Aerospace Systems Division

ASE GRENADE TRANSMITTER FREQUENCY DRIFT

ATM-1074

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DATE 19 Nov 1971

This ATM provides a projection of the maximum frequency of the Flight 5 and Spare ASE grenade transmitters up to 6 years from transmitter acceptance testing. This projection is based on recent KSC test results and provides assurance that the Apollo 16 transmitters will be within specification after a possible one year lunar storage.

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ALSEP Experiments

The Flight 5 (S/N-20) and Flight Spare (S/N-18) live grenade launch assemblies (GLA) were functionally tested at KSC on 29-30 September, 1971. These tests represented the second check on the S/N-20 and the first on the S/N-18 since the units were delivered to KSC in December 1968. The S/N-20 unit was previously checked in November 1970 as the back up unit for the Flight 4 GLA. A portion of the GLA functional test (TCP2337036) measures the frequency of each grenade transmitter. Since all of the production flight transmitters were acceptance tested in December, 1967 and January, 1968, the measurements at KSC provide another timely and accurate check of the 3 year projected frequency drift for each transmitter established by test at the time of acceptance. The KSC measurements also provide a valid basis for revising the 3 year projection and for projecting further drift up to 6 years. ASE grenade transmitters, to be deployed on Apollo 16, will be required by specification to operate after a one year storage on the lunar surface, or up to March 1973. Therefore, it is important to establish that the 6 year projected drift will still permit the transmitter frequencies to remain within the specification frequency tolerance (30.0 ± 0.1 MHz).

During development of the transmitters at Computing Devices of Canada (CDC) a slow, upward frequency drift with time was identified. Extensive testing was conducted to determine the cause of the drifting. The results of those tests eventually led to a new flight configuration design which minimized the frequency drift. In addition, testing over a period of six months verified that a 14 day test on each transmitter was sufficient to accurately predict the drift up to 1000 days, which at that time represented a two year earth and one year lunar storage capability. A 14-day drift test was thus instituted as part of the pre-acceptance testing for all qualification and flight model transmitters. The maximum projected drift limit was set at 40 KHz, and together with an allowable characteristic frequency bandwidth (difference between maximum and minimum frequencies measured during pre-acceptance tests) of 160 KHz, established the criteria for final acceptance or rejection of a transmitter. These criteria were selected to ensure that the frequencies throughout a 3 year storage would remain within the ± 100 KHz frequency tolerance. Only one of the twenty-four production transmitters was rejected and not delivered because it's projected 3 year frequency drift (47 KHz) exceeded the allowable 40 KHz. The results of the 14 day drift test and 3 year projection curve were included in the acceptance data package (ADP) for each transmitter delivered.

As stated earlier, tests were conducted at CDC over a period of six months to establish the validity of using a 14 day drift test to project a 3 year drift. Frequency tests were conducted on 7 flight configuration transmitters for six months and resulted in CDC stating that the results verified that the 14 day drift test was sufficient to predict 3 year frequency drift within 15 KHz to 99.73% confidence limits. Table 1 is a summarization of acceptance test data and 3 year projected drifts from CDC ADPs on eight transmitters installed in S/N's-18 and -20 GLAs. The frequency measurements made on those units at KSC are also shown. It should be noted that the actual frequency drift represented by the 4 year measurements vary from +16 KHz to -11 KHz from the maximum drift projected by the CDC 14-day drift test, thus substantiating the predicted accuracy (15 KHz) of the tests and the 3 year drift projections.

Included in this ATM are the curves (frequency drift versus time) and frequency data reproduced from the ADPs of the flight transmitters. Each curve shows a revised drift vs time projection out to 6 years and the projected maximum frequencies are shown in Table 1. The revised drift for transmitters installed in GLA's S/N-18 and -20 are based on the actual frequency drift shown by the KSC 4 year measurements on those transmitters. Using this method of revising the 3 year projections and additionally projecting to six years shows all transmitter frequency tolerances will still be well within specification.

The initial drift vs time curves, derived at CDC, assumed a linear drift and were based on the curves shown drawn through a set of measured frequency points taken within the 14 day drift test at CDC. The revised projected drift curves similarly assume a linear drift which may not be the actual case. In the case of the S/N-18 transmitters, with only one frequency check point available, (4 year measurement) the revised drift must be based on the one point. In the case of the S/N-20 transmitters, the 4 year measurement point was also used. It should be noted that the additional frequency drift determined by a curve through the 3 year and 4 year measurements adds +2 KHz, +4 KHz, +2 KHz and +3 KHz to the 6 year projected maximum frequencies for the -1, -2, -3 and -4 grenades respectively. From the above, even in the worst case, the transmitter frequencies are still well within specification.

TABLE I

GLA S/N	Grenade No.	Transmitter S/N	CDC ACCEPTANCE DATA: Max. Freq. During Accept. Test (MHz)	CDC ACCEPTANCE DATA: 3 Year Projected Drift (KHz)	CDC ACCEPTANCE DATA: 3 Year Max. Projected Freq. (MHz)	KSC MEASURED DATA: 3 Year Measured Freq. (MHz) *	KSC MEASURED DATA: 4 Year Measured Freq. (MHz)	KSC MEASURED DATA: 4 Year Actual Drift (KHz)	PROJECTED: 5 Year Projected Max. Freq. (MHz)	PROJECTED: 6 Year Projected Max. Freq. (MHz)
18	-1	8	30.067	+17	30.084	N/A	30.083	+16	30.084	30.084
	-2	15	30.040	+9	30.049	N/A	30.046	+6	30.046	30.046
	-3	6	30.052	+10	30.062	N/A	30.060	+8	30.060	30.060
	-4	3	30.035	+14	30.049	N/A	30.055	+20	30.056	30.056
20	-1	21	30.055	+16	30.071	30.066	30.068	+13	30.068	30.069
	-2	19	30.052	+13	30.065	30.050	30.054	+2	30.054	30.054
	-3	17	30.036	+26	30.062	30.074	30.078	+42	30.079	30.080
	-4	24	30.036	+12	30.048	30.060	30.064	+28	30.065	30.066

*Frequency measured in November, 1970.

ASE TRANSMITTER PROJECTED MAXIMUM FREQUENCY

GLA S/N: 18

Grenade No: -1

Transmitter S/N: 8

A. Computing Devices of Canada (CDC) Acceptance Data

Date of acceptance test 22 Dec 1967

Maximum frequency measured during pre-acceptance test	30.064	MHz
Minimum frequency measured during pre-acceptance test	29.918	MHz
Characteristic frequency bandwidth	146	KHz
Projected frequency drift (1000 days)	+17	KHz
Maximum frequency measured during acceptance test	30.067	MHz
Projected maximum frequency at 1000 days (3 years)	30.084	MHz

B. KSC Measured Frequencies

3 year measured frequency	N/A	MHz
4 year measured frequency	30.083	MHz
4 year actual frequency drift	+16	KHz

C. Projected Maximum Frequency

Maximum frequency at 1800 days (5 years)	30.084	MHz
Maximum frequency at 2200 days (6 years)	30.084	MHz

K&E SEMI-LOGARITHMIC 46 6013
3 CYCLES X 70 DIVISIONS MADE IN U.S.A.
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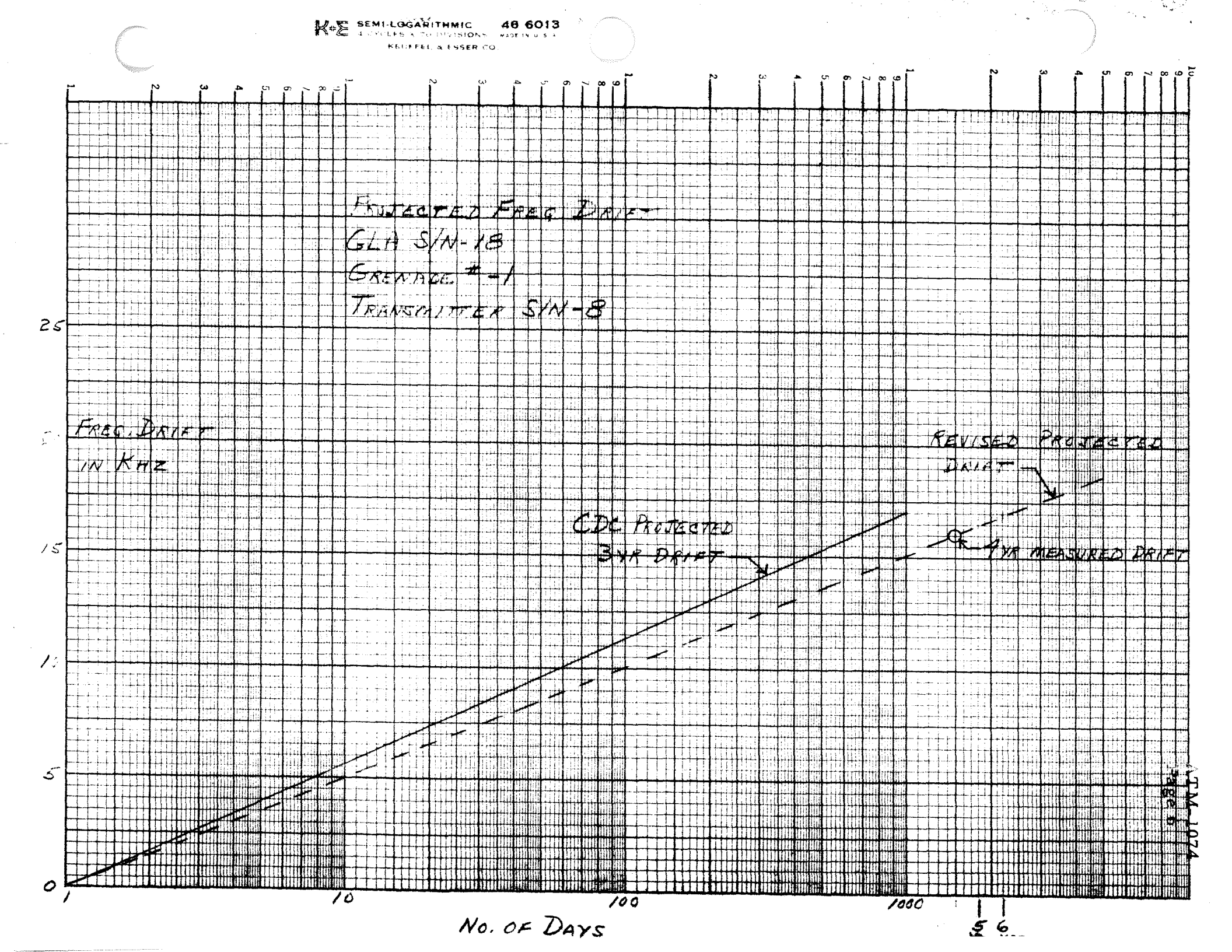

ASE GRENADE TRANSMITTER
FREQUENCY DRIFT

ASE TRANSMITTER PROJECTED MAXIMUM FREQUENCY

GLA S/N: 18

Grenade No: -2

Transmitter S/N: 15

A. Computing Devices of Canada (CDC) Acceptance Data

Date of acceptance test 3 Jan 1968

Maximum frequency measured during pre-acceptance test	30.031	MHz
Minimum frequency measured during pre-acceptance test	29.952	MHz
Characteristic frequency bandwidth	79	KHz
Projected frequency drift (1 1000 days)	+9	KHz
Maximum frequency measured during acceptance test	30.040	MHz
Projected maximum frequency at 1000 days (3 years)	30.049	MHz

B. KSC Measured Frequencies

3 year measured frequency	N/A	MHz
4 year measured frequency	30.046	MHz
4 year actual frequency drift	+6	KHz

C. Projected Maximum Frequency

Maximum frequency at 1800 days (5 years)	30.046	MHz
Maximum frequency at 2200 days (6 years)	30.046	MHz

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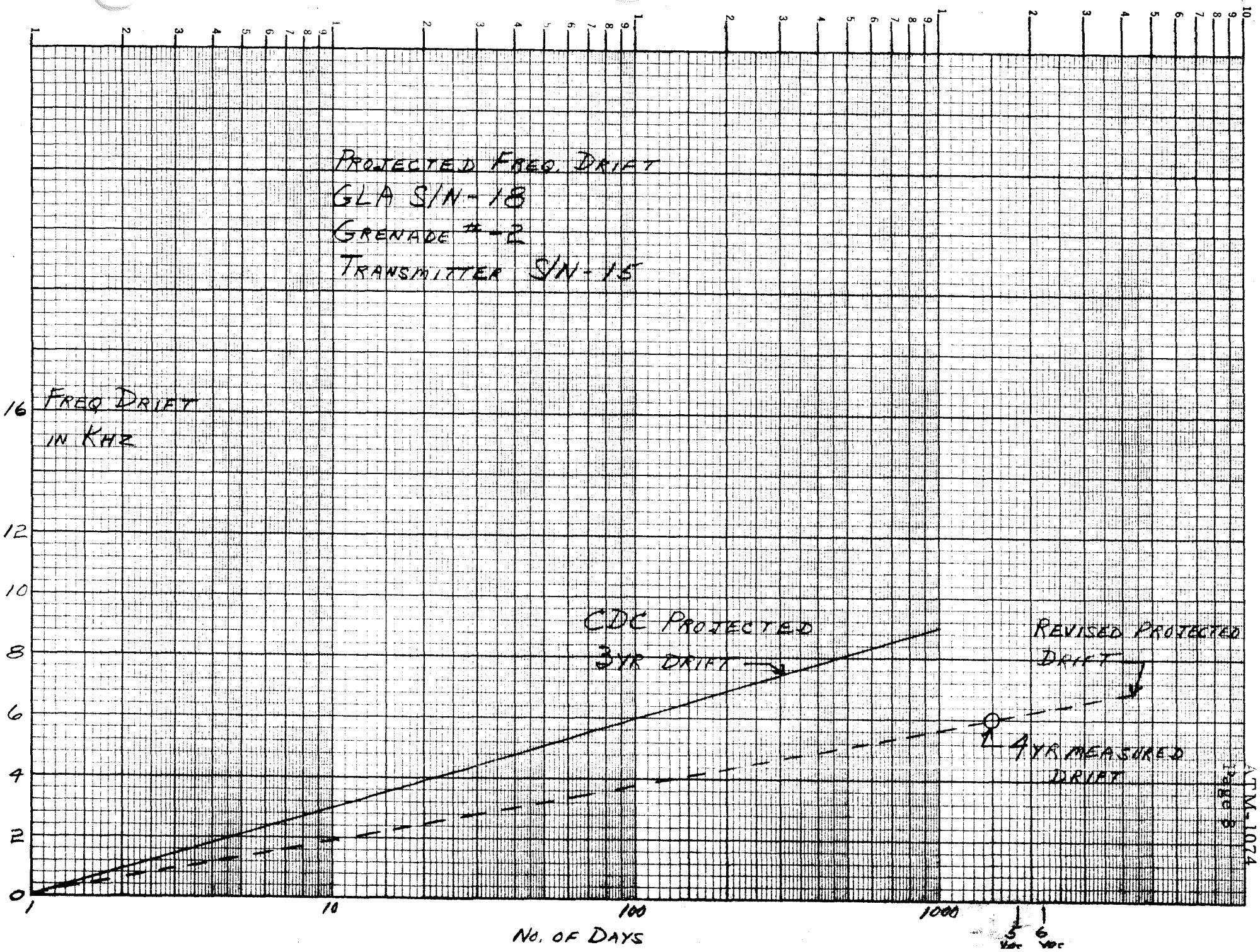

ASE TRANSMITTER PROJECTED MAXIMUM FREQUENCY

GLA S/N: 18

Grenade No: -3

Transmitter S/N: 6

A. Computing Devices of Canada (CDC) Acceptance Data

Date of acceptance test 5 Dec 1967

Maximum frequency measured during pre-acceptance test	30.047	MHz
Minimum frequency measured during pre-acceptance test	29.942	MHz
Characteristic frequency bandwidth	105	KHz
Projected frequency drift (1000 days)	+10	KHz
Maximum frequency measured during acceptance test	30.052	MHz
Projected maximum frequency at 1000 days (3 years)	30.062	MHz

B. KSC Measured Frequencies

3 year measured frequency	N/A	MHz
4 year measured frequency	30.060	MHz
4 year actual frequency drift	+8	KHz

C. Projected Maximum Frequency

Maximum frequency at 1800 days (5 years)	30.060	MHz
Maximum frequency at 2200 days (6 years)	30.060	MHz

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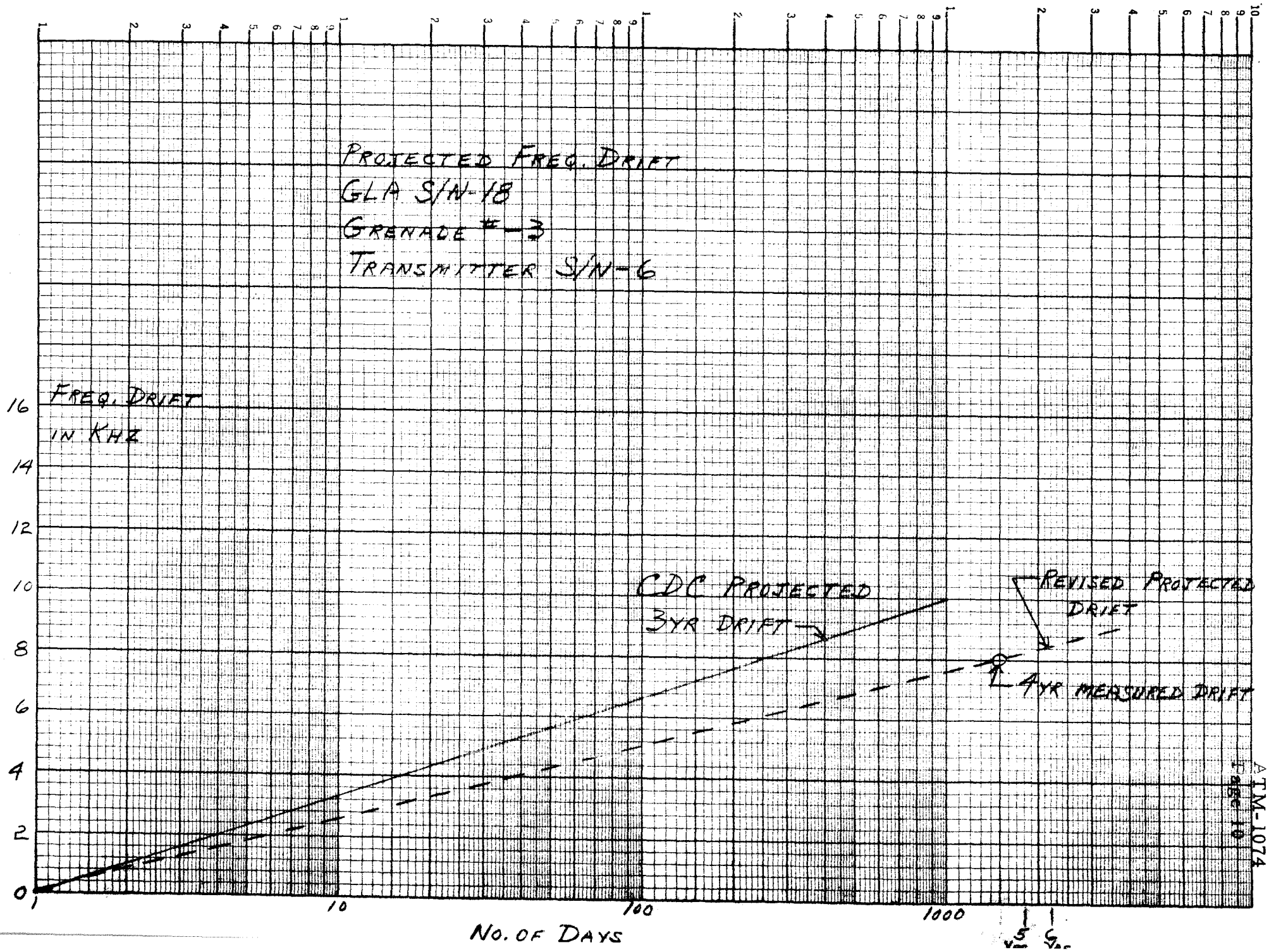

ASE TRANSMITTER PROJECTED MAXIMUM FREQUENCY

GLA S/N: 18

Grenade No: -4

Transmitter S/N: 3

A. Computing Devices of Canada (CDC) Acceptance Data

Date of acceptance test 5 Dec 1967

Maximum frequency measured during pre-acceptance test	30.025	MHz
Minimum frequency measured during pre-acceptance test	29.936	MHz
Characteristic frequency bandwidth	89	KHz
Projected frequency drift (1 1000 days)	+14	KHz
Maximum frequency measured during acceptance test	30.035	MHz
Projected maximum frequency at 1000 days (3 years)	30.049	MHz

B. KSC Measured Frequencies

3 year measured frequency	N/A	MHz
4 year measured frequency	30.055	MHz
4 year actual frequency drift	+20	KHz

C. Projected Maximum Frequency

Maximum frequency at 1800 days (5 years)	30.056	MHz
Maximum frequency at 2200 days (6 years)	30.056	MHz

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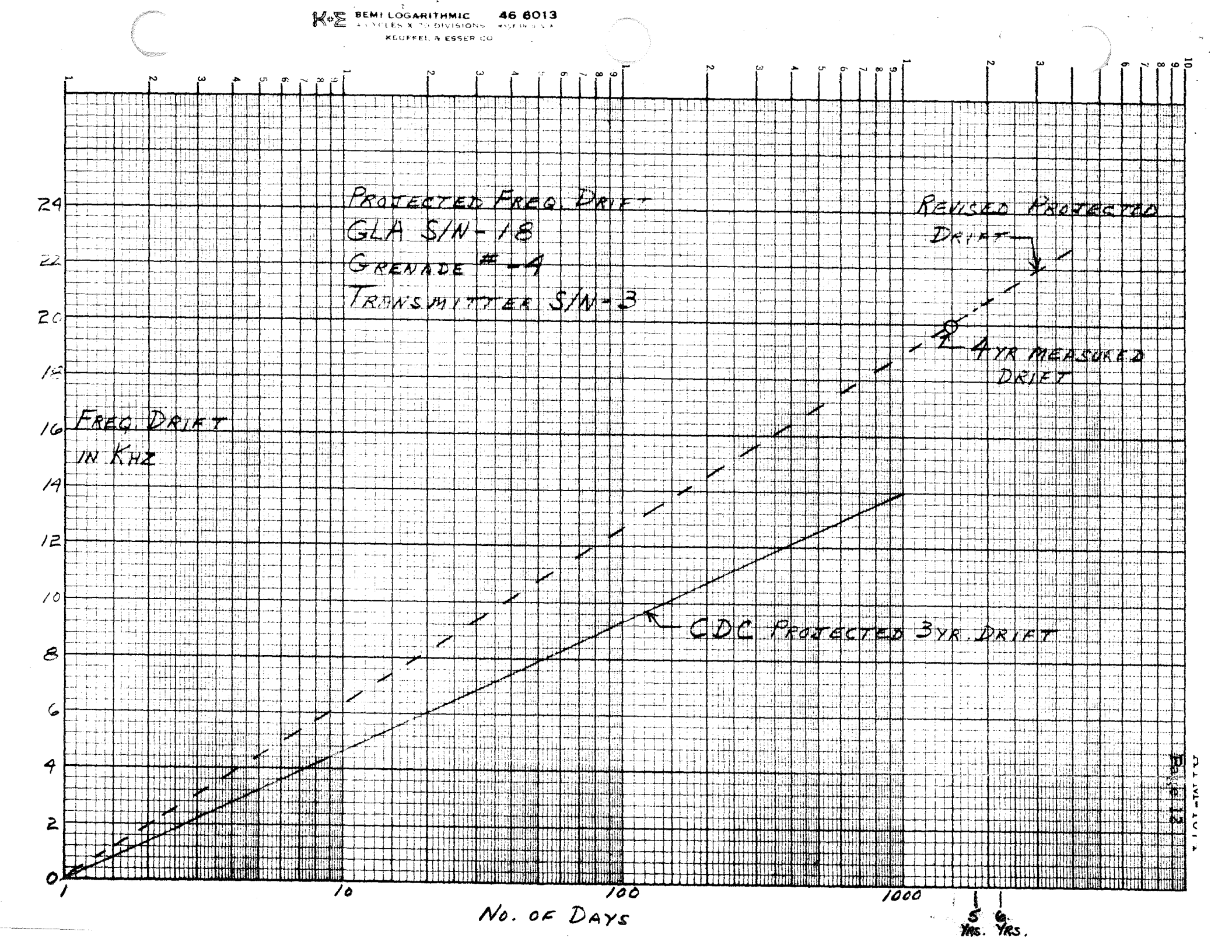

ASE TRANSMITTER PROJECTED MAXIMUM FREQUENCY

GLA S/N: 20

Grenade No: -1

Transmitter S/N: 21

A. Computing Devices of Canada (CDC) Acceptance Data

Date of acceptance test 30 Jan 1968

Maximum frequency measured during pre-acceptance test	30.042	MHz
Minimum frequency measured during pre-acceptance test	29.901	MHz
Characteristic frequency bandwidth	141	KHz
Projected frequency drift (1 1000 days)	+16	KHz
Maximum frequency measured during acceptance test	30.055	MHz
Projected maximum frequency at 1000 days (3 years)	30.071	MHz

B. KSC Measured Frequencies

3 year measured frequency	30.066	MHz
4 year measured frequency	30.068	MHz
4 year actual frequency drift	+13	KHz

C. Projected Maximum Frequency

Maximum frequency at 1800 days (5 years)	30.068	MHz
Maximum frequency at 2200 days (6 years)	30.069	MHz

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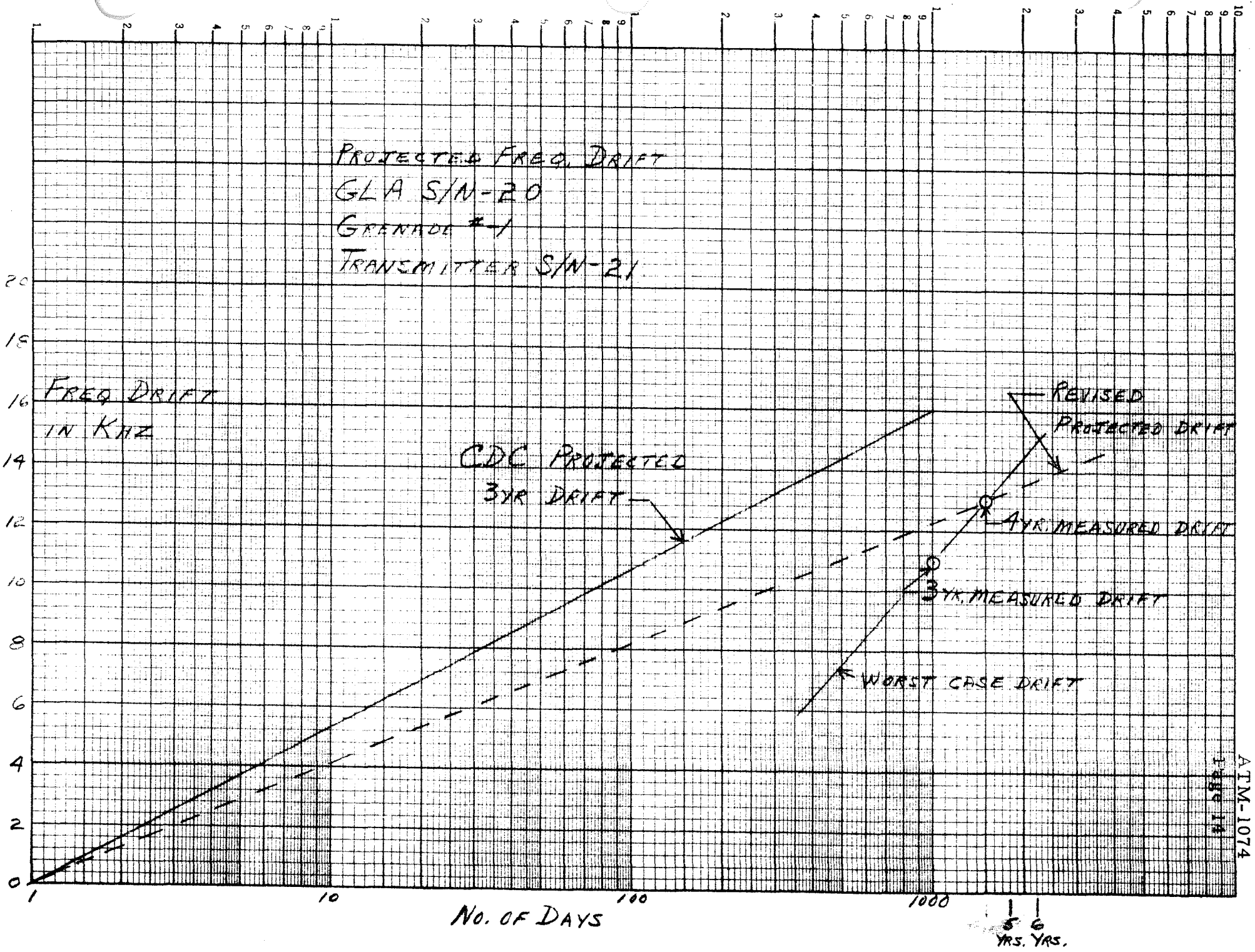

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ASE GRENADE TRANSMITTER
FREQUENCY DRIFT

ASE TRANSMITTER PROJECTED MAXIMUM FREQUENCY

GLA S/N: 20

Grenade No: -2

Transmitter S/N: 19

A. Computing Devices of Canada (CDC) Acceptance Data

Date of acceptance test 29 Jan 1968

Maximum frequency measured during pre-acceptance test	30.039	MHz
Minimum frequency measured during pre-acceptance test	29.942	MHz
Characteristic frequency bandwidth	97	KHz
Projected frequency drift (1 1000 days)	+13	KHz
Maximum frequency measured during acceptance test	30.052	MHz
Projected maximum frequency at 1000 days (3 years)	30.065	MHz

B. KSC Measured Frequencies

3 year measured frequency	30.050	MHz
4 year measured frequency	30.054	MHz
4 year actual frequency drift	+2	KHz

C. Projected Maximum Frequency

Maximum frequency at 1800 days (5 years)	30.054	MHz
Maximum frequency at 2200 days (6 years)	30.054	MHz

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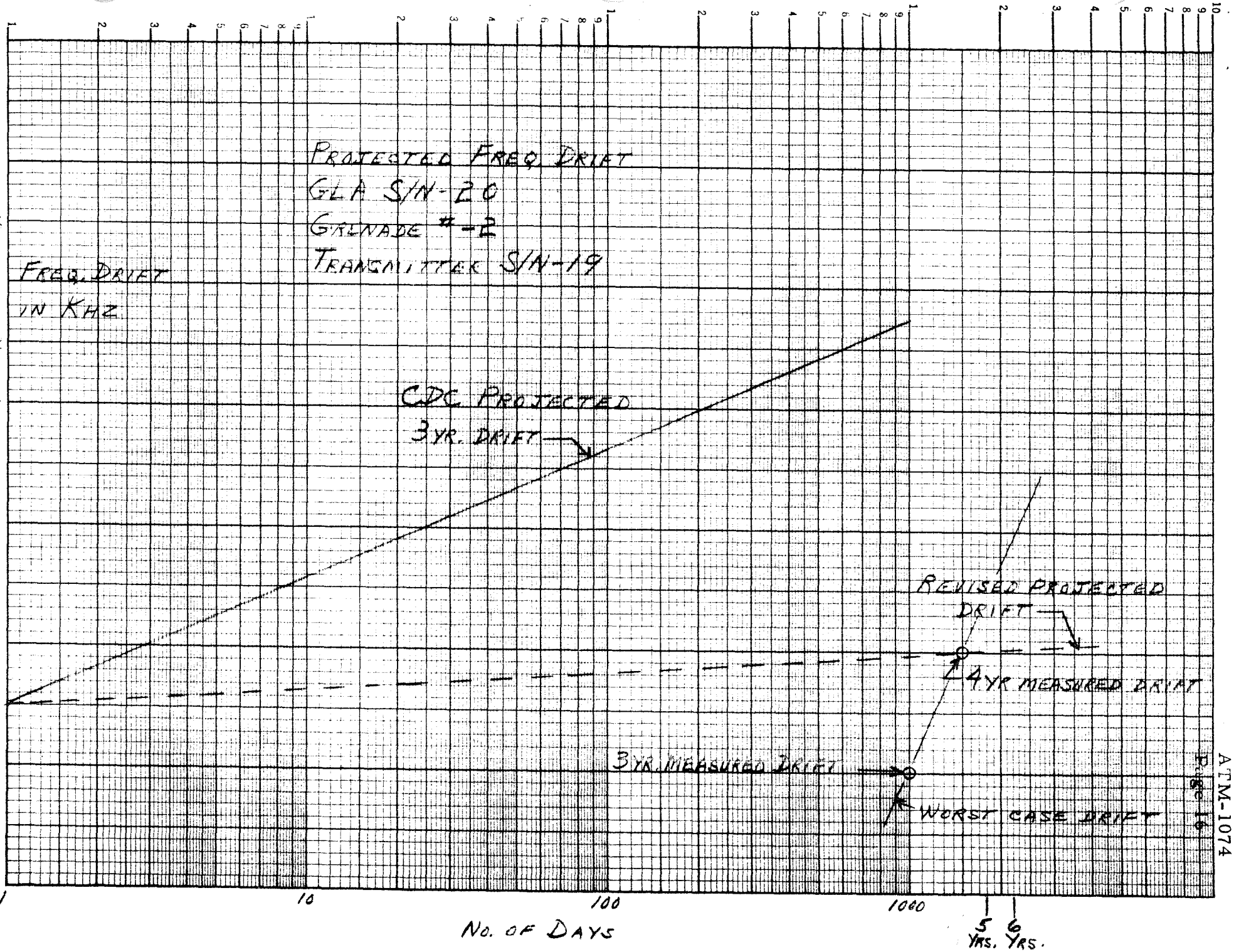

ASE TRANSMITTER PROJECTED MAXIMUM FREQUENCY

GLA S/N: 20

Grenade No: -3

Transmitter S/N: 17

A. Computing Devices of Canada (CDC) Acceptance Data

Date of acceptance test 29 Jan 1968

Maximum frequency measured during pre-acceptance test	30.017	MHz
Minimum frequency measured during pre-acceptance test	29.914	MHz
Characteristic frequency bandwidth	103	KHz
Projected frequency drift (1 1000 days)	+26	KHz
Maximum frequency measured during acceptance test	30.036	MHz
Projected maximum frequency at 1000 days (3 years)	30.062	MHz

B. KSC Measured Frequencies

3 year measured frequency	30.074	MHz
4 year measured frequency	30.078	MHz
4 year actual frequency drift	+42	KHz

C. Projected Maximum Frequency

Maximum frequency at 1800 days (5 years)	30.079	MHz
Maximum frequency at 2200 days (6 years)	30.080	MHz

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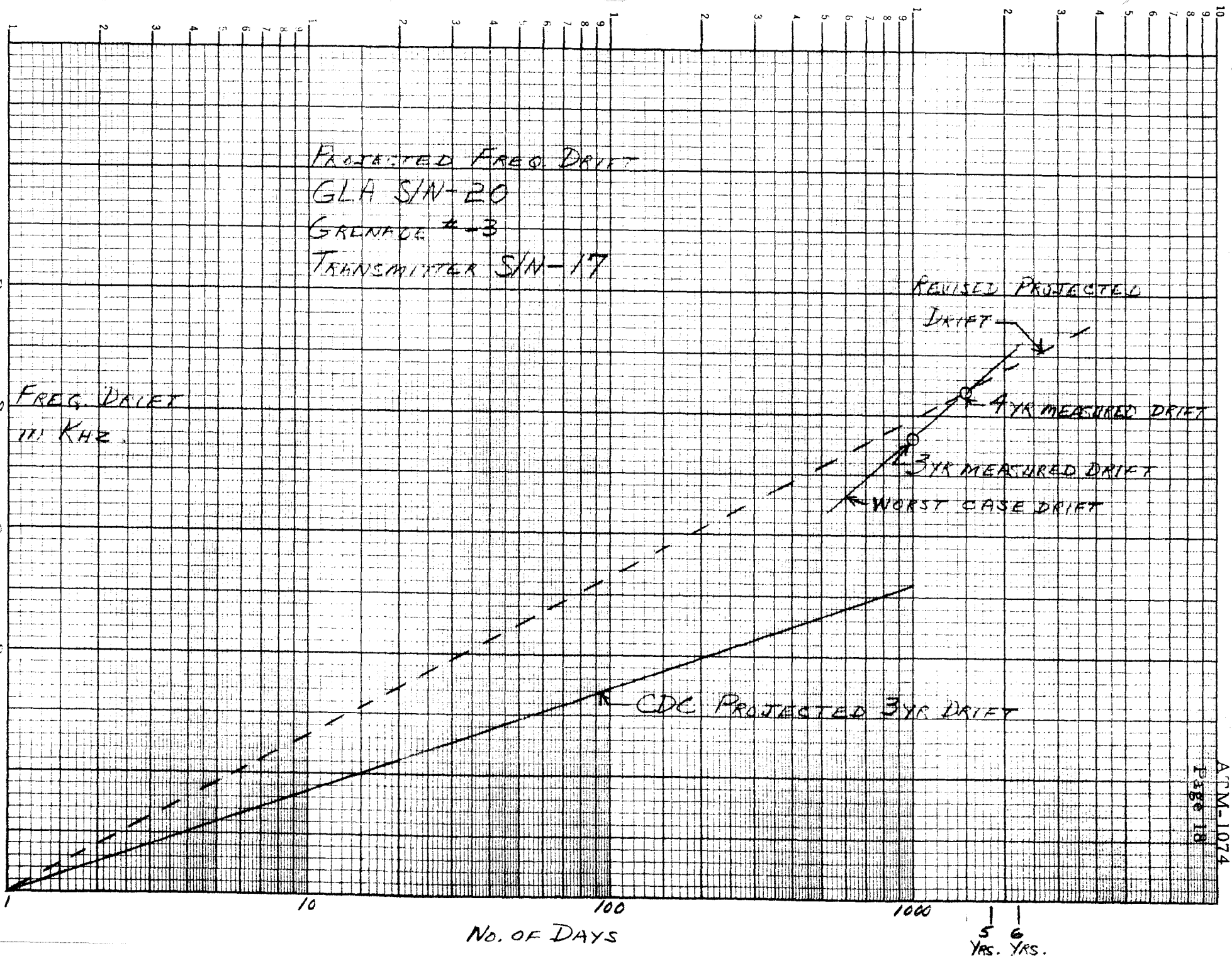


ASE TRANSMITTER PROJECTED MAXIMUM FREQUENCY

GLA S/N: 20

Grenade No: -4

Transmitter S/N: 24

A. Computing Devices of Canada (CDC) Acceptance Data

Date of acceptance test 30 Jan 1968

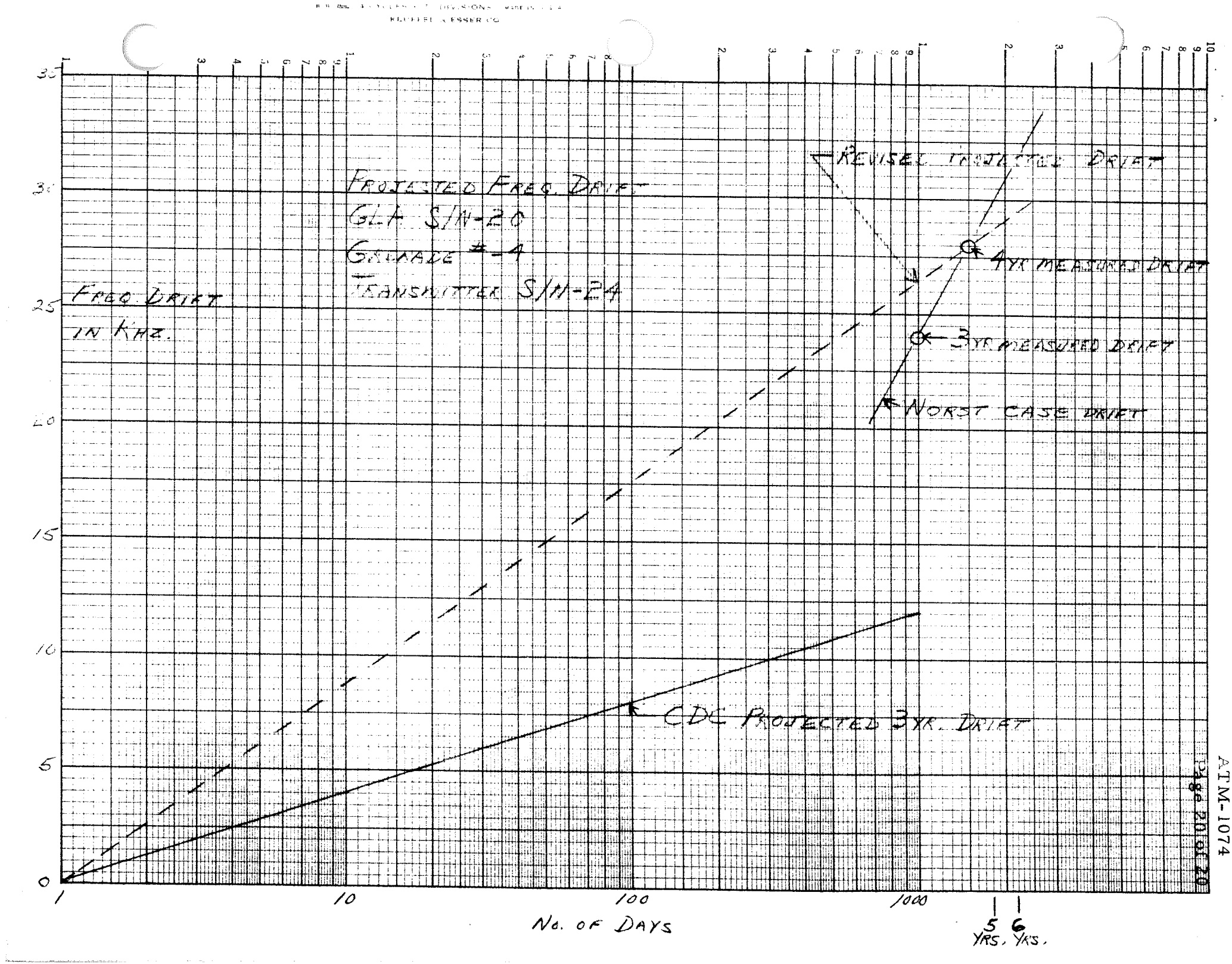
Maximum frequency measured during pre-acceptance test	30.038	MHz
Minimum frequency measured during pre-acceptance test	29.908	MHz
Characteristic frequency bandwidth	130	KHz
Projected frequency drift (1 1000 days)	+12	KHz
Maximum frequency measured during acceptance test	30.036	MHz
Projected maximum frequency at 1000 days (3 years)	30.048	MHz

B. KSC Measured Frequencies

3 year measured frequency	30.060	MHz
4 year measured frequency	30.064	MHz
4 year actual frequency drift	+28	KHz

C. Projected Maximum Frequency

Maximum frequency at 1800 days (5 years)	30.065	MHz
Maximum frequency at 2200 days (6 years)	30.066	MHz


PROJECTED FREQ. DRIFT
GLA S/N-20
GAUGE #-4
TRANSMITTER S/N-24
REVISED PROJECTED DRIFT
4YR MEASURED DRIFT
3YR MEASURED DRIFT
WORST CASE DRIFT
CDC PROJECTED 3YR. DRIFT
FREQ DRIFT IN KHZ.
0
5
10
15
20
25
30
35
1
10
100
1000
NO. OF DAYS
5 YRS.
6 YRS.