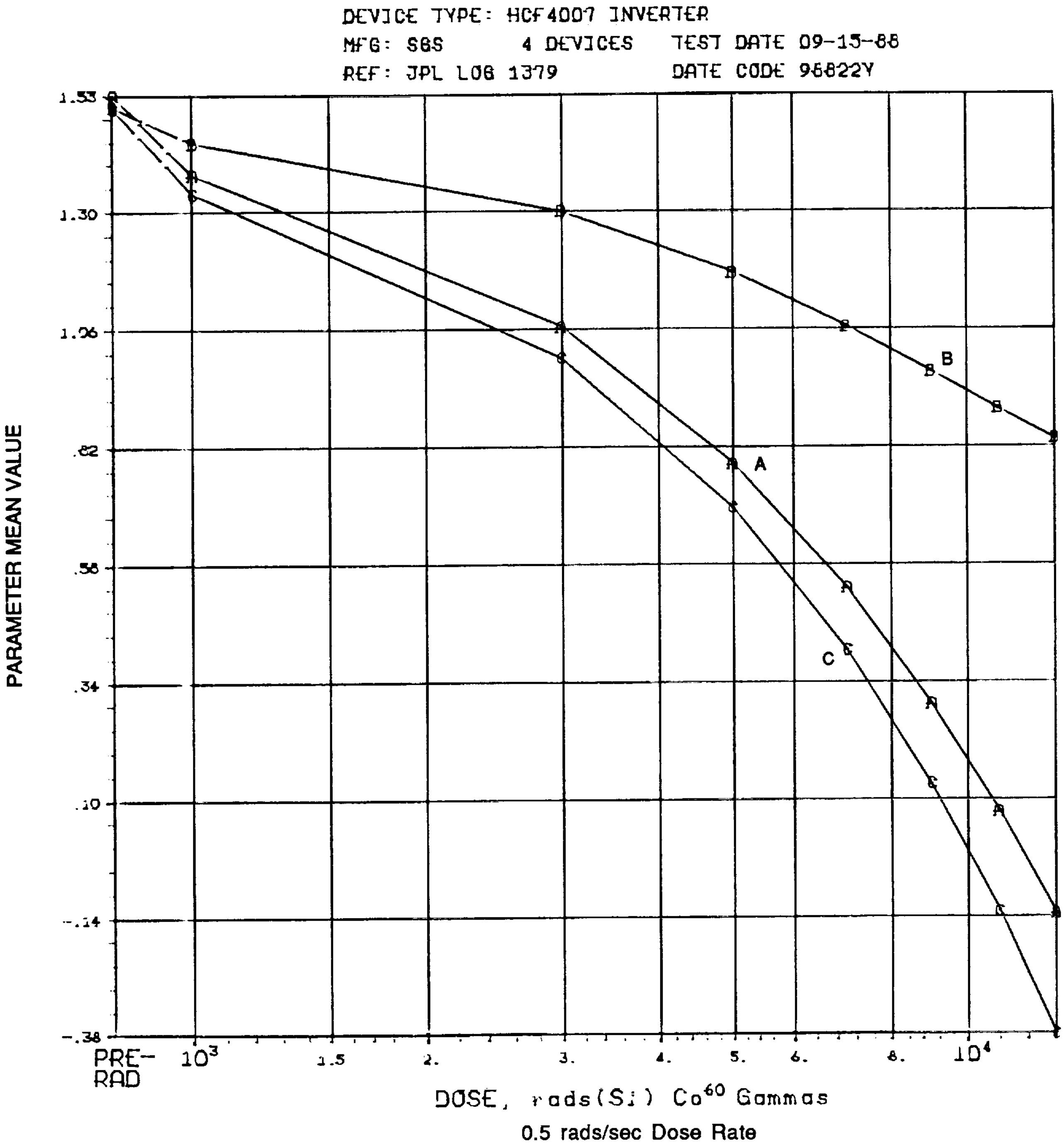
	PARAMETERS		
CURVE A:	(1)	IDSN(6)-ON	(A)
CURVE B:	(2)	IDSN(3)-OFF	(A)
CURVE C:	(3)	IDSN(10)-ON	(A)

DEVICE TYPE: HCF4007 INVERTER
MFG: SGS 4 DEVICES TEST DATE 09-15-88
REF: JPL LOG 1379 DATE CODE 98822Y

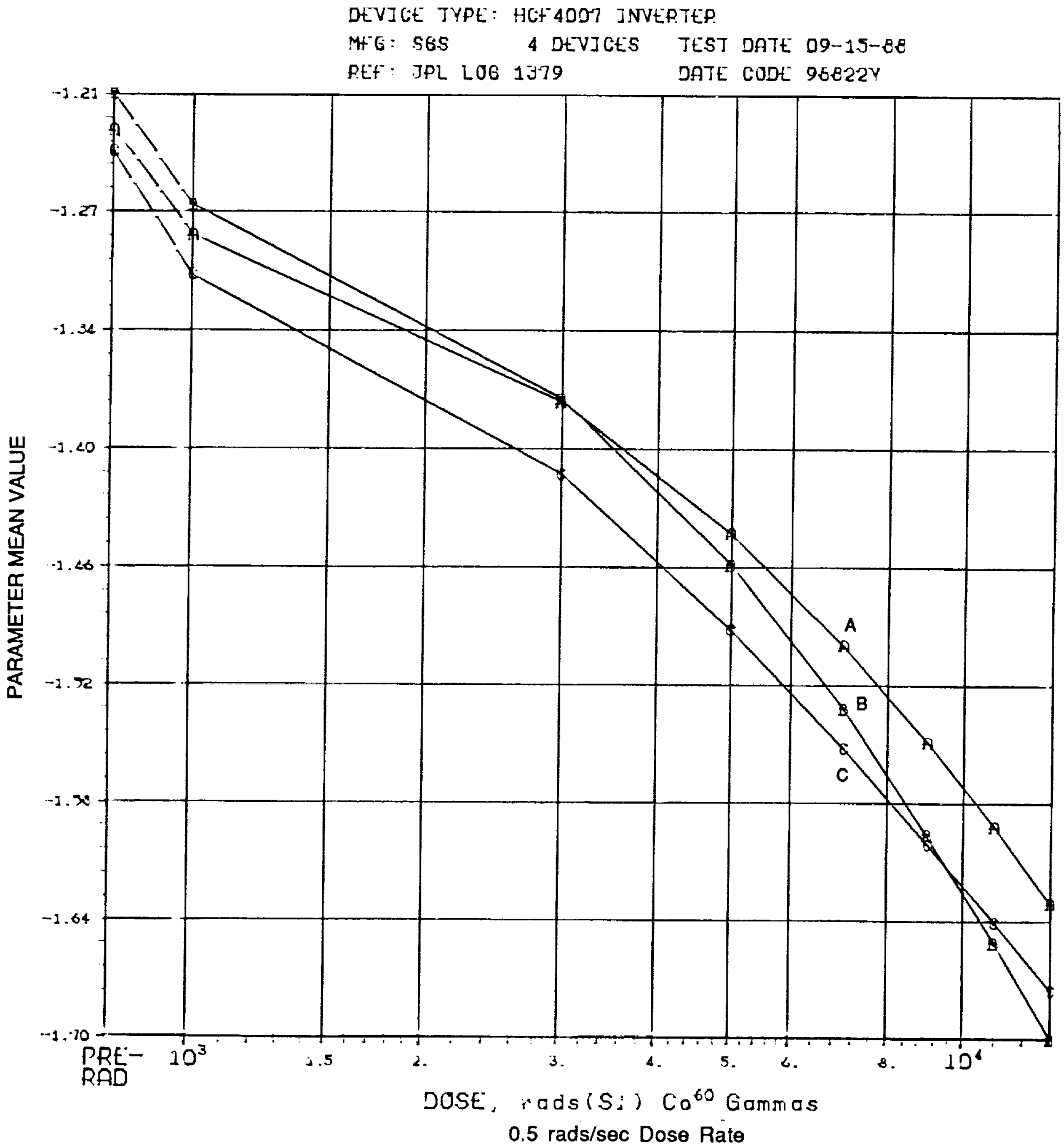


PARAMETERS

CURVE A:	(4)	IDSP(6)--OFF	(A)
CURVE B:	(5)	IDSP(3)--ON	(A)
CURVE C:	(6)	IDSP(10)--OFF	(A)

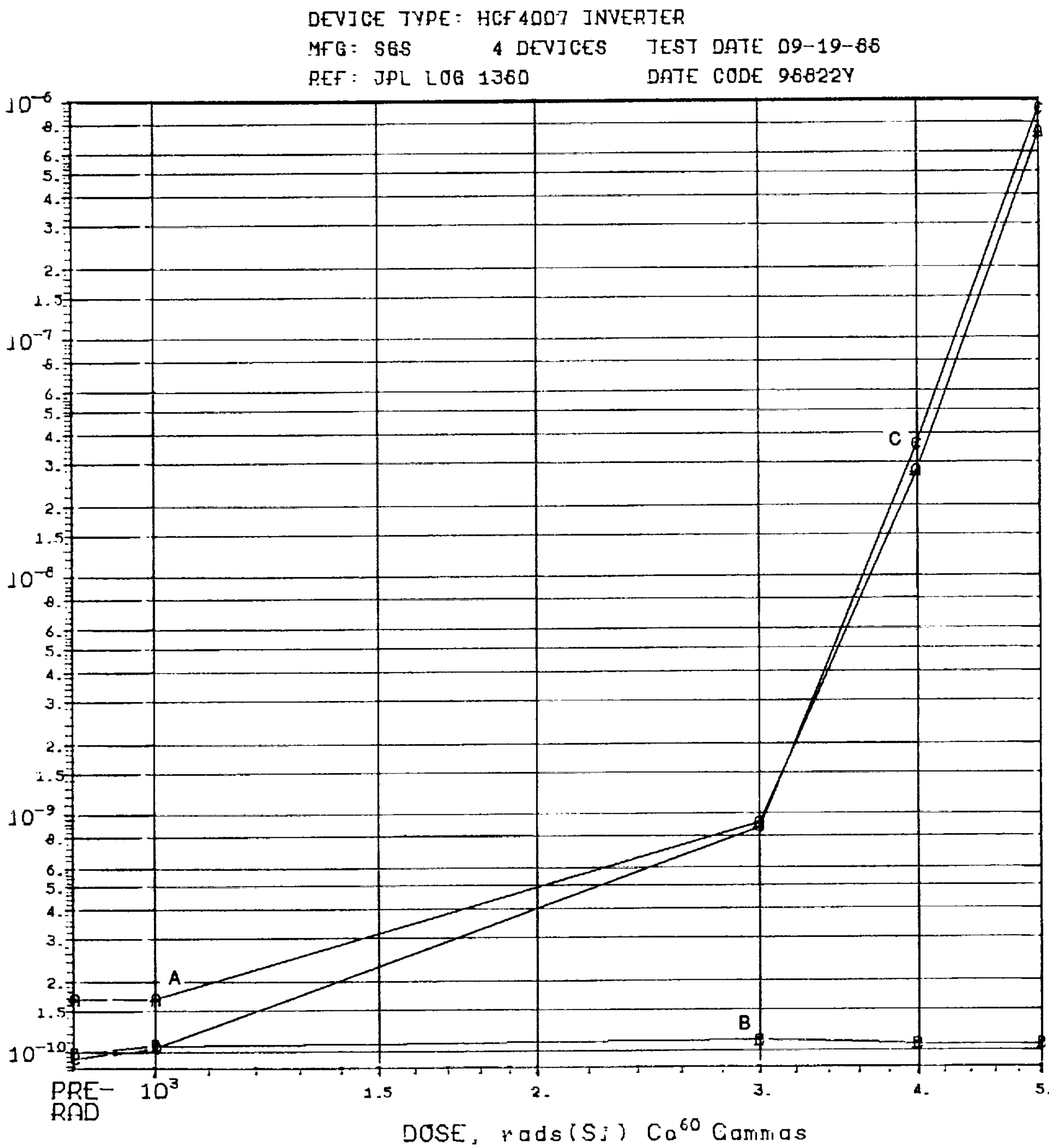


	PARAMETERS
CURVE A:	(7) VTN(6)-ON (V)
CURVE B:	(8) VTN(3)-OFF (V)
CURVE C:	(9) VTP(10)-ON (V)



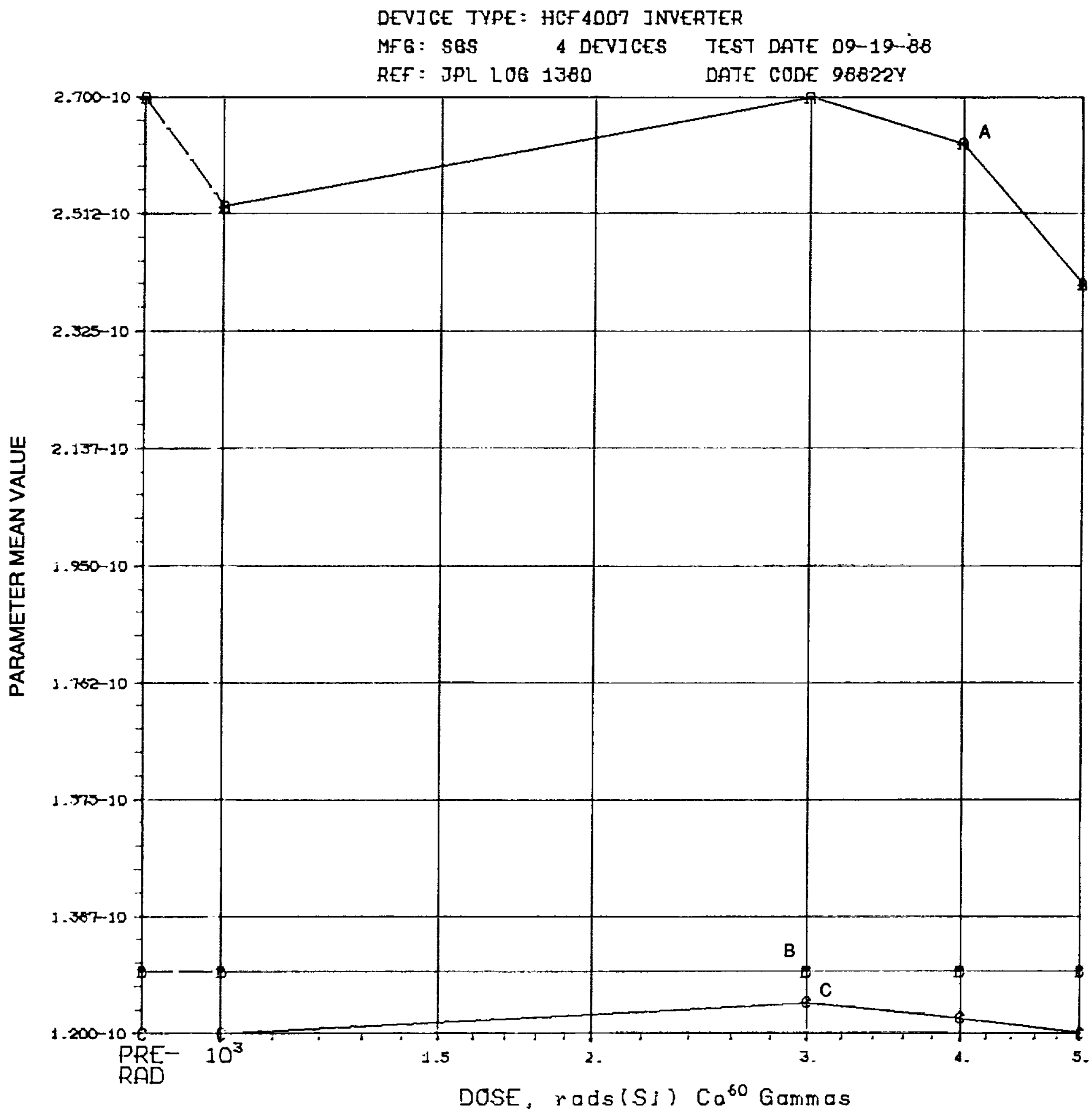
PARAMETERS

CURVE A:	(10) VTP(6)-OFF (V)
CURVE B:	(11) VTP(3)-ON (V)
CURVE C:	(12) VTP(10)-OFF(V)



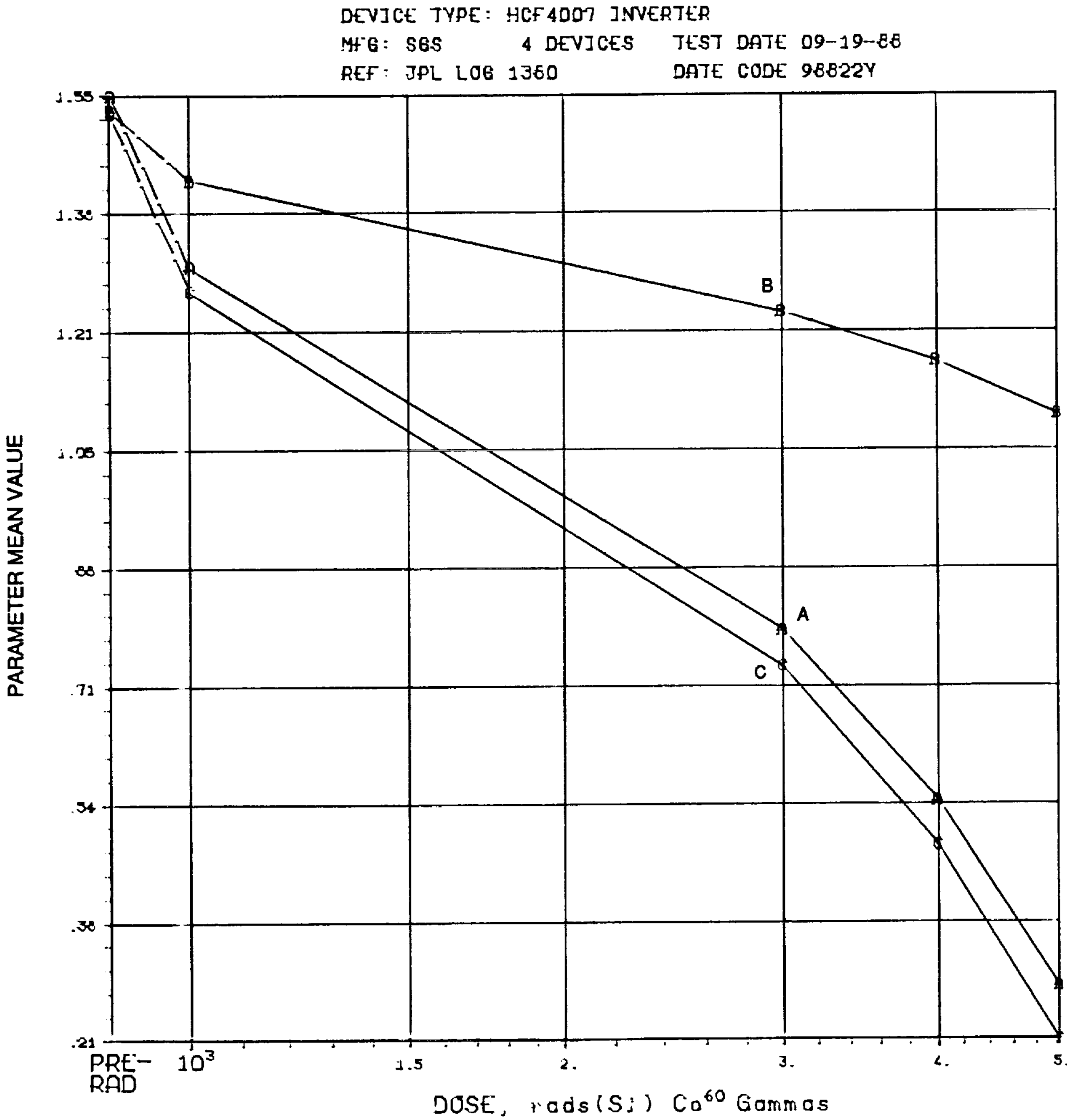
PARAMETERS

CURVE A:	(1)	IDSN(6)--ON	(A)
CURVE B:	(2)	IDSN(3)--OFF	(A)
CURVE C:	(3)	IDSN(10)--ON	(A)



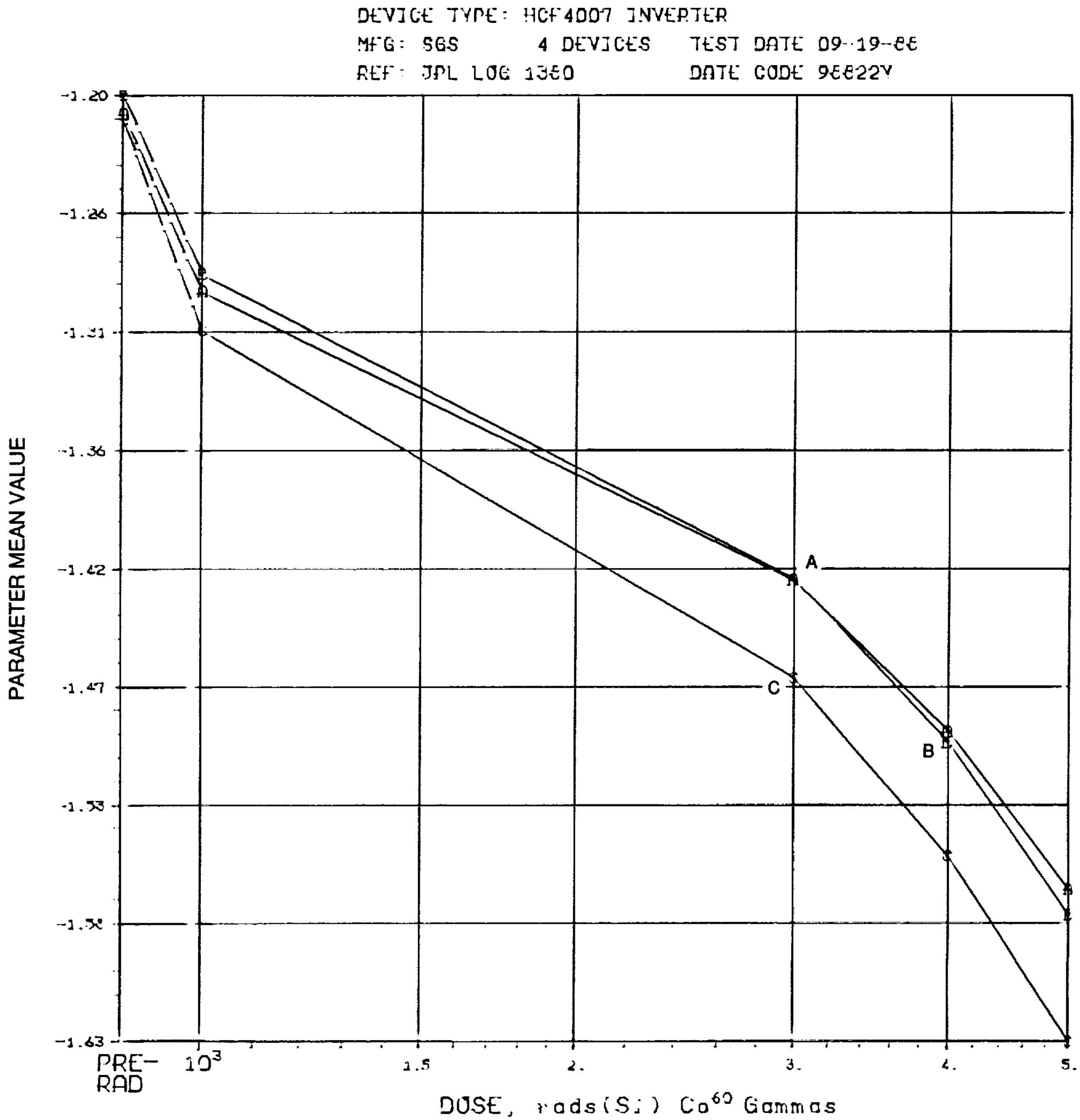
PARAMETERS

CURVE A:	(4)	IDSP(6)-OFF	(A)
CURVE B:	(5)	IDSP(3)-ON	(A)
CURVE C:	(6)	IDSP(10)-OFF	(A)



PARAMETERS

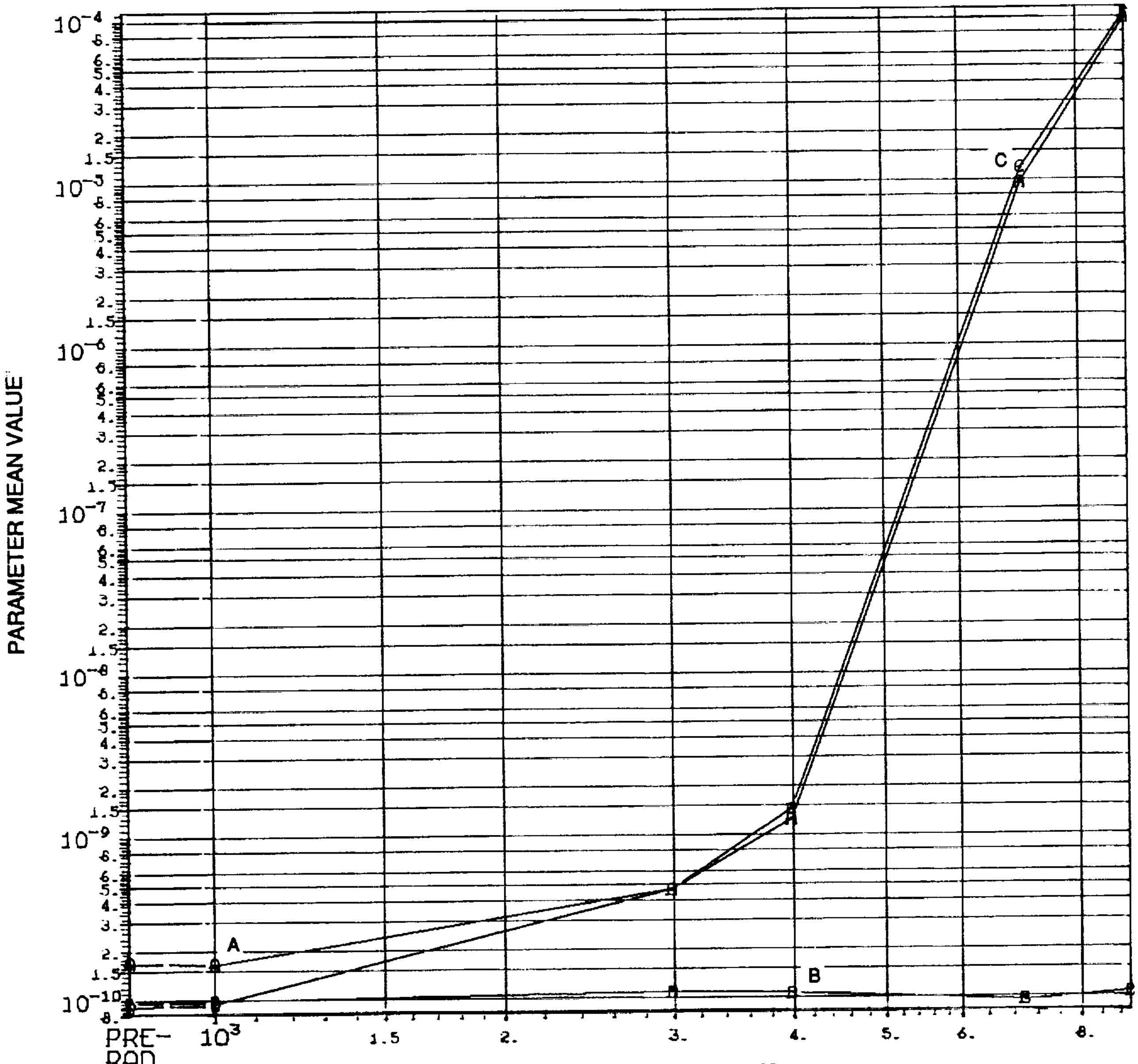
CURVE A: (7) VTN(6)-ON (V)
CURVE B: (8) VTN(3)-OFF (V)
CURVE C: (9) VTP(10)-ON (V)



PARAMETERS

CURVE A:	(10) VTP(6)-OFF (V)
CURVE B:	(11) VTP(3)-ON (V)
CURVE C:	(12) VTP(10)-OFF(V)

DEVICE TYPE: HCF4007 INVERTER
MFG: SGS 4 DEVICES TEST DATE 09-19-86
REF: JPL LOG 1368 DATE CODE 96622Y

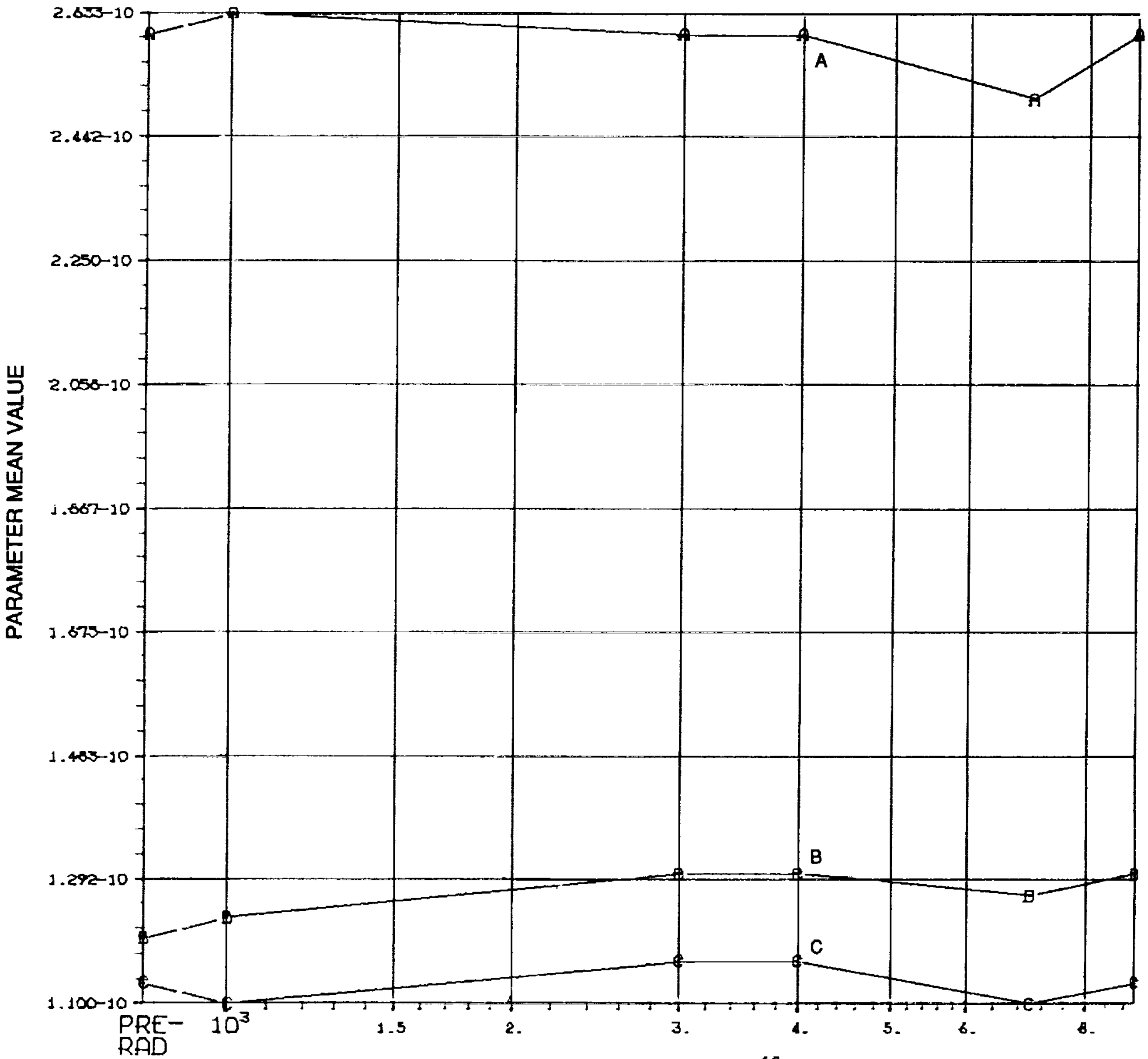


DOSE, rads(Si) Co^{60} Gammas
20 rads/sec Dose Rate

PARAMETERS

CURVE A:	(1)	IDSN(6)-ON	(A)
CURVE B:	(2)	IDSN(3)-OFF	(A)
CURVE C:	(3)	IDSN(10)-ON	(A)

DEVICE TYPE: HCF4007 INVERTER
MFG: SGS 4 DEVICES TEST DATE 09-19-88
REF: JPL LOG 1388 DATE CODE 98822Y

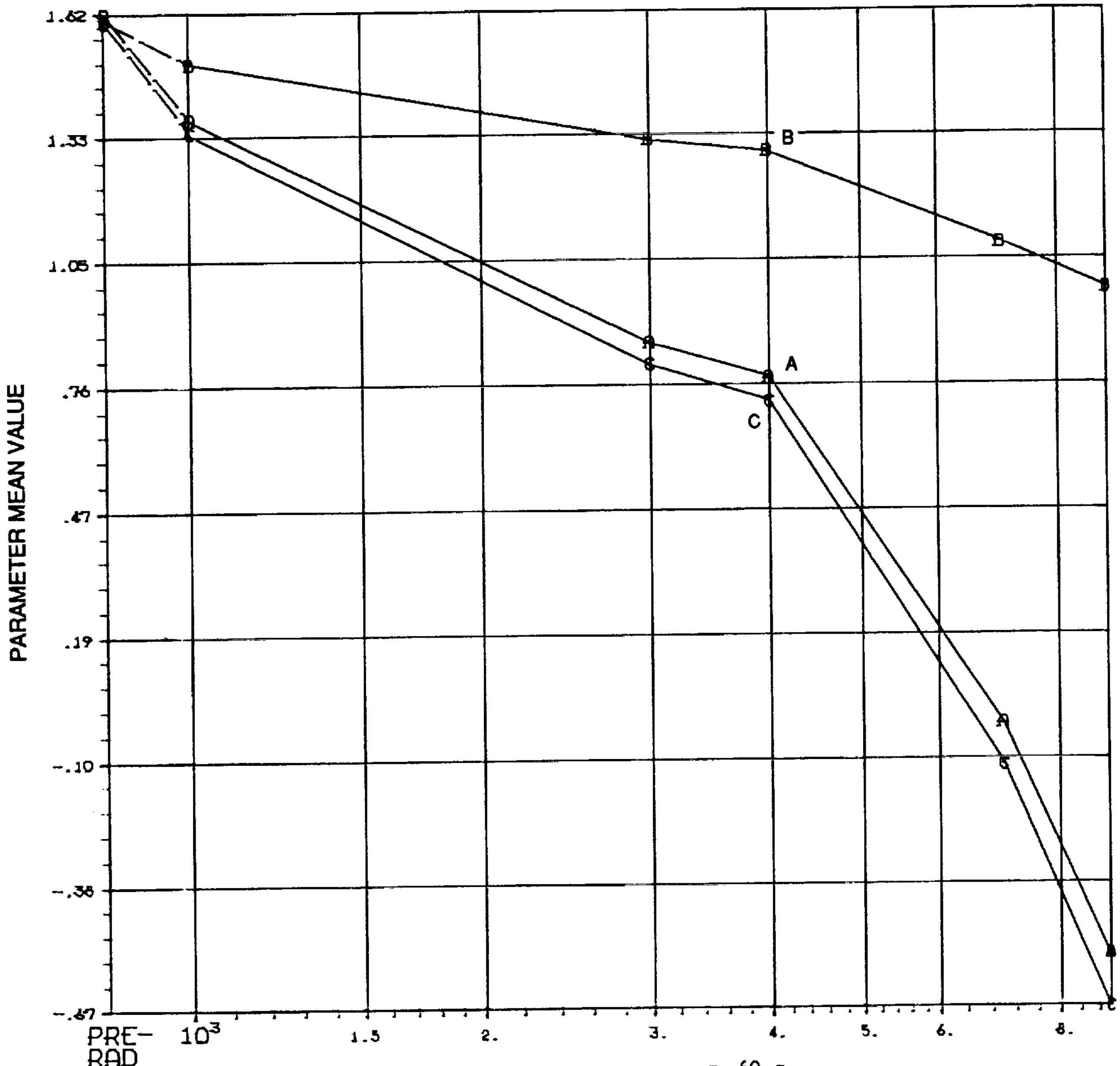


DOSE, rads(Si) Co^{60} Gammas
20 rads/sec Dose Rate

PARAMETERS

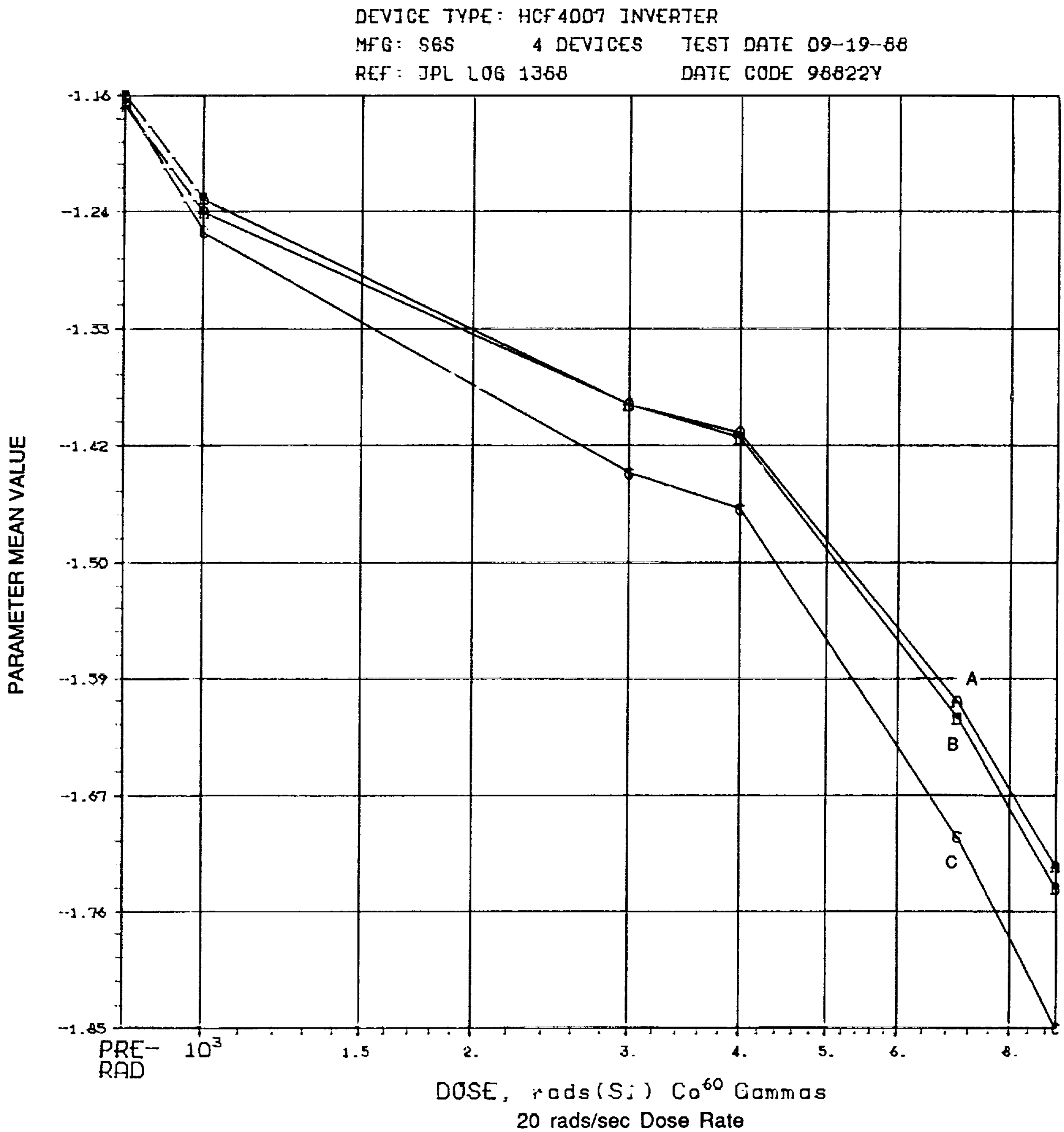
CURVE A:	(4)	IDSP(6)-OFF	(A)
CURVE B:	(5)	IDSP(3)-ON	(A)
CURVE C:	(6)	IDSP(10)-OFF	(A)

DEVICE TYPE: HCF4007 INVERTER
MFG: SGS 4 DEVICES TEST DATE 09-19-88
REF: JPL LOG 1388 DATE CODE 98822Y



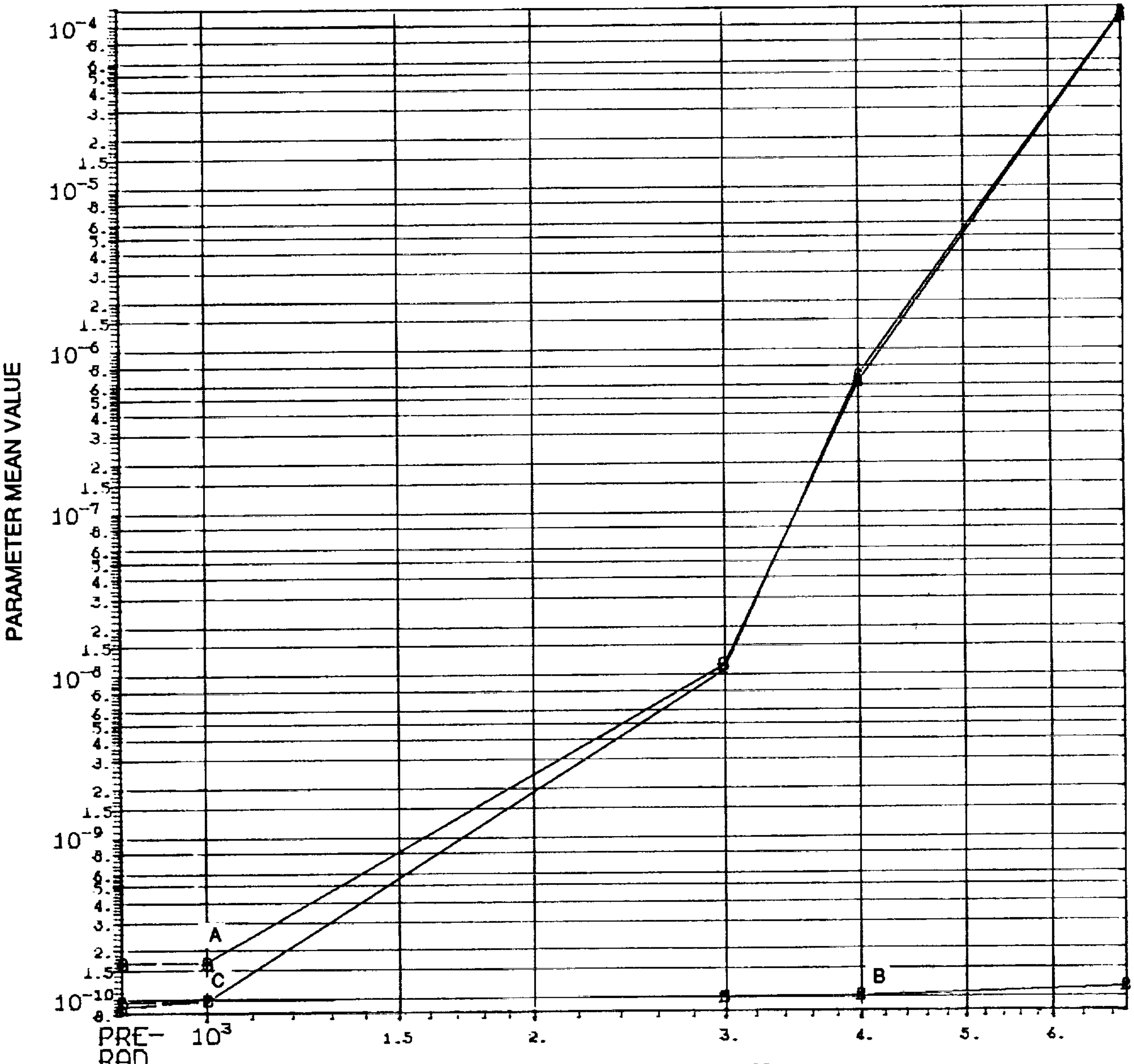
DOSE, rads(Si) Co^{60} Gammas
20 rads/sec Dose Rate

	PARAMETERS
CURVE A:	(7) VTN(6)-ON (V)
CURVE B:	(8) VTN(3)-OFF (V)
CURVE C:	(9) VTP(10)-ON (V)



	PARAMETERS
CURVE A:	(10) VTP(6)-OFF (V)
CURVE B:	(11) VTP(3)-ON (V)
CURVE C:	(12) VTP(10)-OFF (V)

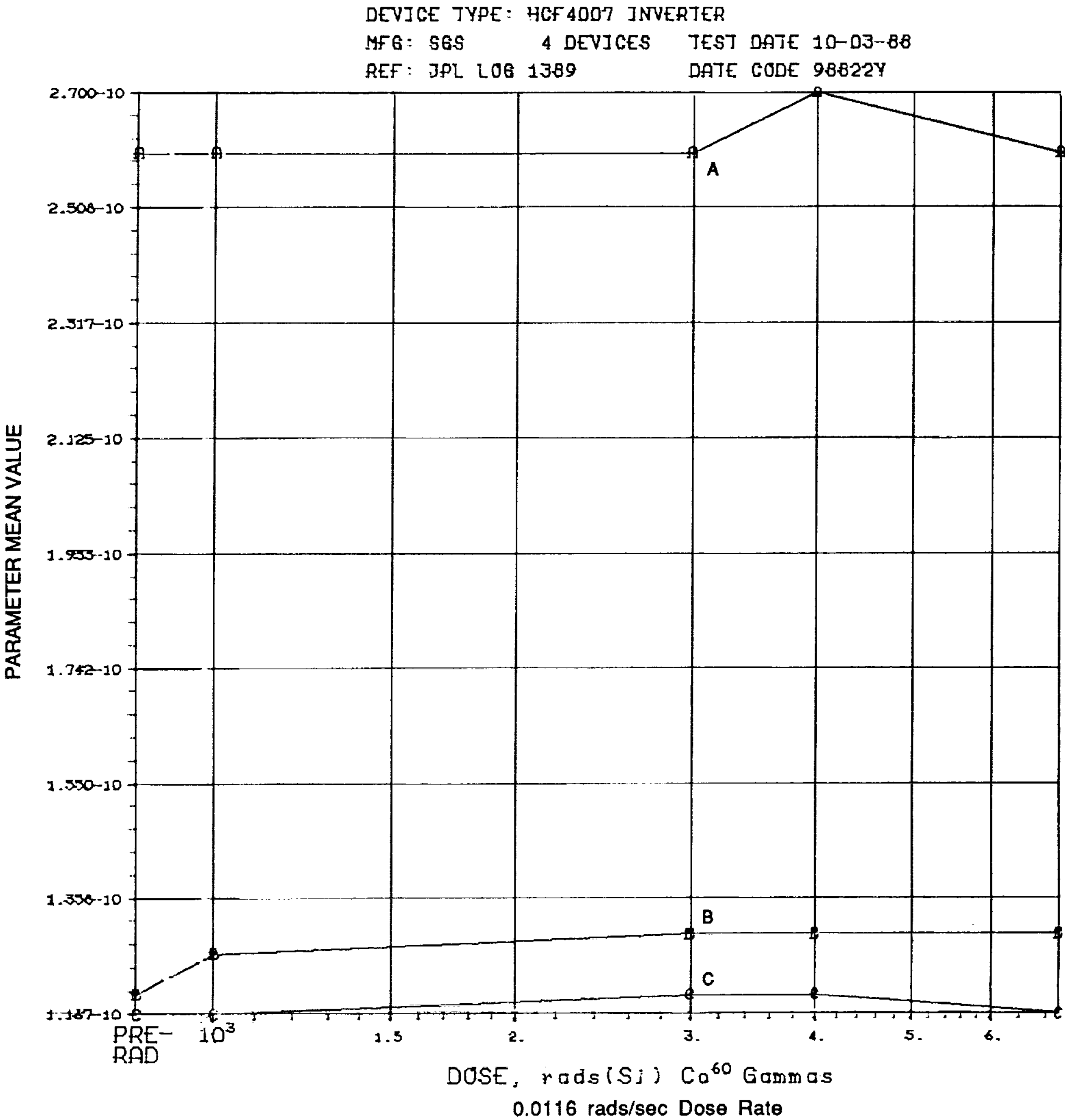
DEVICE TYPE: HCF4007 INVERTER
MFG: SGS 4 DEVICES TEST DATE 10-03-86
REF: JPL LOG 1369 DATE CODE 98822Y



0.0116 rads/sec Dose Rate

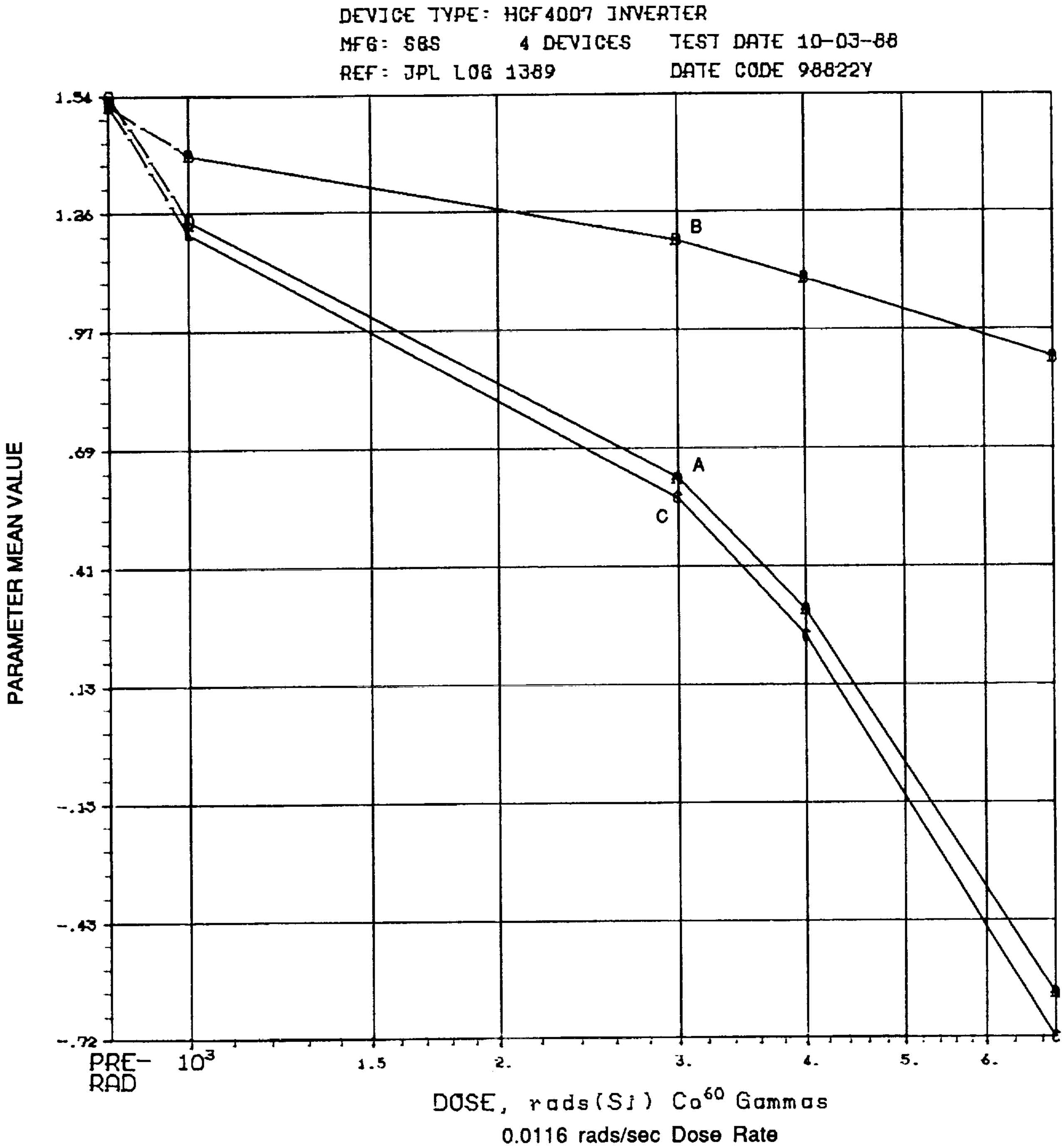
PARAMETERS

CURVE A:	(1)	IDSN(6)-ON	(A)
CURVE B:	(2)	IDSN(3)-OFF	(A)
CURVE C:	(3)	IDSN(10)-ON	(A)



PARAMETERS

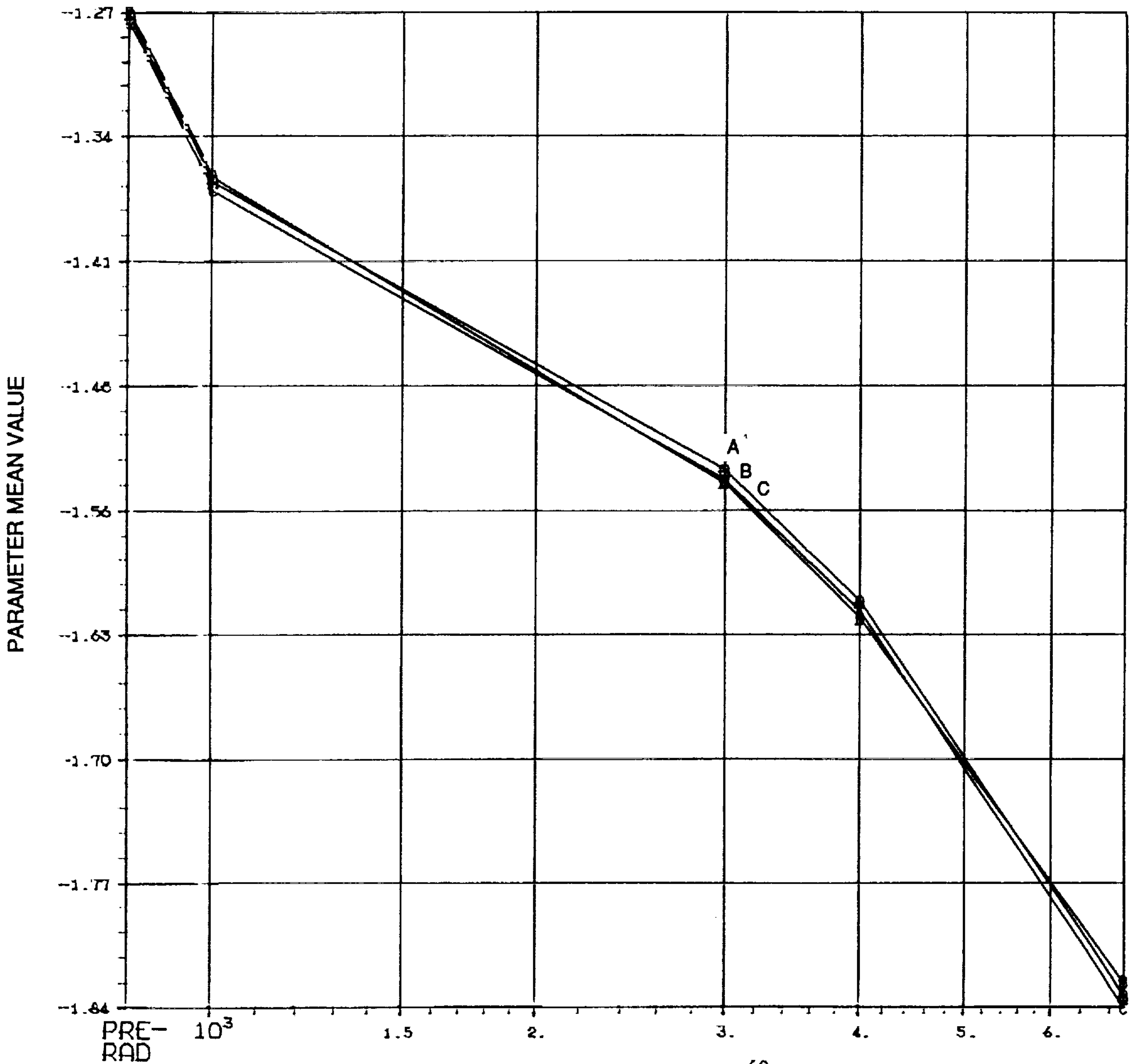
CURVE A:	(4)	IDSP(6)--OFF	(A)
CURVE B:	(5)	IDSP(3)--ON	(A)
CURVE C:	(6)	IDSP(10)--OFF	(A)



PARAMETERS

CURVE A:	(7) VTN(6)-ON (V)
CURVE B:	(8) VTN(3)-OFF (V)
CURVE C:	(9) VTP(10)-ON (V)

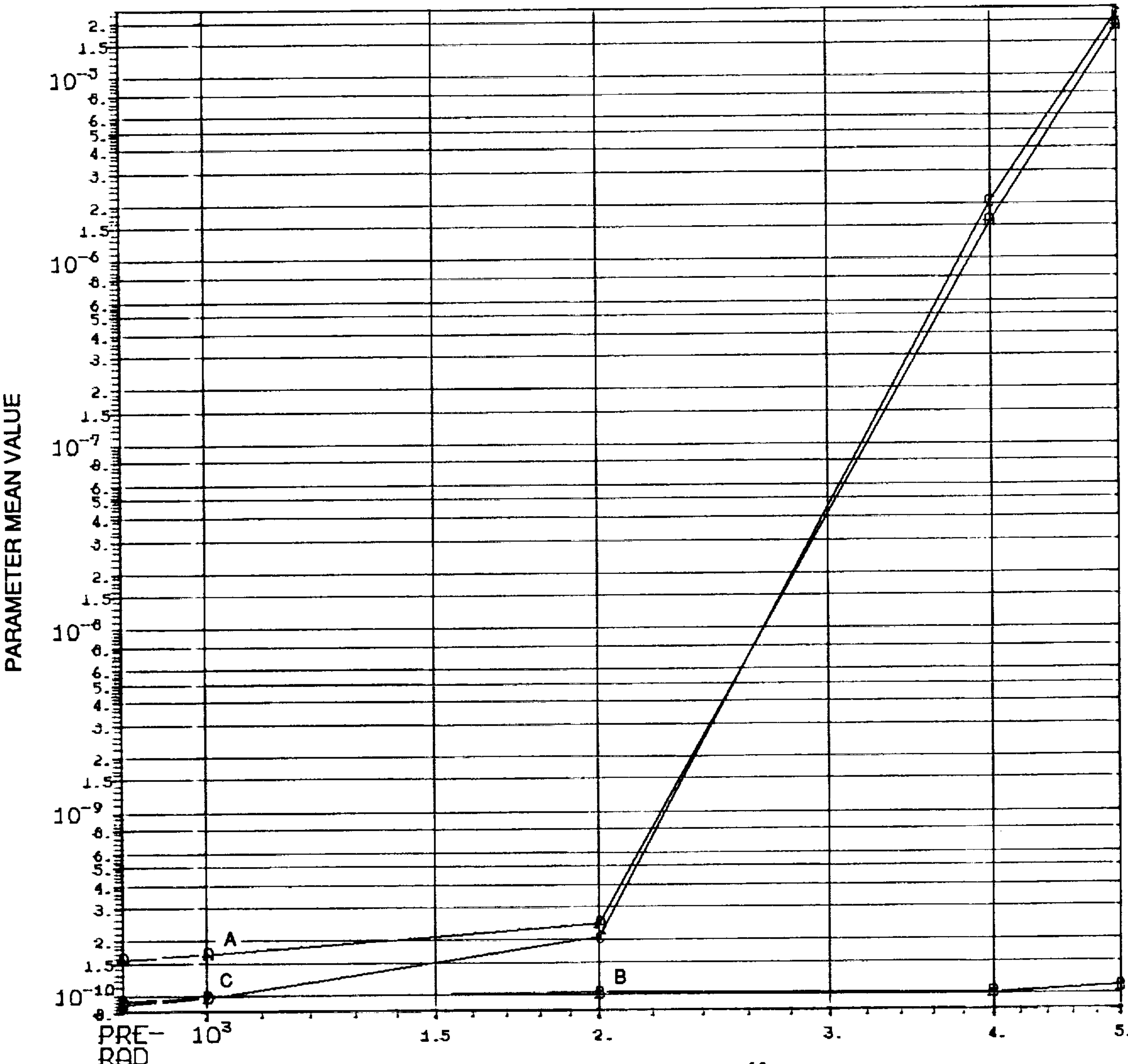
DEVICE TYPE: HCF4007 INVERTER
MFG: SGS 4 DEVICES TEST DATE 10-03-88
REF: JPL LOG 1389 DATE CODE 98822Y



0.0116 rads/sec Dose Rate

	PARAMETERS
CURVE A:	(10) VTP(6)-OFF (V)
CURVE B:	(11) VTP(3)-ON (V)
CURVE C:	(12) VTP(10)-OFF(V)

DEVICE TYPE: HCF4007 INVERTER
MFG: SGS 4 DEVICES TEST DATE 10-10-88
REF: JPL LOG 1390 DATE CODE 98622Y

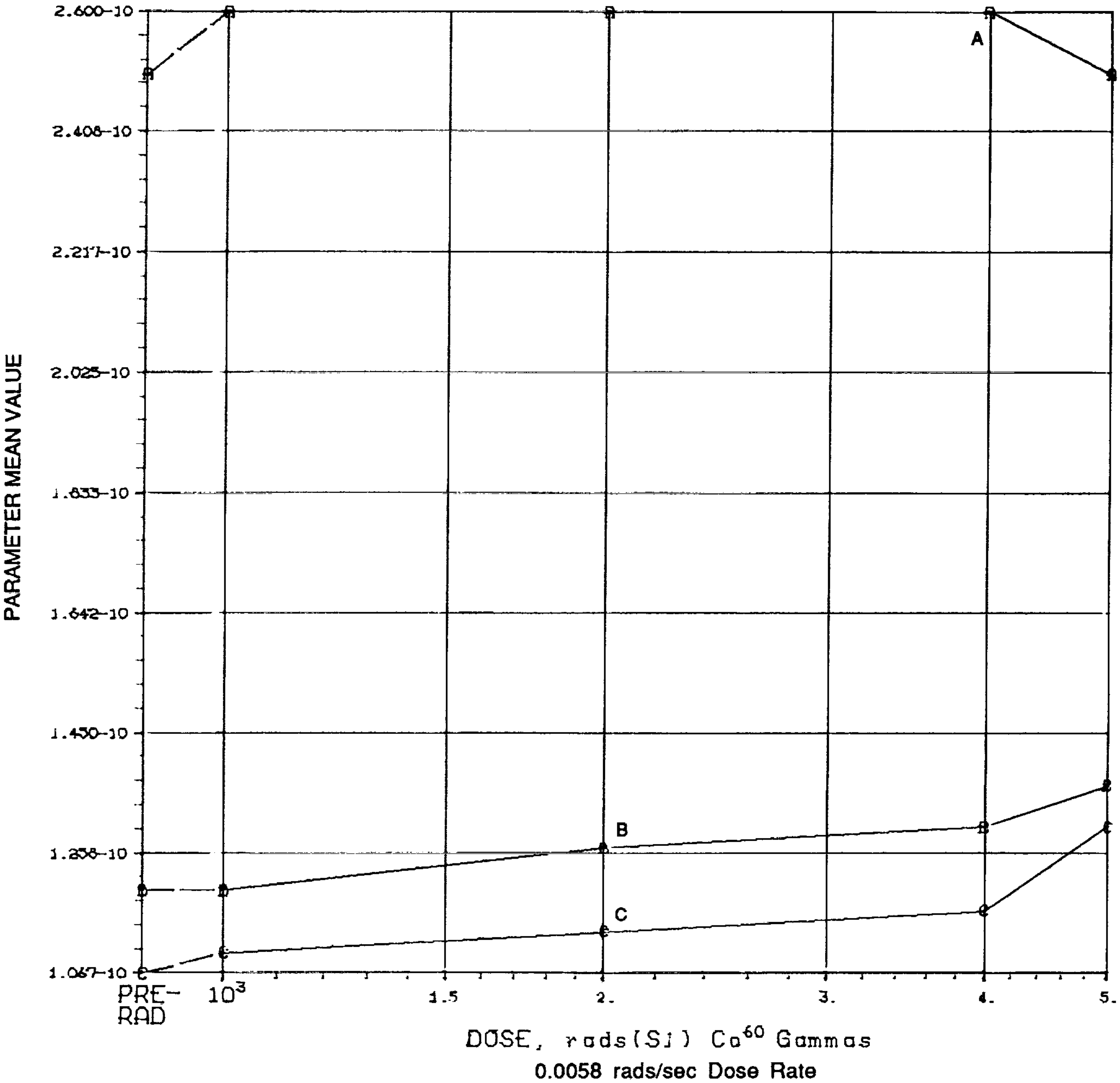


DOSE, rads(Si) Co^{60} Gammas
0.0058 rads/sec Dose Rate

PARAMETERS

CURVE A:	(1)	IDSN(6)-ON	(A)
CURVE B:	(2)	IDSN(3)-OFF	(A)
CURVE C:	(3)	IDSN(10)-ON	(A)

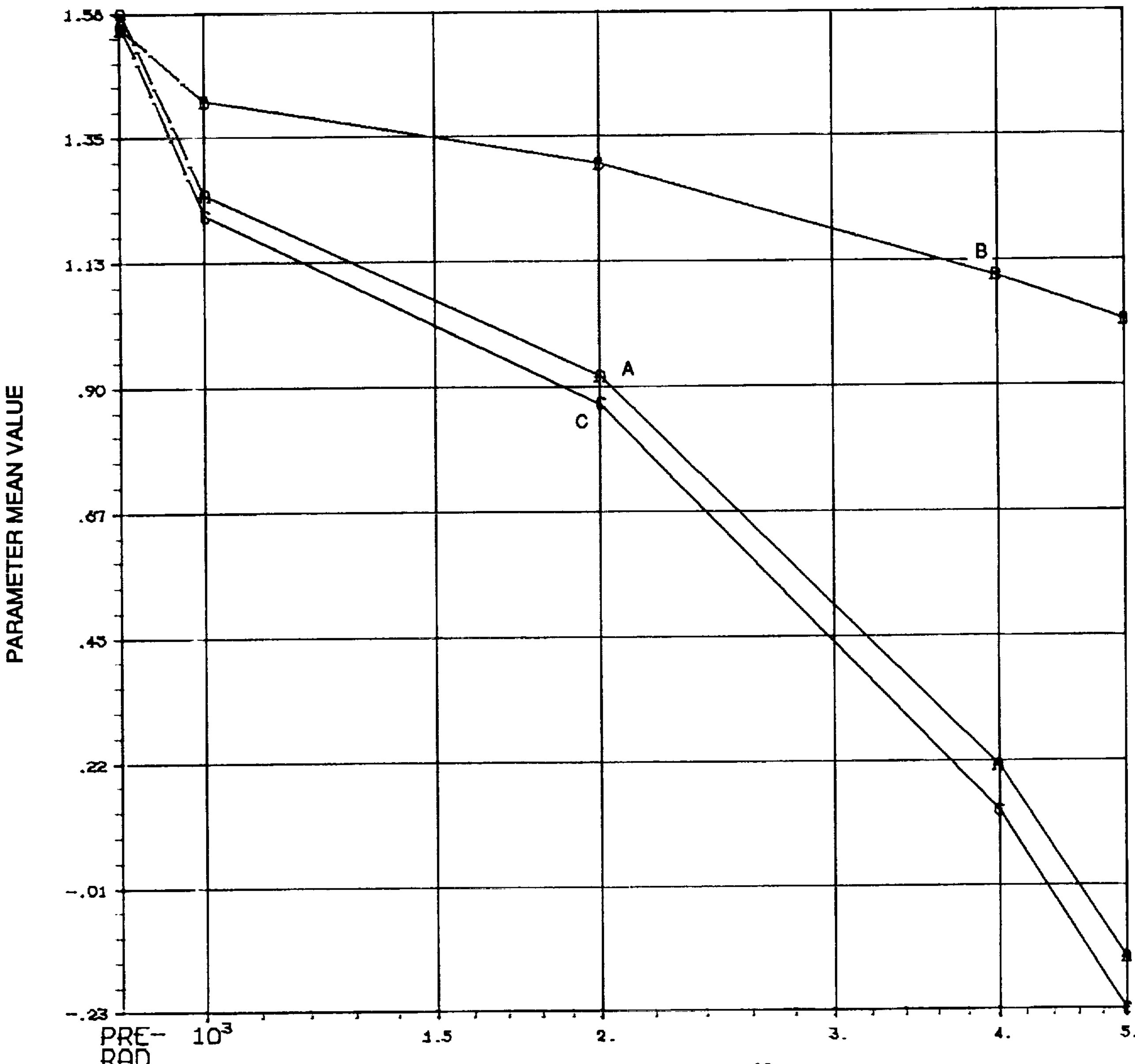
DEVICE TYPE: HCF4007 INVERTER
MFG: SGS 4 DEVICES TEST DATE 10-10-88
REF: JPL LOG 1390 DATE CODE 98822Y



PARAMETERS

CURVE A:	(4)	IDSP(6)-OFF	(A)
CURVE B:	(5)	IDSP(6)-ON	(A)
CURVE C:	(6)	IDSP(10)-OFF	(A)

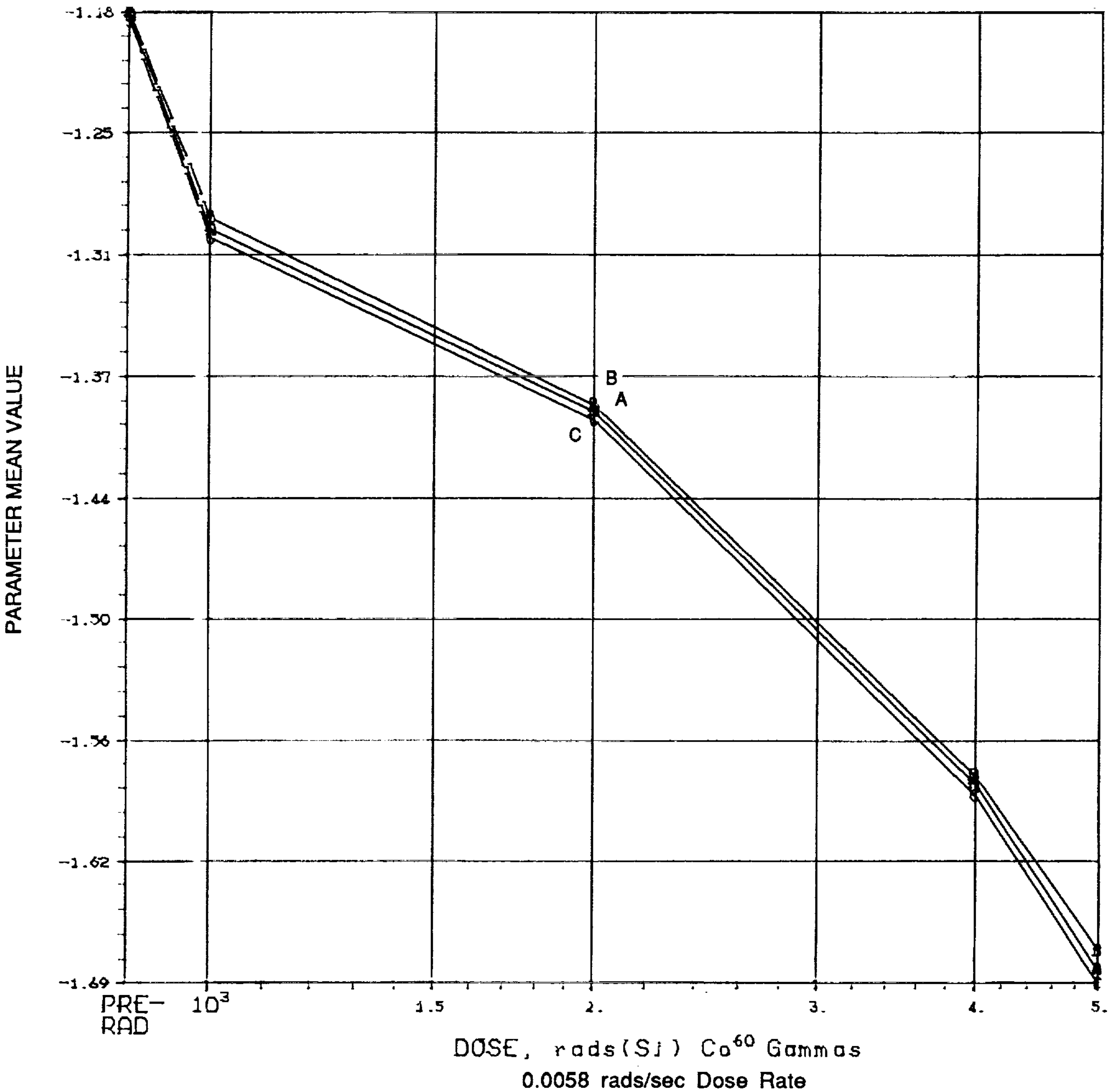
DEVICE TYPE: HCF4007 INVERTER
MFG: SGS 4 DEVICES TEST DATE 10-10-88
REF: JPL LOG 1390 DATE CODE 98822Y



PARAMETERS

CURVE A:	(7)	VTN(6)-ON (V)
CURVE B:	(8)	VTN(3)-OFF (V)
CURVE C:	(9)	VTP(10)-ON (V)

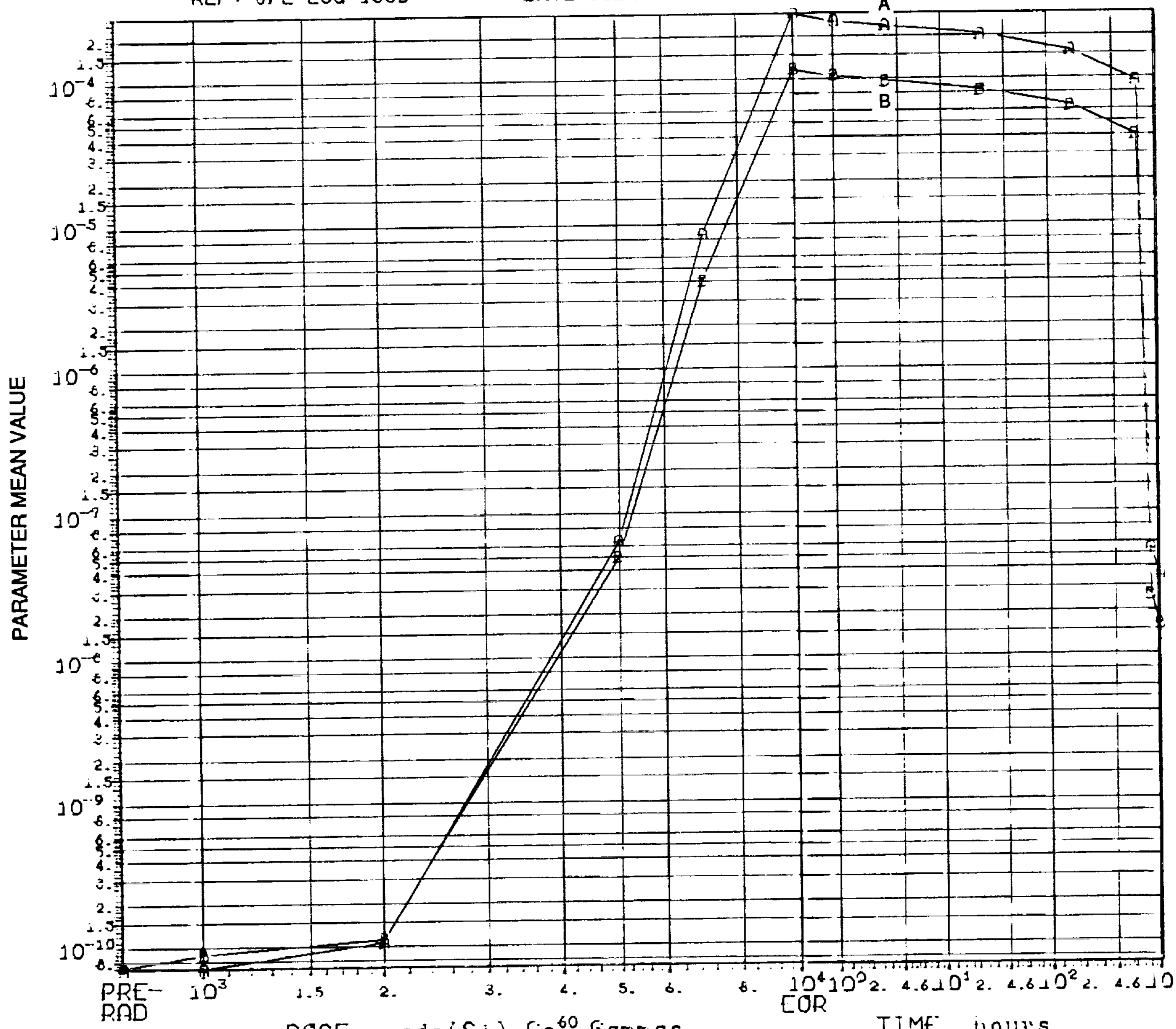
DEVICE TYPE: HCF4007 INVERTER
MFG: SGS 4 DEVICES TEST DATE 10-10-88
REF: JPL LOG 1390 DATE CODE 98822Y



PARAMETERS

CURVE A:	(10) VTP(6)-OFF (V)
CURVE B:	(11) VTP(3)-ON (V)
CURVE C:	(12) VTP(10)-OFF(V)

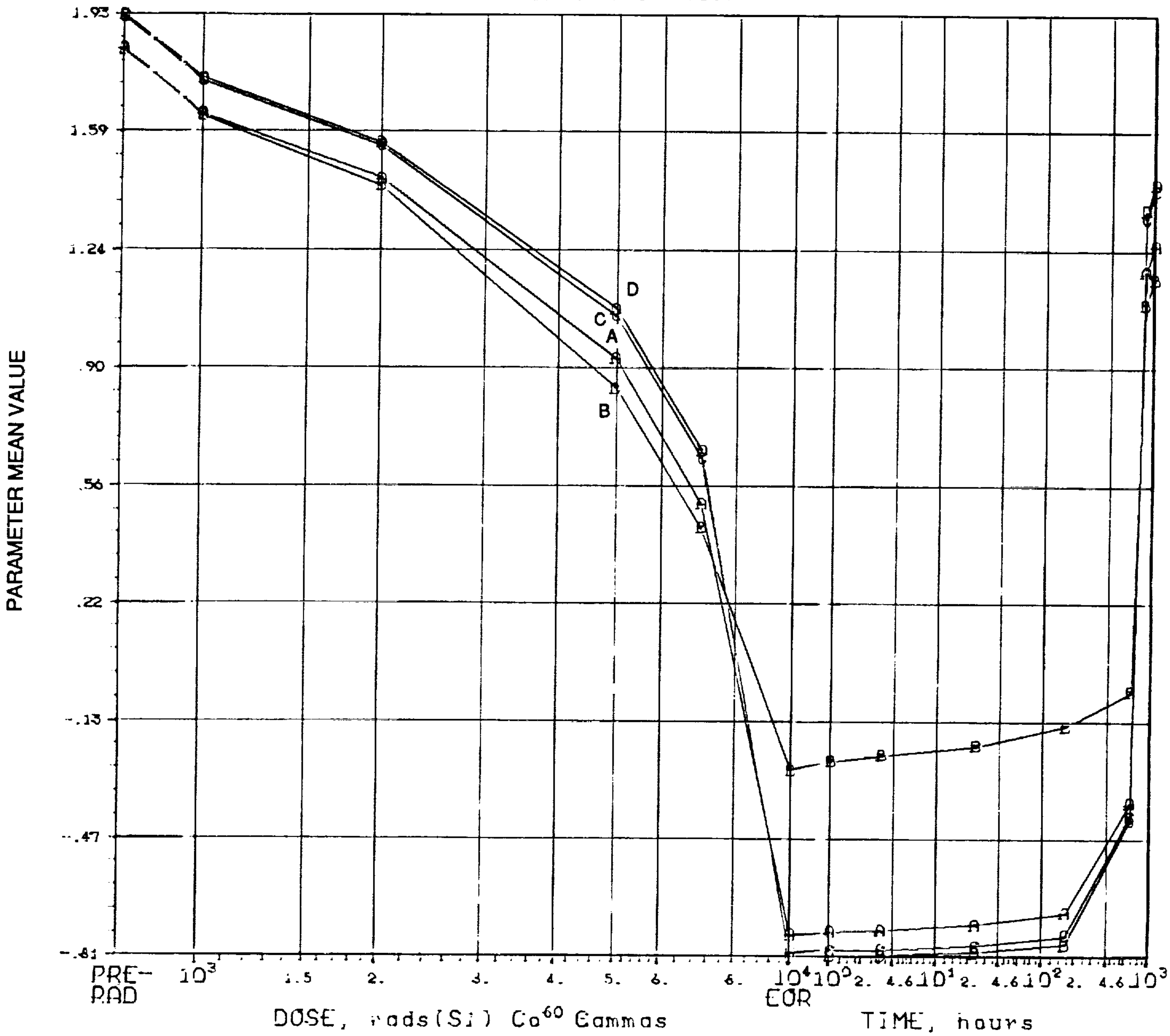
DEVICE TYPE: HCF4013 DUAL D-TYPE F/F
MFG: SGS 6 DEVICES TEST DATE 07-19-88
REF: JPL LOG 1360 DATE CODE 98814Y



1.0 rads/sec Dose Rate

PARAMETERS			
CURVE A:	(1)	IQH	(A)
CURVE B:	(2)	IQL	(A)

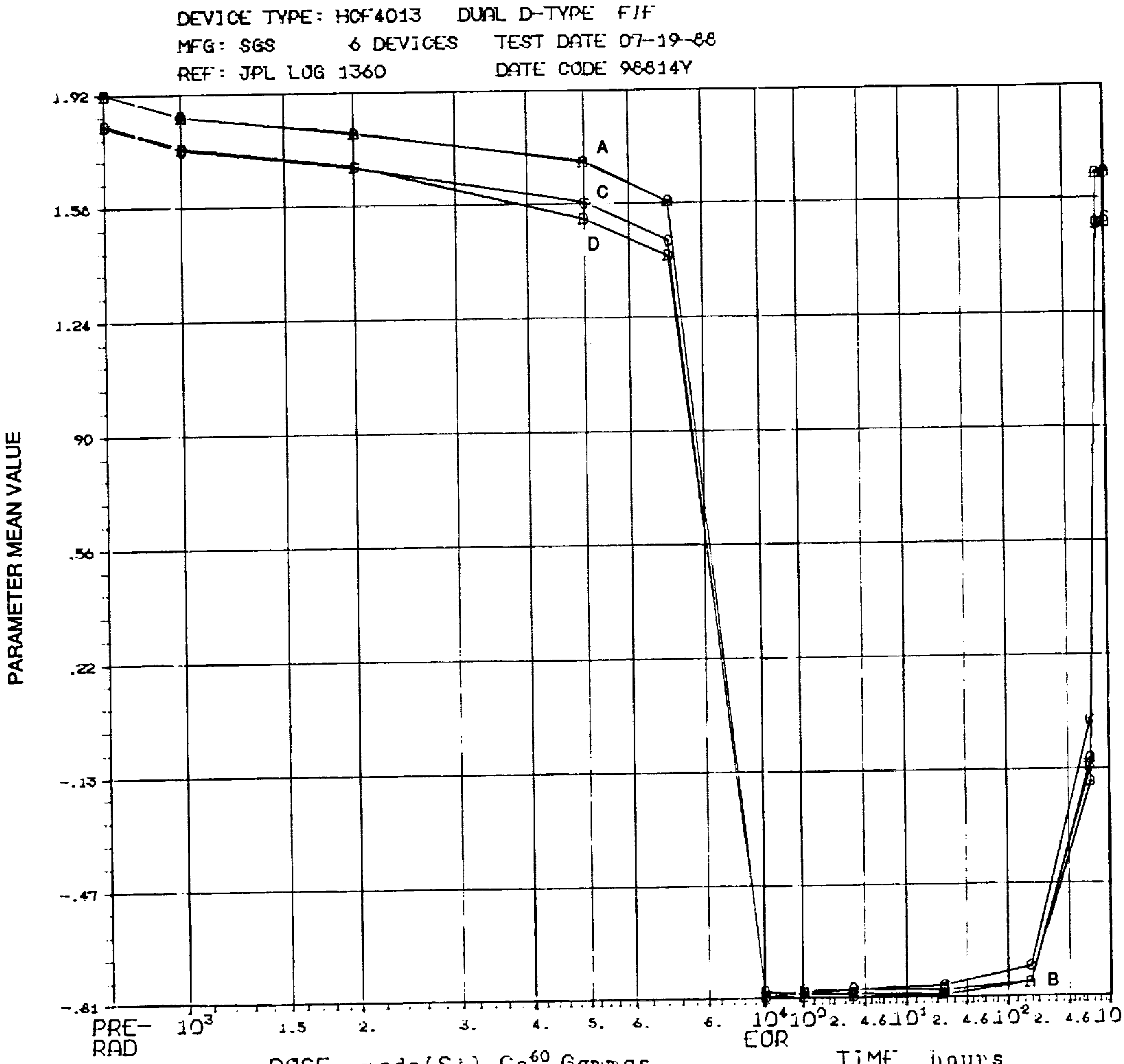
DEVICE TYPE: HCF4013 DUAL D-TYPE F/F
MFG: SGS 6 DEVICES TEST DATE 07-19-88
REF: JPL LOG 1360 DATE CODE 98814Y



1.0 rads/sec Dose Rate

PARAMETERS

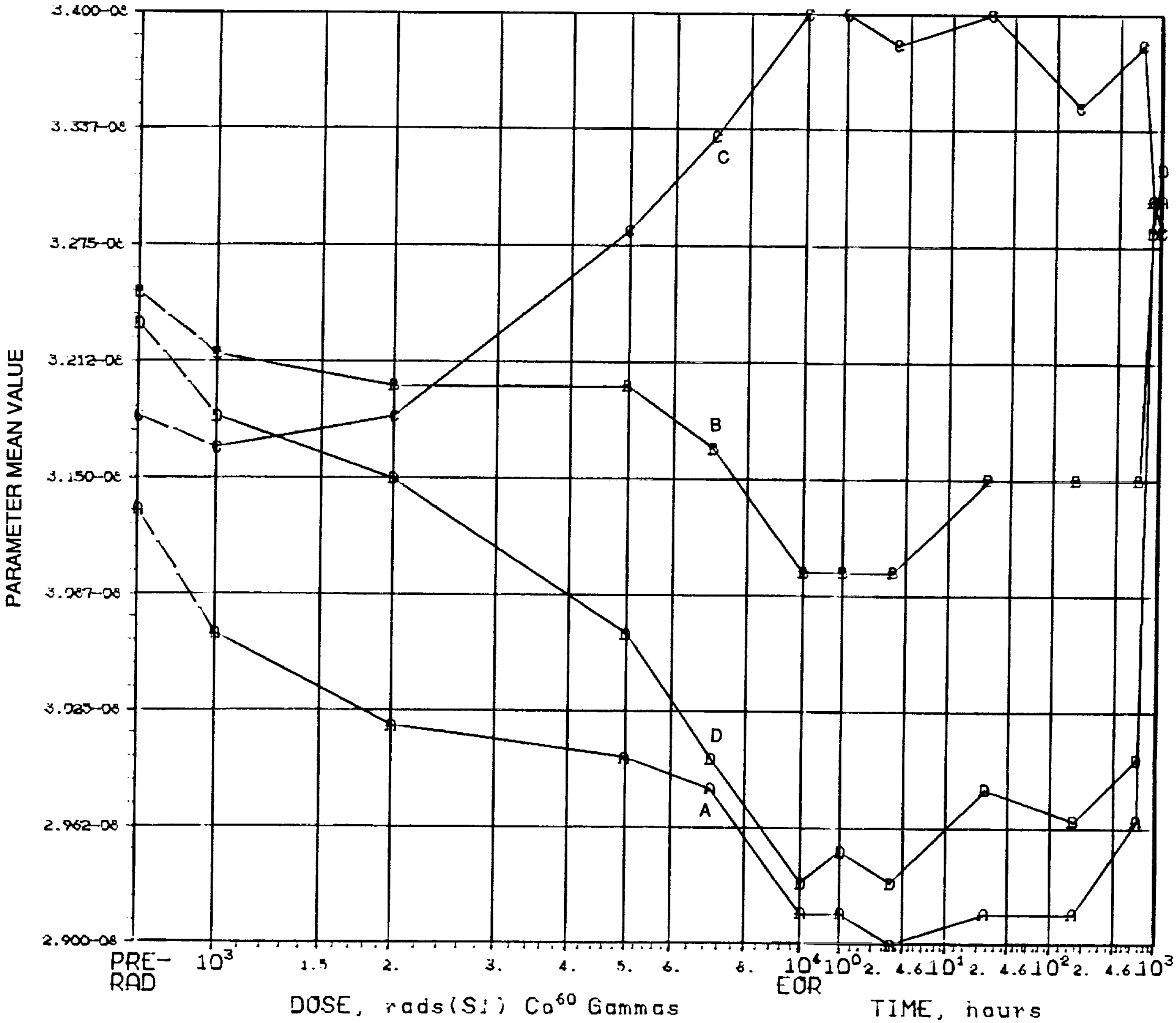
CURVE A:	(3)	VTN(3)--ON	(V)
CURVE B:	(5)	VTN(5)--ON	(V)
CURVE C:	(6)	VTN(6)--ON	(V)
CURVE D:	(9)	VTN(10)--ON	(V)



1.0 rads/sec Dose Rate

	PARAMETERS
CURVE A:	(4) VTN(4)--OFF (V)
CURVE B:	(7) VTN(8)--OFF (V)
CURVE C:	(8) VTN(9)--OFF (V)
CURVE D:	(10) VTN(11)--OFF (V)

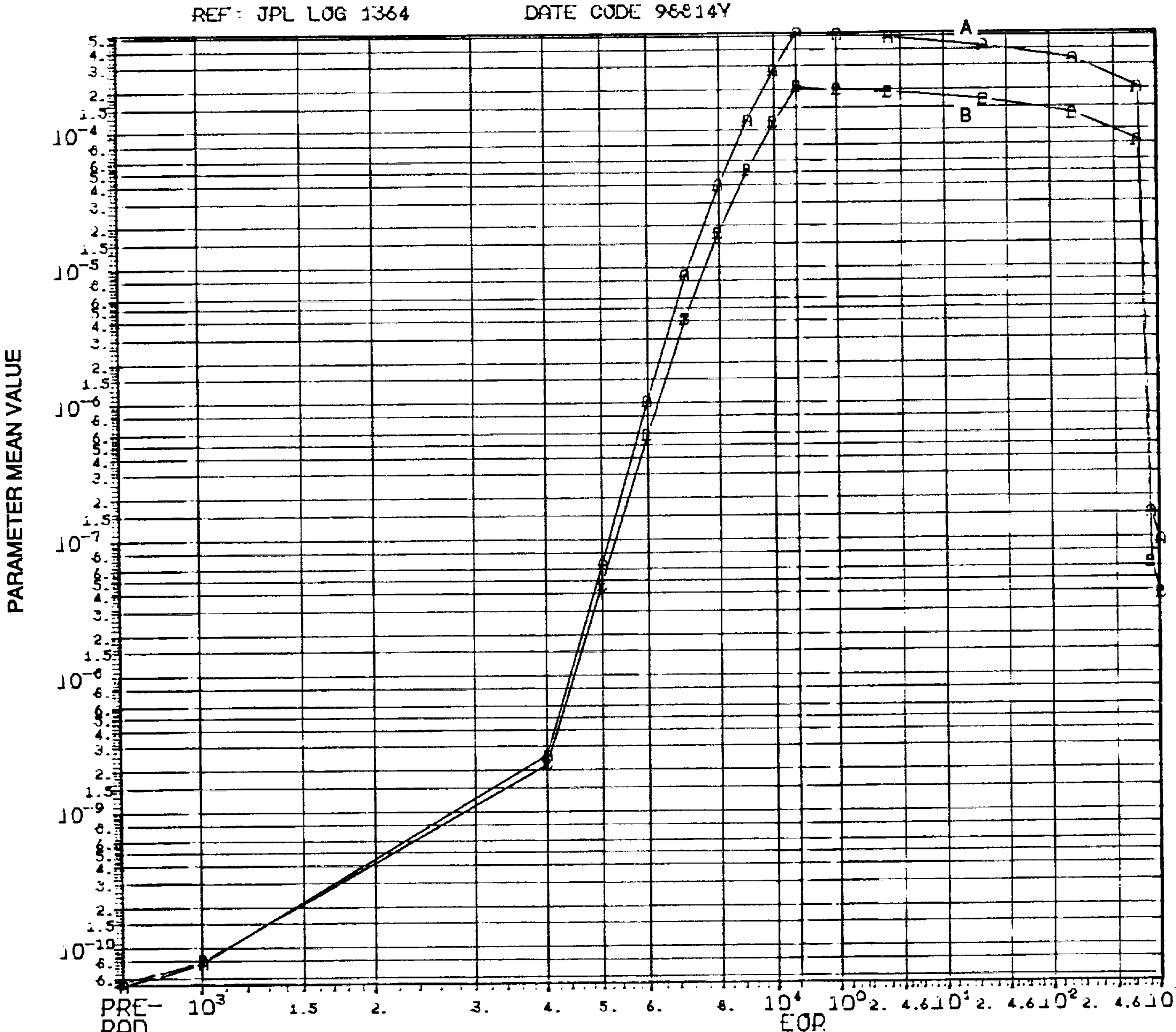
DEVICE TYPE: HCF4013 DUAL D-TYPE F/F
MFG: SGS 6 DEVICES TEST DATE 07-19-88
REF: JPL LOG 1360 DATE CODE 98814Y



1.0 rads/sec Dose Rate

	PARAMETERS
CURVE A:	(19) TPLHQ1 (S)
CURVE B:	(20) TPHLQ1 (S)
CURVE C:	(21) TPLHQ2 (S)
CURVE D:	(22) TPHLQ2 (S)

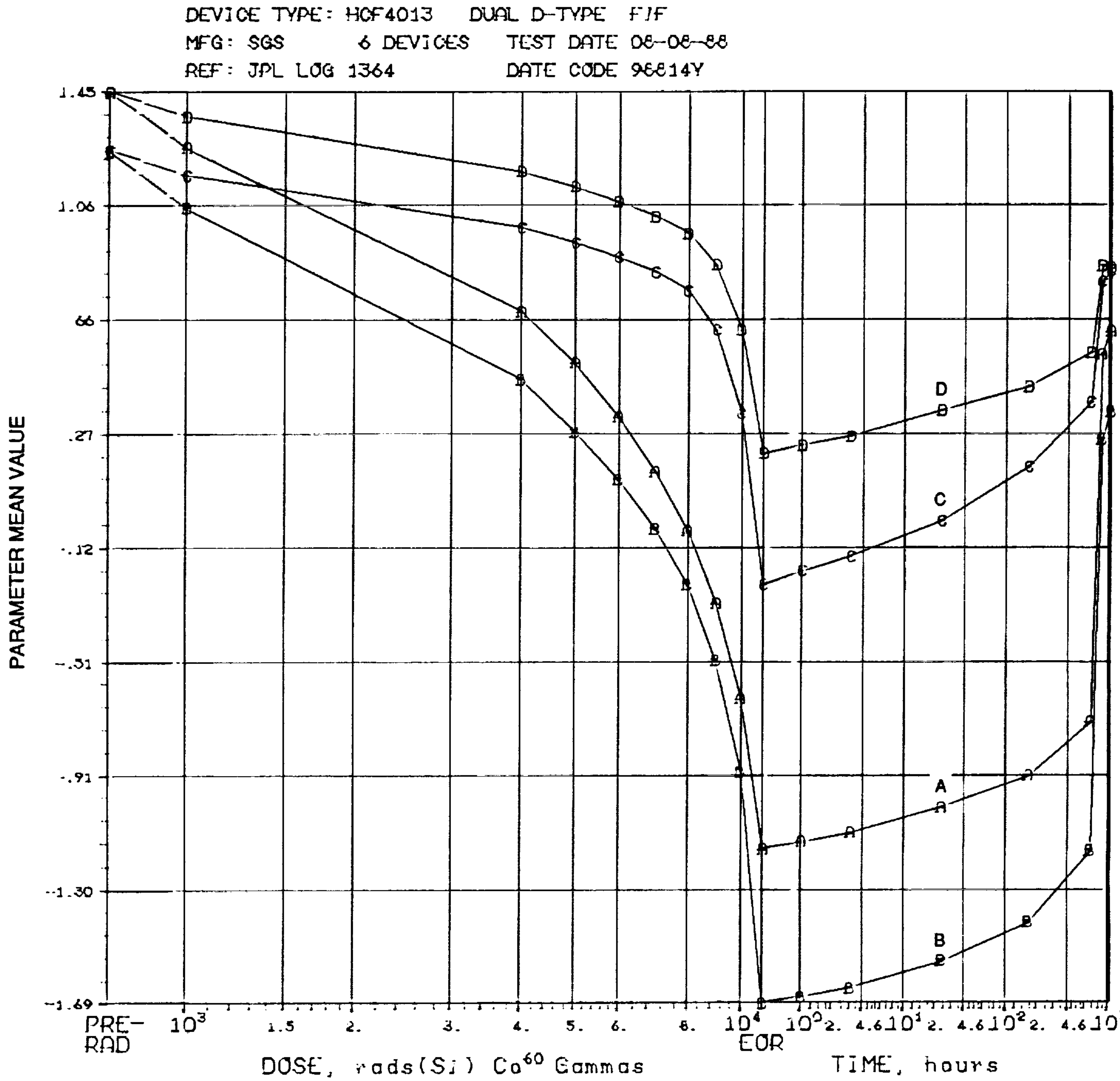
DEVICE TYPE: HCF4013 DUAL D-TYPE F/F
MFG: SGS 6 DEVICES TEST DATE 08-08-88
REF: JPL LOG 1364 DATE CODE 98814Y



0.5 rads/sec Dose Rate

PARAMETERS

CURVE A:	(1)	IQH	(A)
CURVE B:	(2)	IQL	(A)

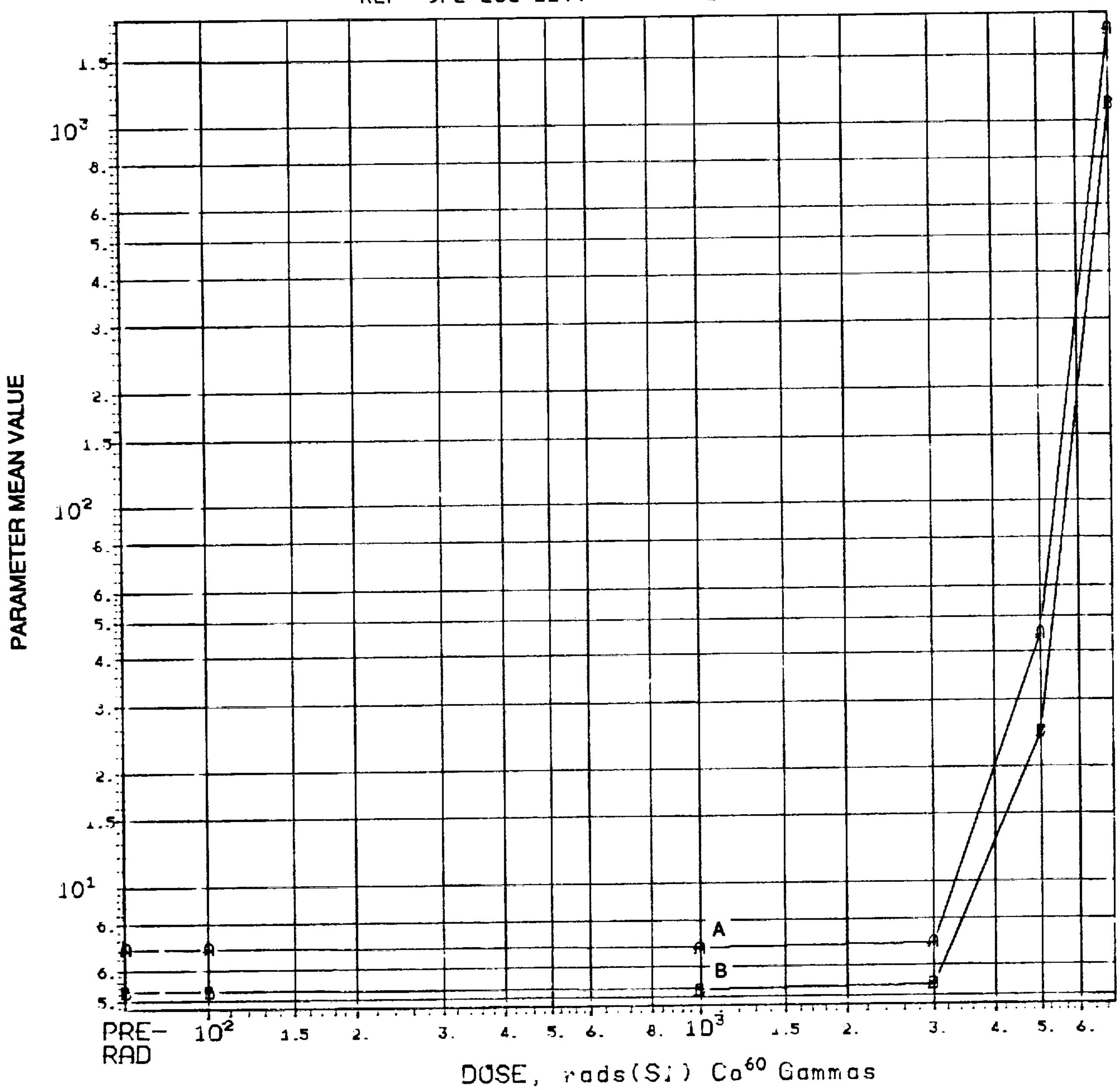


0.5 rads/sec Dose Rate

PARAMETERS

CURVE A:	(3)	VTN(3)-ON	(V)
CURVE B:	(4)	VTN(6)-ON	(V)
CURVE C:	(5)	VTN(8)-OFF	(V)
CURVE D:	(6)	VTN(11)-OFF	(V)

DEVICE TYPE: HCF4013BE DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 9-25-86
REF: JPL LOG 1177 DATE CODE 352Y



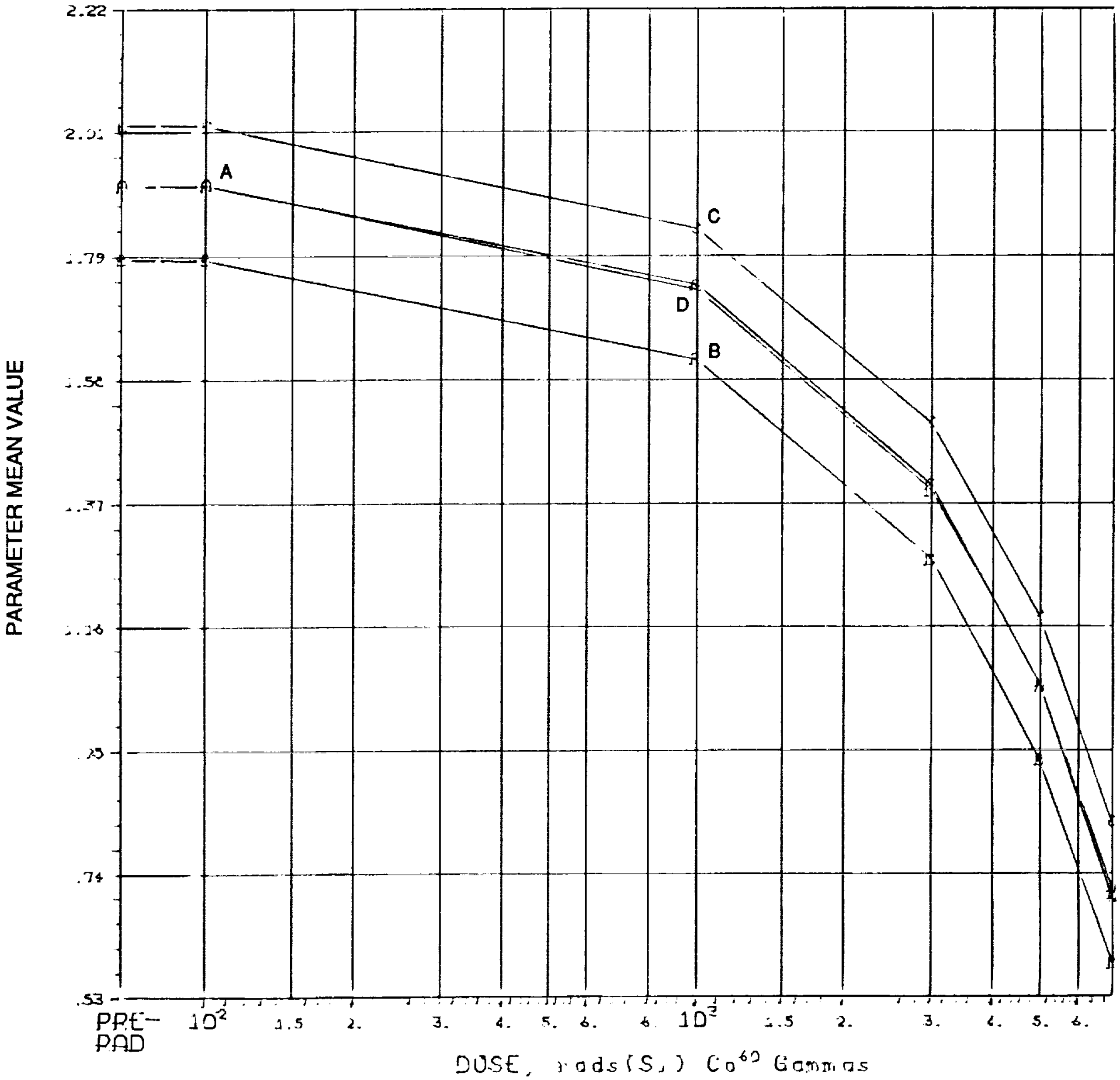
PARAMETERS

CURVE A: (1)IQH(NA)
CURVE B: (2)IQL(NA)

DEVICE TYPE: HCF4013BE DUAL D F/F

MFG: SGS 5 DEVICES TEST DATE 9-25-86

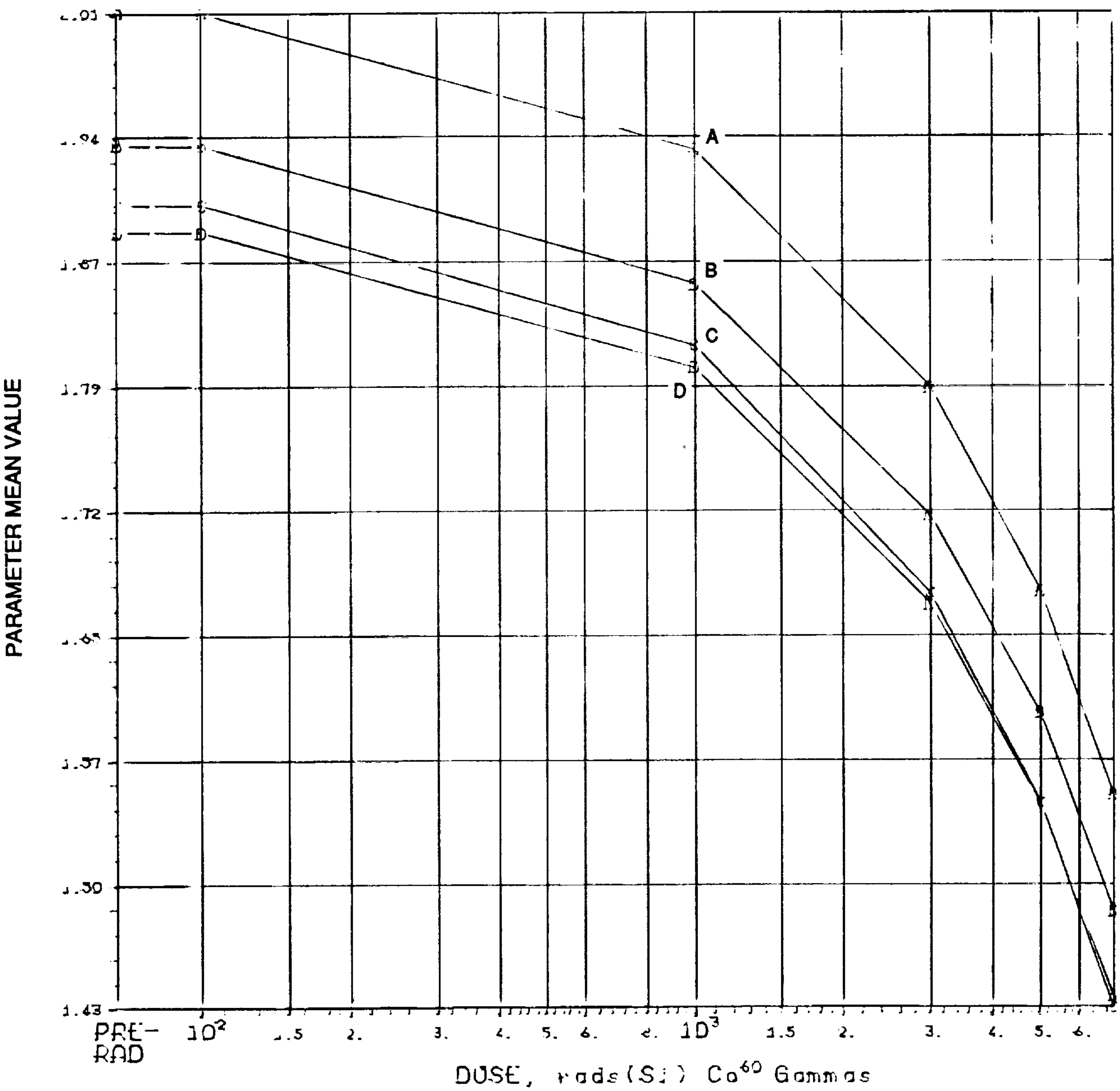
REF: JPL LOG 1177 DATE CODE 352Y



PARAMETERS

CURVE A:	(3)	VTN3-ON	(V)
CURVE B:	(5)	VTN5-ON	(V)
CURVE C:	(6)	VTN6-ON	(V)
CURVE D:	(9)	VTN10-ON	(V)

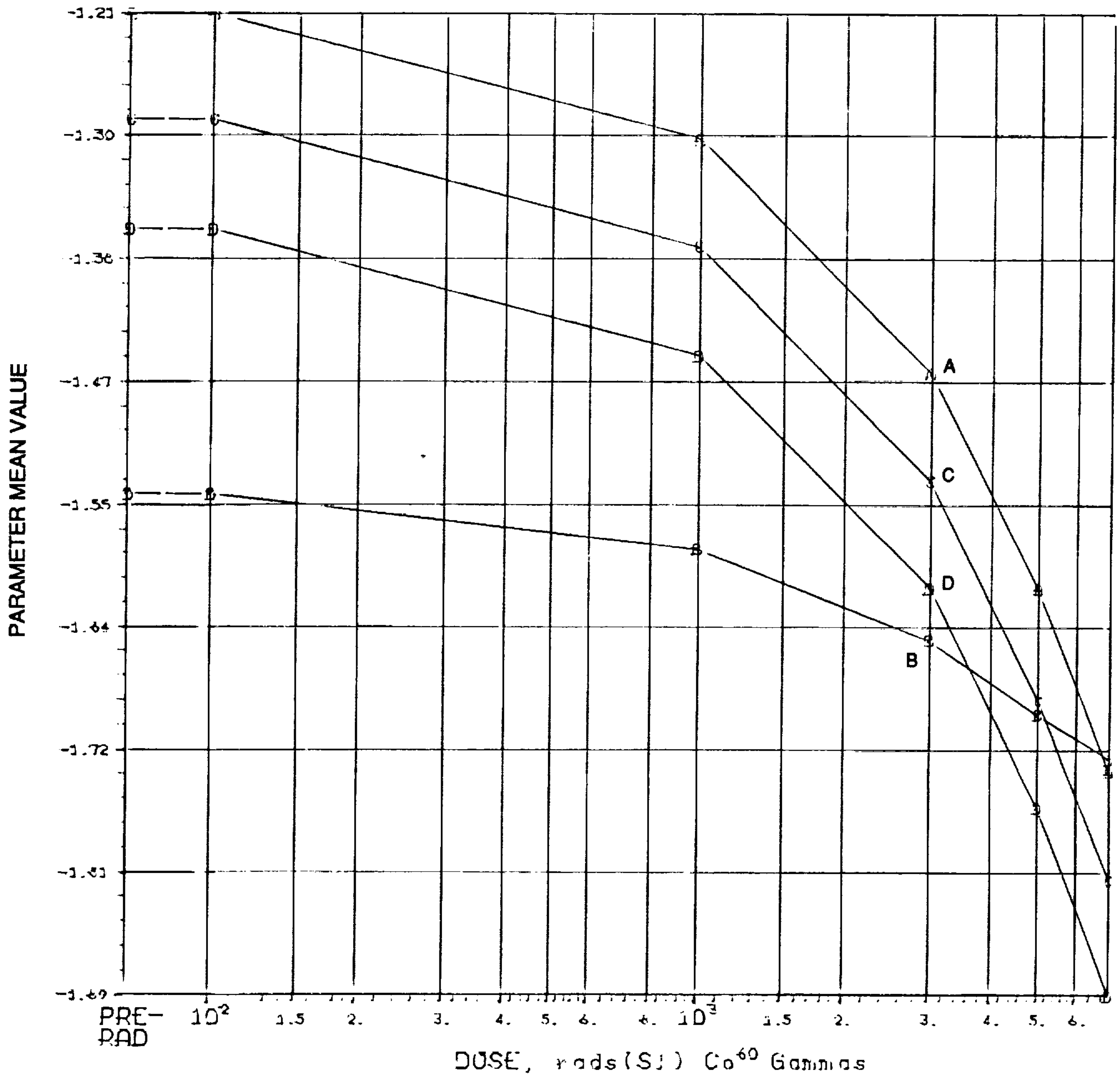
DEVICE TYPE: HCF4013BE DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 9-25-86
REF: JPL LOG 1177 DATE CODE 352Y



PARAMETERS

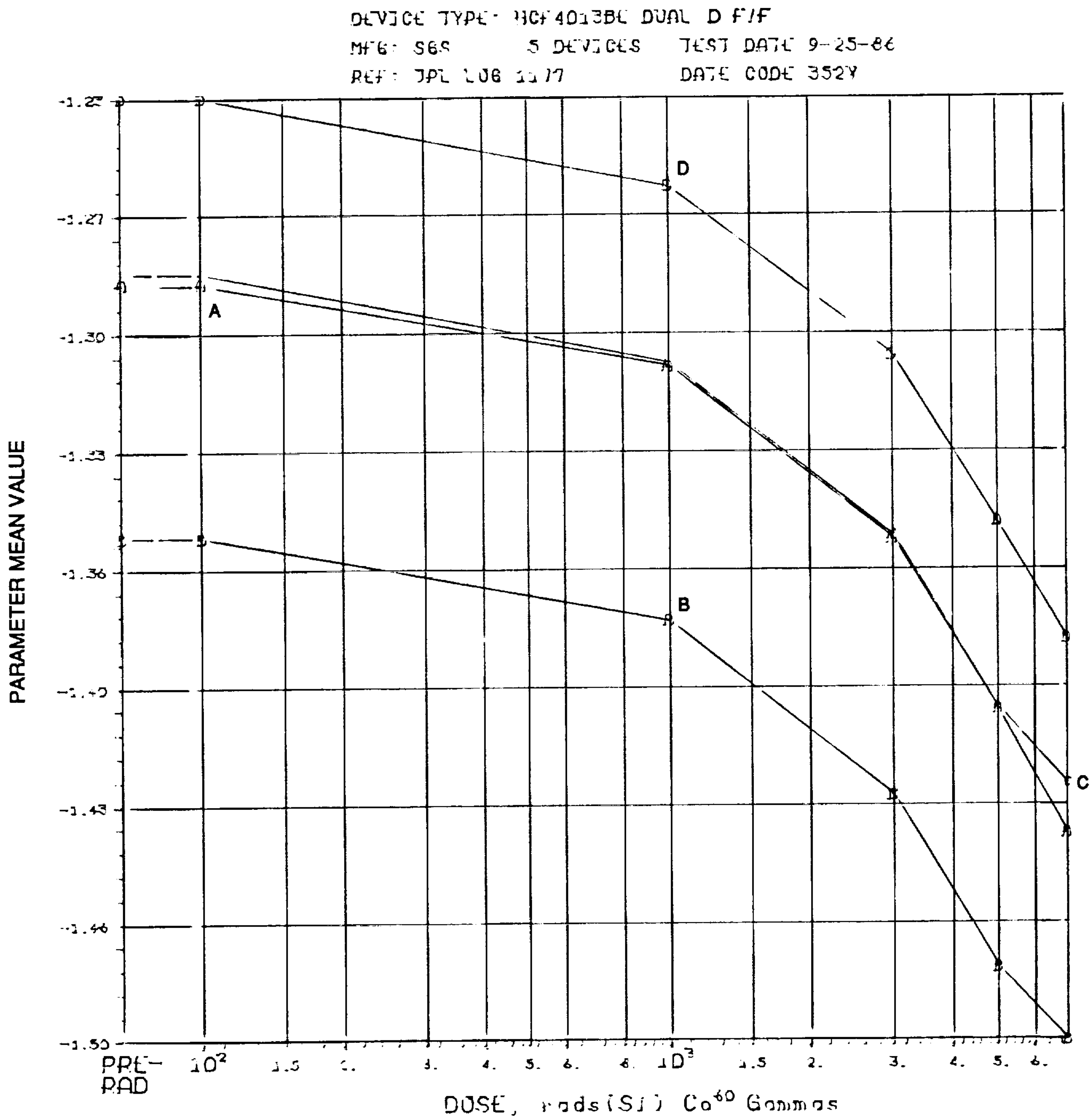
CURVE A:	(4) VTN4-OFF	(V)
CURVE B:	(7) VTN8-OFF	(V)
CURVE C:	(8) VTN9-OFF	(V)
CURVE D:	(10) VTN11-OFF	(V)

DEVICE TYPE: HCF4013BE DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 9-25-86
REF: JPL LOG 1177 DATE CODE 352Y



PARAMETERS

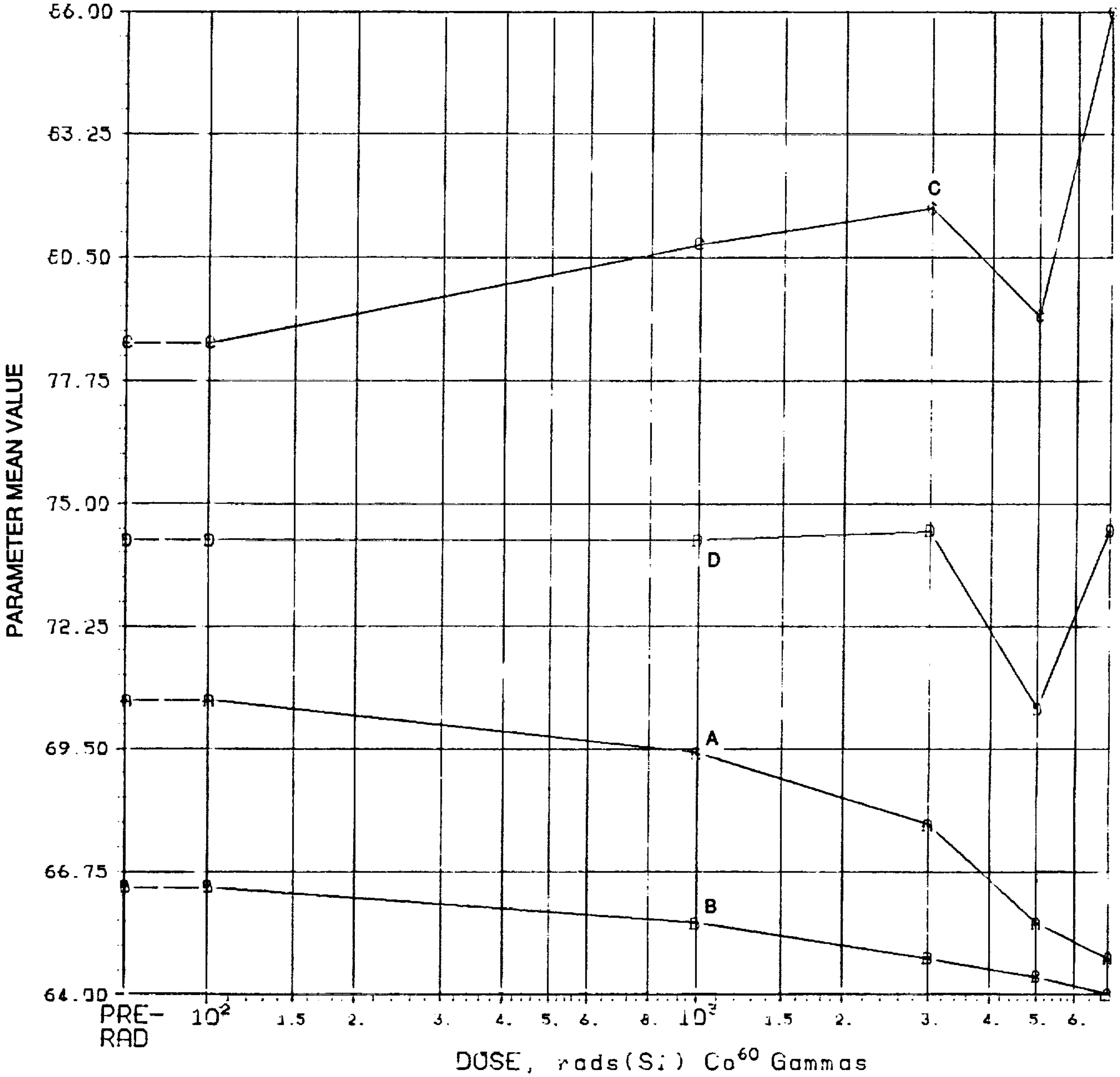
CURVE A:	(11) VTP3-OFF (V)
CURVE B:	(13) VTP5-OFF (V)
CURVE C:	(14) VTP6-OFF (V)
CURVE D:	(17) VTP10-OFF (V)



PARAMETERS

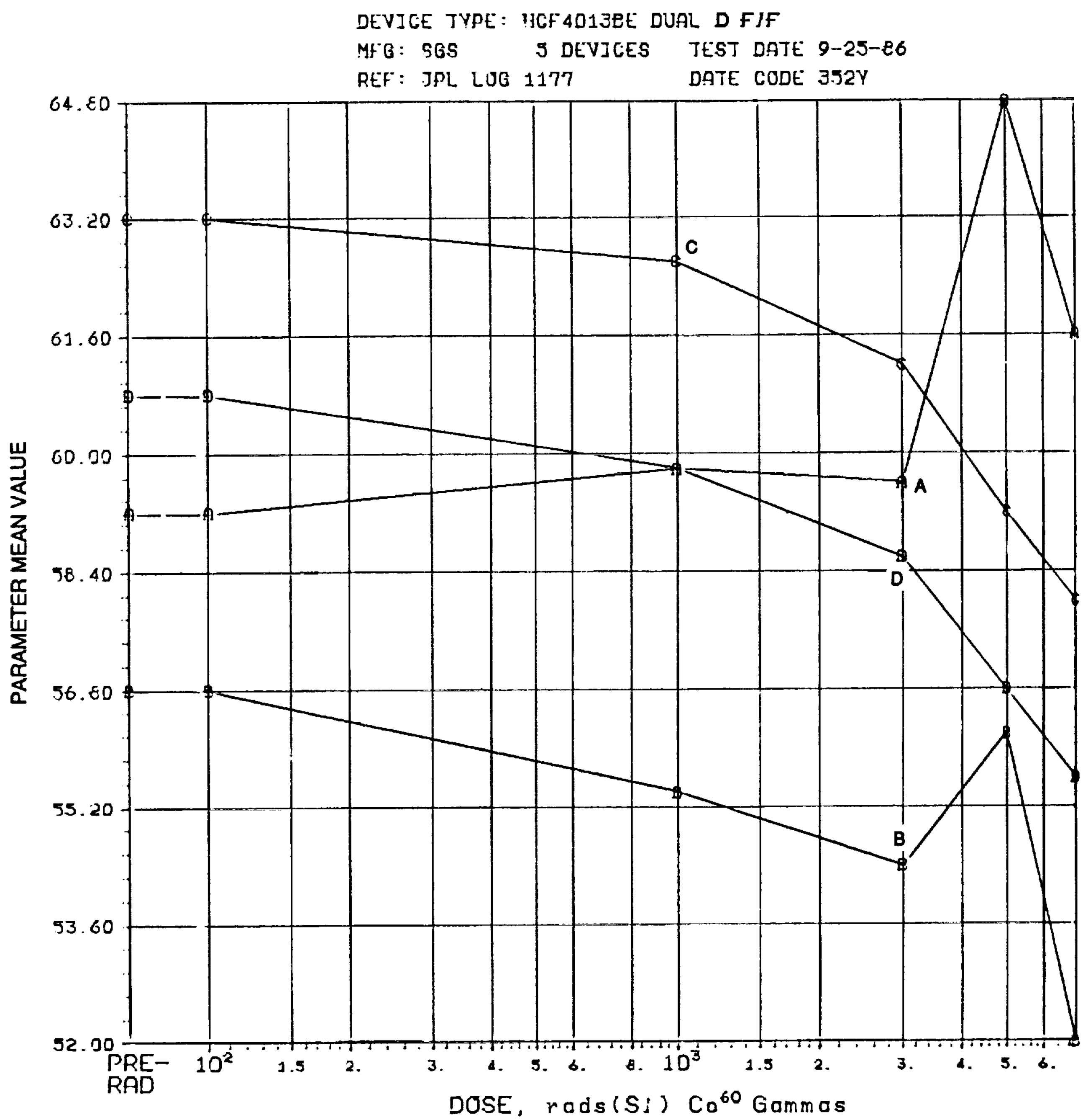
CURVE A:	(12)	VTP4-ON	(V)
CURVE B:	(15)	VTP6-ON	(V)
CURVE C:	(16)	VTP9-ON	(V)
CURVE D:	(18)	VTP11-ON	(V)

DEVICE TYPE: HCF4013BE DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 9-25-86
REF: JPL LOG 1177 DATE CODE 352Y



PARAMETERS

CURVE A: (19)TF1(NS)
CURVE B: (20)TF2(NS)
CURVE C: (21)TR1(NS)
CURVE D: (22)TR2(NS)



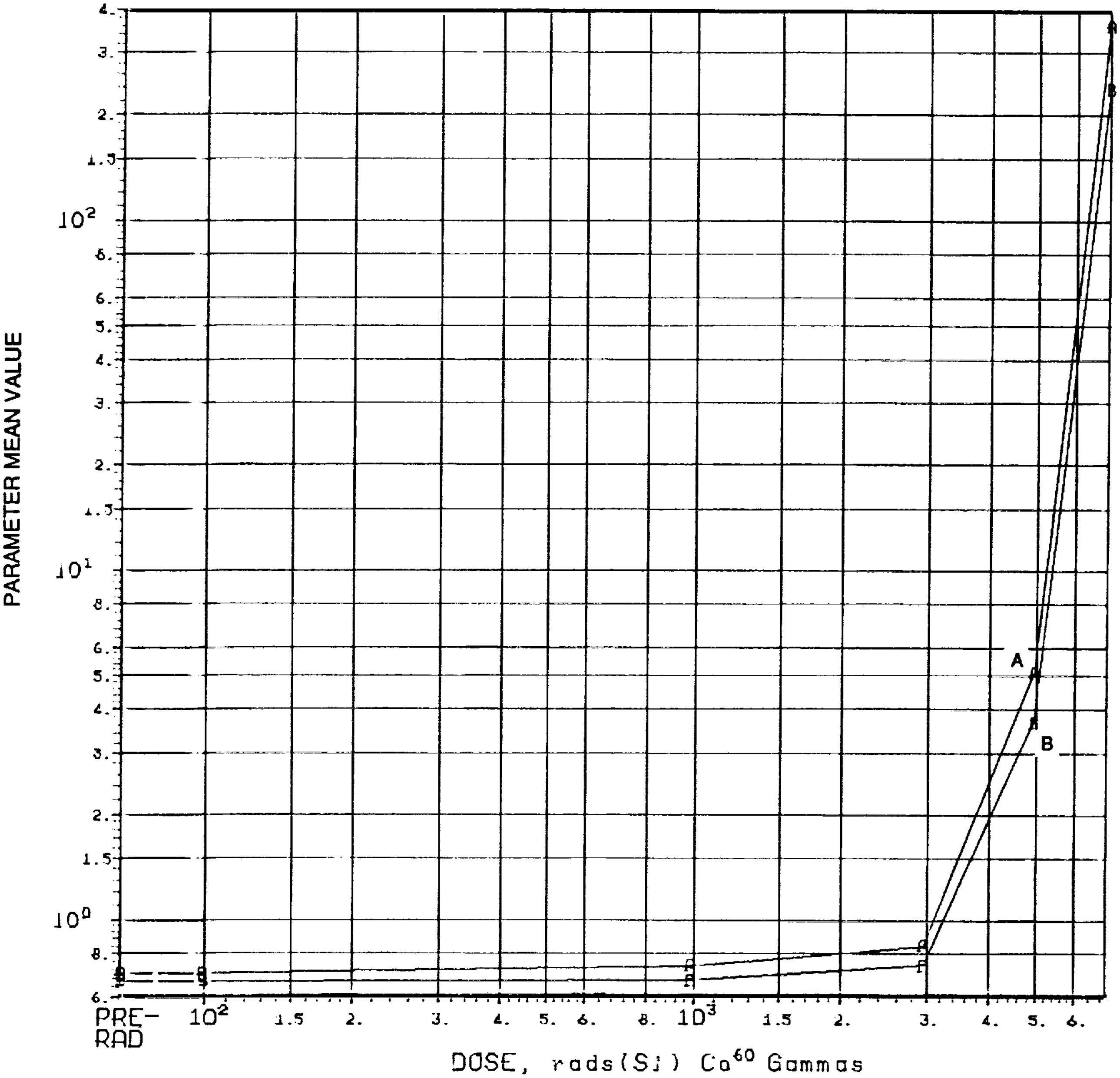
PARAMETERS

CURVE A: (23)TPLH1(NS)
CURVE B: (24)TPLH2(NS)
CURVE C: (25)TPHL1(NS)
CURVE D: (26)TPHL2(NS)

DEVICE TYPE: HCF4013BE DUAL D F/F

MFG: SGS 5 DEVICES TEST DATE 9-25-86

REF: JPL LOG 1178 DATE CODE 352Y

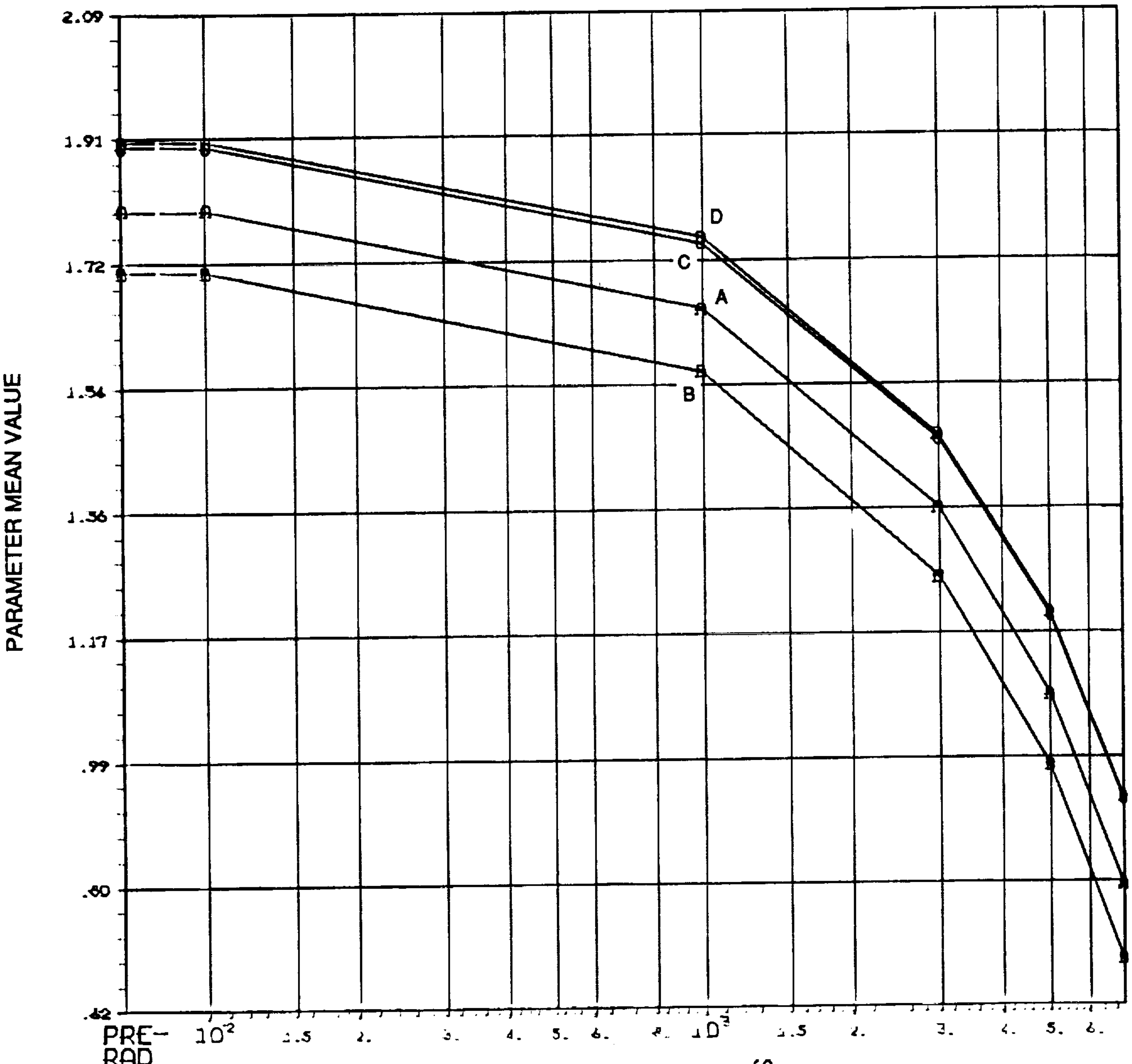


PARAMETERS

CURVE A: (1)IQH(NA)

CURVE B: (2)IQL(NA)

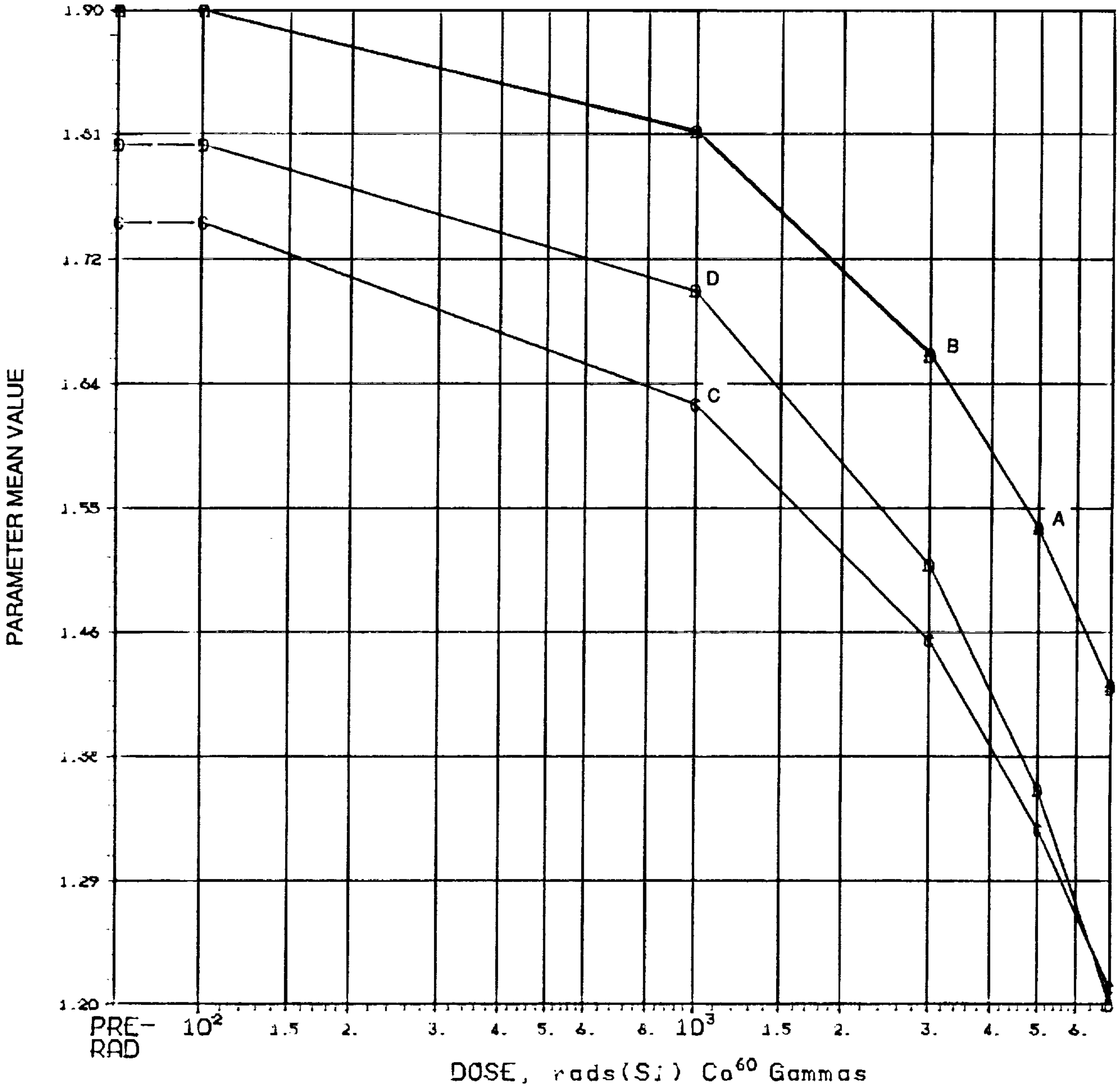
DEVICE TYPE: HCF4013BE DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 9-25-86
REF: JPL LOG 1178 DATE CODE 352Y



PARAMETERS

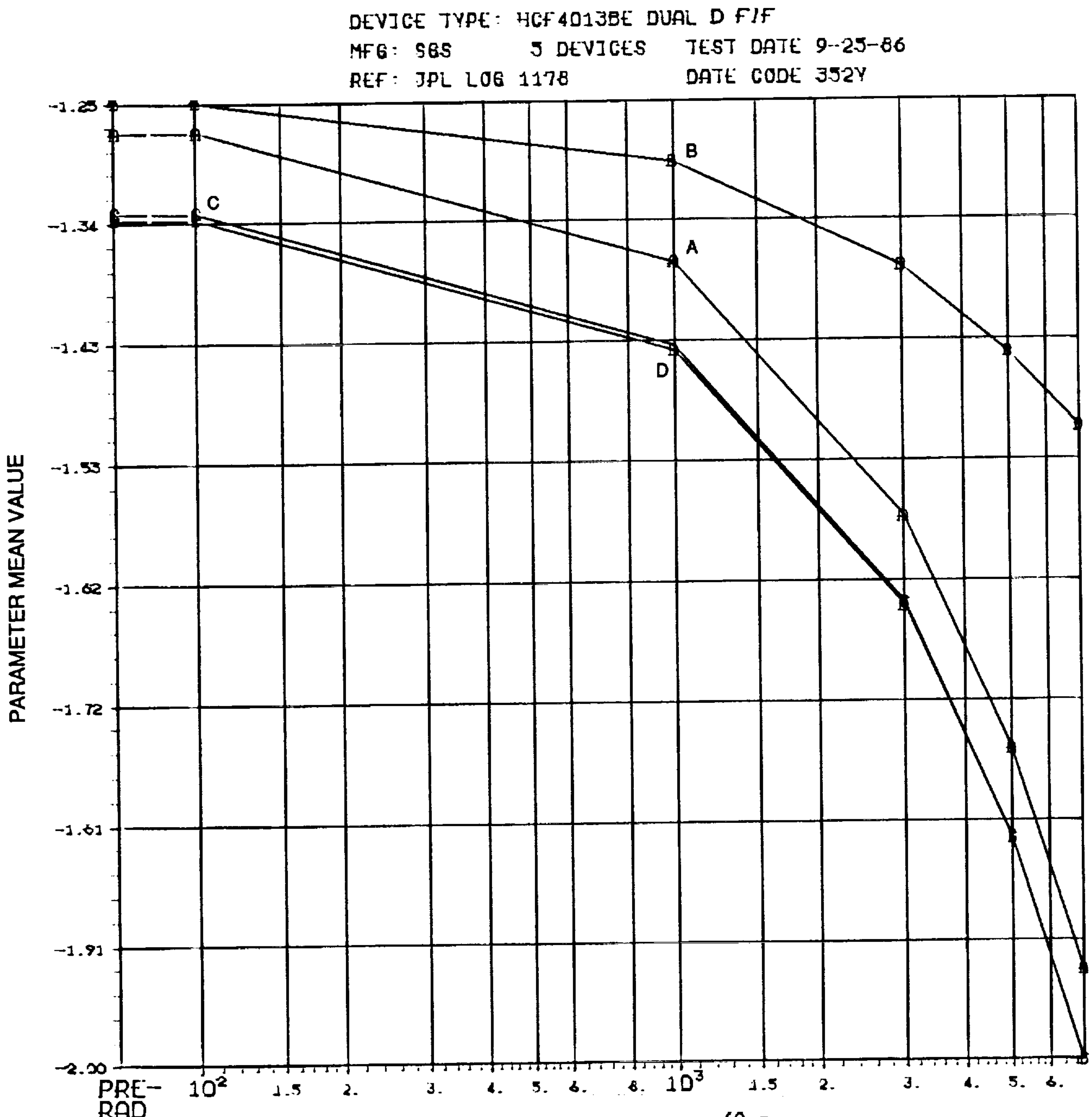
CURVE A:	(3) VTN3-ON	(V)
CURVE B:	(5) VTN5-ON	(V)
CURVE C:	(6) VTN6-ON	(V)
CURVE D:	(9) VTN10-ON	(V)

DEVICE TYPE: HCF4013BE DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 9-25-86
REF: JPL LOG 1178 DATE CODE 352Y



PARAMETERS

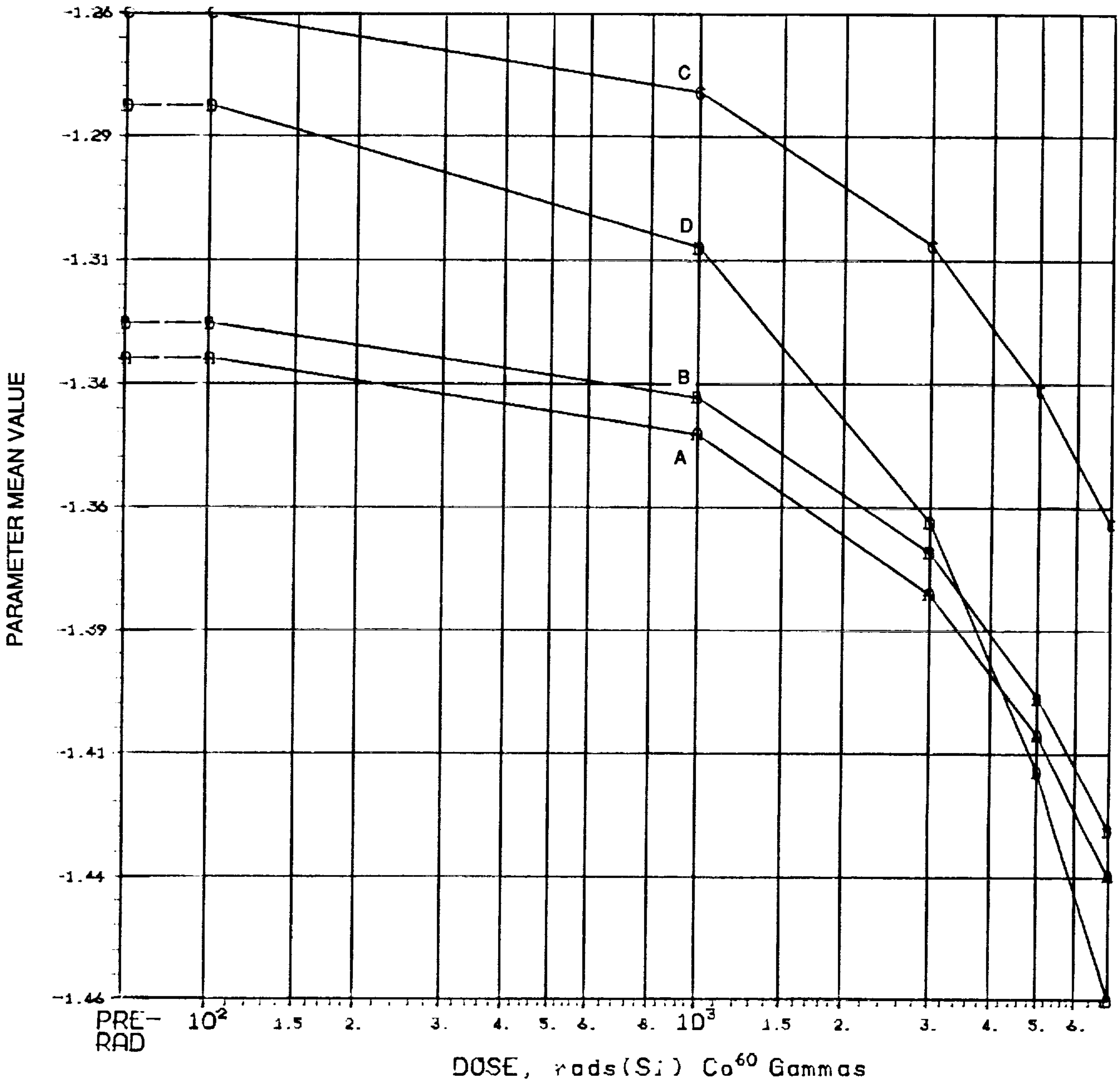
CURVE A:	(4) VTN4-OFF (V)
CURVE B:	(7) VTN8-OFF (V)
CURVE C:	(8) VTN9-OFF (V)
CURVE D:	(10) VTN11-OFF (V)



PARAMETERS

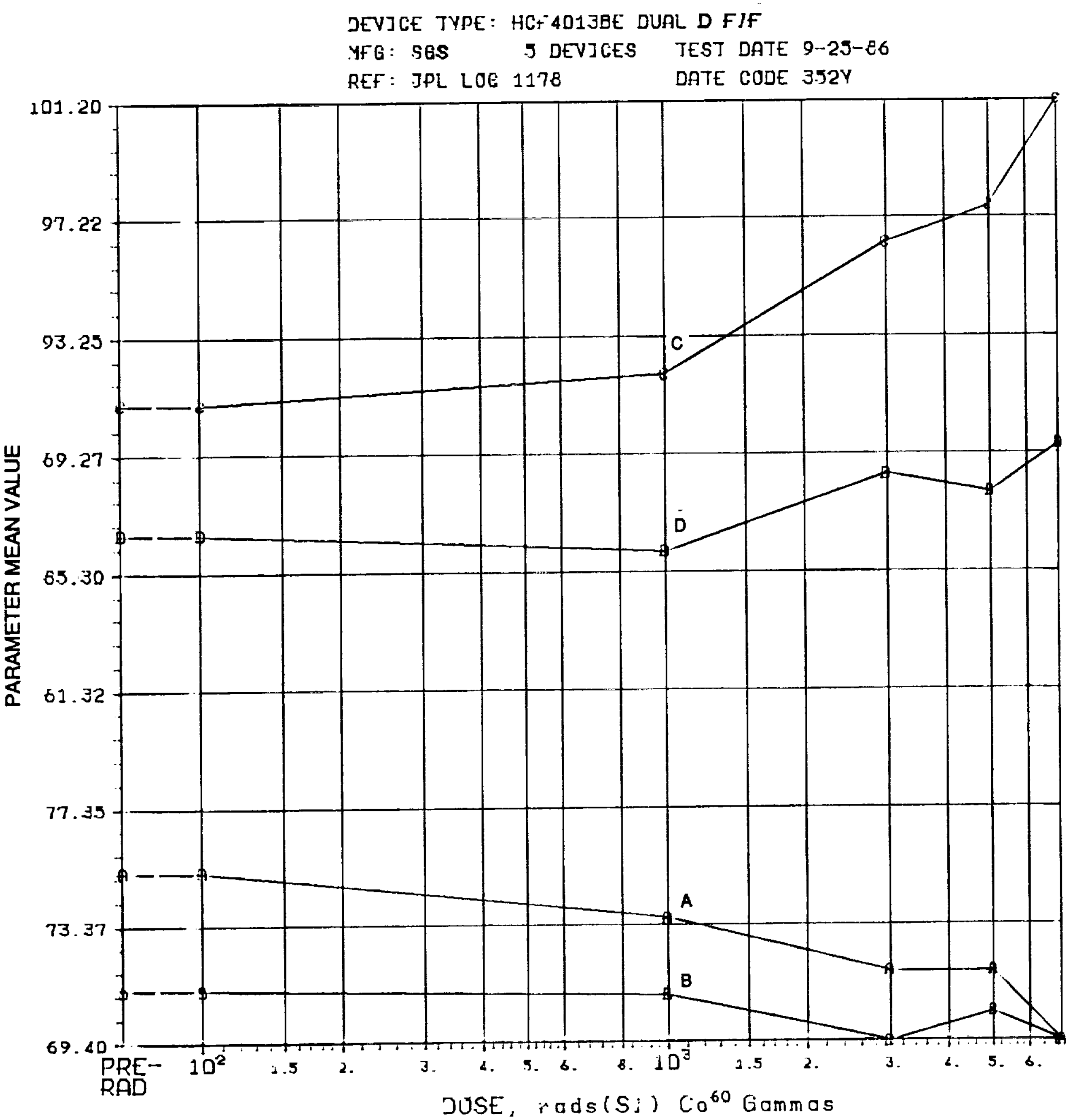
CURVE A: (11) VTP3-OFF (V)
CURVE B: (13) VTP5-OFF (V)
CURVE C: (14) VTP6-OFF (V)
CURVE D: (17) VTP10-OFF (V)

DEVICE TYPE: HCF4013BE DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 9-25-86
REF: JPL LOG 1178 DATE CODE 352Y



PARAMETERS

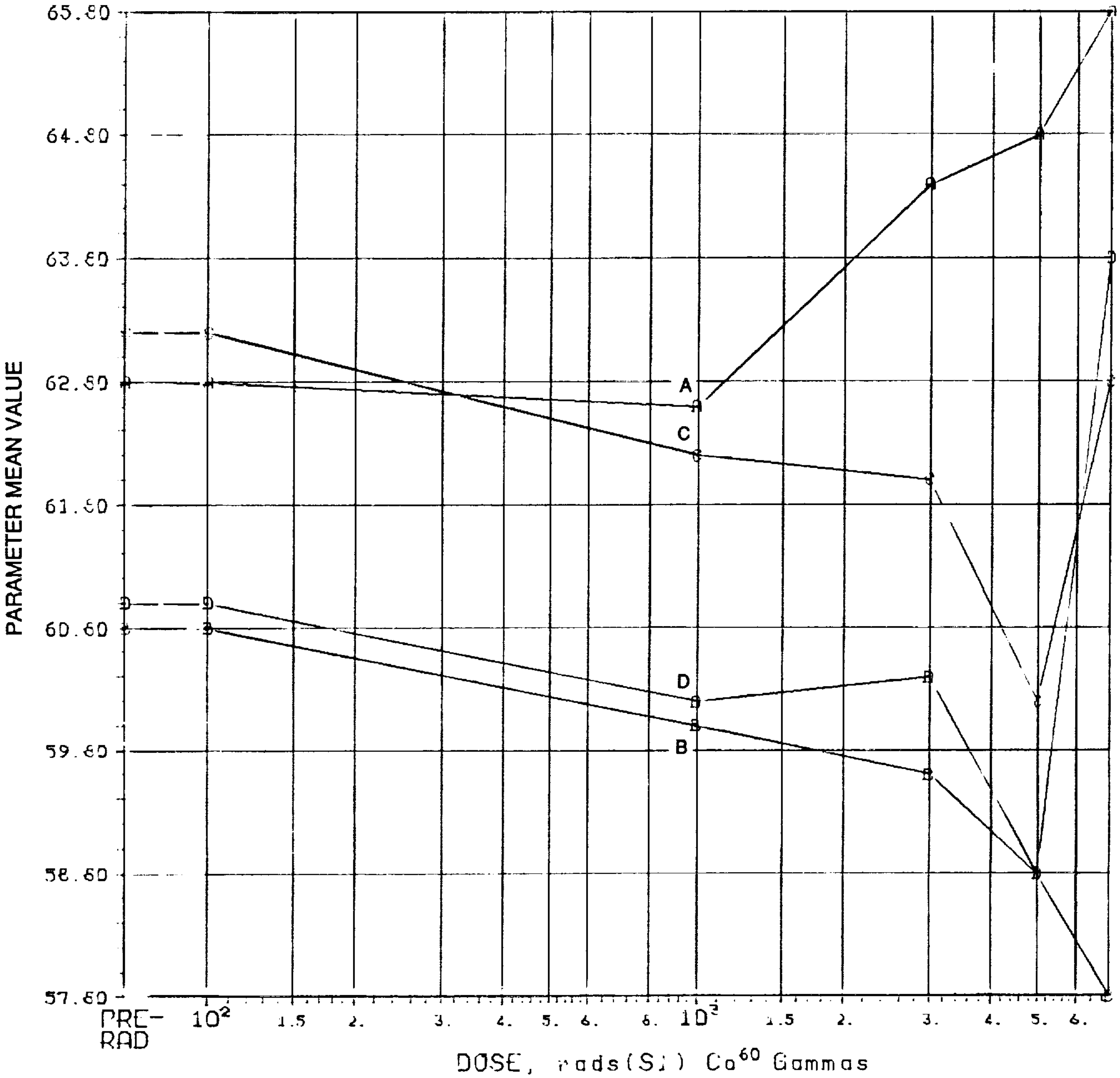
CURVE A:	(12) VTP4-ON	(V)
CURVE B:	(15) VTP8-ON	(V)
CURVE C:	(16) VTP9-ON	(V)
CURVE D:	(18) VTP11-ON	(V)



PARAMETERS

CURVE A: (19)TF1(NS)
CURVE B: (20)TF2(NS)
CURVE C: (21)TR1(NS)
CURVE D: (22)TR2(NS)

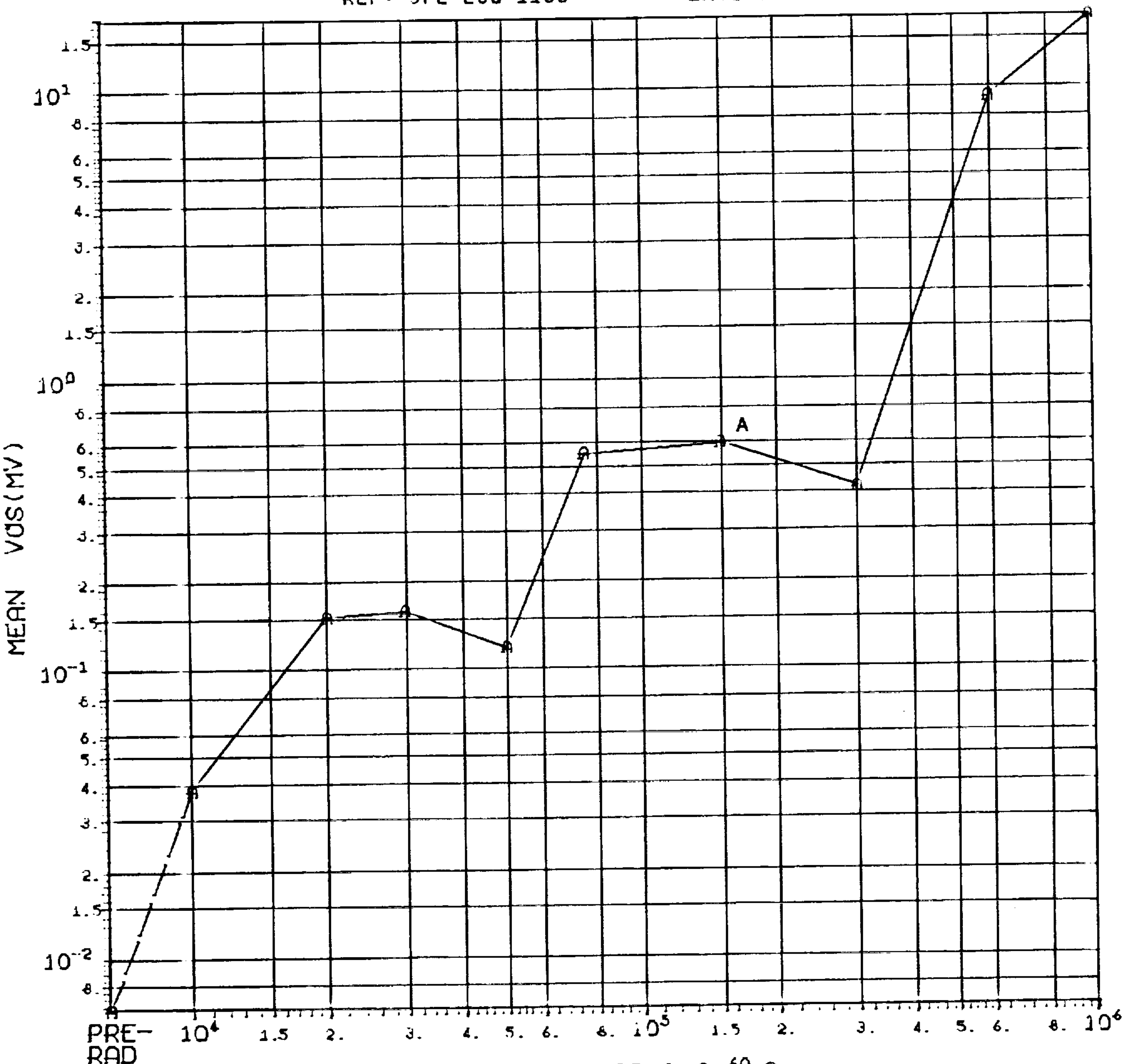
DEVICE TYPE: HCF4013BE DUAL D F/F
MFG: SGS 5 DEVICES TEST DATE 9-25-86
REF: JPL LOG 1178 DATE CODE 352Y



PARAMETERS

CURVE A: (23)TPLA1(NS)
CURVE B: 24)TPLA2(NS)
CURVE C: (25)TPHL1(NS)
CURVE D: (26)TPHL2(NS)

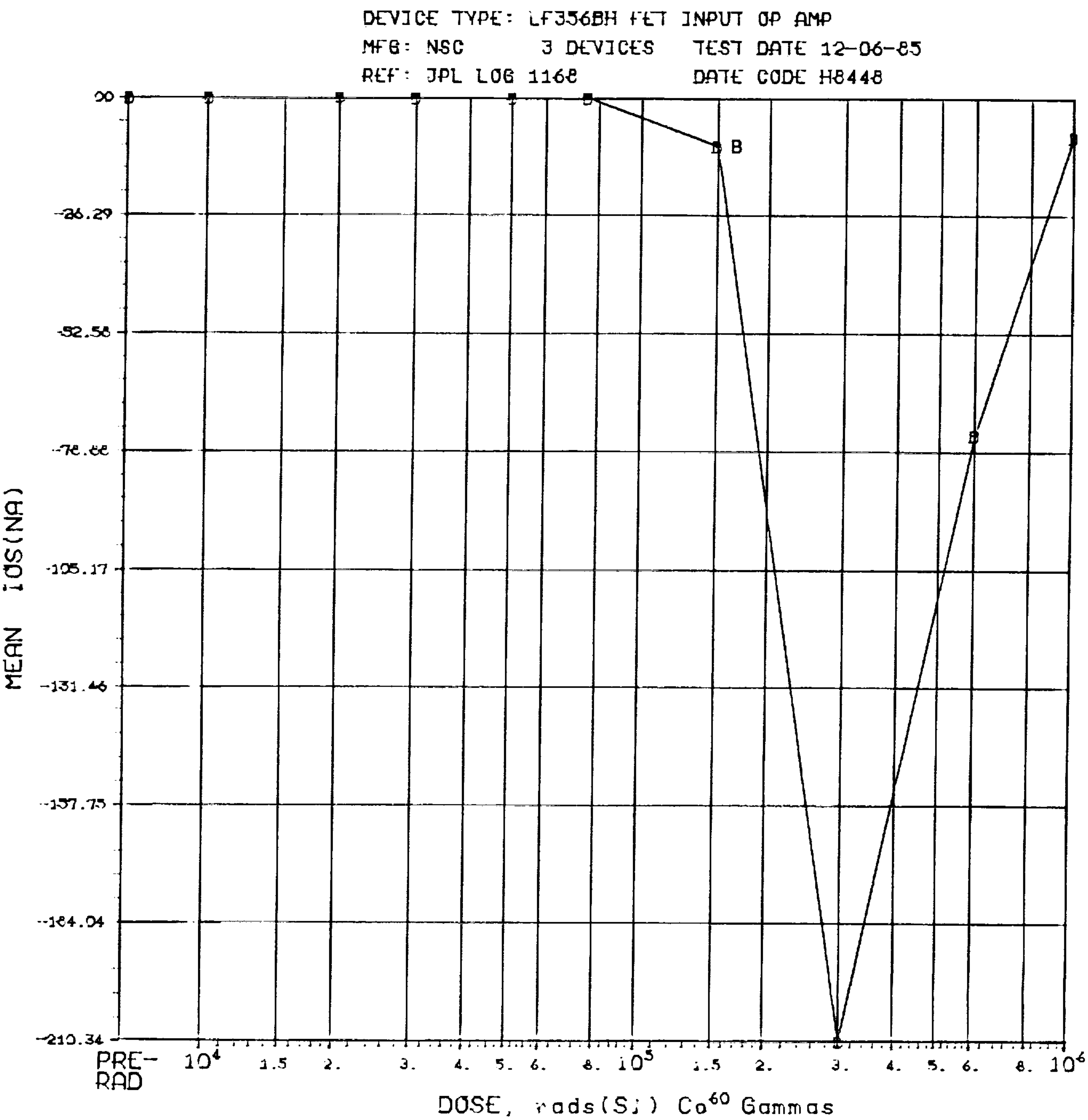
DEVICE TYPE: LF356BH FET INPUT OP AMP
MFG: NSC 3 DEVICES TEST DATE 12-06-85
REF: JPL LOG 1168 DATE CODE H8448



(1) VOS (RS=50 OHMS) IN MV: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS										
CURVE	DOSE, rads(Si)									
DOSE	0.0E0	1.0E4	2.0E4	3.0E4	5.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
STD. DEV.	1.200	1.237	1.220	1.188	.9932	1.011	.6604	1.177	3.646	13.69

INITIAL MEAN VALUE VOS(MV) = -6.63×10^{-3}

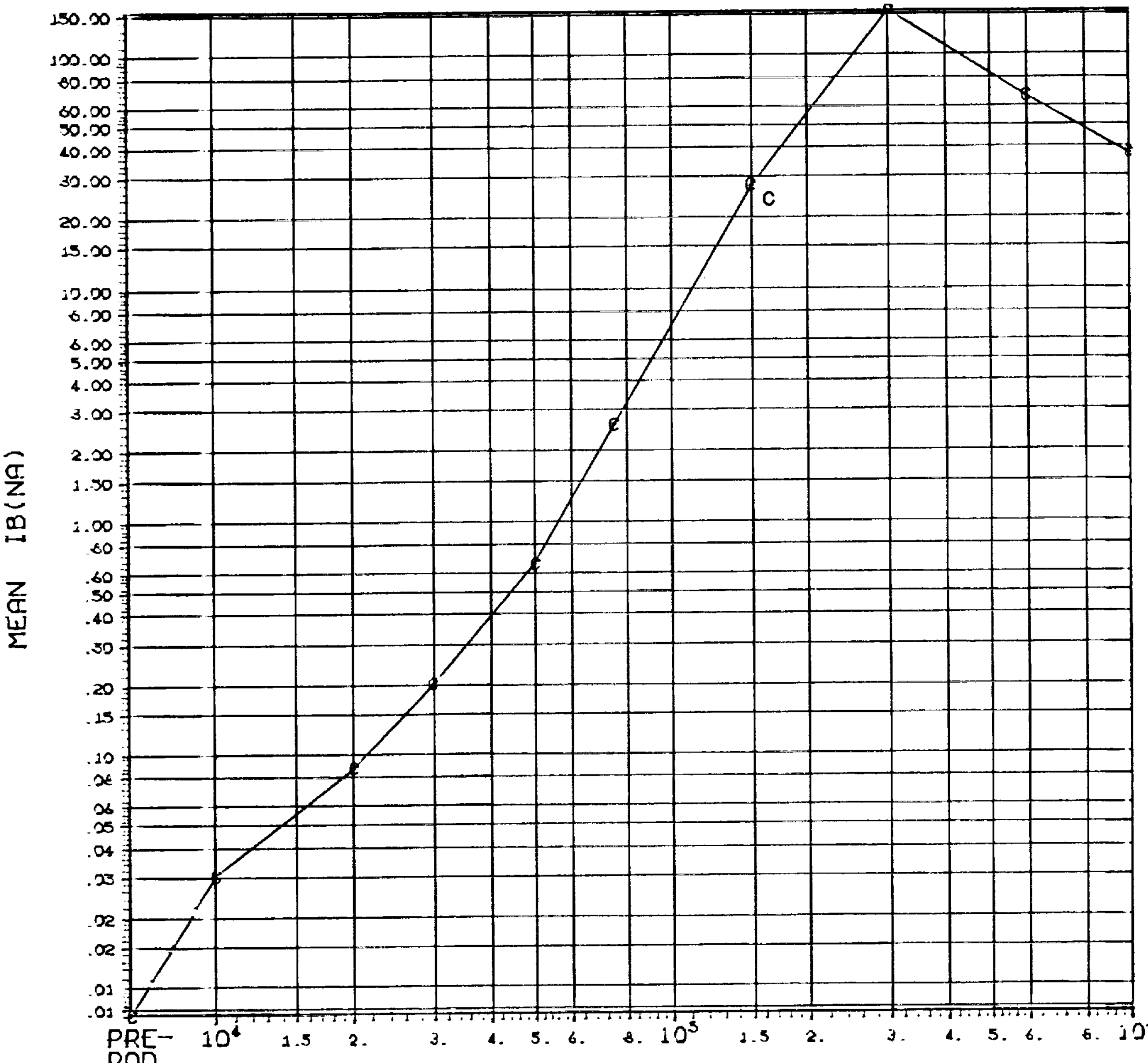


(2) IOS (VOUT=0V) IN NA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS										
CURVE	DOSE, rads(Si)									
DOSE	0.0E0	1.0E4	2.0E4	3.0E4	5.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
STD. DEV.	.0007	.0006	.0042	.0145	.0185	.0943	16.67	310.7	118.6	31.90

INITIAL MEAN VALUE IOS(NA) = $+3.79\times10^{-4}$

DEVICE TYPE: LF356BH FET INPUT OP AMP
MFG: NSC 3 DEVICES TEST DATE 12-06-85
REF: JPL LOG 1168 DATE CODE H8448

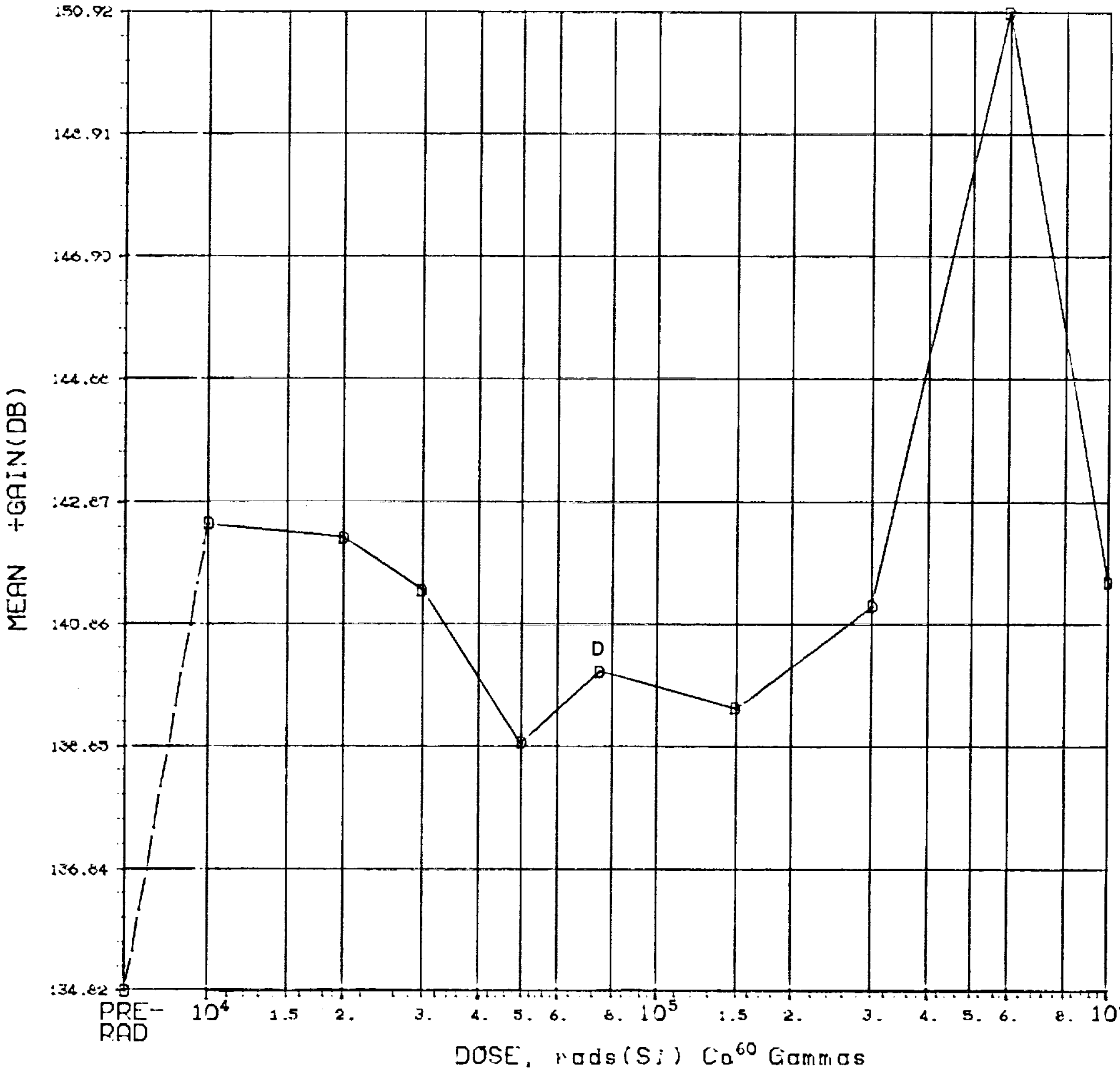


(3) IB (VOUT=0V) IN NA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS										
CURVE	DOSE, rads(Si)									
DOSE	0.0E0	1.0E4	2.0E4	3.0E4	5.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
STD. DEV.	.0025	.0033	.0165	.0230	.0733	.1888	15.01	151.1	53.10	14.10

INITIAL MEAN VALUE IB(NA) = $+7.61X10^{-2}$

DEVICE TYPE: LF356BH FET INPUT OP AMP
MFG: NSC 3 DEVICES TEST DATE 12-06-85
REF: JPL LOG 1168 DATE CODE H6448

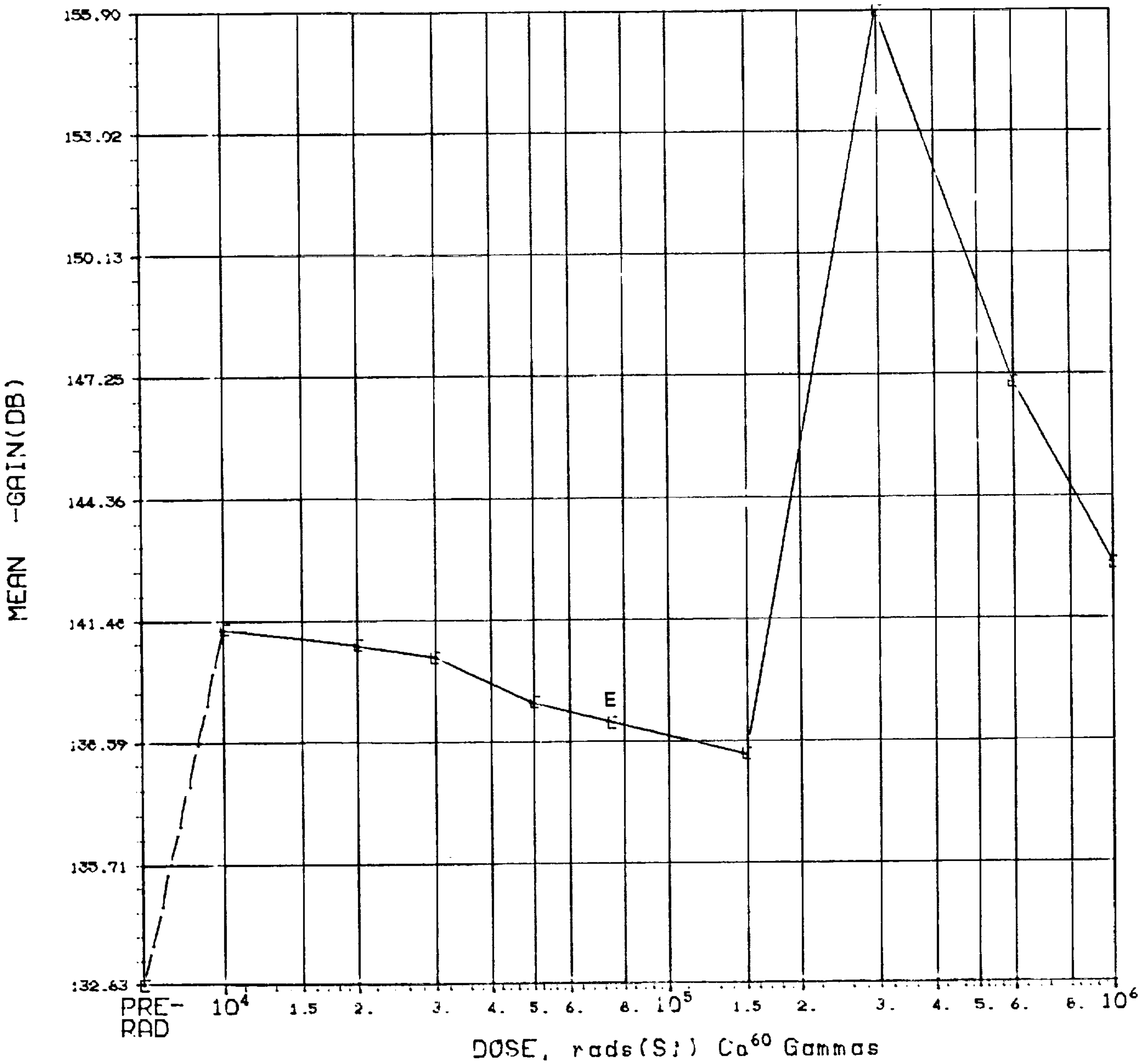


(4) +GAIN (VOUT=10V) IN DB: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS										
CURVE	DOSE, rads(Si)									
DOSE	0.0E0	1.0E4	2.0E4	3.0E4	5.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
STD. DEV.	2.493	2.516	2.591	2.054	4.782	2.035	2.687	3.675	30.06	11.69

INITIAL MEAN VALUE (GAIN(DB)) = $+1.35X10^{+2}$

DEVICE TYPE: LF356BH FET INPUT OP AMP
MFG: NSC 3 DEVICES TEST DATE 12-06-85
REF: JPL LOG 1168 DATE CODE H8448

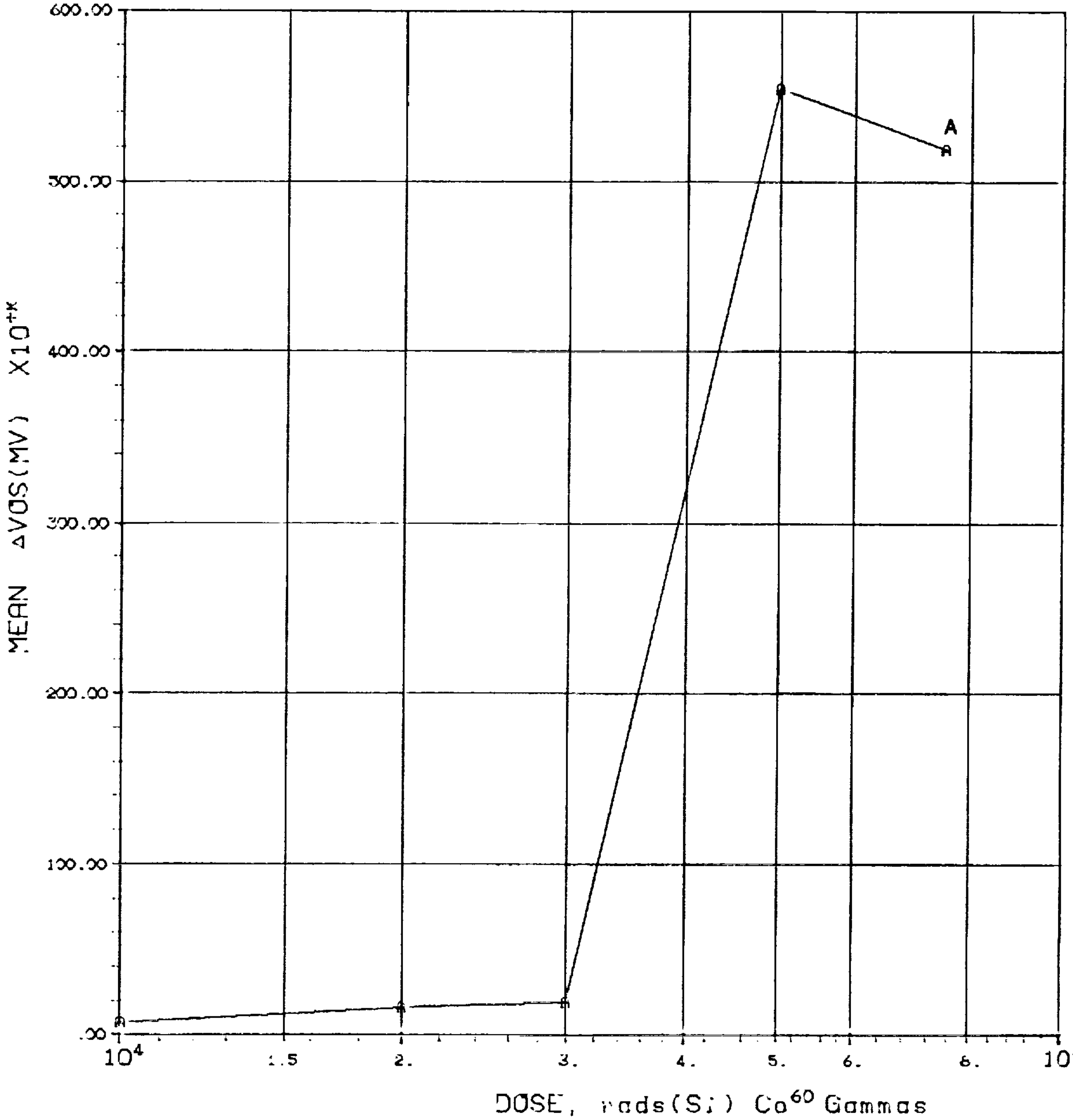


(5) -GAIN (VOUT=-10V) IN DB: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS										
CURVE	DOSE, rads(Si)									
DOSE	0.0E0	1.0E4	2.0E4	3.0E4	5.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6
STD. DEV.	2.110	2.281	2.519	2.232	1.624	2.116	2.395	16.33	34.37	17.06

INITIAL MEAN VALUE -GAIN(DB) = 41.33X10^{+2}

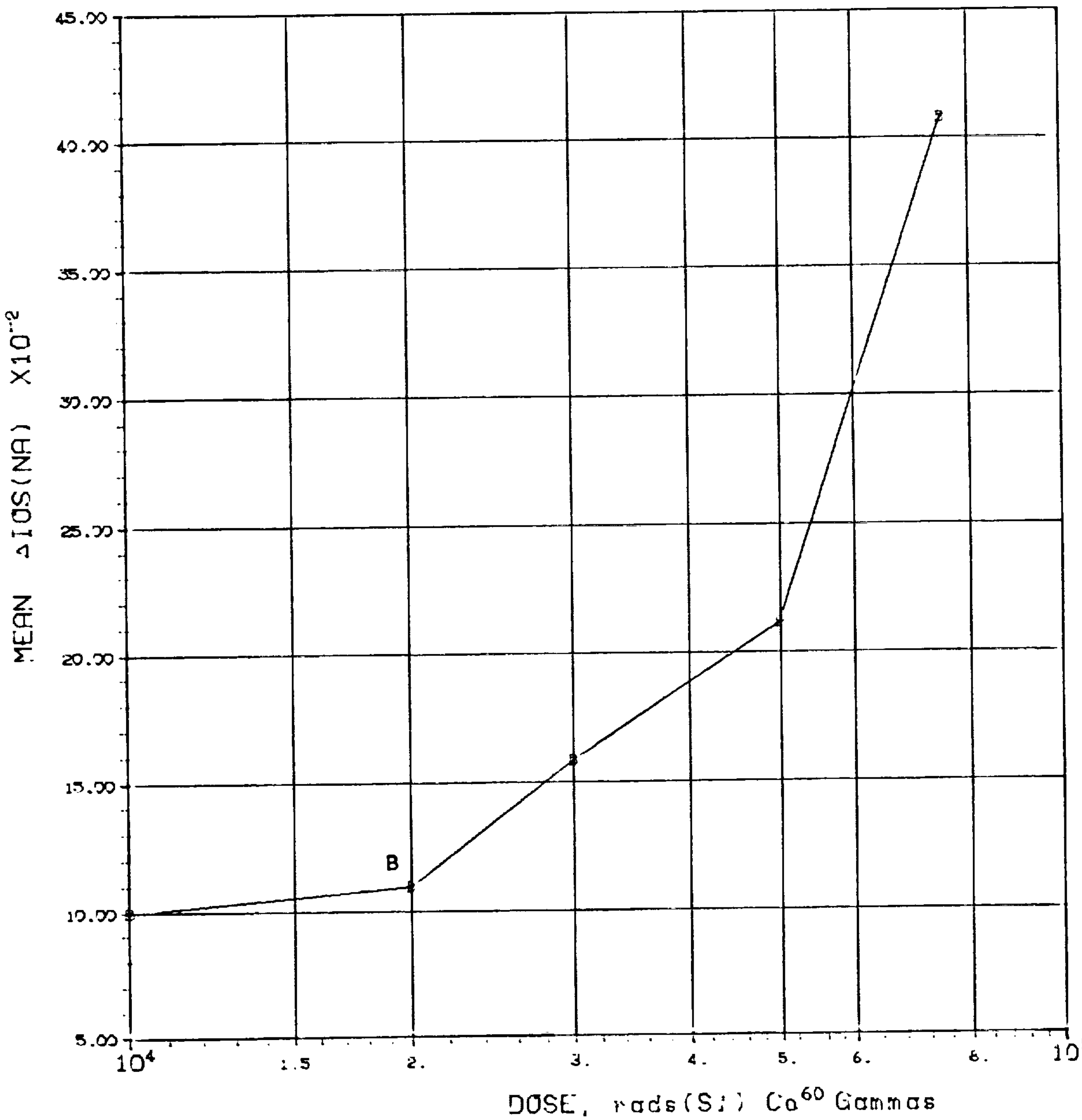
DEVICE TYPE: LF356BH OP AMP
MFG: NSC 4 DEVICES TEST DATE 09-30-85
REF: JPL LOG 1169 DATE CODE H6448



(1)VOS(MV): VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, rads(Si)				
	1.0E4	2.0E4	3.0E4	5.0E4	7.5E4
A	.0165	.0407	.0911	1.209	1.080

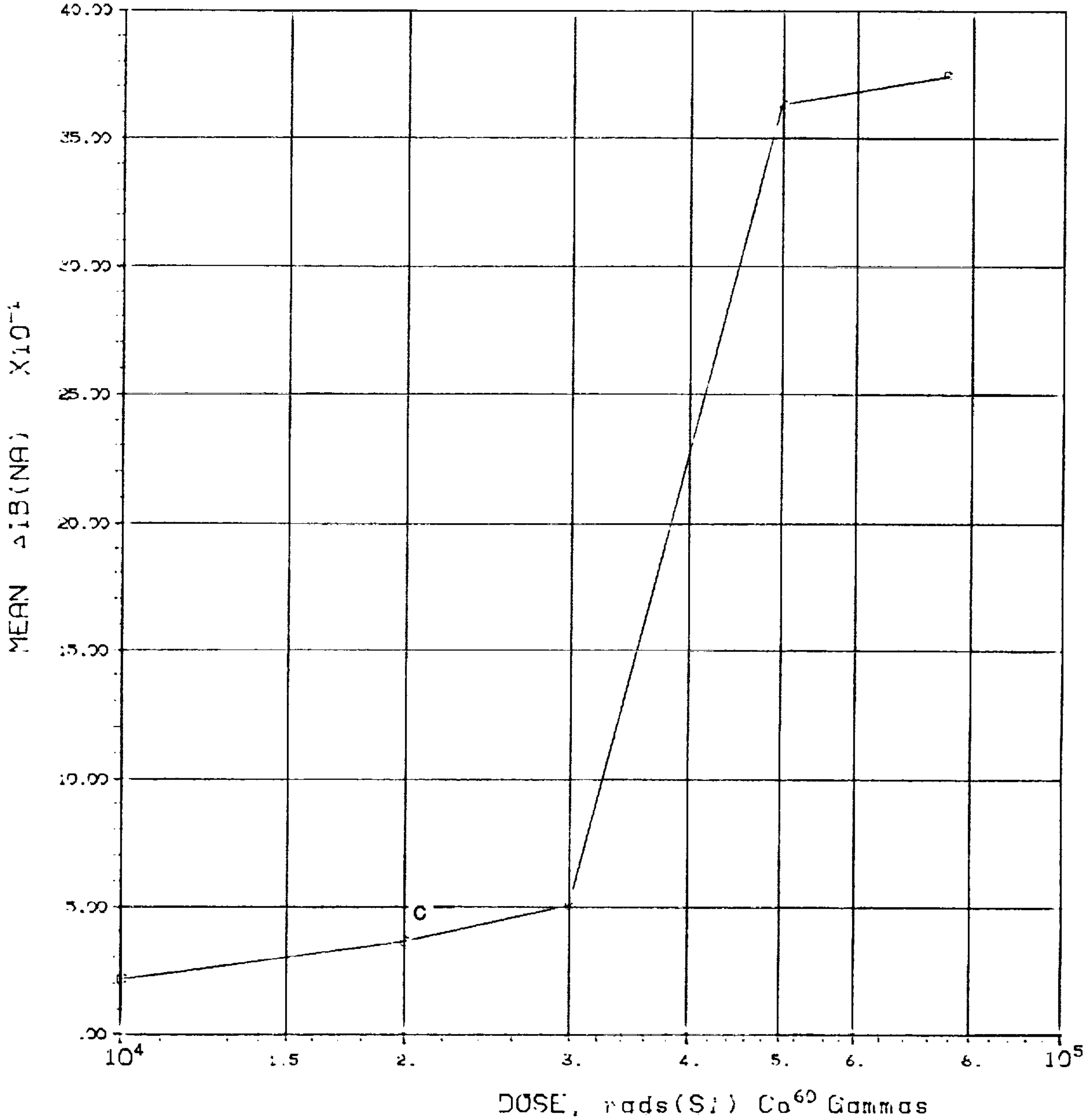
DEVICE TYPE: LF356BH OP AMP
MFG: NSC 4 DEVICES TEST DATE 09-30-85
REF: JPL LOG 1169 DATE CODE H8448



(2)IOS(NA): VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS					
CURVE	DOSE, rads(Si)				
	1.0E4	2.0E4	3.0E4	5.0E4	7.5E4
B	.1134	.1526	.0844	.0776	.2011

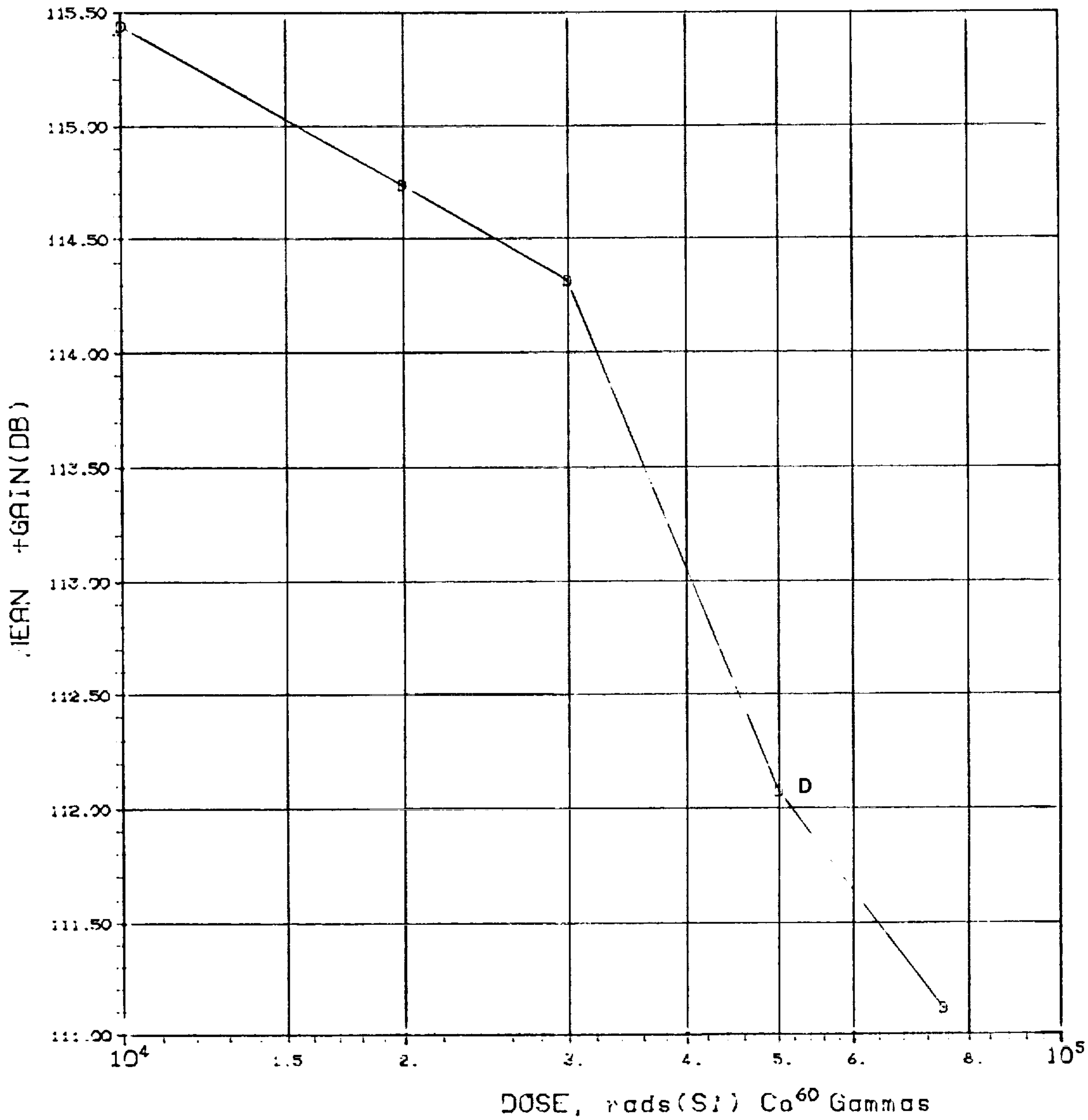
DEVICE TYPE: LF356BH OP AMP
MFG: NSC 4 DEVICES TEST DATE 09-30-85
REF: JPL LOG 1169 DATE CODE H8448



(2)IB (NA): VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, rads(Si)
	1.0E4 2.0E4 3.0E4 5.0E4 7.5E4
C	.2459 .2354 .2654 .3878 .4585

DEVICE TYPE: LF356BH OP AMP
MFG: NSC 4 DEVICES TEST DATE 09-20-85
REF: JPL LOG 1169 DATE CODE H8448

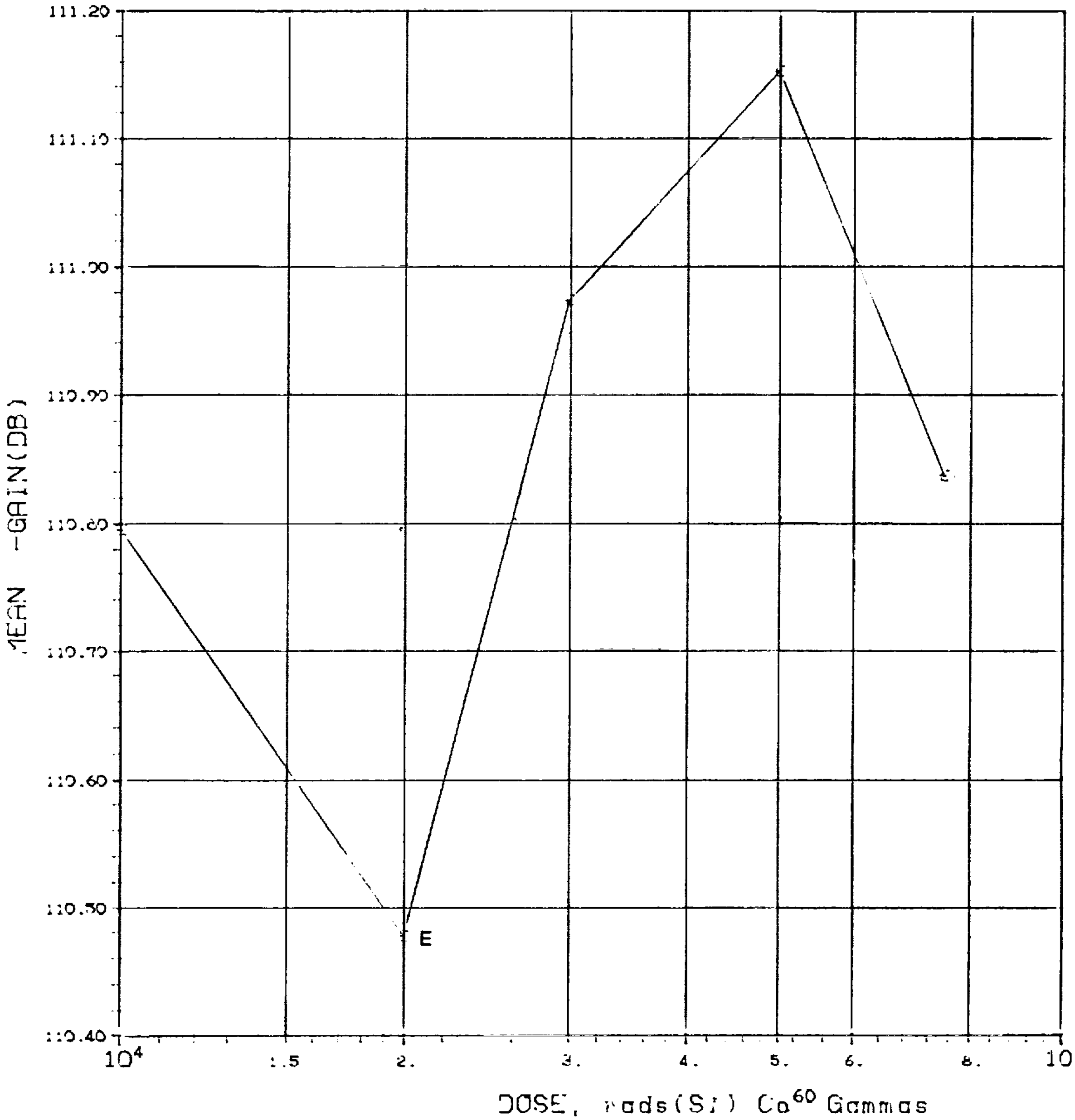


(4)+GAIN IN DB(10MA LOAD,+10V): VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_L (mA)	DOSE, rads(Si) 1.0E4	2.0E4	3.0E4	5.0E4	7.5E4
D	1.00	3.276	2.789	3.706	2.207	2.907

INITIAL MEAN VALUE +GAIN(DB) = $1.15X10^{+2}$

DEVICE TYPE: LF356BH OP AMP
MFG: NSC 4 DEVICES TEST DATE 09-30-85
REF: JPL LOG 1169 DATE CODE H6448

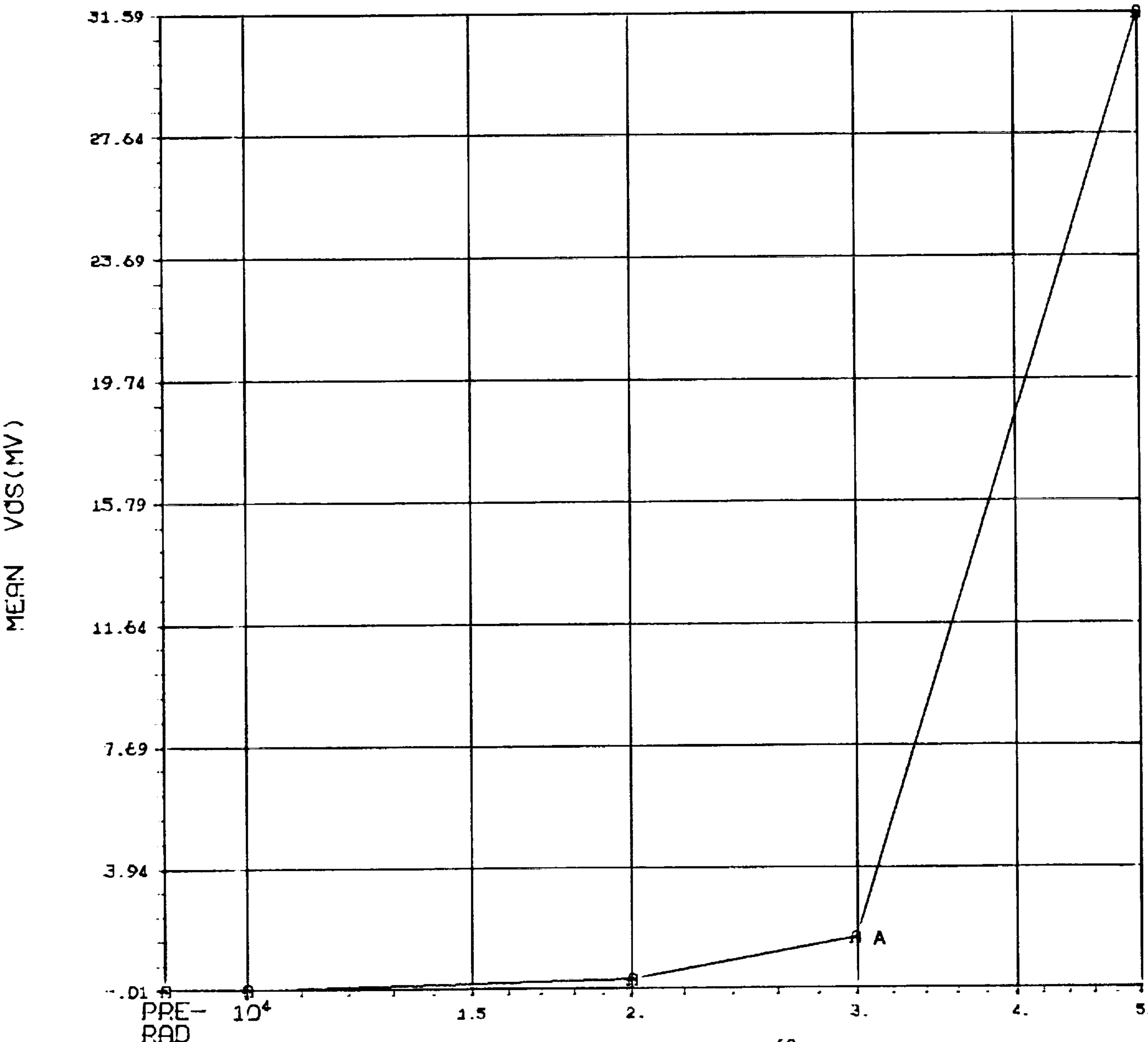


(5)-GAIN IN DB(10MA LOAD,-10V): VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS						
CURVE	I_L (mA)	DOSE, rads(Si) 1.0E4	2.0E4	3.0E4	5.0E4	7.5E4
E	1.00	4.024	3.676	3.235	3.327	3.162

INITIAL MEAN VALUE -GAIN(DB) = 1.13X10^{+2}

DEVICE TYPE: LT1012 OP AMP
MFG: LTC 4 DEVICES TEST DATE 12-16-85
REF: JPL LOG 1150 DATE CODE 8437

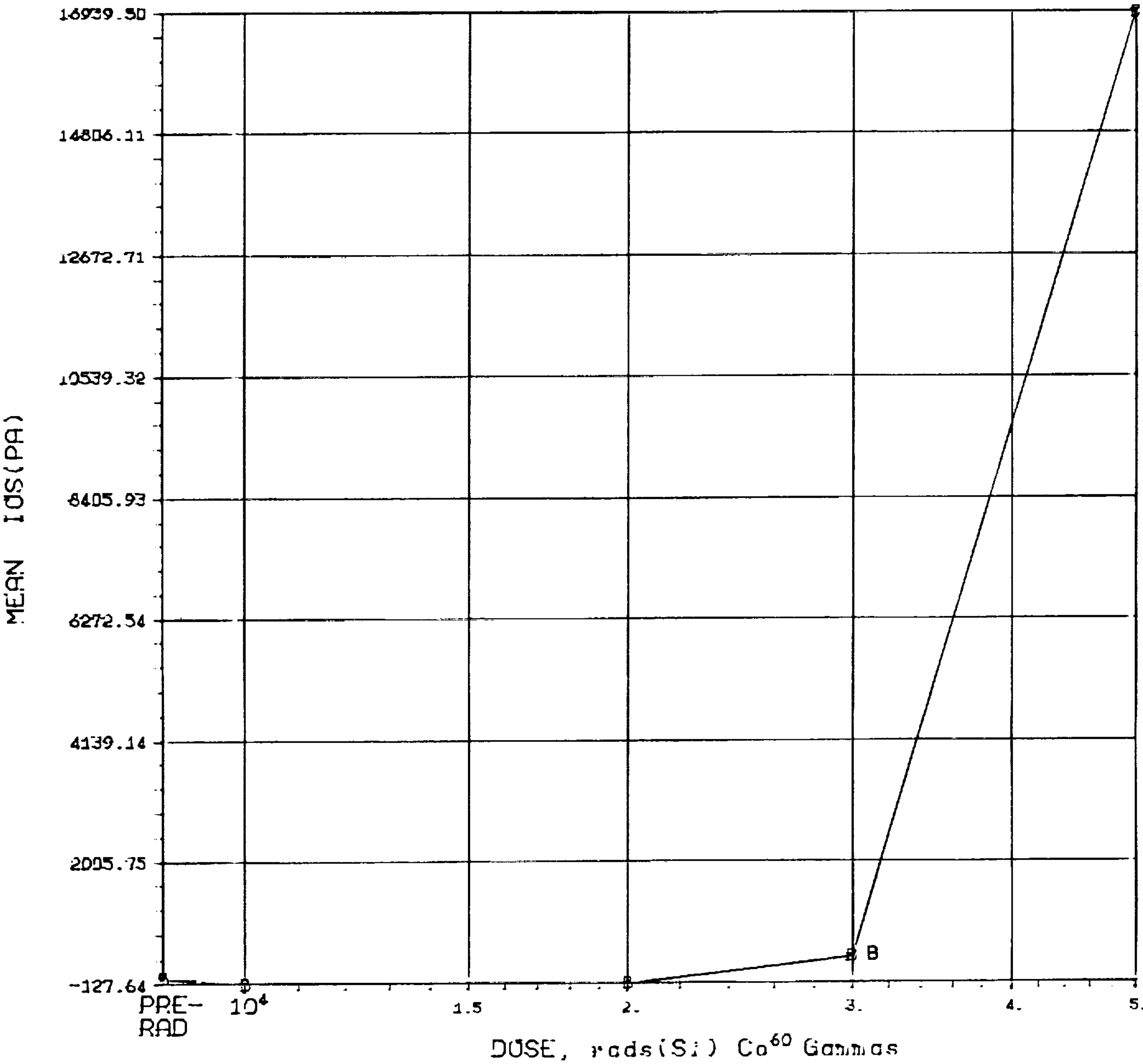


(1)VOS (RS=50 OHMS) IN MV: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, rads(Si)
DOSE	0.0E0 1.0E4 2.0E4 3.0E4 5.0E4
STD. DEV.	.0242 .0281 .2639 .6557 17.01

INITIAL MEAN VALUE VOS(MV) = $-1.26X10^{-2}$

DEVICE TYPE: LT1012 OP AMP
MFG: LTC 4 DEVICES TEST DATE 12-16-85
REF: JPL LOG 1150 DATE CODE 8437

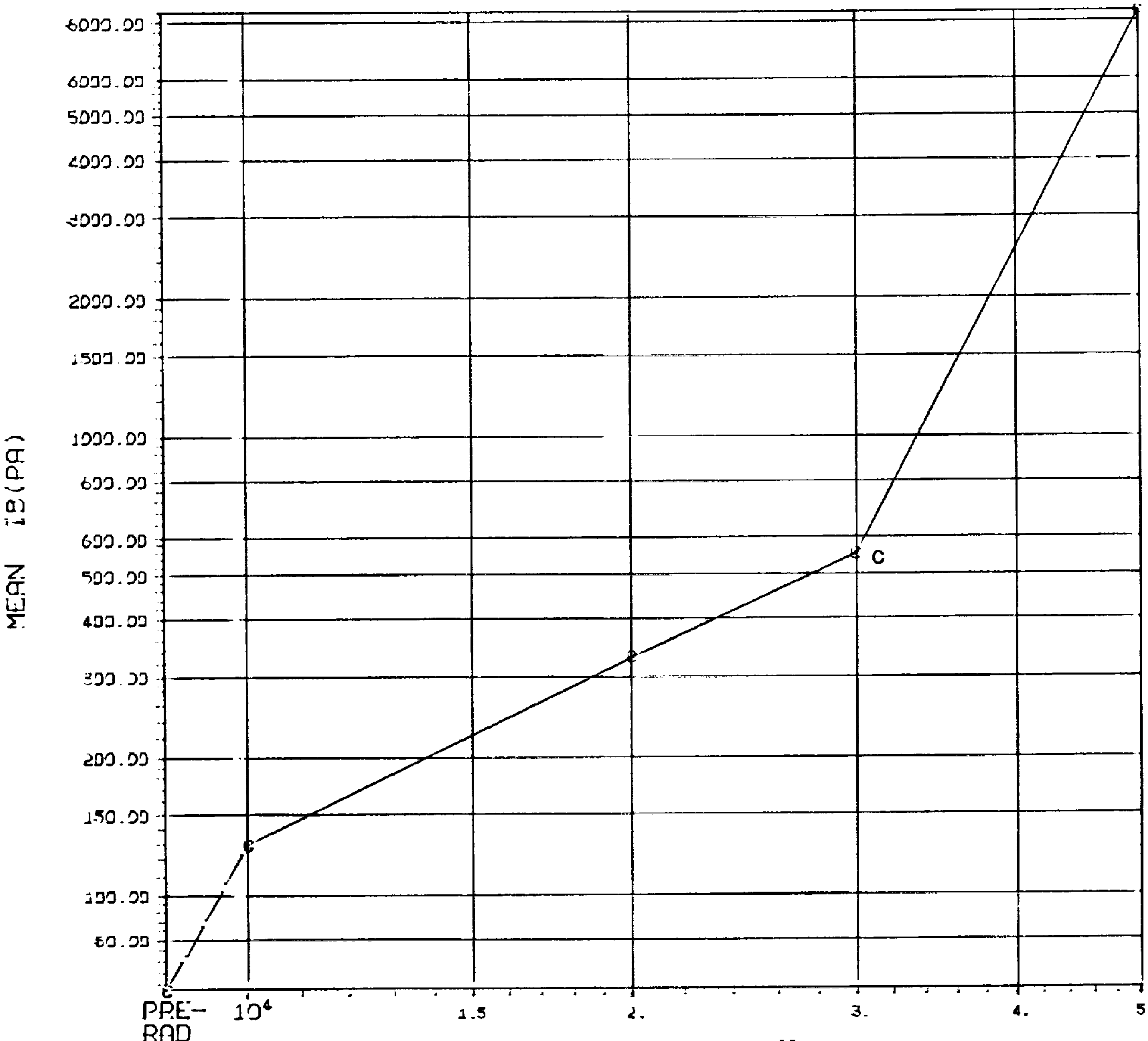


(2)IOS (VOUT=0V) IN PA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, rads(Si)
DOSE	0.0E0 1.0E4 2.0E4 3.0E4 5.0E4
STD. DEV.	31.07 66.58 93.39 258.6 9757.

INITIAL MEAN VALUE IOS(PA) = $-1.89X10^{+1}$

DEVICE TYPE: LT1012 OP AMP
MFG: LTC 4 DEVICES TEST DATE 12-16-85
REF: JPL LOG 1150 DATE CODE 8437

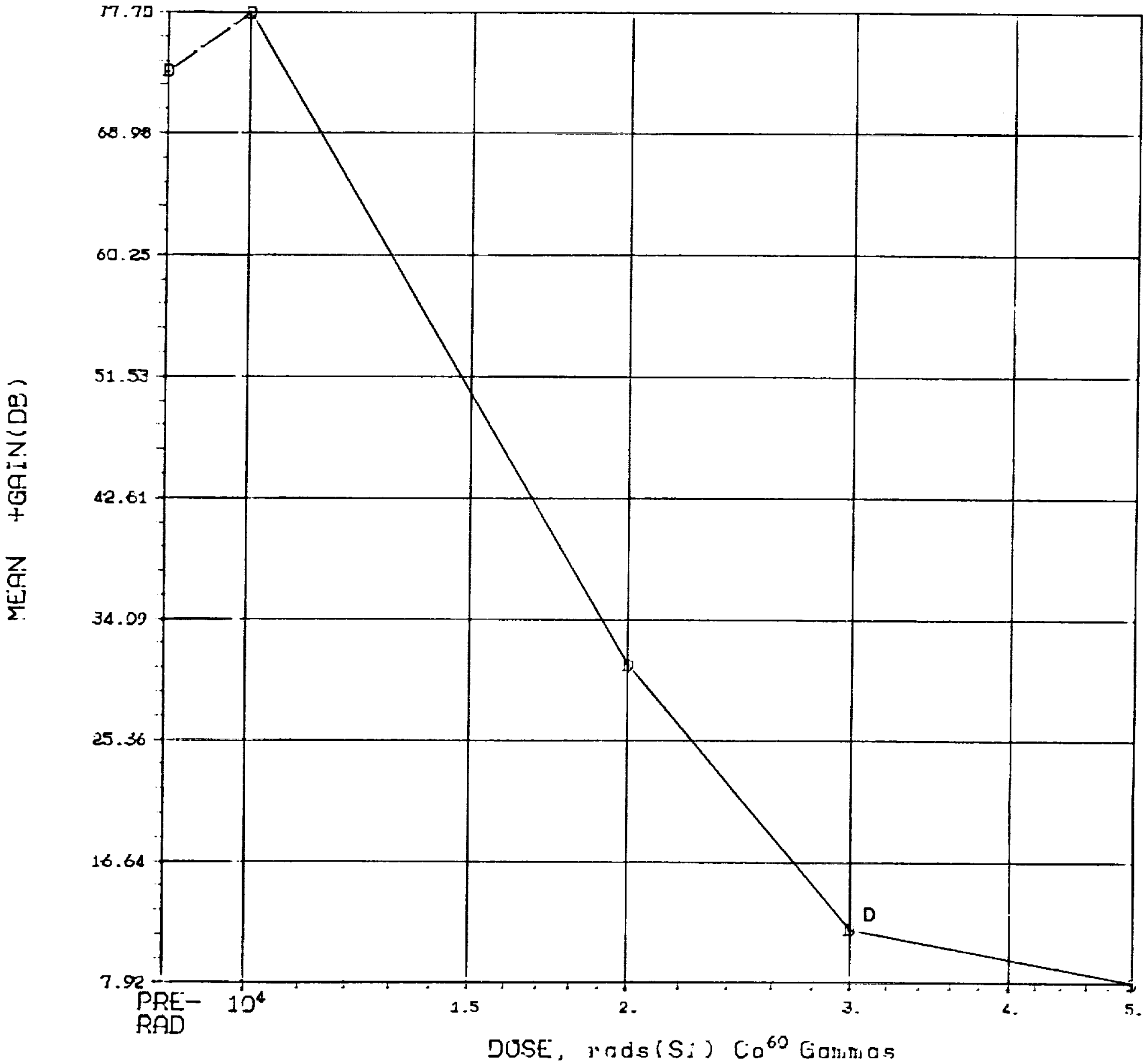


(3)IB (VOUT=0V) IN PA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, rads(Si)
DOSE	0.0E0 1.0E4 2.0E4 3.0E4 5.0E4
STD. DEV.	30.51 41.31 65.17 197.1 4843.

INITIAL MEAN VALUE IB(PA) = $+6.21\text{X}10^{+1}$

DEVICE TYPE: LT1012 OP AMP
MFG: LTC 4 DEVICES TEST DATE 12-16-85
REF: JPL LOG 1150 DATE CODE 8437

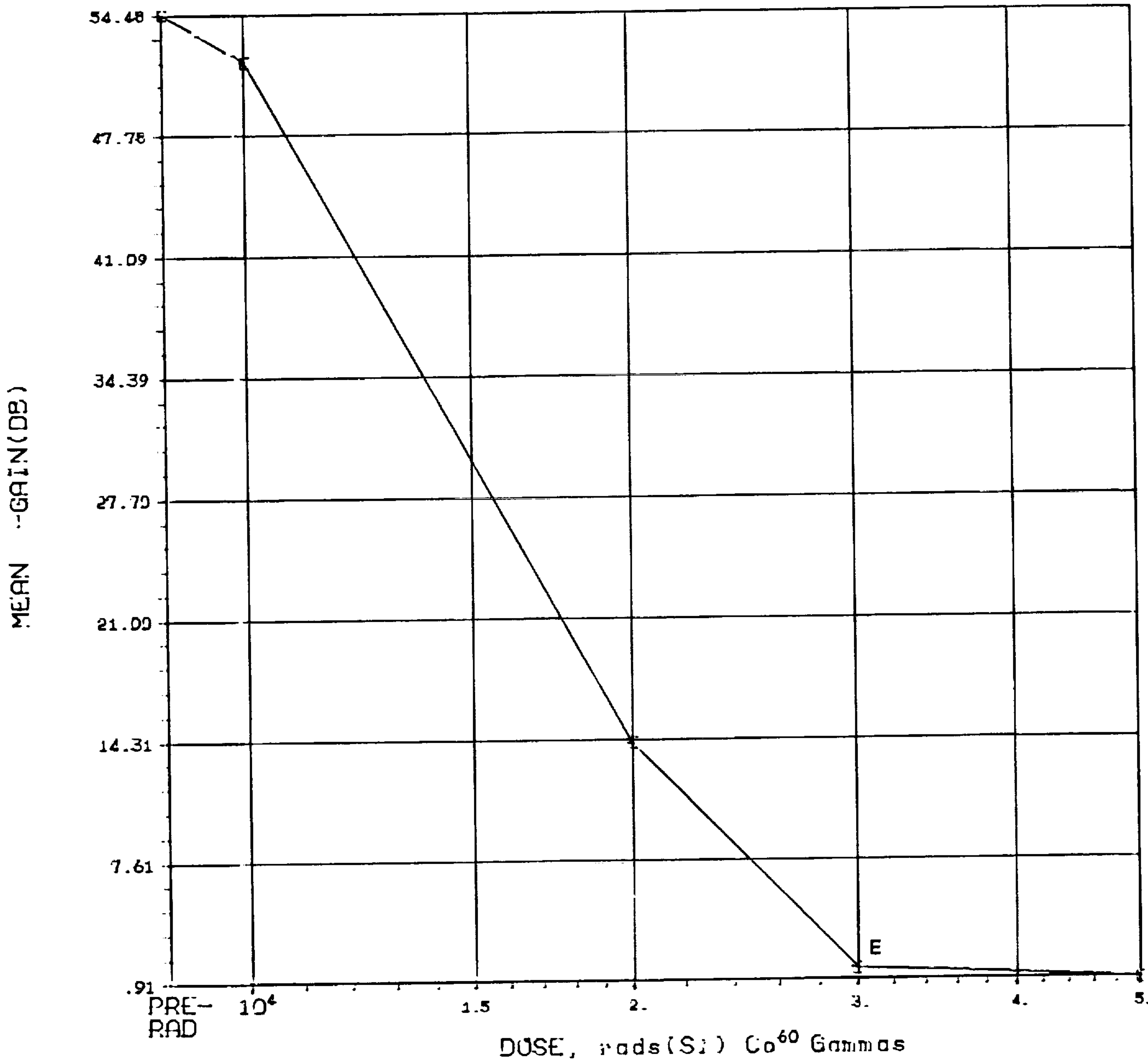


(4)+GAIN (VOUT=10V,RL=2KOHMS) IN DB VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, rads(Si)
DOSE	0.0E0 1.0E4 2.0E4 3.0E4 5.0E4
STD. DEV.	3.261 11.06 12.06 1.160 2.466

INITIAL MEAN VALUE +GAIN(DB) = $+7.35X10^{+1}$

DEVICE TYPE: LT1012 OP AMP
MFG: LTC 4 DEVICES TEST DATE 12-16-85
REF: JPL LOG 1150 DATE CODE 8437

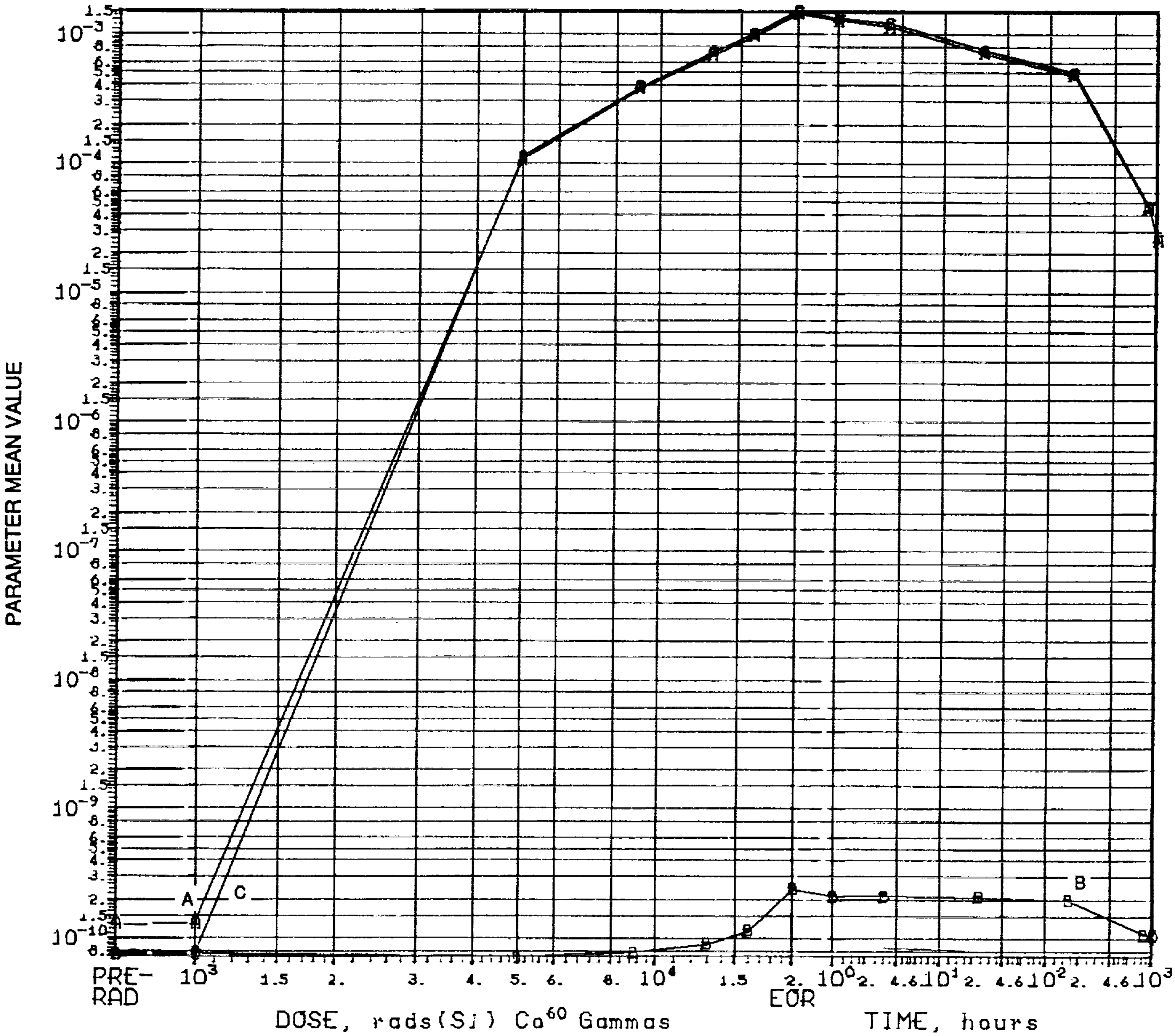


(5)-GAIN (VOUT=-10V,RL=2KOHMS) IN D VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, rads(Si)
DOSE	0.0E0 1.0E4 2.0E4 3.0E4 5.0E4
STD. DEV.	1.738 2.322 7.476 .7681 .7135

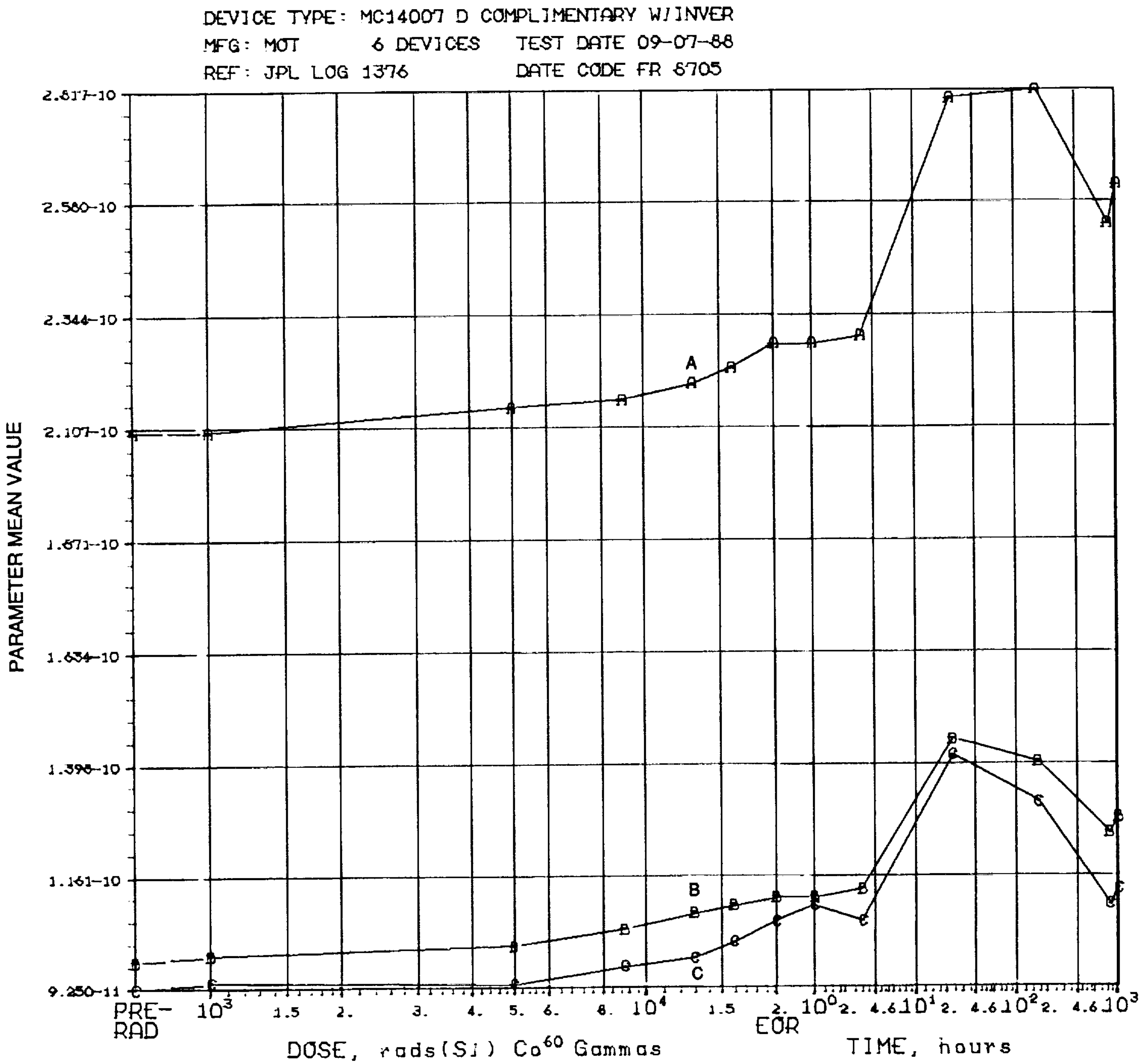
INITIAL MEAN VALUE -GAIN(DB) = $+5.45X10^{+1}$

DEVICE TYPE: MC14007 D COMPLIMENTARY W/INVER
MFG: MOT 6 DEVICES TEST DATE 09-07-88
REF: JPL LOG 1376 DATE CODE FR 8705



0.5 rads/sec Dose Rate

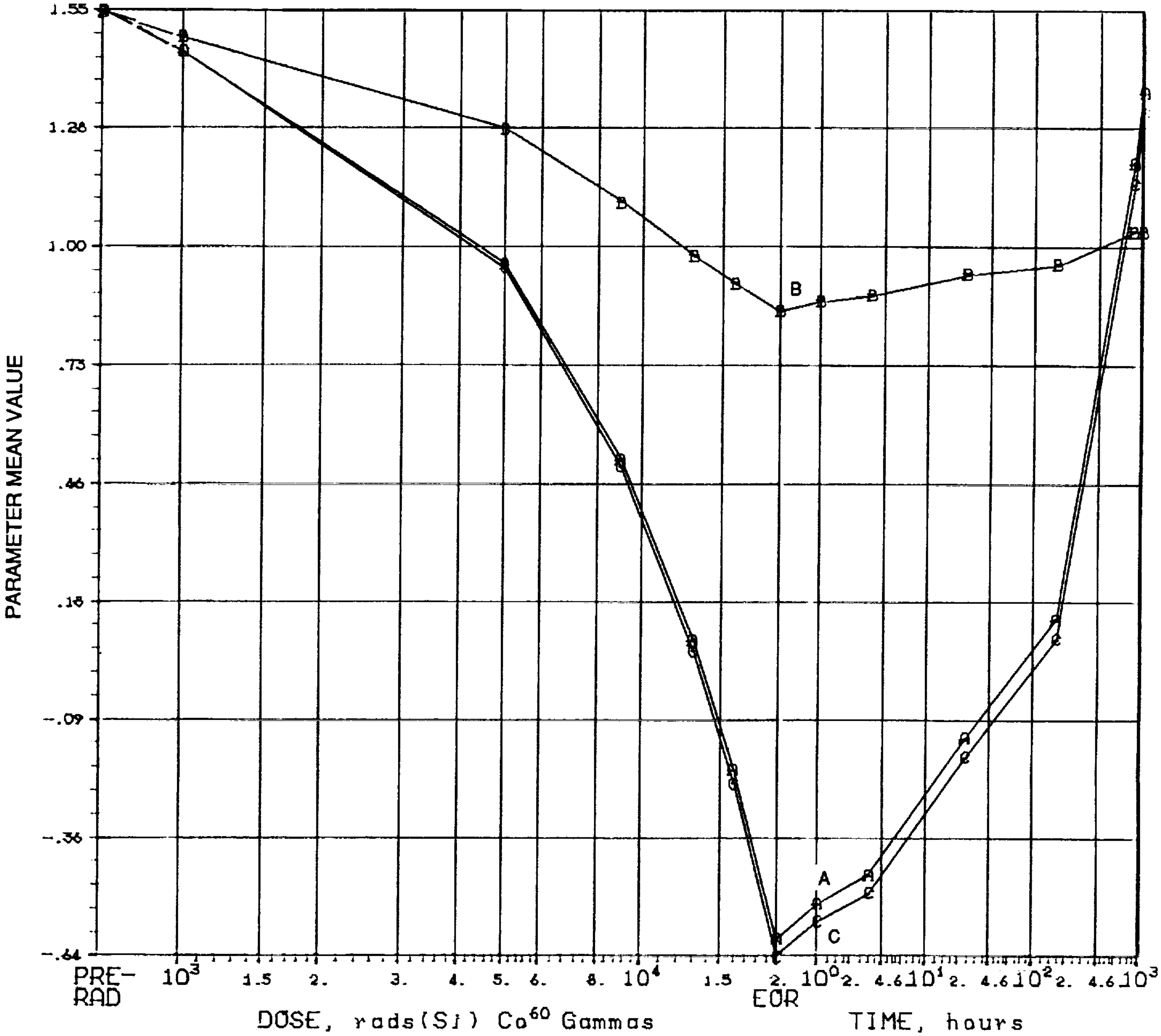
	PARAMETERS	
CURVE A:	(1) IDSN(6)-ON	(A)
CURVE B:	(2) IDSN(3)-OFF	(A)
CURVE C:	(3) IDSN(10)-ON	(A)



0.5 rads/sec Dose Rate

	PARAMETERS		
CURVE A:	(4)	IDSP(6)-OFF	(A)
CURVE B:	(5)	IDSP(3)-ON	(A)
CURVE C:	(6)	IDSP(10)-OFF	(A)

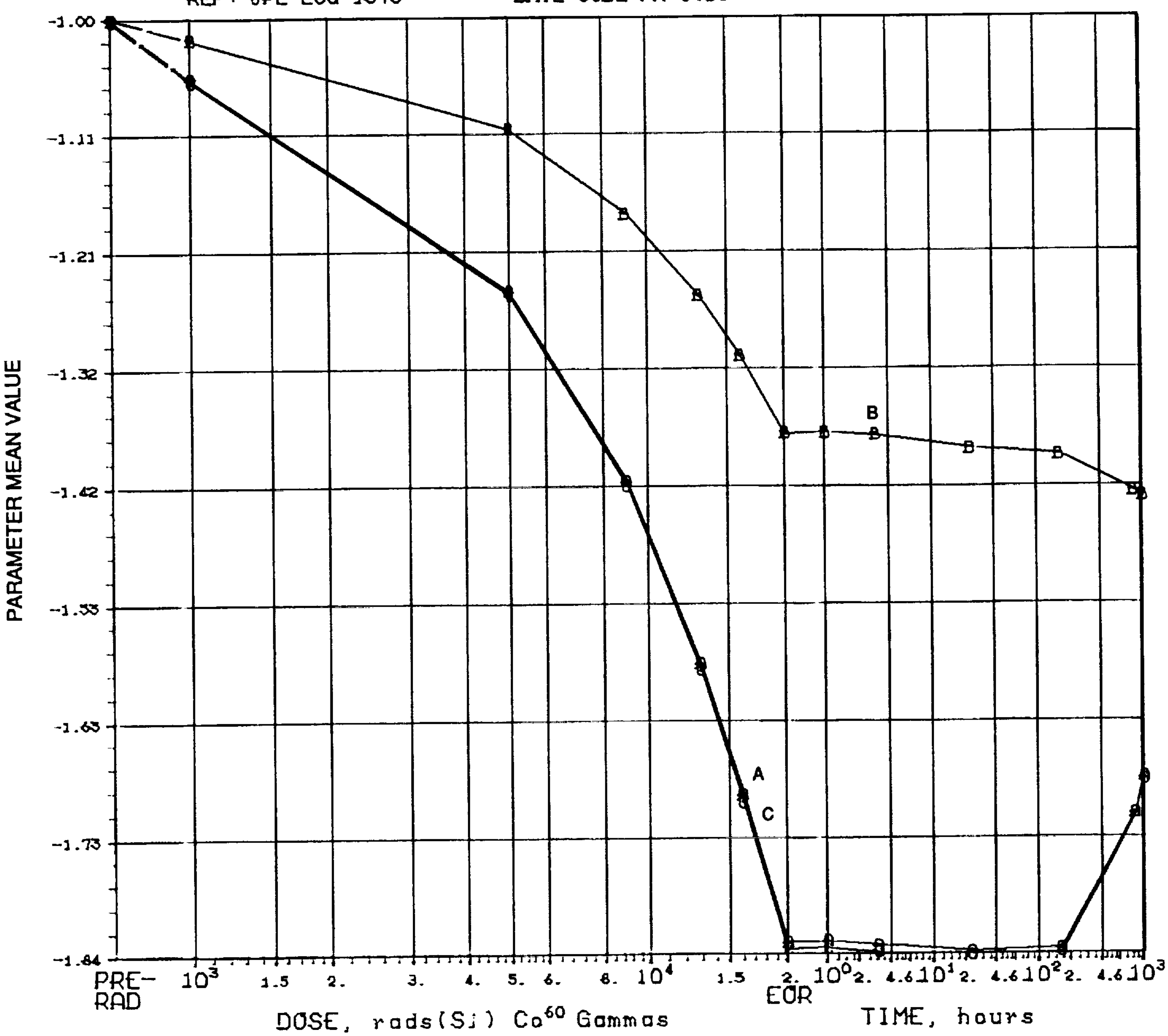
DEVICE TYPE: MC14007 D COMPLIMENTARY W/INVER
MFG: MOT 6 DEVICES TEST DATE 09-07-88
REF: JPL LOG 1376 DATE CODE FR 8705



0.5 rads/sec Dose Rate

	PARAMETERS
CURVE A:	(7) VTN(6)-ON (V)
CURVE B:	(8) VTN(3)-OFF (V)
CURVE C:	(9) VTP(10)-ON (V)

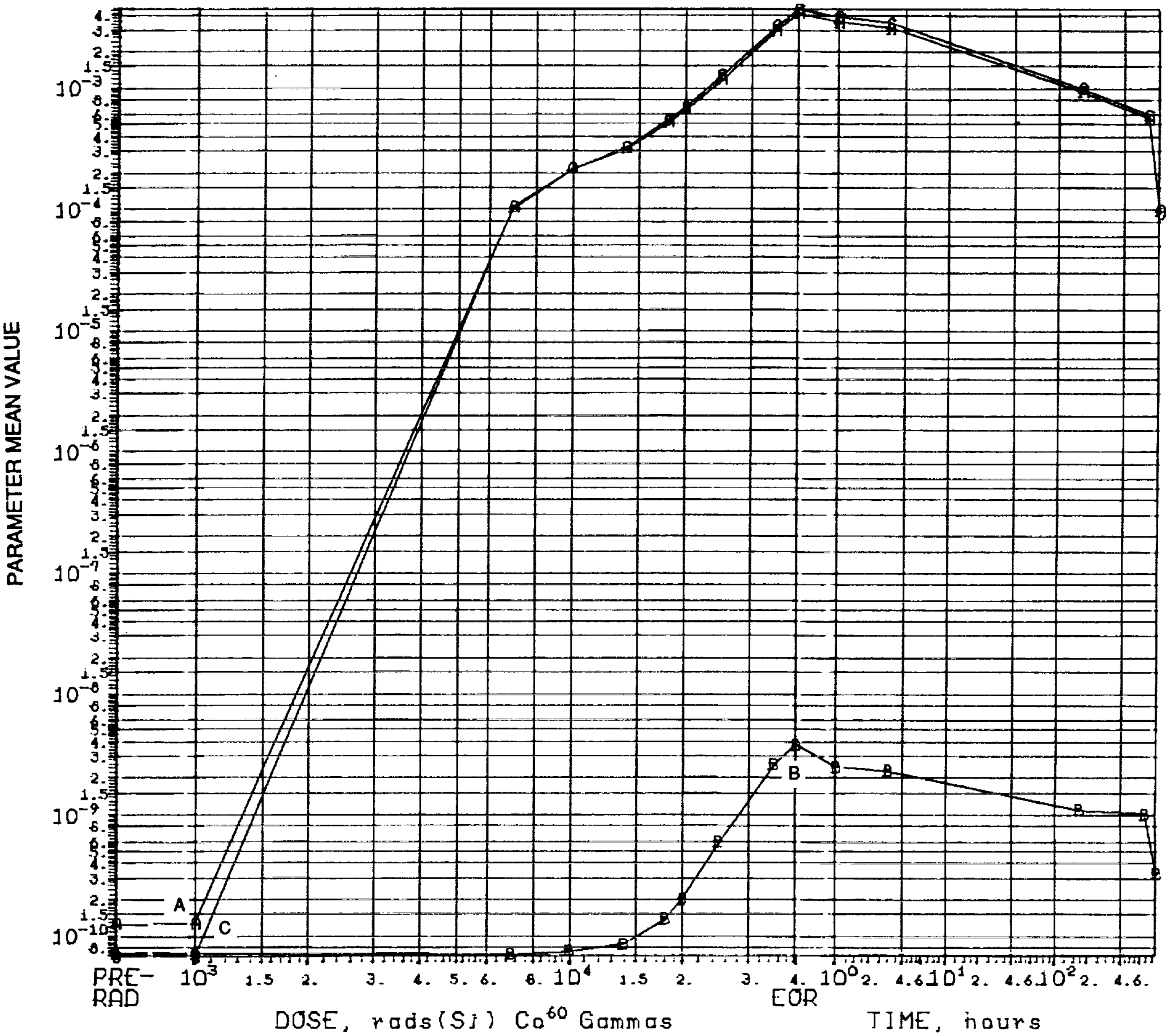
DEVICE TYPE: MC14007 D COMPLIMENTARY W/INVER
MFG: MOT 6 DEVICES TEST DATE 09-07-88
REF: JPL LOG 1376 DATE CODE FR 8705



0.5 rads/sec Dose Rate

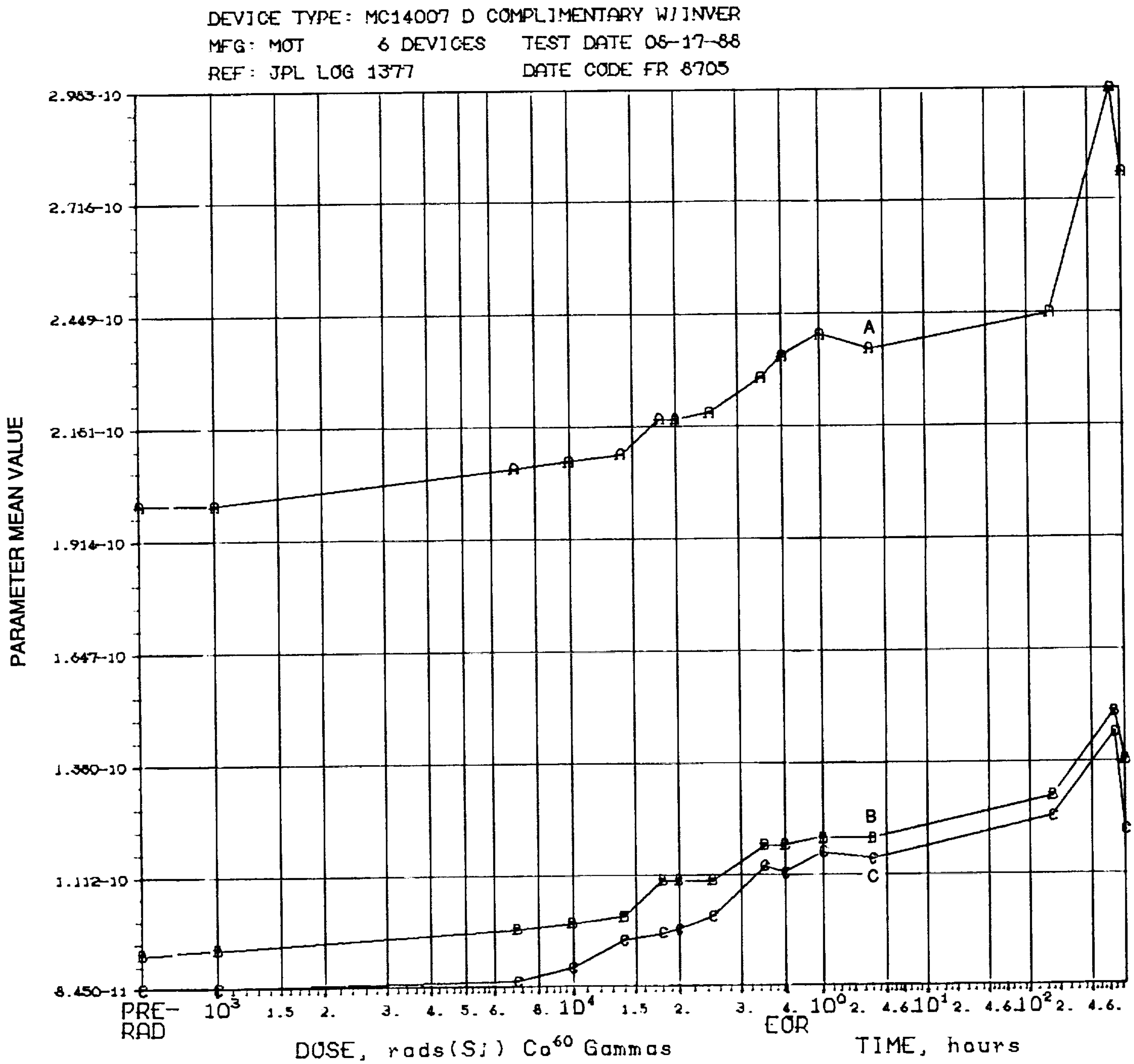
	PARAMETERS
CURVE A:	(10) VTP(6)-OFF (V)
CURVE B:	(11) VTP(3)-ON (V)
CURVE C:	(12) VTP(10)-OFF(V)

DEVICE TYPE: MC14007 D COMPLIMENTARY W/INVER
MFG: MOT 6 DEVICES TEST DATE 06-17-88
REF: JPL LOG 1377 DATE CODE FR 8705



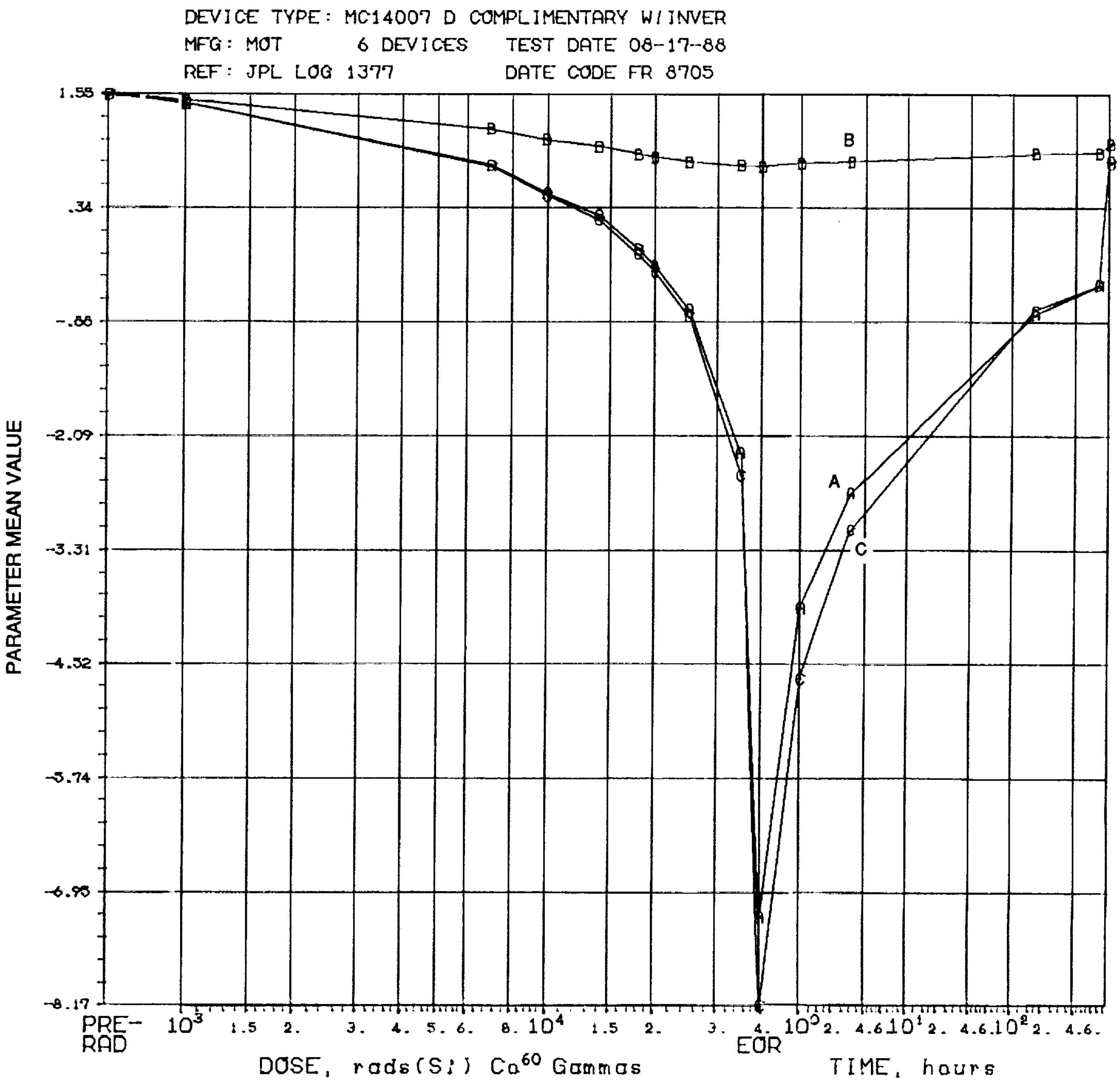
20 rads/sec Dose Rate

	PARAMETERS		
CURVE A:	(1)	IDSN(6)-ON	(A)
CURVE B:	(2)	IDSN(3)-OFF	(A)
CURVE C:	(3)	IDSN(10)-ON	(A)



20 rads/sec Dose Rate

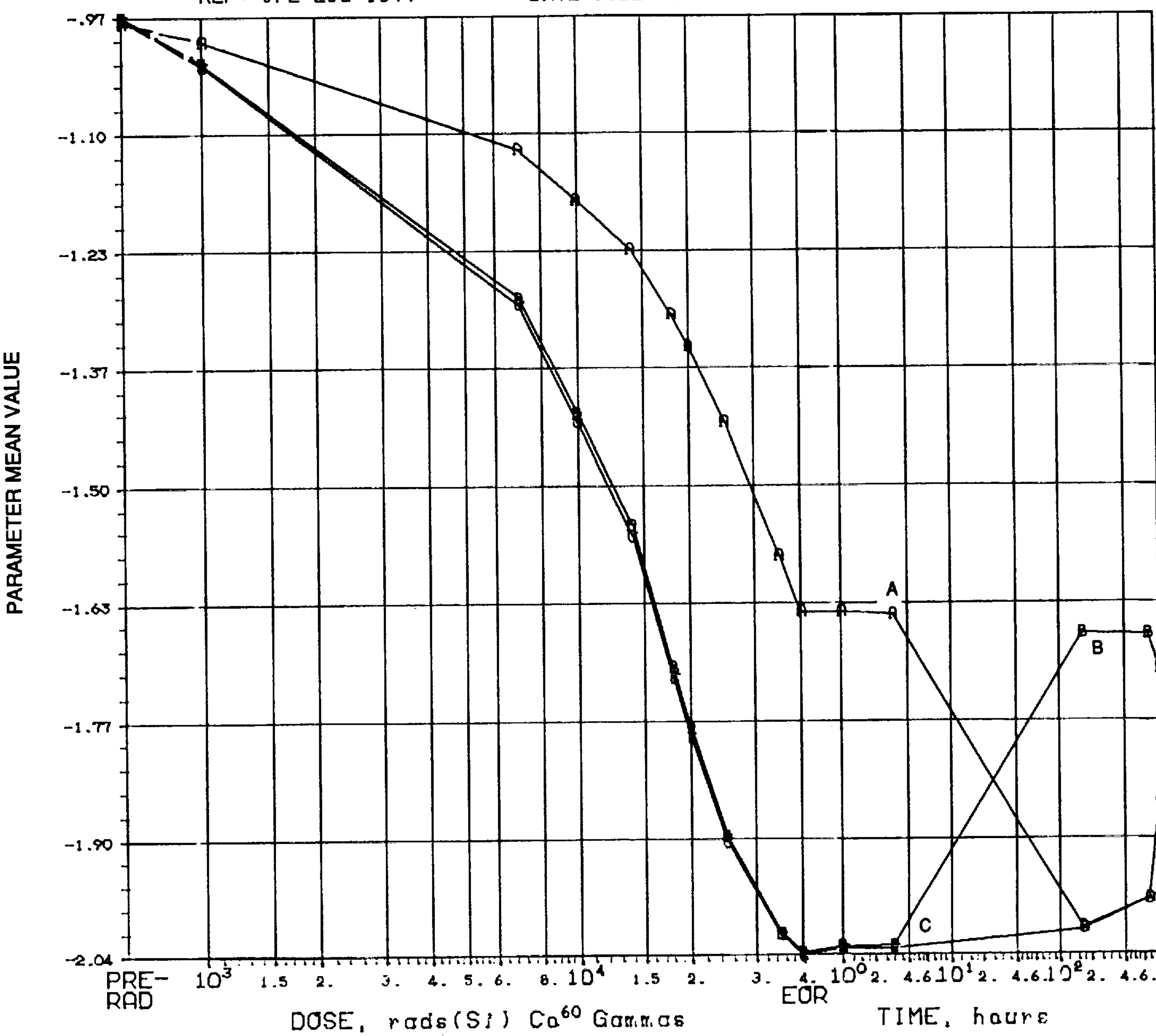
	PARAMETERS		
CURVE A:	(4)	IDSP(6)-ON	(A)
CURVE B:	(5)	IDSP(3)-OFF	(A)
CURVE C:	(6)	IDSP(10)-OFF	(A)



20 rads/sec Dose Rate

	PARAMETERS
CURVE A:	(7) VTN(6)-ON (V)
CURVE B:	(8) VTN(3)-OFF (V)
CURVE C:	(9) VTP(10)-ON (V)

DEVICE TYPE: MC14007 D COMPLIMENTARY W/INVER
MFG: MOT 6 DEVICES TEST DATE 08-17-88
REF: JPL LOG 1377 DATE CODE FR 8705

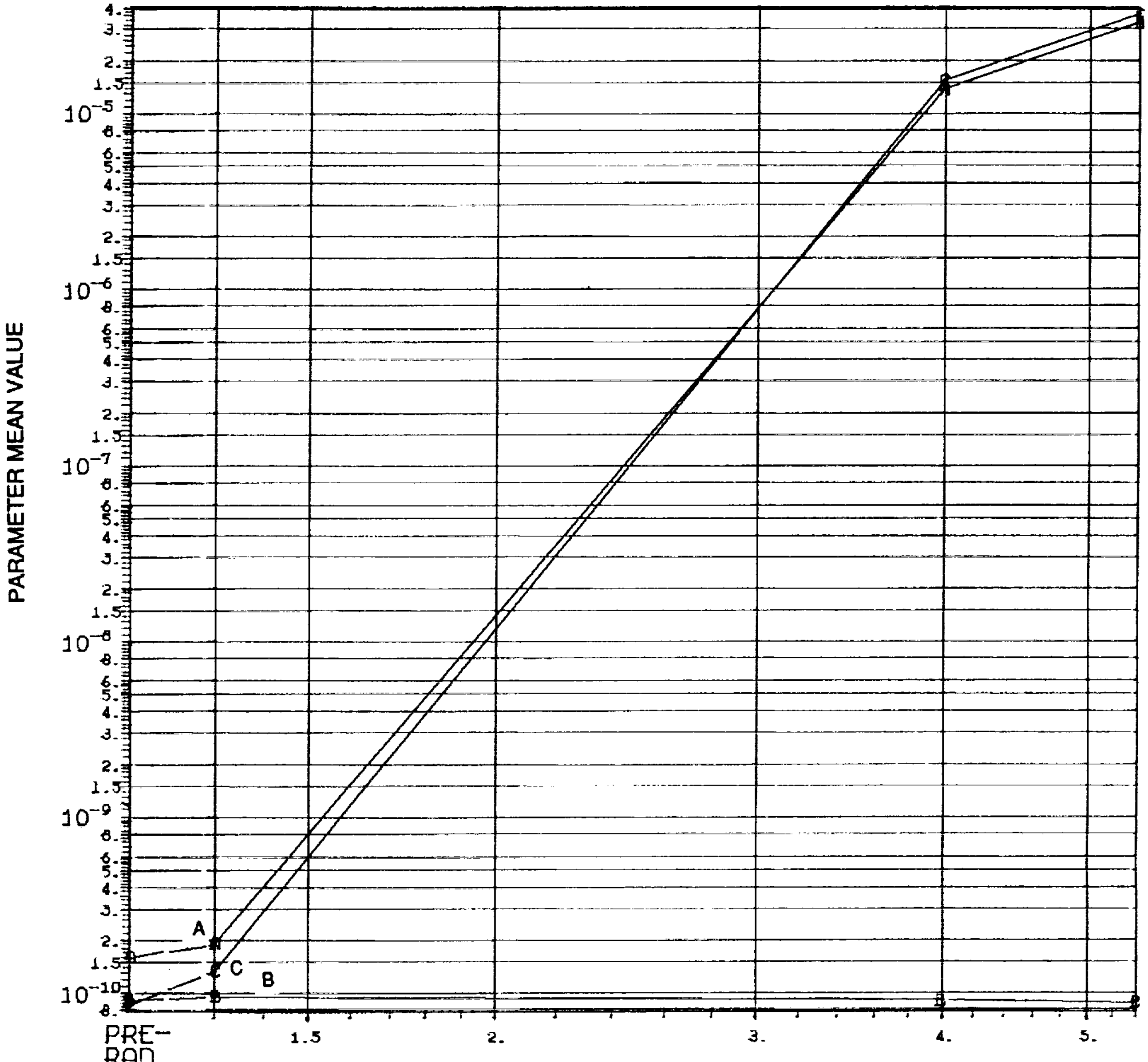


20 rads/sec Dose Rate

PARAMETERS

CURVE A:	(10) VTP(6)-ON (V)
CURVE B:	(11) VTP(3)-OFF (V)
CURVE C:	(12) VTP(10)-OFF(V)

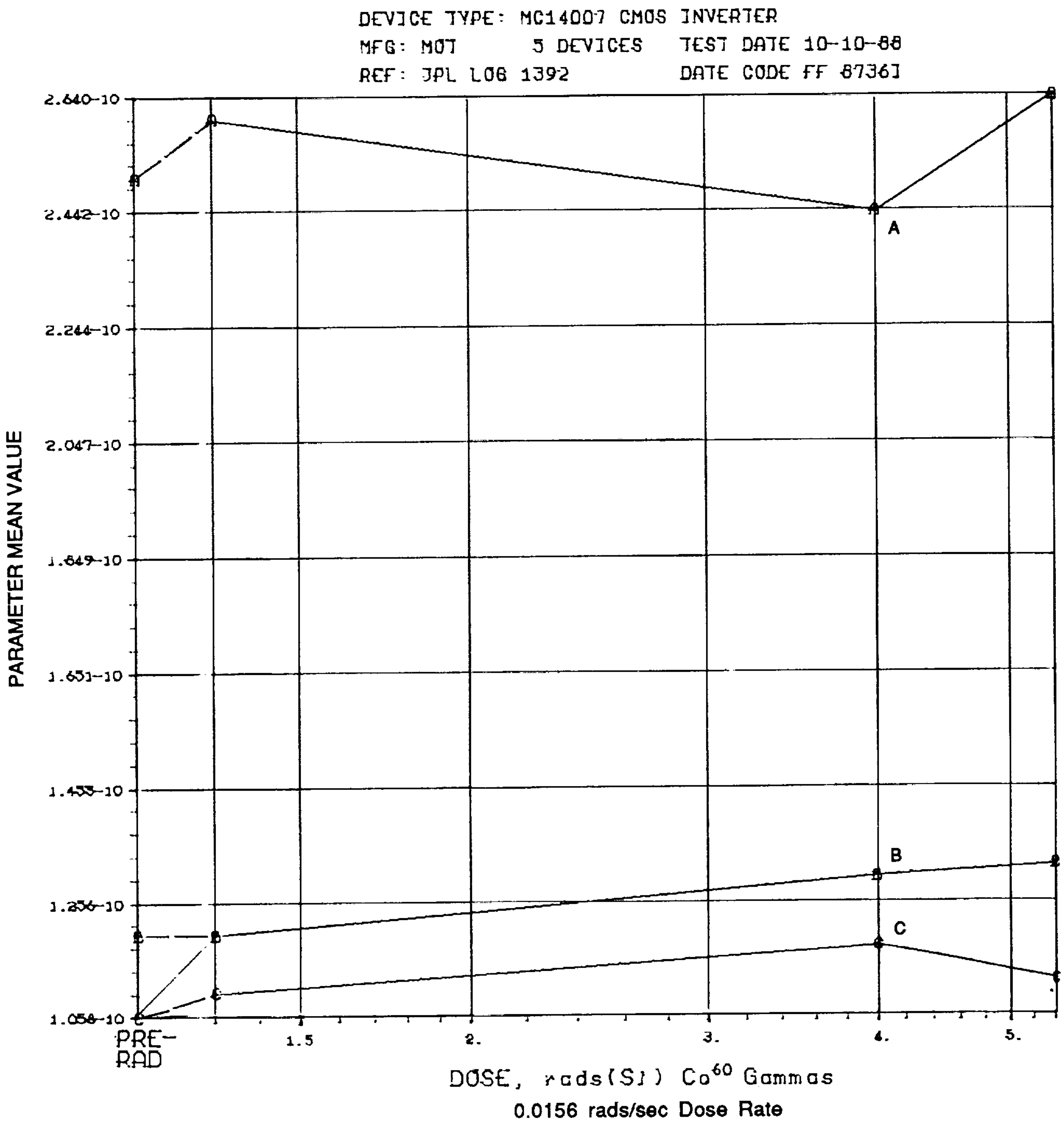
DEVICE TYPE: MC14007 CMOS INVERTER
MFG: MOT 5 DEVICES TEST DATE 10-10-88
REF: JPL LOG 1392 DATE CODE FF 8736J



DOSE, rads(Si) Co^{60} Gammas
0.0156 rads/sec Dose Rate

PARAMETERS

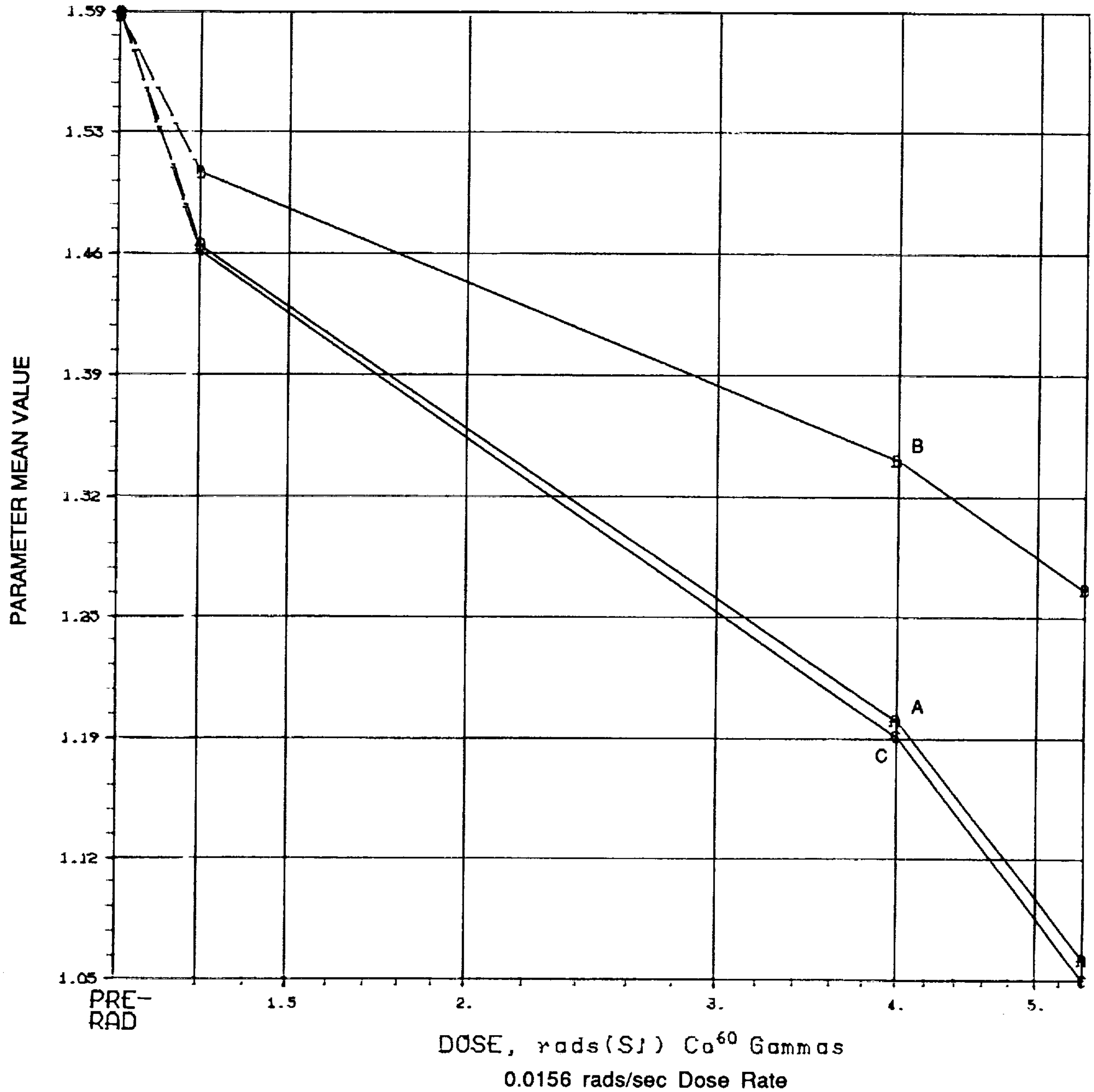
CURVE A:	(1)	IDSN(6)--ON	(A)
CURVE B:	(2)	IDSN(3)--OFF	(A)
CURVE C:	(3)	IDSN(10)--ON	(A)



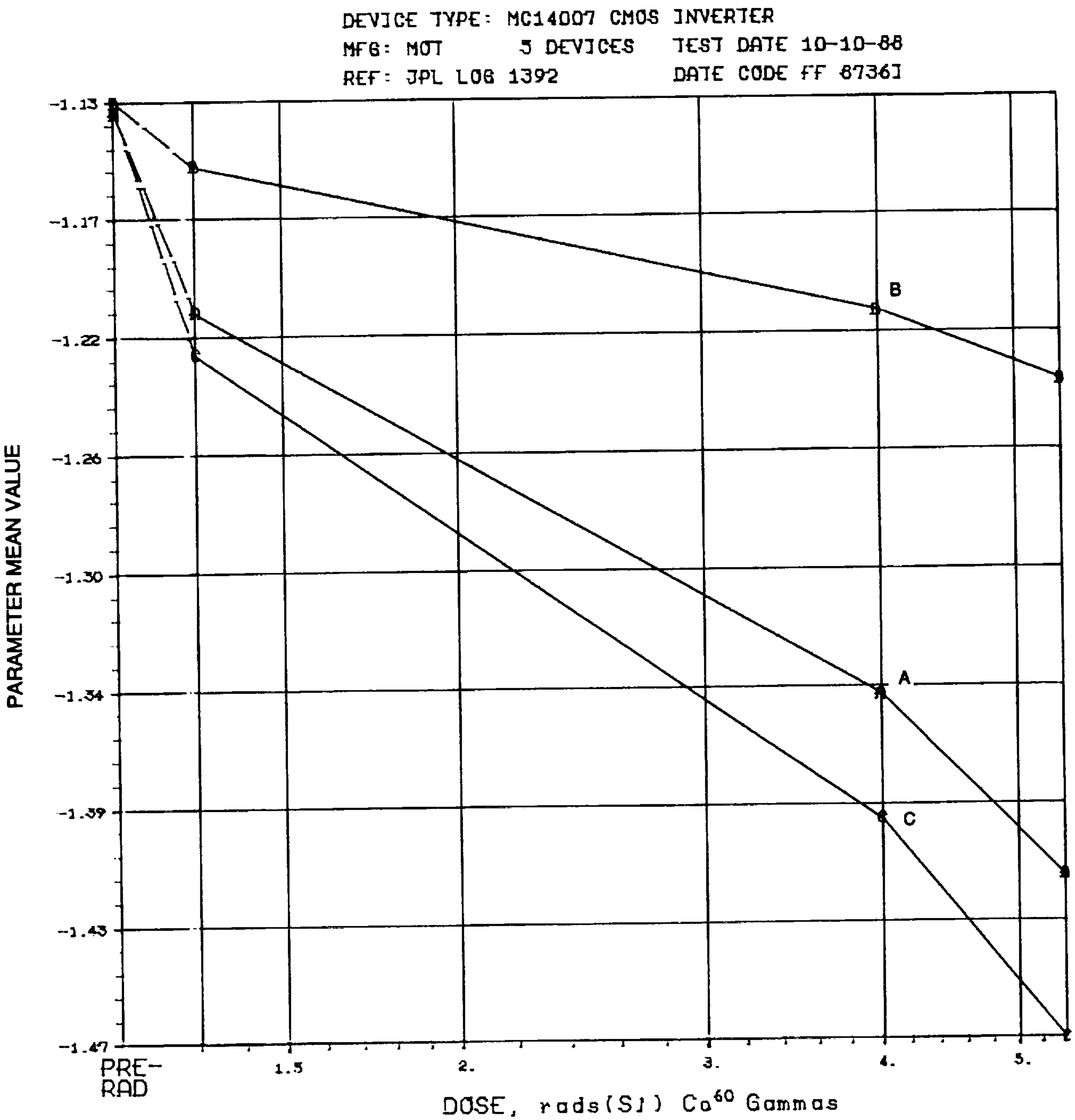
PARAMETERS

CURVE A:	(4)	IDSP(6)-ON	(A)
CURVE B:	(5)	IDSP(3)-OFF	(A)
CURVE C:	(6)	IDSP(10)-OFF	(A)

DEVICE TYPE: MC14007 CMOS INVERTER
MFG: MOT 5 DEVICES TEST DATE 10-10-88
REF: JPL LOG 1392 DATE CODE FF 87361

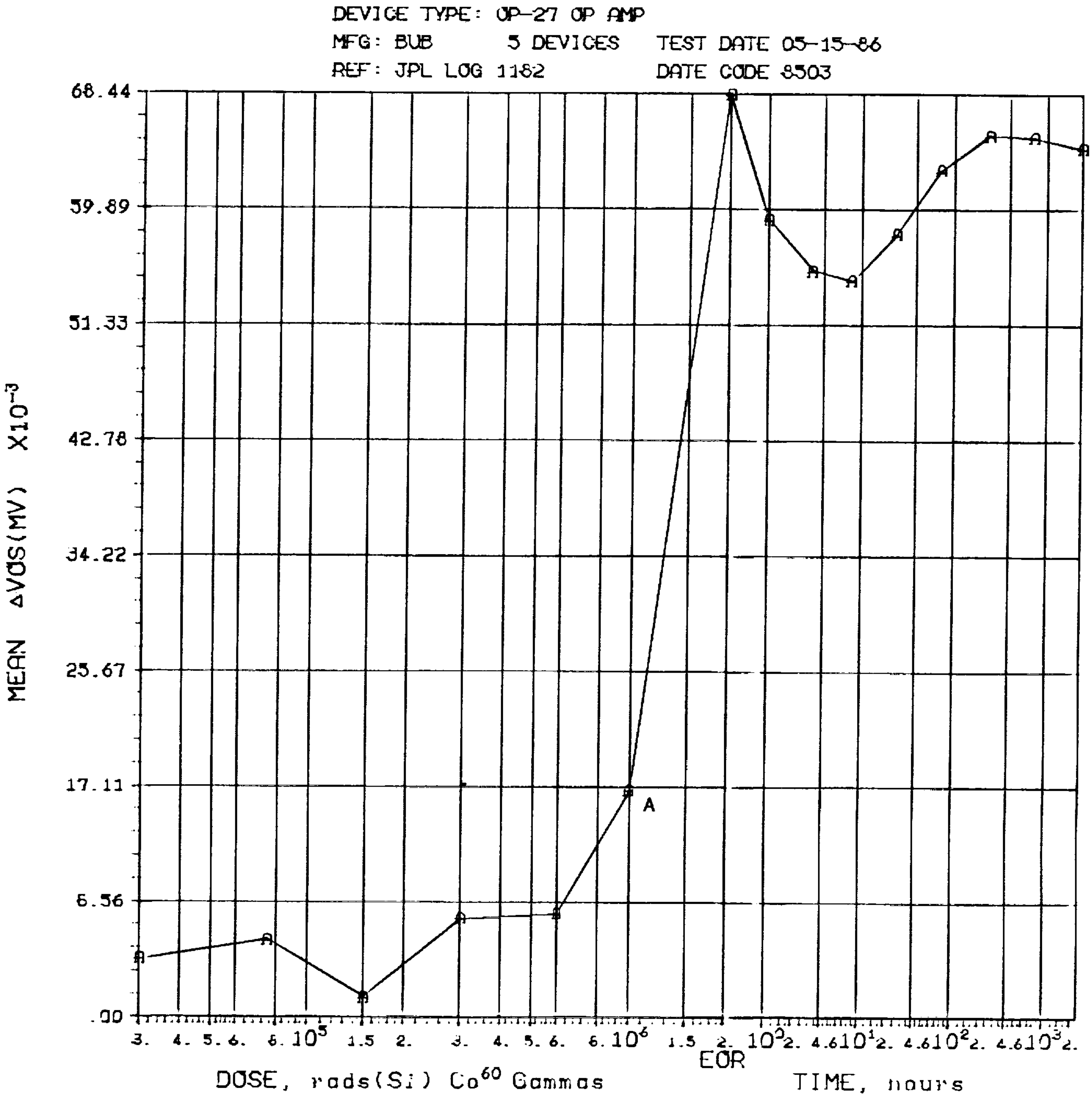


	PARAMETERS
CURVE A:	(7) VTN(6)-ON (V)
CURVE B:	(8) VTN(3)-OFF (V)
CURVE C:	(9) VTP(10)-ON (V)



PARAMETERS

CURVE A:	(10) VTP(6)-OFF (V)
CURVE B:	(11) VTP(3)-ON (V)
CURVE C:	(12) VTP(10)-OFF(V)



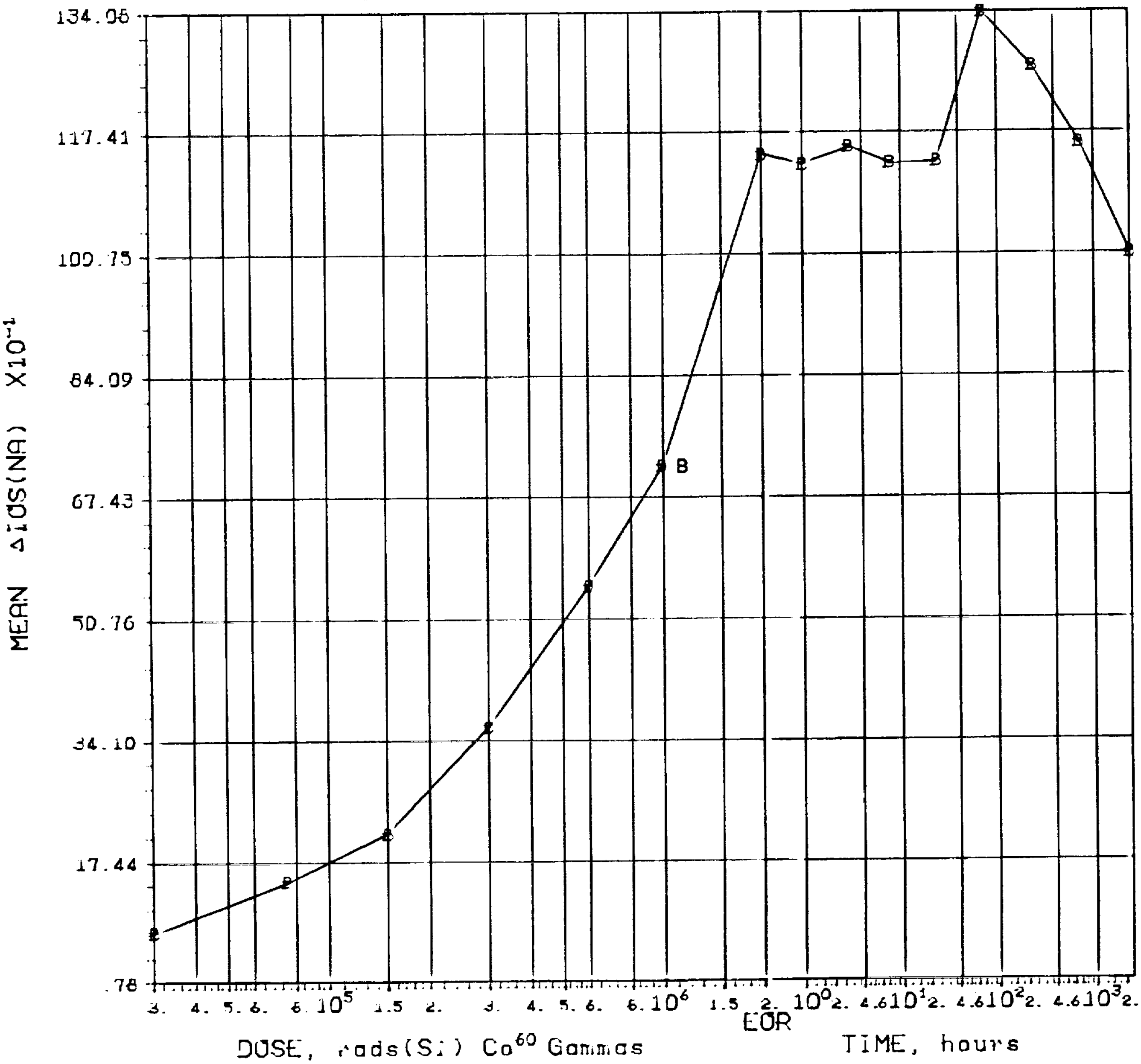
(1) ¬VOS IN MV VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.	.0034	.0030	.0021	.0059	.0042	.0272	.1209	.1076	.1042	.1033	.1017
DOSE/HOURS	7.2E1	2.4E2	7.2E2	2.4E3							
STD. DEV.	.1086	.1122	.1196	.1161							

DEVICE TYPE: OP-27 OP AMP

MFG: BUB 5 DEVICES TEST DATE 05-15-86

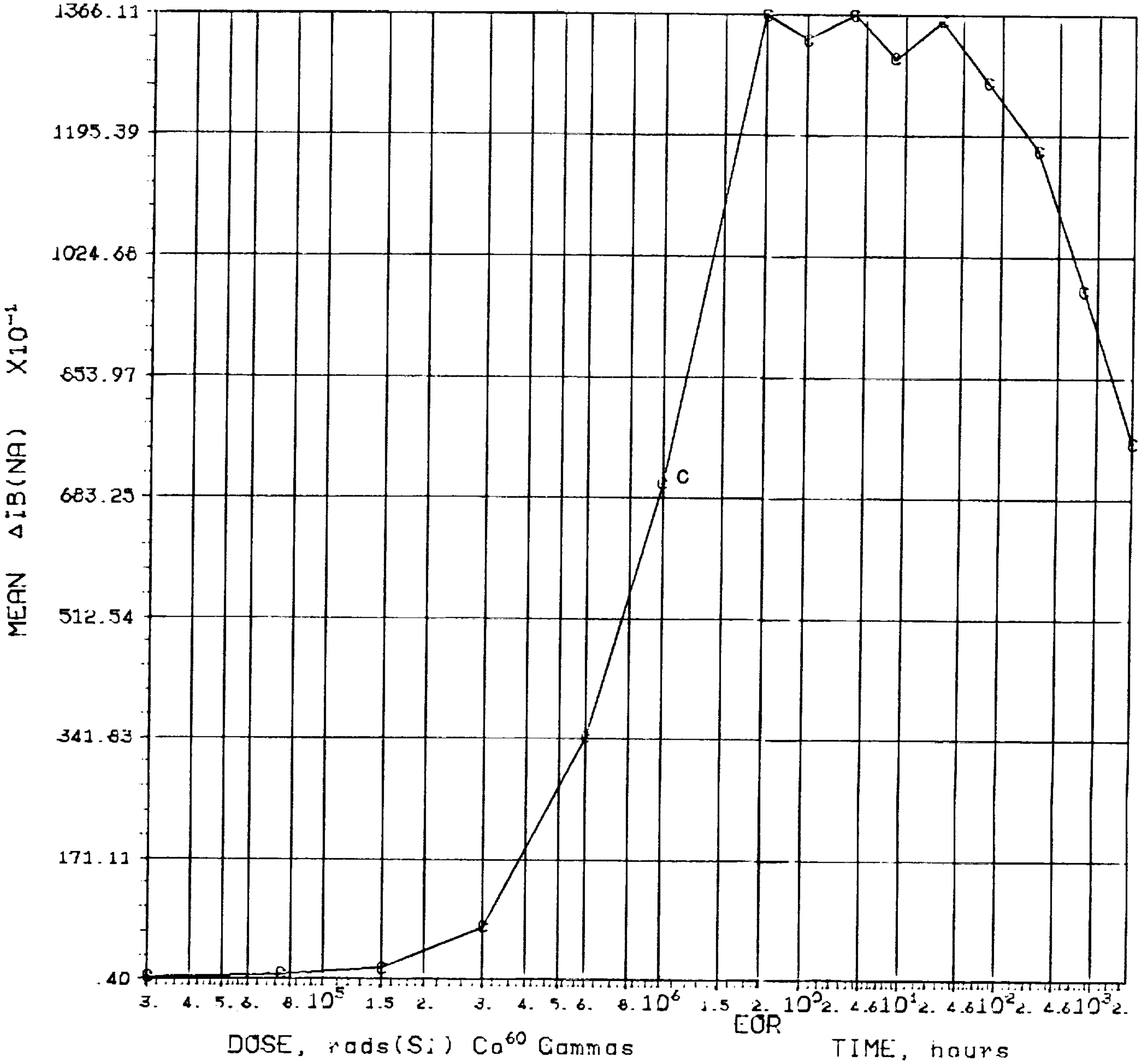
REF: JPL LOG 1162 DATE CODE 8503



(2) ΔIOS IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.	.2925	.5472	1.124	2.126	3.673	6.128	12.33	12.07	12.58	12.51	12.67
DOSE/HOURS	7.2E1	2.4E2	7.2E2	2.4E3							
STD. DEV.	16.45	15.06	13.13	13.75							

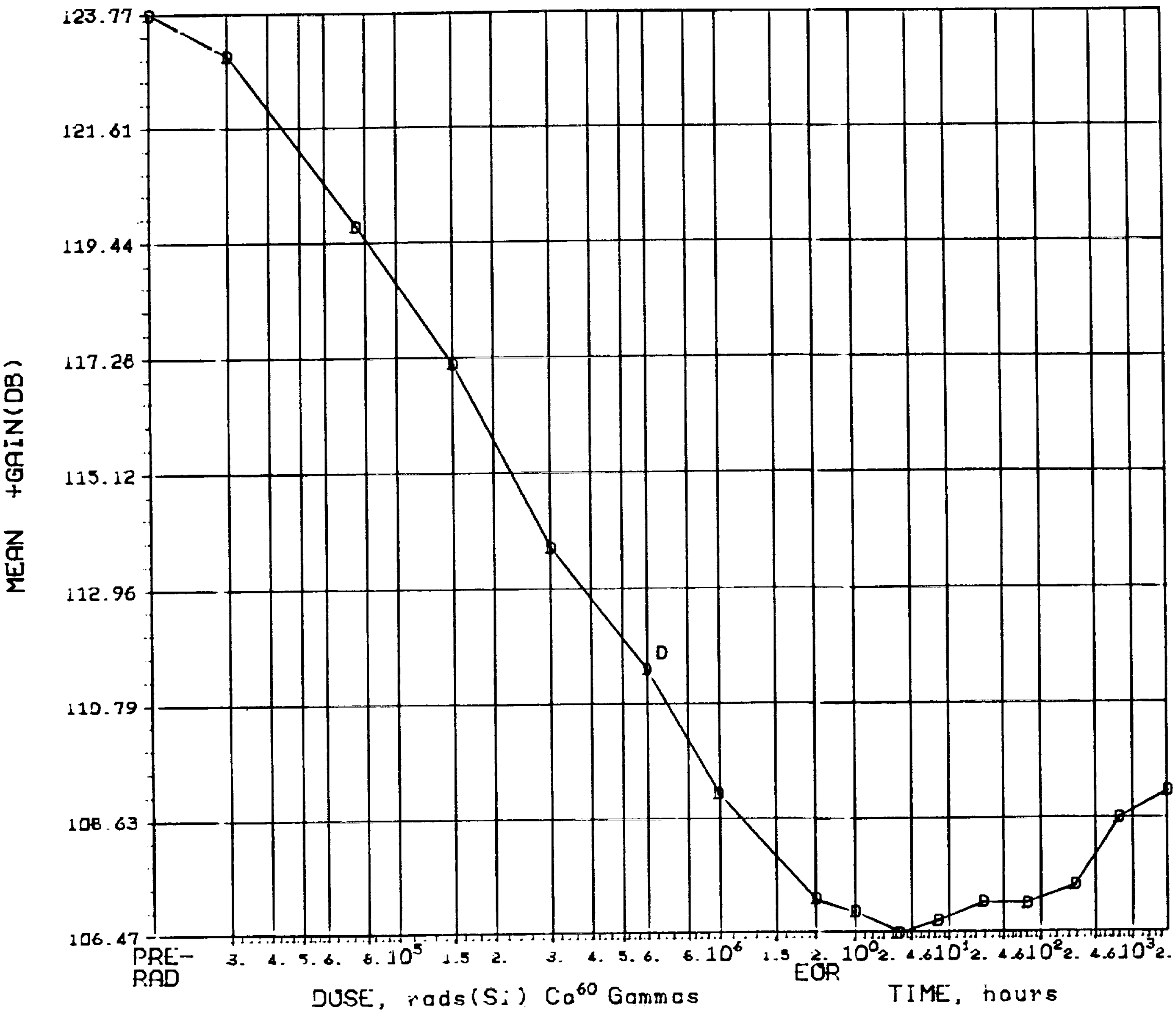
DEVICE TYPE: OP-27 OP AMP
MFG: BUB 5 DEVICES TEST DATE 05-15-86
REF: JPL LOG 1162 DATE CODE 8503



(3) ¬IB IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.	1.234	1.279	1.046	9.345	16.69	21.17	24.66	24.94	24.64	24.30	25.05
DOSE/HOURS	7.2E1	2.4E2	7.2E2	2.4E3							
STD. DEV.	23.33	20.96	16.66	11.93							

DEVICE TYPE: OP-27 OP AMP
MFG: BUB 5 DEVICES TEST DATE 05-15-86
REF: JPL LOG 1182 DATE CODE 8503

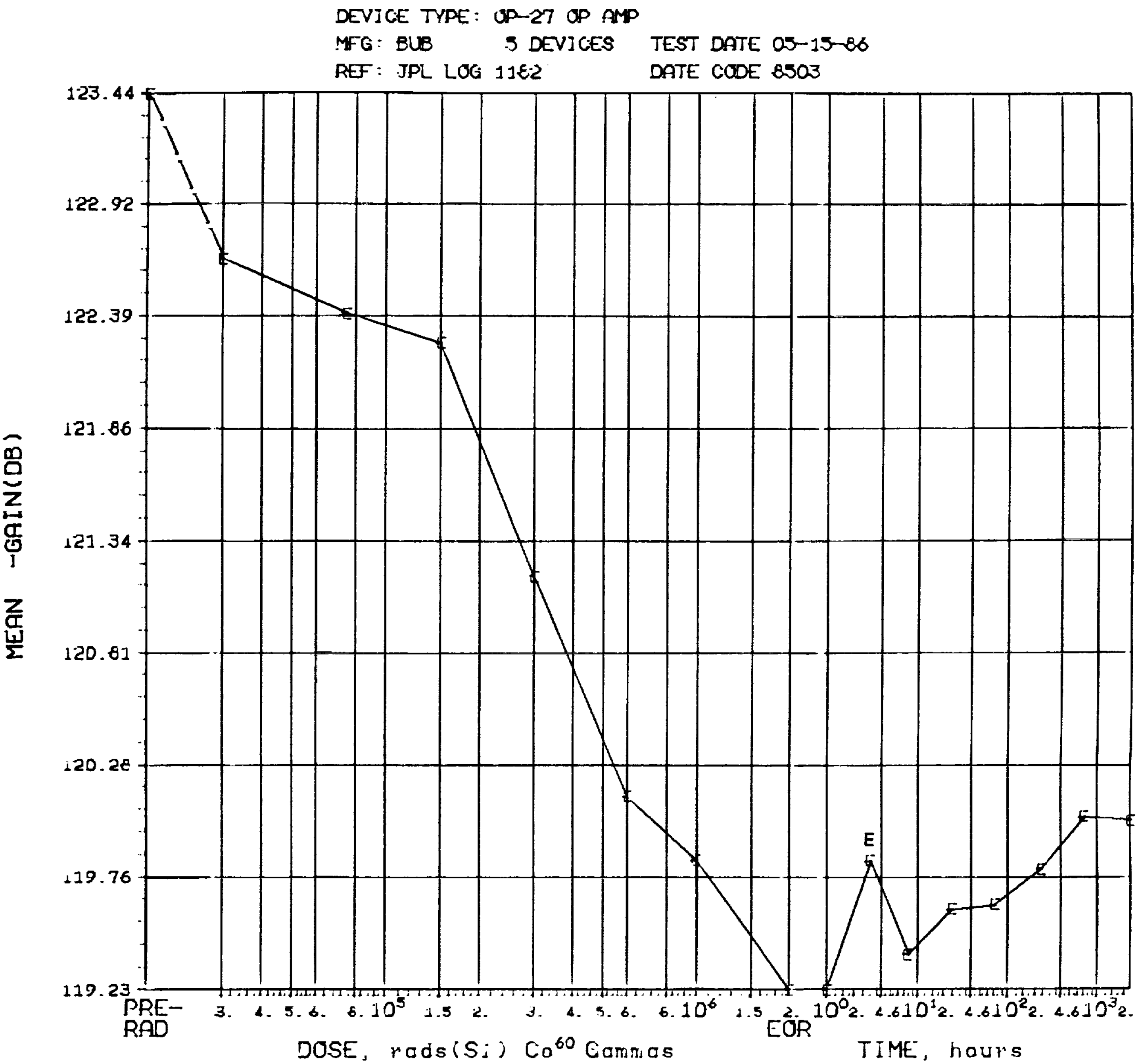


(4) +GAIN (1K LOAD=10MA, +10V) IN DBB VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
I_L= 10.0 mA	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.0	.7512	2.005	1.422	3.133	3.792	3.265	3.069	2.389	2.662	2.514	2.296

DOSE/HOURS	7.2E1	2.4E2	7.2E2	2.4E3
STD. DEV.	2.700	2.465	3.295	1.772

INITIAL MEAN VALUE +GAIN(DB) = $+1.24X10^{+2}$

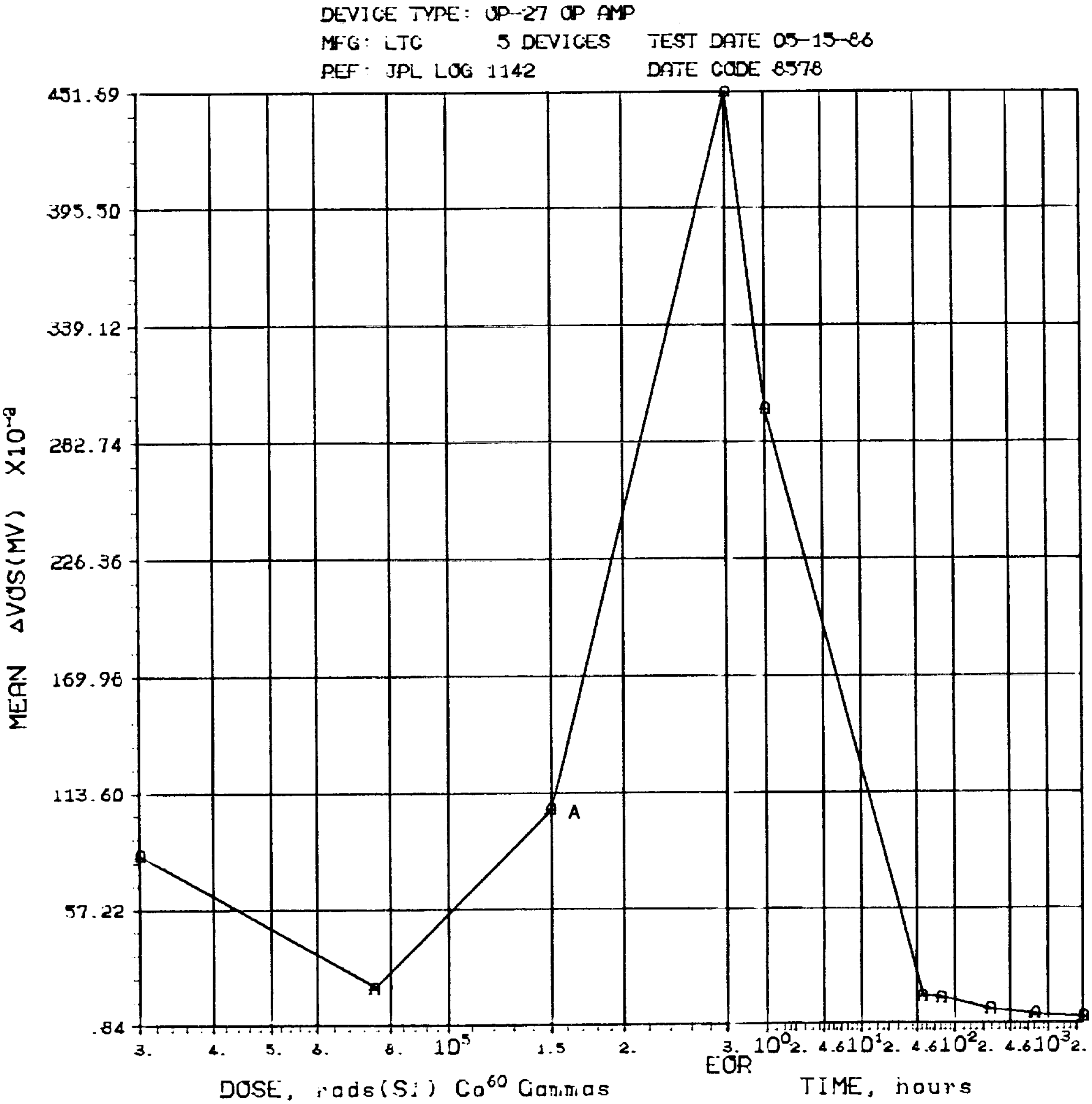


(5) -GAIN (1K LOAD=10MA,-10V) IN DBB VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
I_L= 10.0 mA	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.0	.5570	1.031	1.051	.5115	.7417	1.038	1.179	1.179	1.038	.7614	.7918

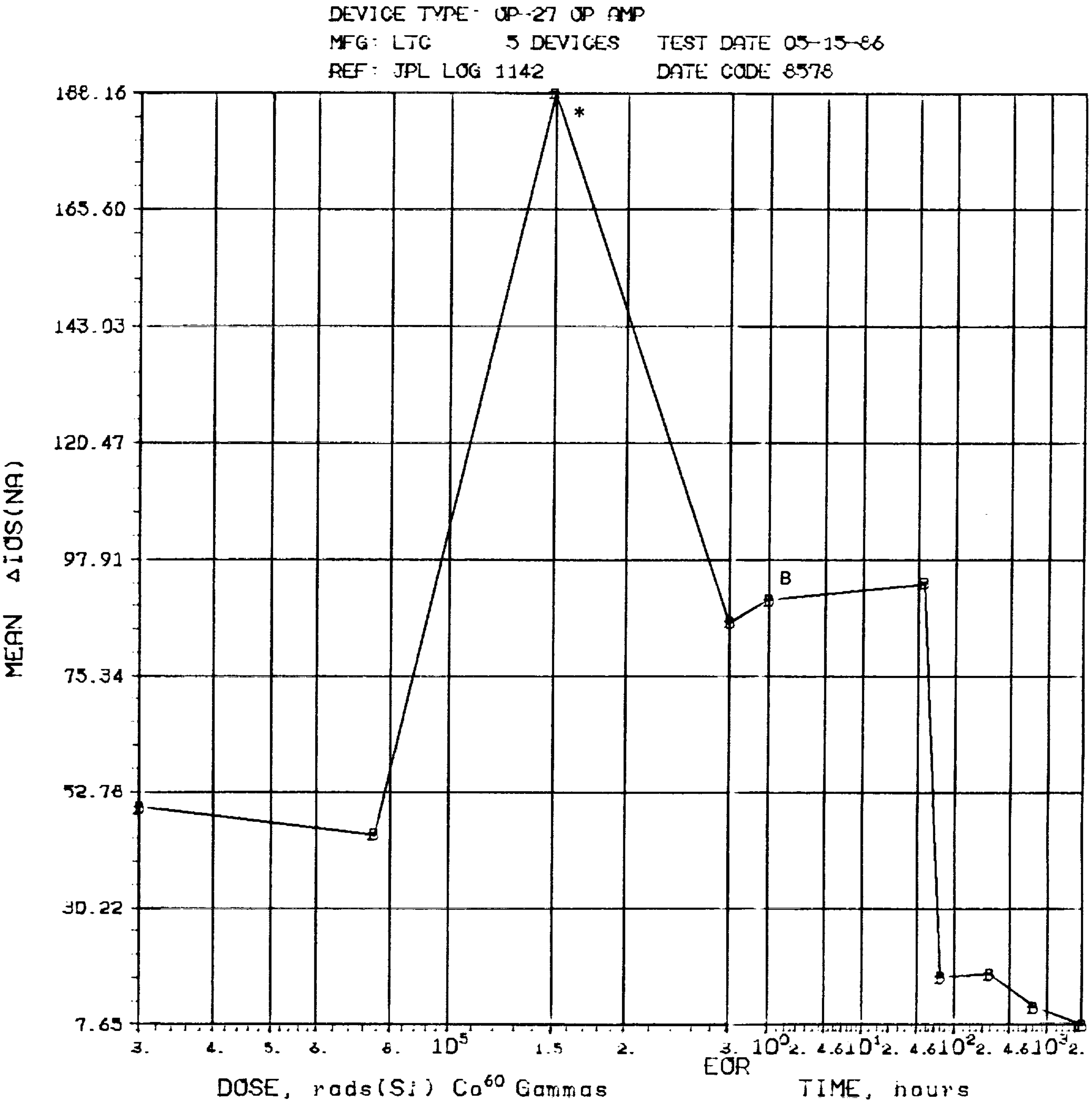
DOSE/HOURS	7.2E1	2.4E2	7.2E2	2.4E3
STD. DEV.	1.076	.4139	.9749	.7120

INITIAL MEAN VALUE -GAIN(DB) = +1.23X10^{+2}



(1) ¬VOS IN MV VS DOSE

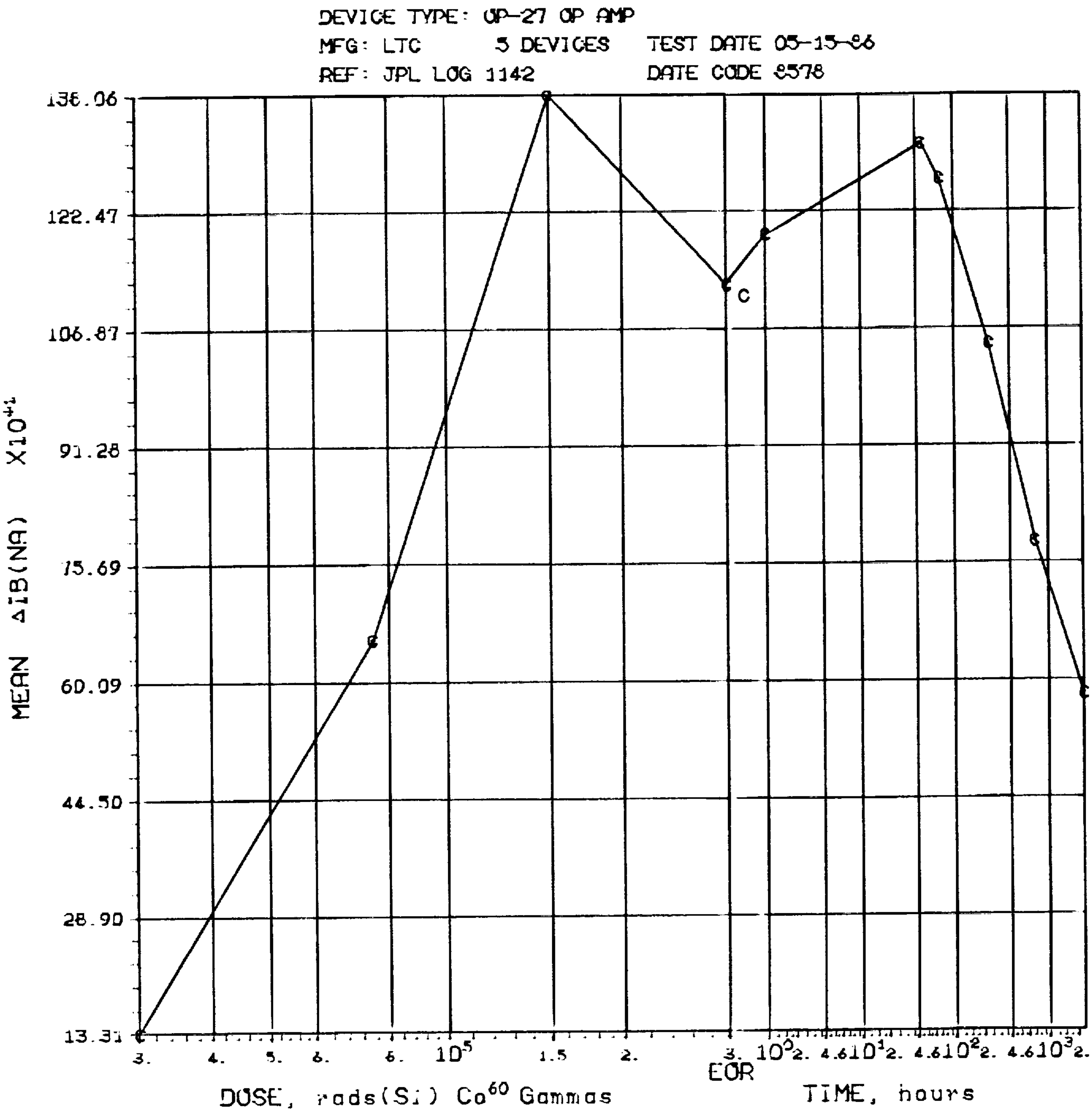
TABLE OF NORMAL STANDARD DEVIATIONS	
	DOSE, rads(Si) TIME, hours
DOSE/HOURS	3.0E4 7.5E4 1.5E5 3.0E5 1.0E0 4.6E1 7.2E1 2.4E2 7.2E2 2.4E3 @@@@@
STD. DEV.	.1539 .0736 .2284 5.677 3.788 .1880 .1389 .0811 .0457 .0314



(2) ΔIOS IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
	DOSE, rads(SI) TIME, hours
DOSE/HOURS	3.0E4 7.5E4 1.5E5 3.0E5 1.0E0 4.6E1 7.2E1 2.4E2 7.2E2 2.4E3 @@@@@
STD. DEV.	19.49 21.19 104.9 72.62 58.70 40.00 15.17 8.633 3.742 6.368

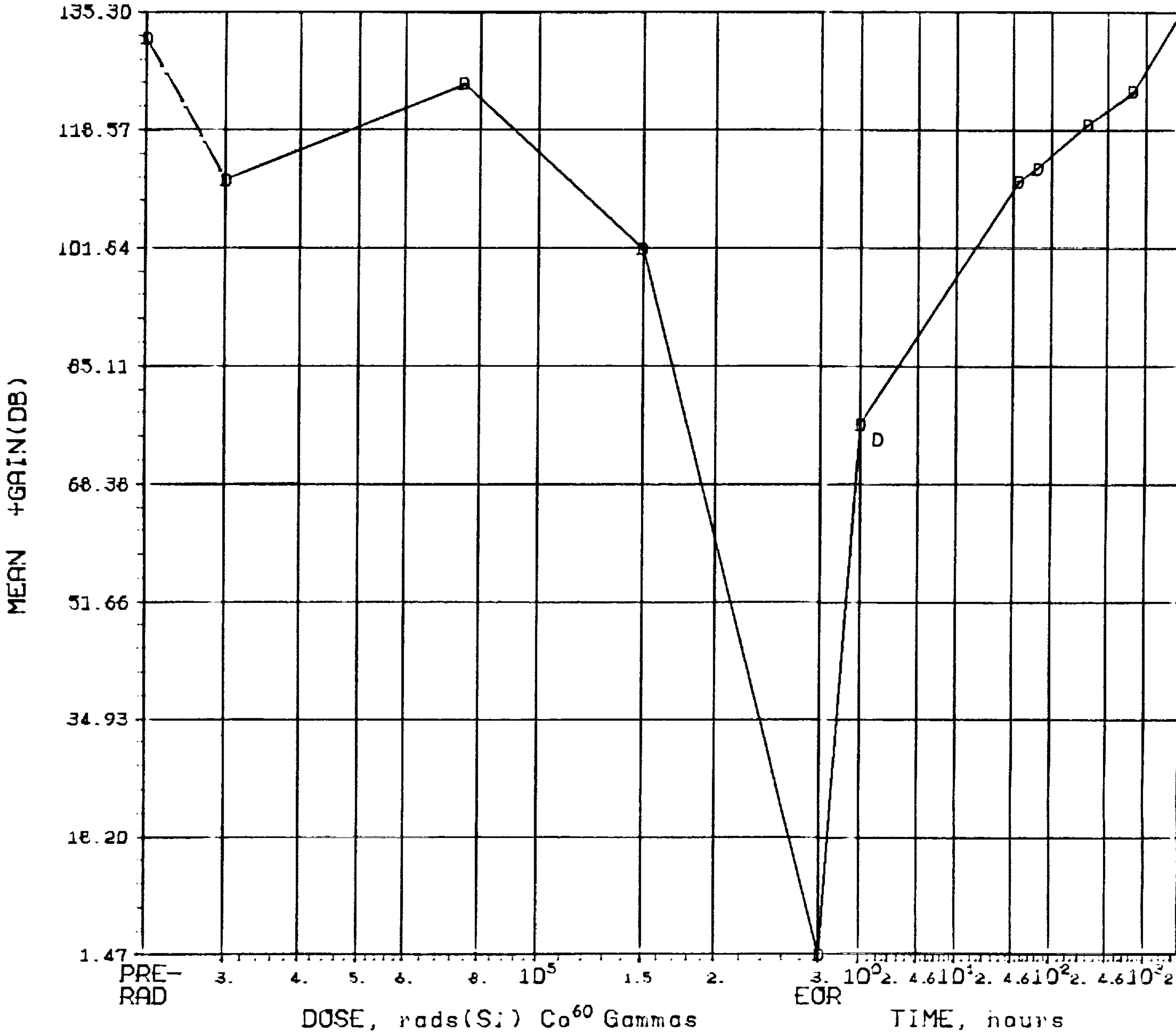
* MEASUREMENT PROBLEM



(3) ΔIB IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS										
	DOSE, rads(SI) TIME, hours									
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	1.0E0	4.6E1	7.2E1	2.4E2	7.2E2	2.4E3 @@@@@
STD. DEV.	39.36	146.1	20.01	132.5	128.6	76.11	109.6	123.5	104.5	91.44

DEVICE TYPE: OP-27 OP AMP
MFG: LTC 5 DEVICES TEST DATE 05-15-86
REF: JPL LOG 1142 DATE CODE 8578

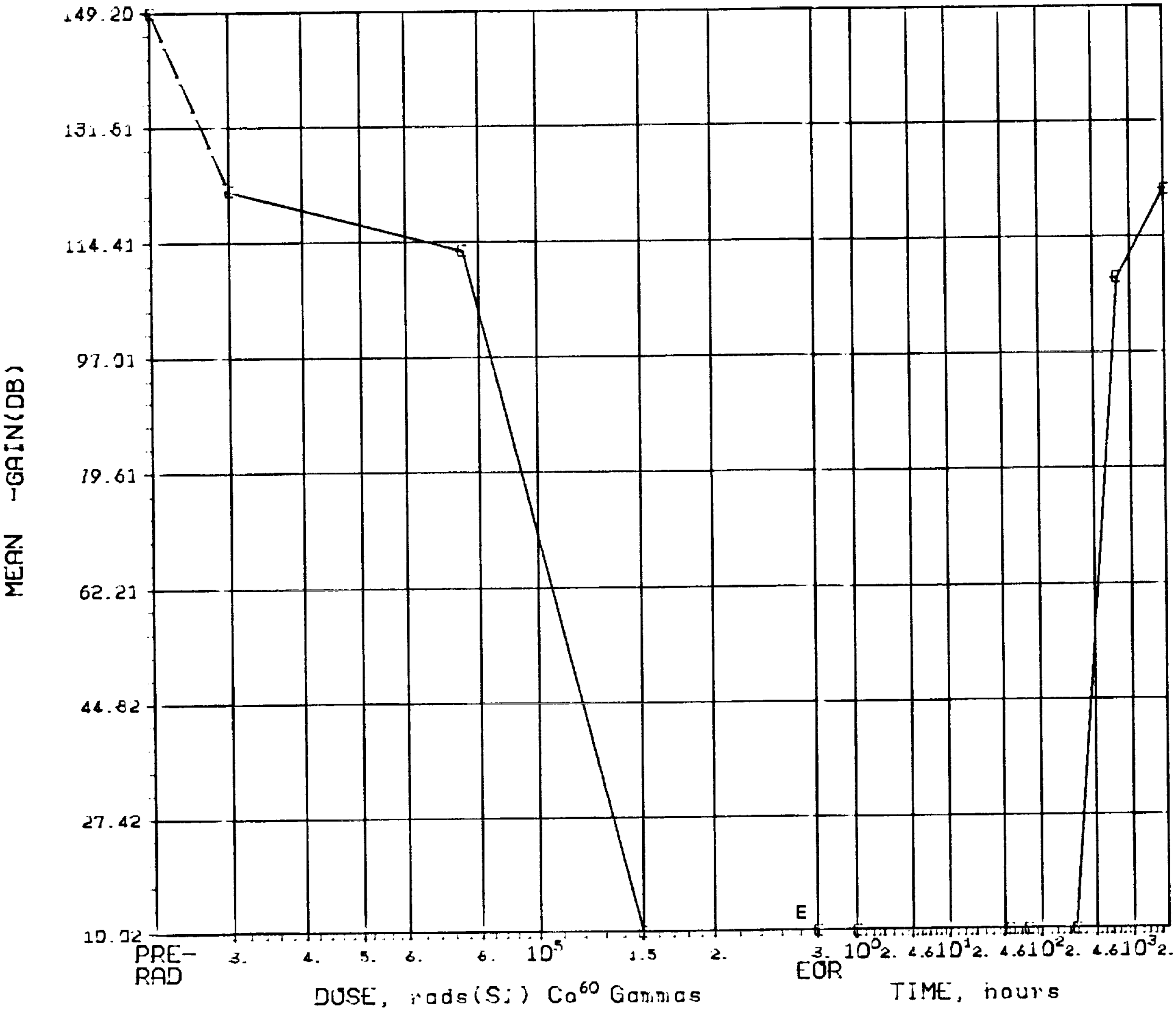


(4) +GAIN (1K LOAD=10MA,+10V) IN DBB VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
I_L= 10.0 mA	DOSE, rads(Si)			TIME, hours							
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	1.0E0	4.6E1	7.2E1	2.4E2	7.2E2	2.4E3	@@@@@
STD. DEV.0	2.062	4.910	1.559	XXXXX	13.16	12.91	10.55	5.424	4.544	10.44	

INITIAL MEAN VALUE +GAIN(DB) = $+1.31X10^{+2}$

DEVICE TYPE: OP-27 OP AMP
MFG: LTC 5 DEVICES TEST DATE 05-15-86
REF: JPL LOG 1142 DATE CODE 8578



(5) -GAIN (1K LOAD=10MA,-10V) IN DBB VS DOSE

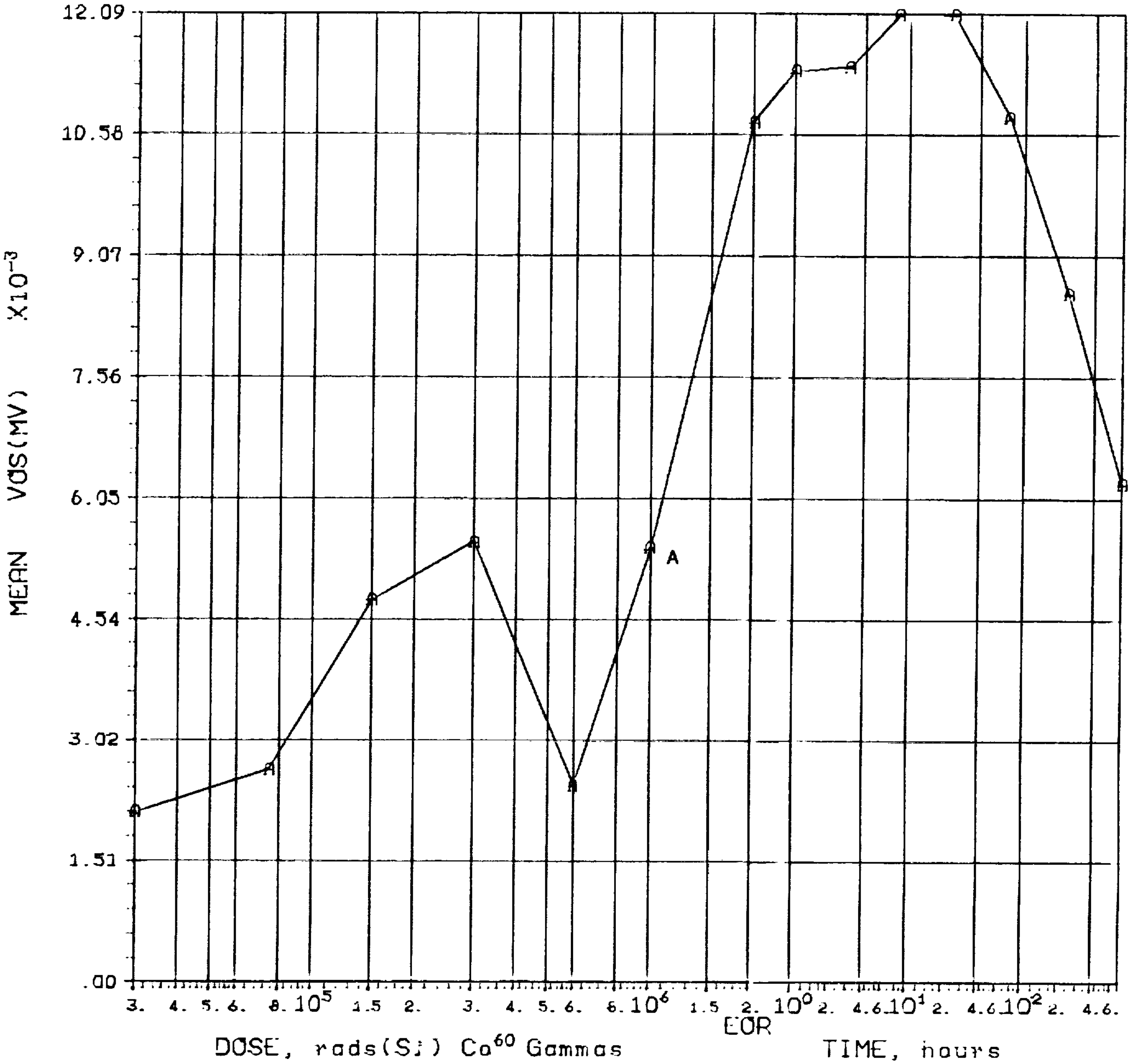
TABLE OF NORMAL STANDARD DEVIATIONS	
I_L= 10.0 mA	DOSE, rads(Si) TIME, hours
DOSE/HOURS	3.0E4 7.5E4 1.5E5 3.0E5 1.0E0 4.6E1 7.2E1 2.4E2 7.2E2 2.4E3 @@@@@
STD. DEV.0	2.067 10.31 ***** ***** ***** ***** ***** ***** 3.314 5.933

INITIAL MEAN VALUE -GAIN(DB) = $+1.49\times10^{+2}$

DEVICE TYPE: OP-27 OP AMP

MFG: MPS 4 DEVICES TEST DATE 06-11-86

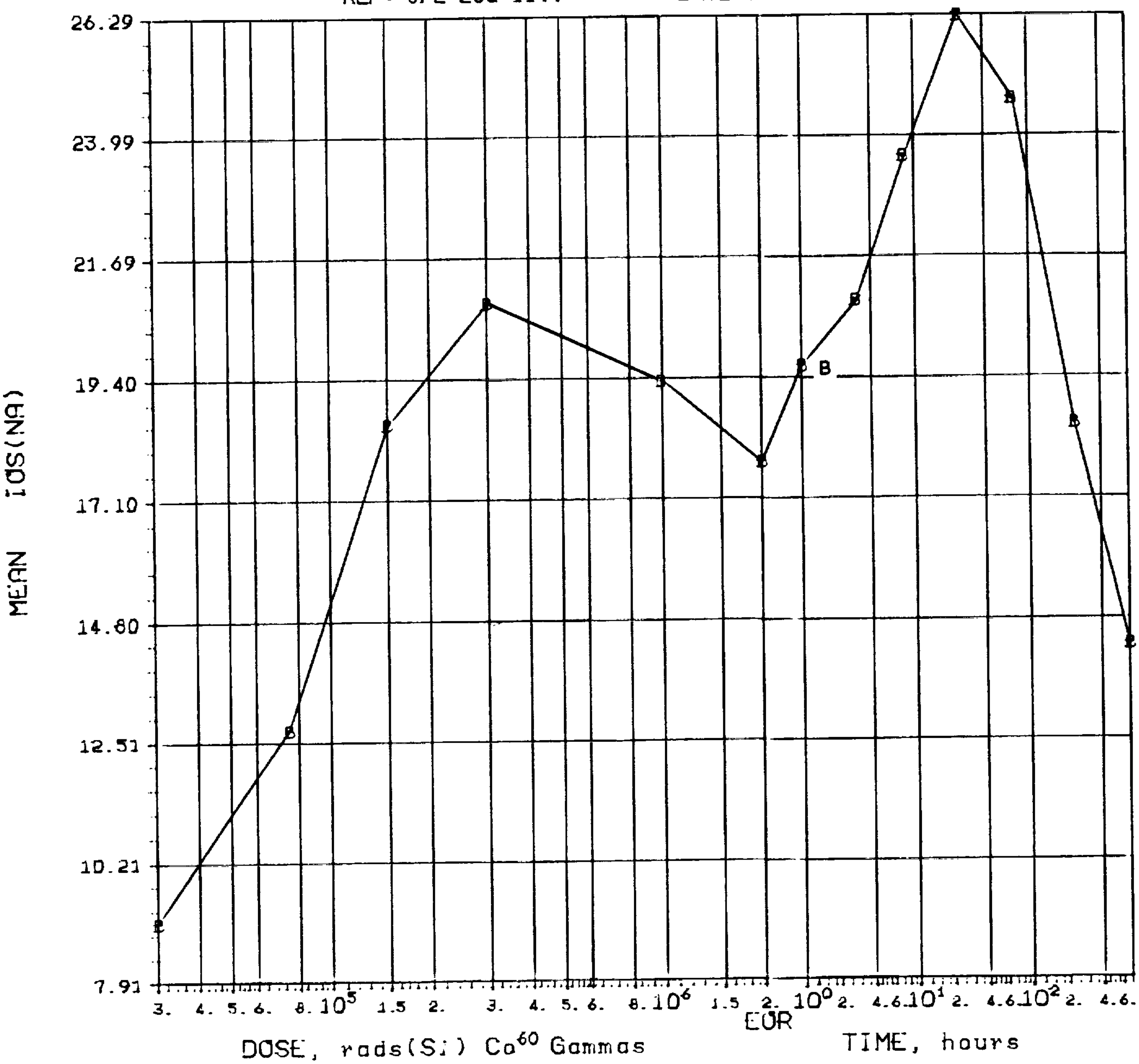
REF: JPL LOG 1147 DATE CODE 8350



(1) VOS IN MV VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.	.0020	.0024	.0041	.0063	.0015	.0017	.0089	.0080	.0075	.0075	.0070
DOSE/HOURS	7.2E1	2.4E2	7.2E2								
STD. DEV.	.0042	.0036	.0039								

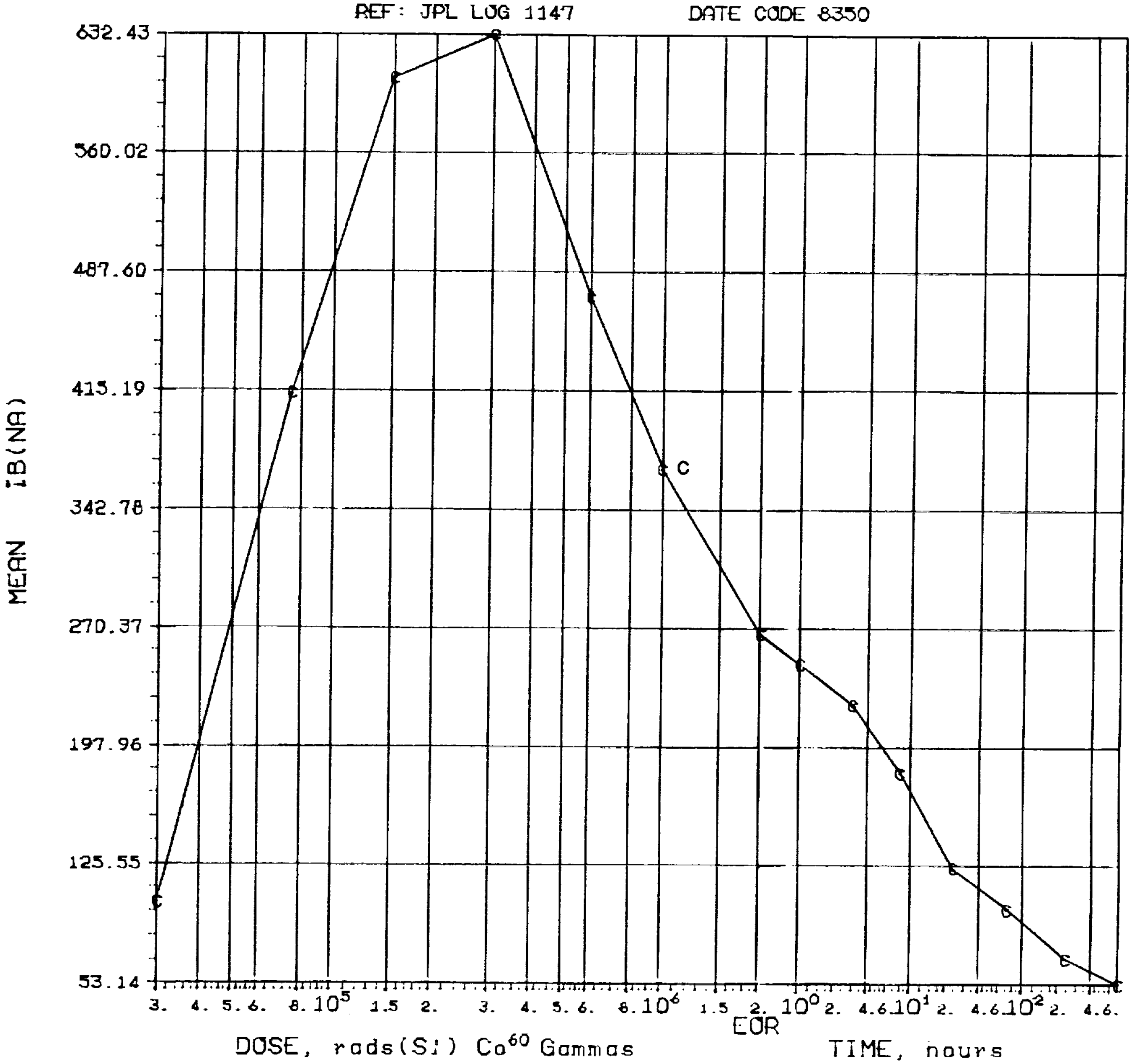
DEVICE TYPE: OP-27 OP AMP
MFG: MPS 4 DEVICES TEST DATE 06-11-86
REF: JPL LOG 1147 DATE CODE 8350



(2) IOS IN NA VS DOSE

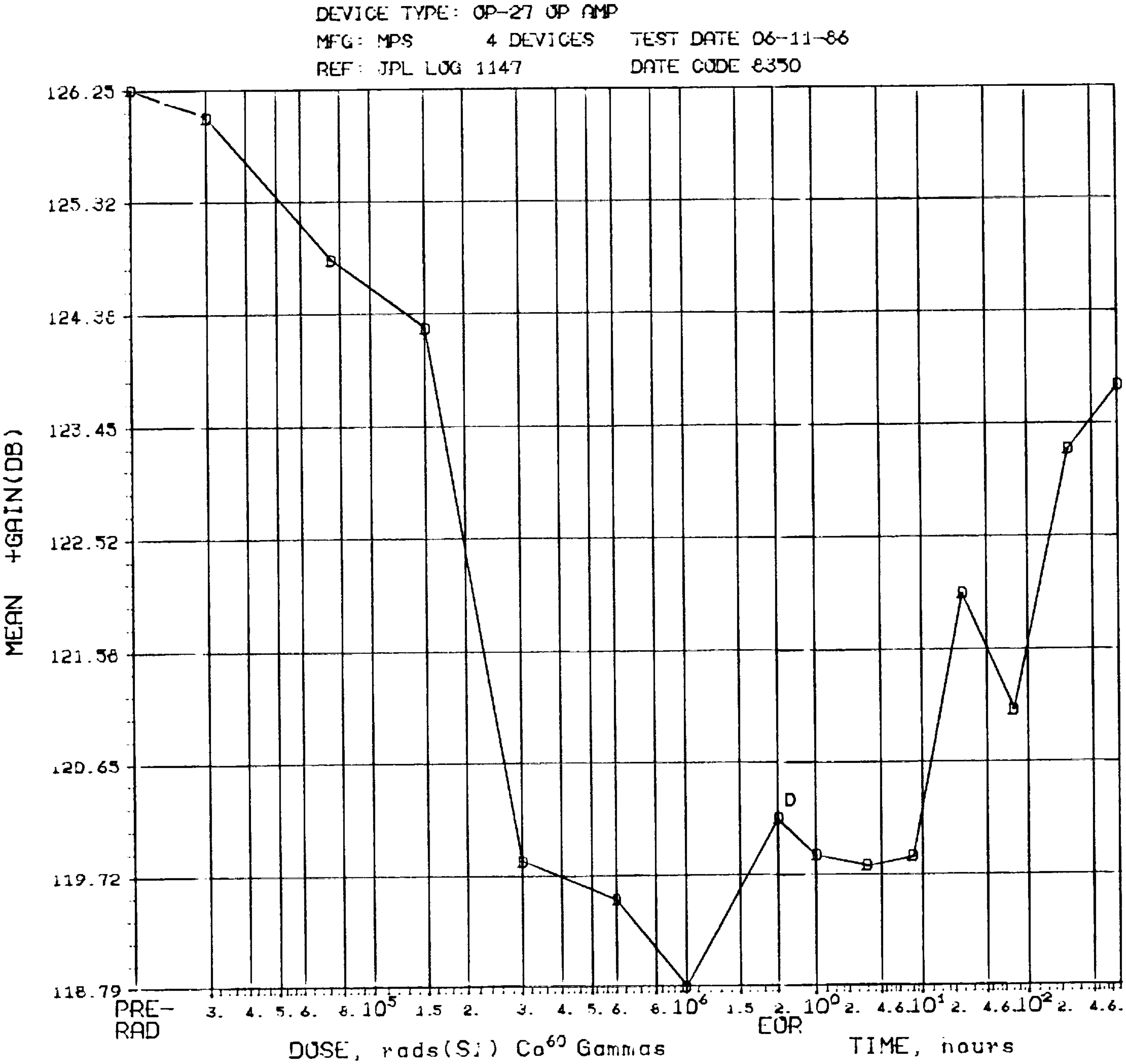
TABLE OF NORMAL STANDARD DEVIATIONS											
	DOSE, rads(Si)						TIME, hours				
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.	7.670	14.57	26.75	29.04	5.053	17.65	20.38	25.45	32.97	37.64	39.65
DOSE/HOURS	7.2E1	2.4E2	7.2E2								
STD. DEV.	35.77	23.75	20.12								

DEVICE TYPE: OP-27 OP AMP
MFG: MPS 4 DEVICES TEST DATE 06-11-86
REF: JPL LOG 1147 DATE CODE 8350



(3) IB IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.	13.07	22.47	6.149	39.88	28.00	22.74	34.64	40.35	52.36	68.74	82.60
DOSE/HOURS	7.2E1	2.4E2	7.2E2								
STD. DEV.	54.90	23.11	19.16								



(4) +GAIN (1K LOAD=10MA, +10V) IN DB VS DOSE

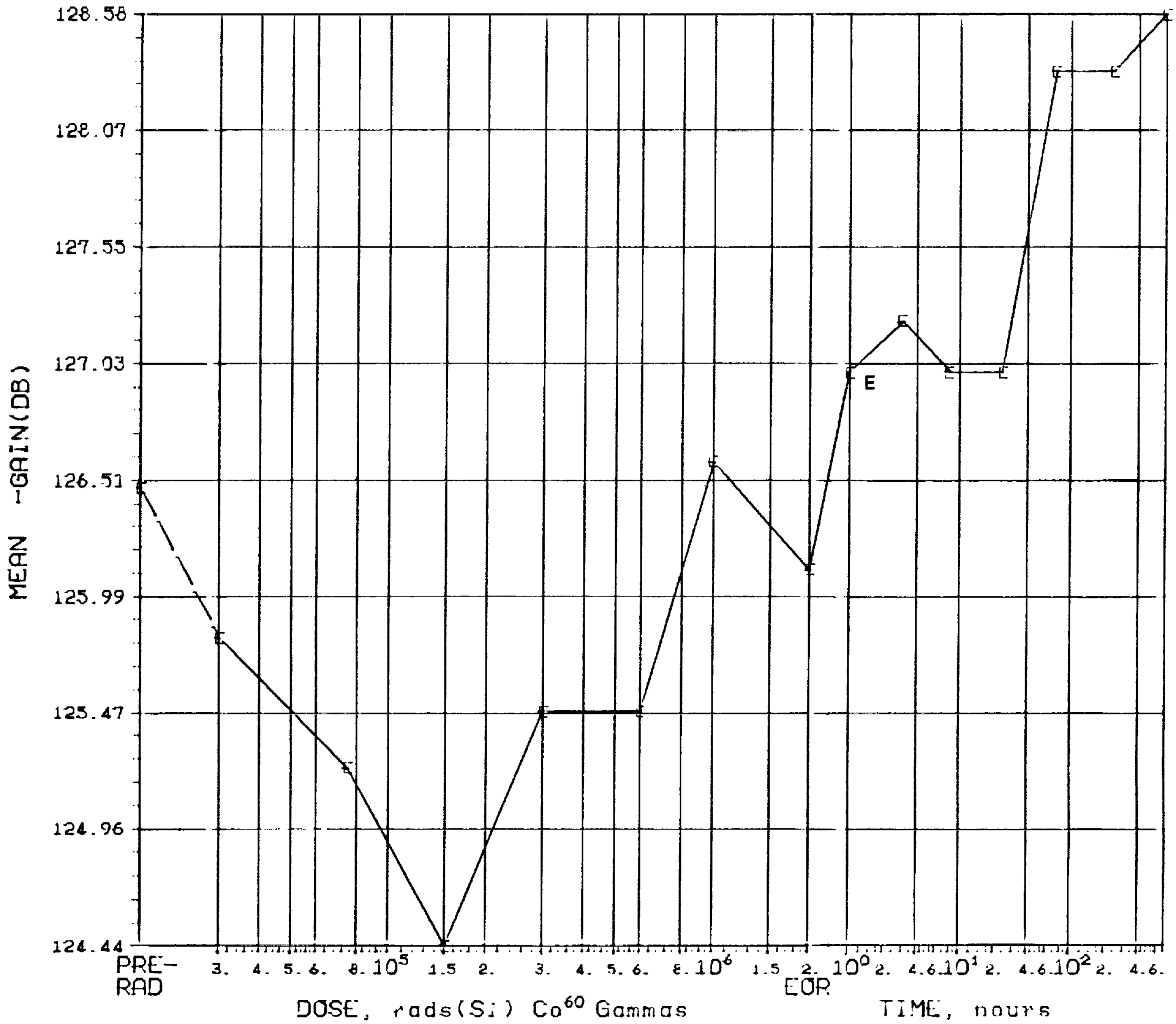
TABLE OF NORMAL STANDARD DEVIATIONS

I_L= 10.0 mA	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.0	.0000	.7918	.3476	5.024	5.734	4.260	3.725	4.640	4.933	3.845	5.189

DOSE/HOURS	7.2E1	2.4E2	7.2E2
STD. DEV.	3.900	3.360	2.978

INITIAL MEAN VALUE +GAIN(DB) = $+1.26 \times 10^{+2}$

DEVICE TYPE: OP-27 OP AMP
MFG: MPS 4 DEVICES TEST DATE 06-11-86
REF: JPL LOG 1147 DATE CODE 8350

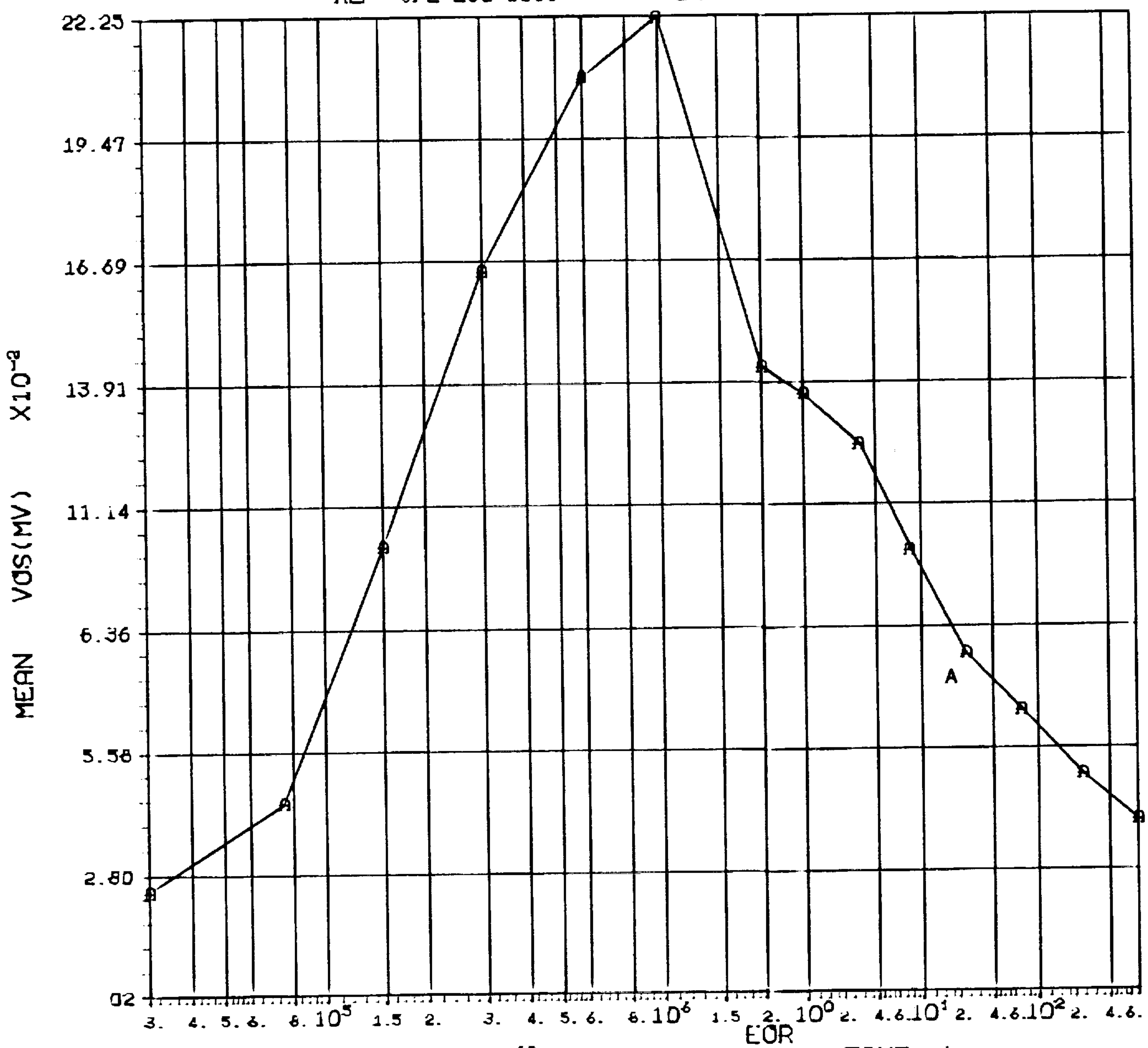


(5) -GAIN (1K LOAD=10MA, -10V) IN DB VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
I_L= 10.0 mA	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.0	.4139	.9143	.0000	2.535	2.535	1.704	1.441	1.119	.9329	1.119	1.119
DOSE/HOURS	7.2E1	2.4E2	7.2E2								
STD. DEV.	1.500	1.500	1.249								

INITIAL MEAN VALUE -GAIN(DB) = $+1.26X10^{+2}$

DEVICE TYPE: OP-27 OP AMP
MFG: RAY 5 DEVICES TEST DATE 06-11-86
REF: JPL LOG 1168 DATE CODE 8230



(1) VOS IN MV VS DOSE

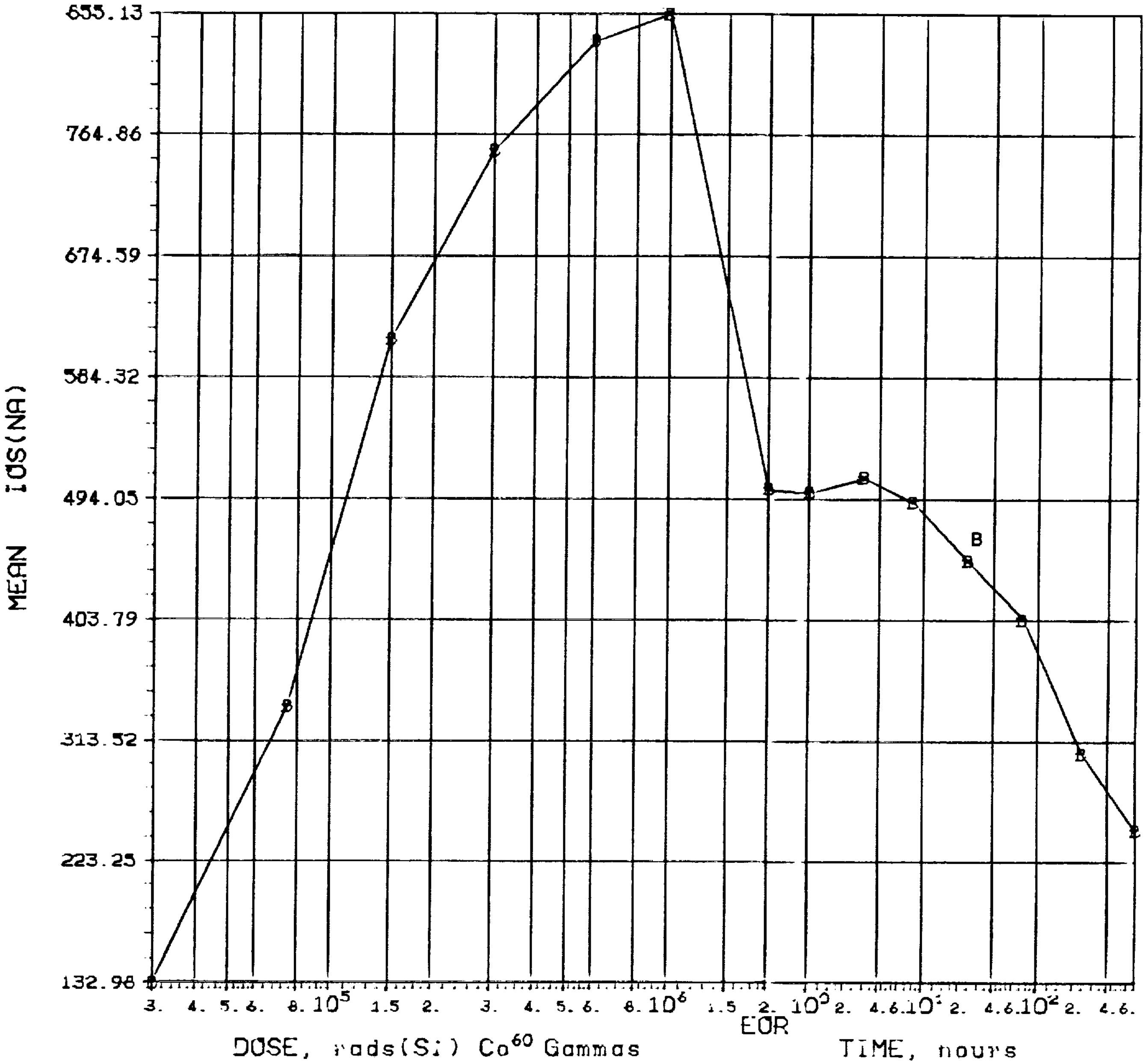
TABLE OF NORMAL STANDARD DEVIATIONS											
	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.	.0130	.0434	.1657	.1567	.1665	.2199	.1162	.1083	.0980	.0693	.0553

DOSE/HOURS	7.2E1	2.4E2	7.2E2
STD. DEV.	.0489	.0277	.0225

DEVICE TYPE: OP-27 OP AMP

MFG: RAY 5 DEVICES TEST DATE 06-11-86

REF: JPL LOG 1168 DATE CODE 8230

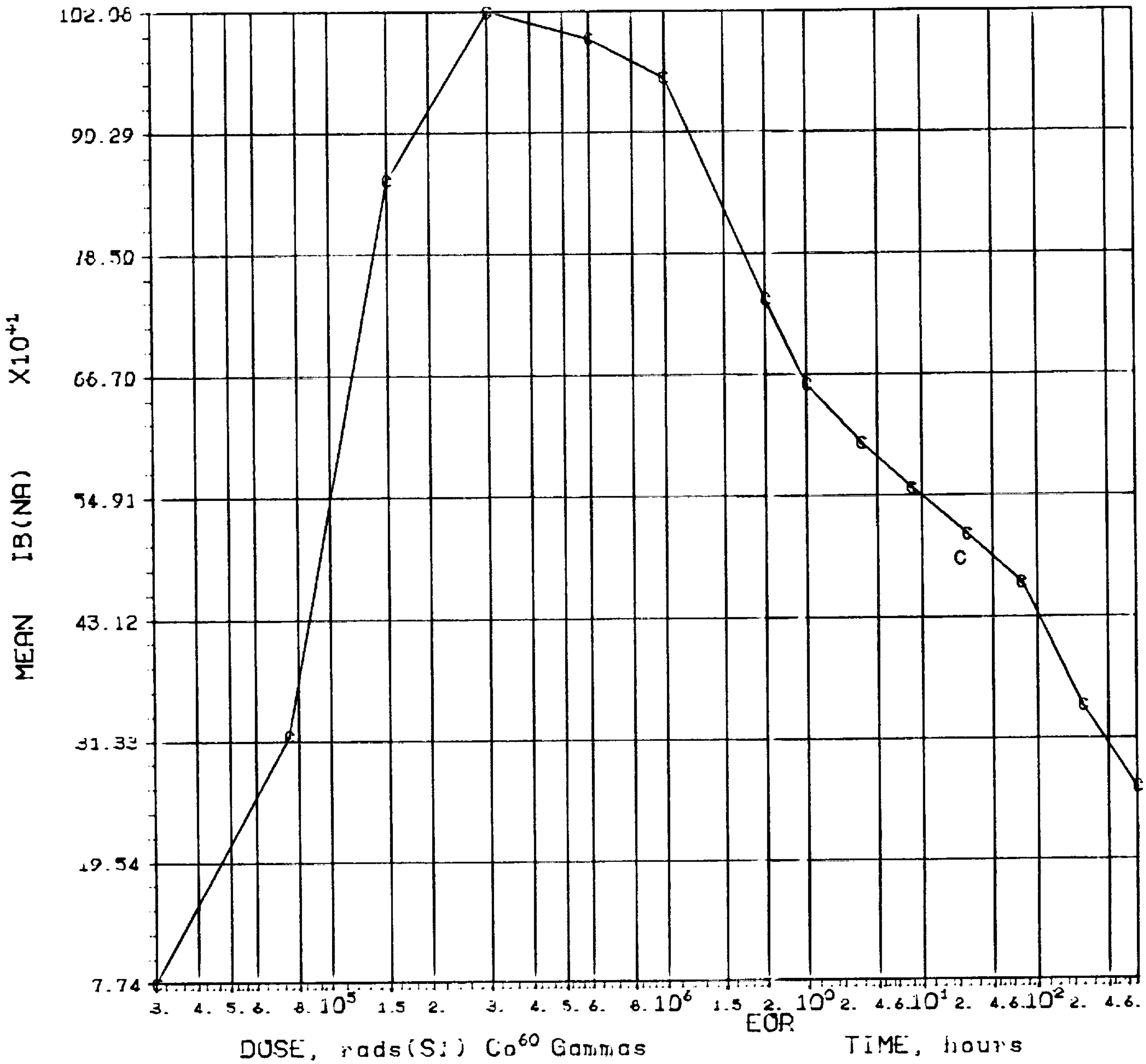


(2) IOS IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	6.0E0	2.4E1
STD. DEV.	62.67	195.5	298.4	257.9	147.2	228.0	221.6	226.0	254.1	286.4	313.5

DOSE/HOURS	7.2E1	2.4E2	7.2E2
STD. DEV.	321.7	288.3	250.0

DEVICE TYPE: OP-27 OP AMP
MFG: PMI 5 DEVICES TEST DATE 06-11-86
REF: JPL LOG 1168 DATE CODE 8230



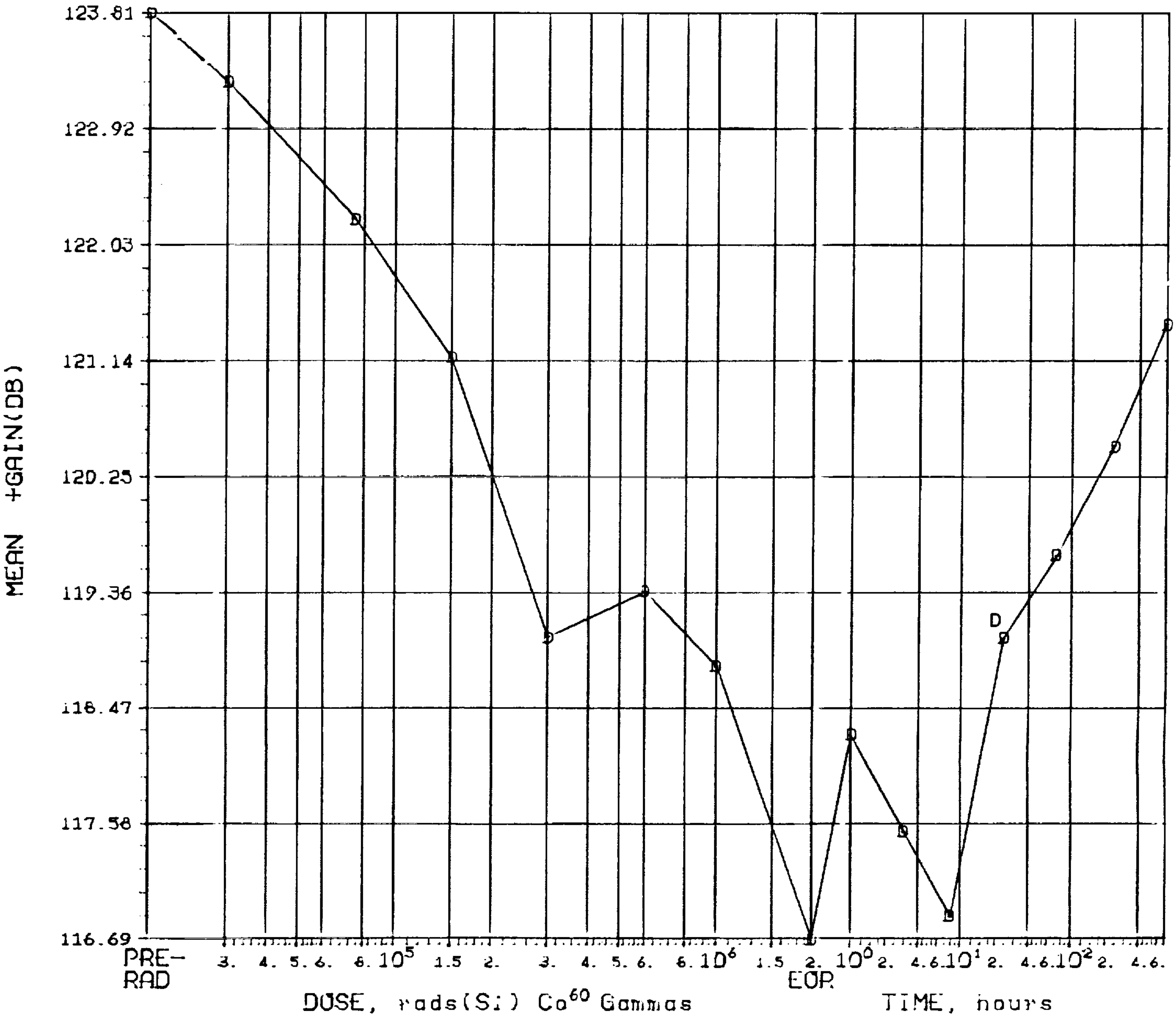
(3) IB IN NA VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
	DOSE, rads(Si)						TIME, hours				
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.	52.92	166.0	581.6	491.6	493.4	433.0	491.6	414.9	360.5	311.5	227.6
DOSE/HOURS	7.2E1	2.4E2	7.2E2								
STD. DEV.	166.1	128.1	97.02								

DEVICE TYPE: OP-27 OP AMP

MFG: RAY 5 DEVICES TEST DATE 06-11-86

REF: JPL LOG 1168 DATE CODE 8230

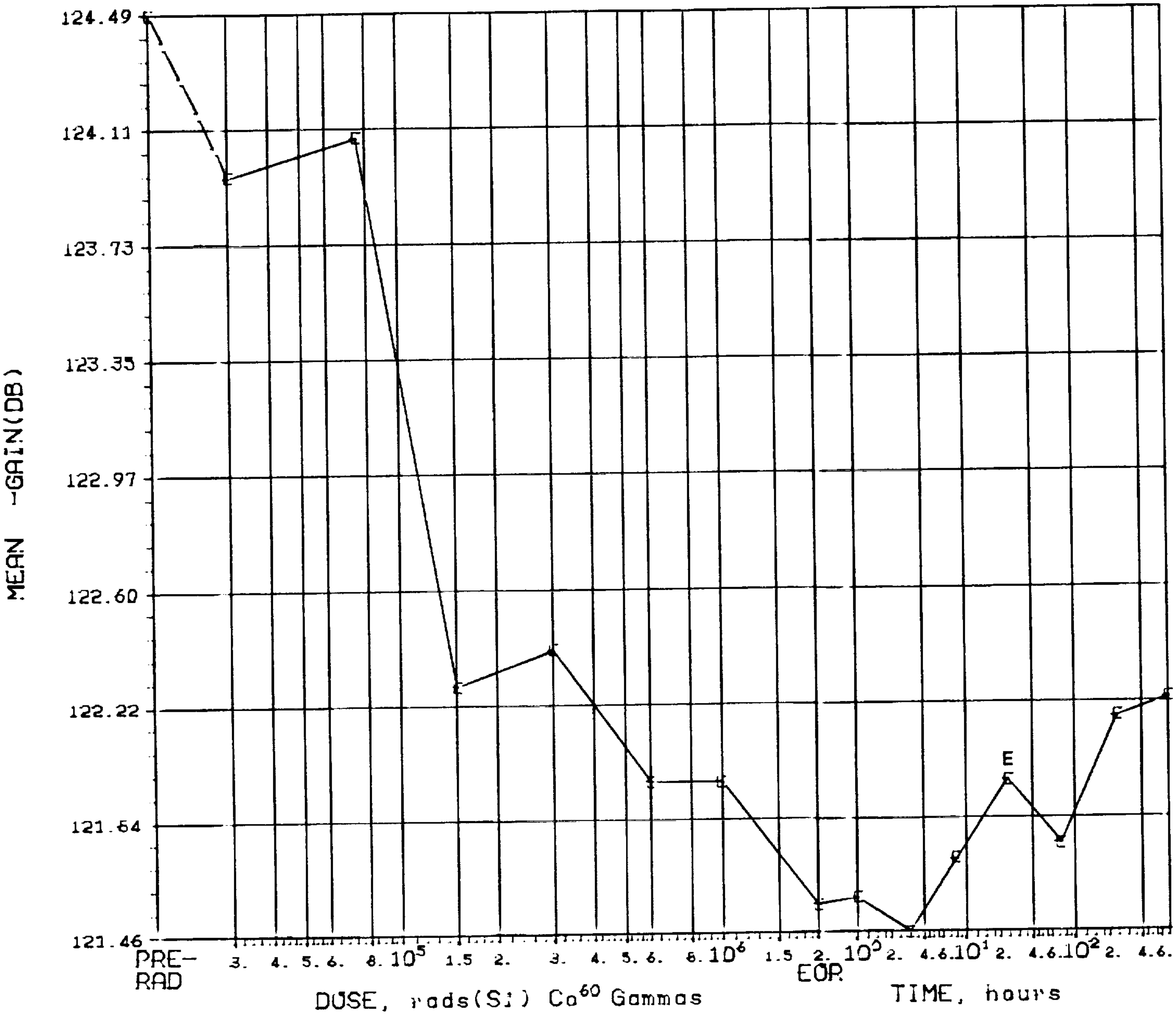


(4) +GAIN (1K LOAD=10MA, +10V) IN DB VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
I_L= 10.0 mA	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.0	1.131	1.264	1.803	3.386	2.737	2.771	2.938	2.909	2.610	.6159	1.603
DOSE/HOURS	7.2E1	2.4E2	7.2E2								
STD. DEV.	1.264	.6927	1.575								

INITIAL MEAN VALUE +GAIN(DB) = $+1.24X10^{+2}$

DEVICE TYPE: OP-27 OP AMP
MFG: RAY 5 DEVICES TEST DATE 06-11-86
REF: JPL LOG 1168 DATE CODE 8230



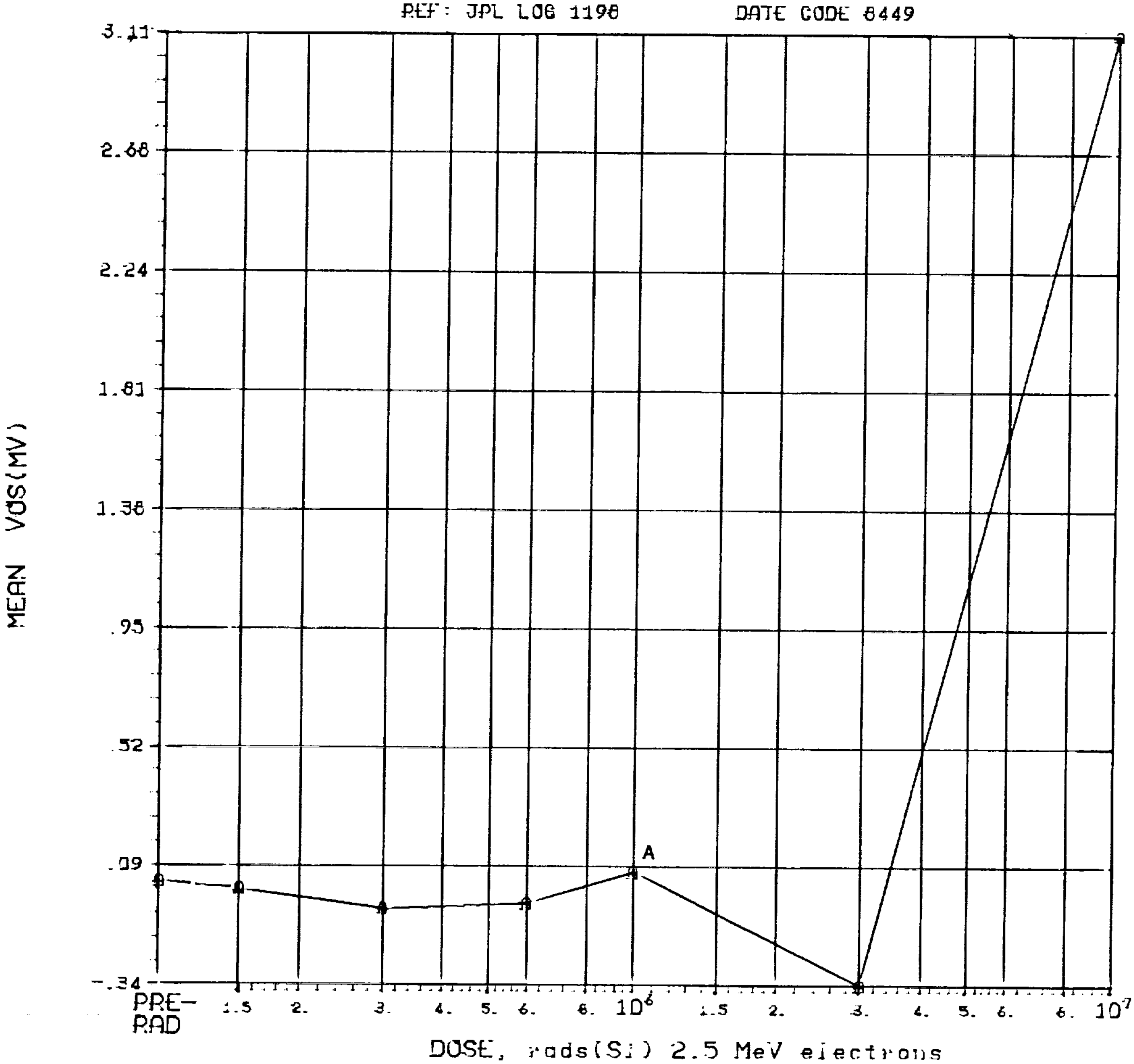
(5) -GAIN (1K LOAD=10MA, -10V) IN DB VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS											
I_L= 10.0 mA	DOSE, rads(Si)							TIME, hours			
DOSE/HOURS	3.0E4	7.5E4	1.5E5	3.0E5	6.0E5	1.0E6	2.0E6	1.0E0	3.0E0	8.0E0	2.4E1
STD. DEV.0	1.294	1.218	.5166	.6353	.7727	.7727	.9690	1.173	1.065	1.395	.7727

DOSE/HOURS	7.2E1	2.4E2	7.2E2
STD. DEV.	.8334	1.618	1.309

INITIAL MEAN VALUE -GAIN(DB) = +1.24X10+2

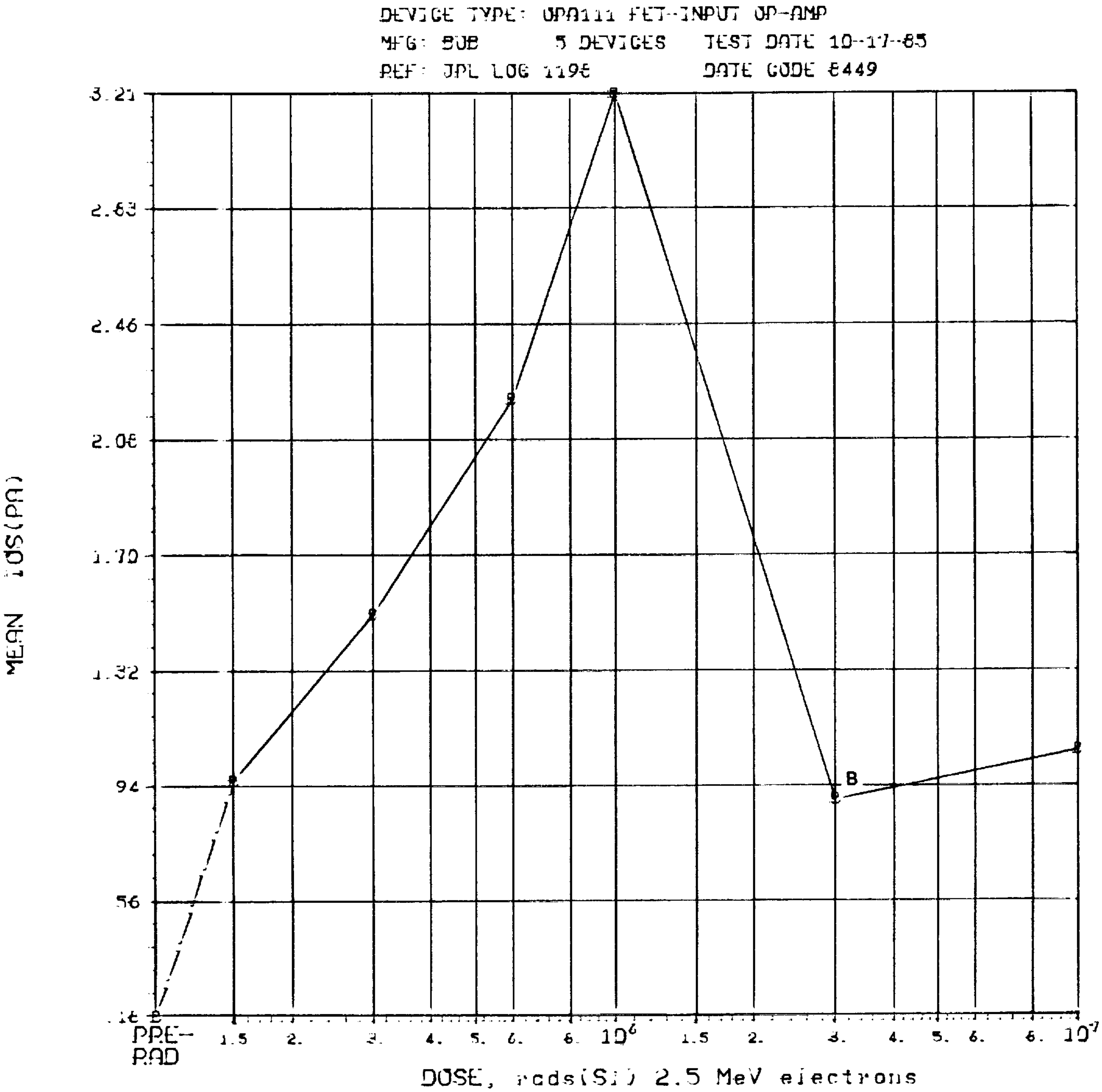
DEVICE TYPE: OPA111 FET-INPUT OP-AMP
MFG: BUB 5 DEVICES TEST DATE 10-17-85
REF: JPL LOG 1198 DATE CODE 8449



(1) VOS IN MV: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, rads(Si)
DOSE	0.0E0 1.5E5 3.0E5 6.0E5 1.0E6 3.0E6 1.0E7
STD. DEV.	.0530 .0745 .2361 .4535 .6849 1.679 3.080

INITIAL MEAN VALUE VOS(MV) $= +3.57 \times 10^{-2}$

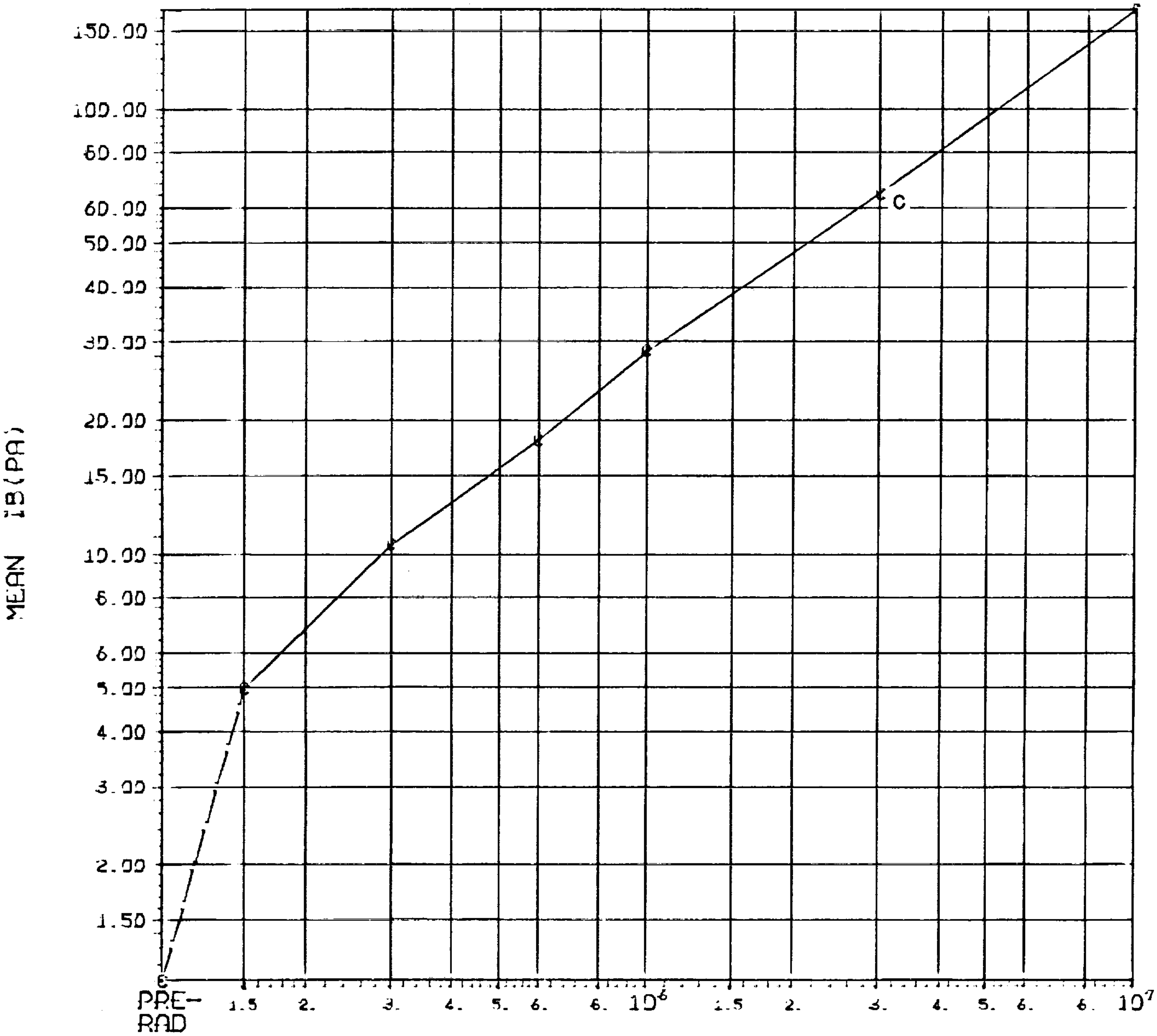


(2) IOS IN PA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, rads(Si)
DOSE	0.0E0 1.5E5 3.0E5 6.0E5 1.0E6 3.0E6 1.0E7
STD. DEV.	.1163 .2486 .6682 .5630 .1678 .9330 2.971

INITIAL MEAN VALUE IOS(PA) = $+1.60 \times 10^{-1}$

DEVICE TYPE: OPA111 FET-INPUT OP-AMP
MFG: BUB 5 DEVICES TEST DATE 10-17-85
REF: JPL LOG 1198 DATE CODE 8449

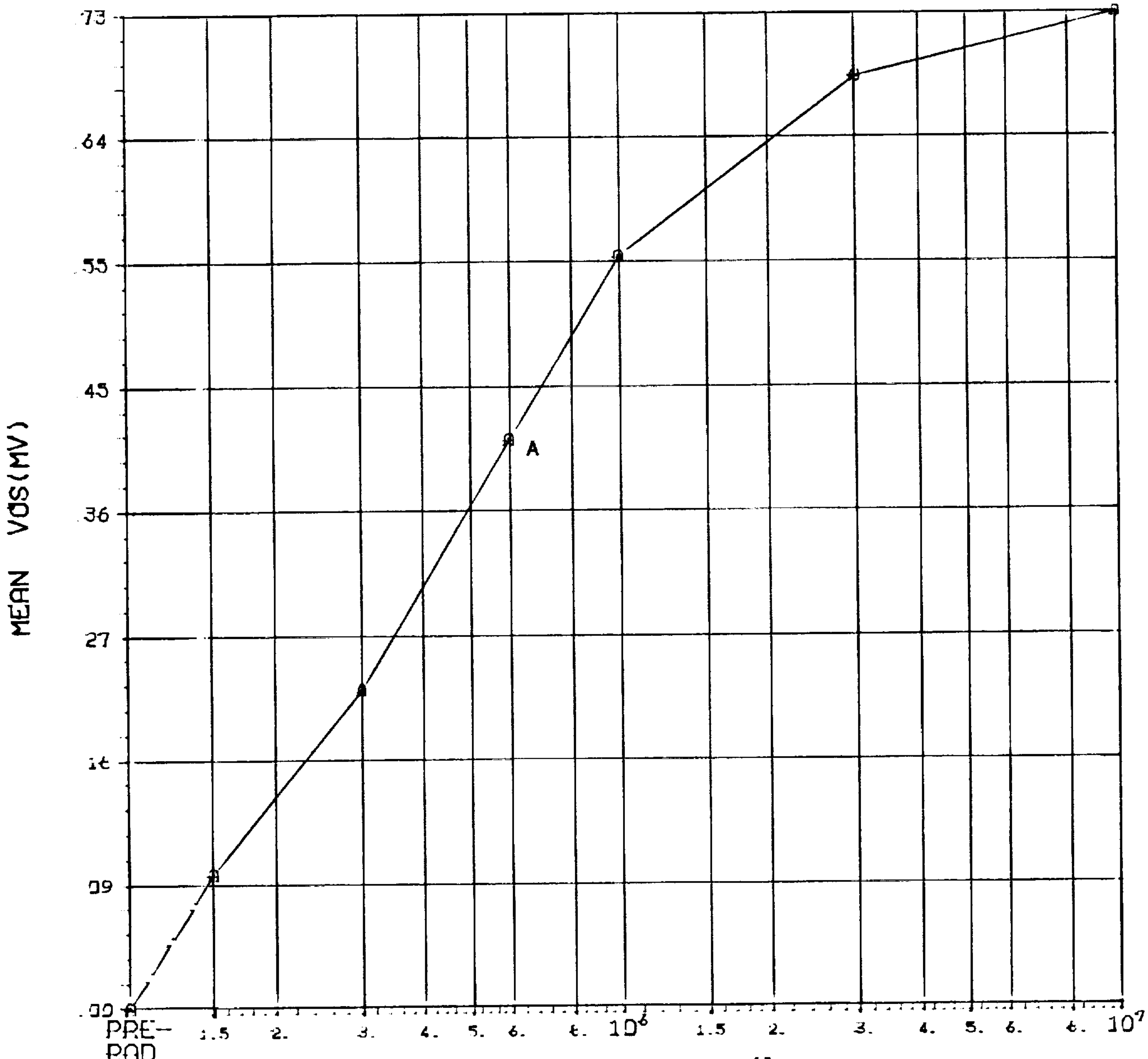


(3) IB IN PA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE DOSE	DOSE, rads(Si) 0.0E0 1.5E5 3.0E5 6.0E5 1.0E6 3.0E6 1.0E7
STD. DEV.	.4523 2.014 3.985 6.449 10.07 21.14 56.64

INITIAL MEAN VALUE IB(PA) $= +1.10X10^{0}$

DEVICE TYPE: OPA111 FET-INPUT OP-AMP
MFG: BUB 5 DEVICES TEST DATE 10-09-85
REF: JPL LOG 1199 DATE CODE 8449



(1) VOS IN MV: VS DOSE

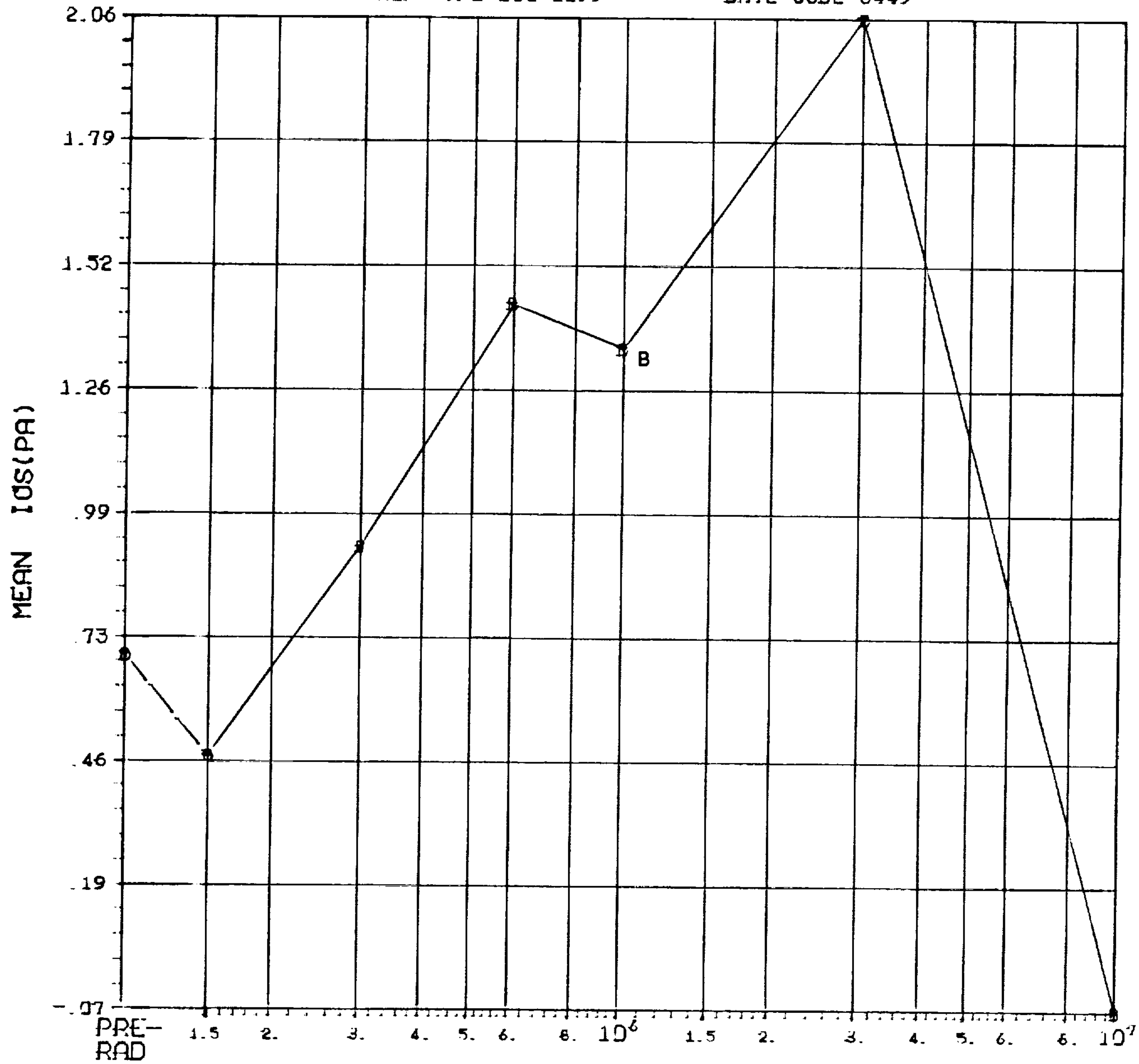
TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, rads(Si)
DOSE	0.0E0 1.5E5 3.0E5 6.0E5 1.0E6 3.0E6 1.0E7
STD. DEV.	.0580 .1696 .3524 .5660 .7006 .6302 .7916

INITIAL MEAN VALUE VOS(MV) = -6.61×10^{-4}

DEVICE TYPE: OPA111 FET-INPUT OP-AMP

MFG: BUB 5 DEVICES TEST DATE 10-09-85

REF: JPL LOG 1199 DATE CODE 8449



(2) IOS IN PA: VS DOSE

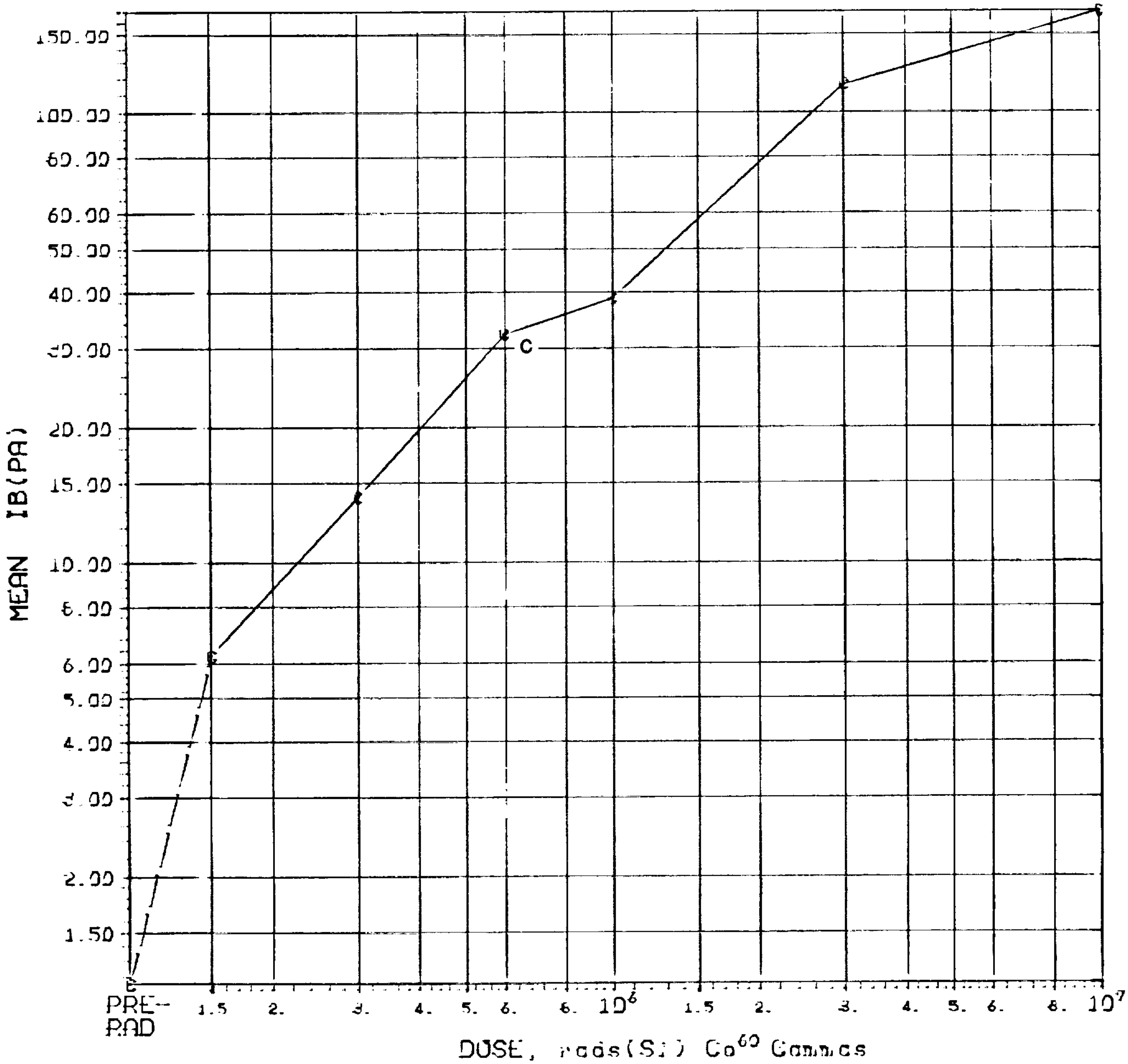
TABLE OF NORMAL STANDARD DEVIATIONS	
CURVE	DOSE, rads(Si)
DOSE	0.0E0 1.5E5 3.0E5 6.0E5 1.0E6 3.0E6 1.0E7
STD. DEV.	.3481 .2569 .5916 .5164 .1865 1.051 1.172

INITIAL MEAN VALUE IOS(PA) = $+6.86X10^{-1}$

DEVICE TYPE: OPA111 FET-INPUT OP-AMP

MFG: BUB 5 DEVICES TEST DATE 10-09-85

REF: JPL LOG 1199 DATE CODE 8449



(3) IB IN PA: VS DOSE

TABLE OF NORMAL STANDARD DEVIATIONS							
CURVE	DOSE, rads(Si)						
DOSE	0.0E0	1.5E5	3.0E5	6.0E5	1.0E6	3.0E6	1.0E7
STD. DEV.	.3627	2.143	5.341	13.35	12.69	66.61	74.61

INITIAL MEAN VALUE IB(PA) = $+1.15X10^{-3}$

APPENDIX A

VENDOR IDENTIFICATION CODE LIST

VENDOR IDENTIFICATION CODE LIST

AMD	Advanced Microdevices Corporation
BUB	Burr-Brown
FSC	Fairchild Semiconductor
LTC	Linear Technology, Inc.
MOT	Motorola, Inc., Semiconductor Products Division
MPS	Micro Power Systems, Inc.
NSC	National Semiconductor Corporation
PPC	PPC Products, Inc.
RAY	Ratheon Co., Semiconductor Division
RCA	RCA Corporation, Solid State Division
SGS	SGS Semiconductors
SSS	Solid State Scientific Corp.
TIX	Texas Instruments, Inc.

APPENDIX B

ELECTRICAL PARAMETER SYMBOLS AND ABBREVIATIONS

ELECTRICAL PARAMETER SYMBOLS AND ABBREVIATIONS

DNL	Diff. Non-Linearity
HFE	DC Current Gain
+ Gain	Open Loop Gain
- Gain	Open Loop Gain
IB	Bias Current
ICCH	Supply Current with Input High, Output Open
ICCL	Supply Current with Input Low, Output Open
ICCZ	Supply Current with Input Low, Outputs at VCC and Tri-Stated
IDSN	Drain Source Current, N-channel
IDSP	Drain Source Current, P-channel
IFSS	Full-Scale Output Symmetry
IIH	Input Current High
IIL	Input Current Low
IOH	High-Level Output Current
IOL	Low-Level Output Current
IOS	Input Offset Current
IOZH	Tri-State Output Leakage Current, Outputs High
IOZL	Tri-State Output Leakage Current, Outputs Low
IQH	Quiescent Current High
IQL	Quiescent Current Low
IREF	Ref. Input Bias Current
IZS	Zero Scale Output Current
NONLIN	Nonlinearity
PO	Relative Output Power
PSS	Power Supply Sensitivity
TF	Fall Time
TPHL	Propagation Delay Time High- to Low-Level Output
TPLH	Propagation Delay Time Low- to High-Level Output
TR	Rise Time
VF	Forward Voltage
VOH	High-Level Output Voltage
VOL	Low-Level Output Voltage
VOS	Offset Voltage
VTN	Threshold Voltage n-channel Transistor
VTP	Threshold Voltage p-channel Transistor