Centre National d'Etudes
des Télécommunications

Technical Document N° 274

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"STUDY OF V.L.F. RADIATION BY USE OF ROCKETS"

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TECHNICAL REPORT

Contract n° AF 61 (052)-436

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- ABSTRACT -

A rocket equipment prepared on Contract AF 61 (052) 436 for measuring the three components of the magnetic field associated to the V.L.F. wave radiated by the transmitter of Jim Creek (N.L.K.), Washington on 18, 6 Kc/s has been fired on a NIKE-ASP Rocket in EGLIN Air Force Base (Virginia). A mechanical failure in the dielectric nose cone of the rocket 3 seconds after the firing has compromised most of the experimentation. Data on the aspect of the rocket along the earth magnetic field during the first minute of the flight has been the only information to be recorded. The three seconds of work of the V.L.F. equipment has shown a large interference of the V.L.F. receivers with the other equipments of the nose cone as more important as the signal from Jim Creek was very weak due to the large distance to Eglin Air Force Base of this transmitter. N.S.S. transmitter in ANNAPOLIS has been first chosen but was out of work at the time of experimentation.

I - DESCRIPTION OF THE ROCKET EQUIPMENT -

In order to reach a physical description of the propagation modes of V.L.F. waves at high altitudes, it has been thought to carry out experiments giving the amplitude and position in space of the magnetic field intensity vectors, associated with the wave originated by a conventional ground transmitter.

The magnetic component of the wave is studied by means of three orthogonal coils tied to the missile, the three corresponding induced voltages being analyzed inside the missile and the data telemetered to the ground.

The amplitude of these three components are measured by three identical receivers as well as the phase between two components and the third taken as a reference are measured by two identical phasemeters.

.../...

With these five parameters and the knowledge of the aspect of the rocket, one can compute the amplitude and position in space of the V.L.F. magnetic field vector and thus deduce absorption, direction of propagation, status of polarization, ... of the wave.

The sensitivity of the equipment is such as correct measurements can be made as long as the V.L.F. magnetic field is above 0,1 amp/meter.

II - DEVELOPMENT OF THE EXPERIMENTATION -

The firing of the NIKE-ASP Rocket was first planned for the end of 1960 at WALLOPS-ISLAND. Difficulties encountered in the final test and in the matting of V.L.F. equipment with the other parts of the nose cone obliged to rescheduled the firing for first of March at EGLIN Air Force Base. Simultaneous change in transmitter to be used has occured so that it was decided to use Jim Creek instead of N.S.S. located in ANNAPOLIS (Maryland).

The main difficulties encountered was due to the interference between V.L.F. receivers and noisy or powerful equipments of the nose cone such as transistorized converter, beacon, telemetry, commutator, transmitter.... Most of the interferences have been reduced during the additional delay needed before the launching but not completely.

Preparation of firing has begun in EGLIN Air Force Base about February 15th, 1961. A special test-set was used for the test and calibration of V.L.F. equipment.

This test-set carried from FRANCE has suffered of the transportation and needed about 3 or 4 days for being repaired and on work again.

Test and calibration of the V.L.F. rocket borne equipment began about one week before the date planned for the firing. Some difficulties appeared concerning the transmitting mode of Jim Creek. Indeed, it was first planned that the V.L.F. transmission will be CW but, in fact, that was not possible and it has been decided to use a special code already used by Jim Creek for others experimenters on V.L.F. wave. This code was made of dots and dashes of special duration, and was not very well matched with the band pass of the equipments. Elsewhere, the field strength of this transmitter was very weak in EGLIN and consequently the signal to noise ratio at the output of the receivers already affected by a rest of interference, very poor.

.../...

It was thought that the signal strength will increase with the altitude in the first part of the path of the rocket and the experimentation was still carried on to the firing.

The firing was occured as planned on March 1st, 1961 - 10,41 A.M. local time. The nose cone broke up into two parts at H + 3 seconds. The front end package was recovered few hundred feet from the pad. Dislocation occured at the junction section between the metallic and dielectric skin covering the antennas.

It is assumed that the stress developped on the skin have been greater than these used for the calculation of it, the safety margin being not sufficient.

III - DATA RECOVERED -

III.1 - V.L.F. data :

For all the reasons already described no V.L.F. data has been recovered. The first three seconds only show a large interference in the receiver and a very noisy signal. Sketch 1 shows the data issued from the three receivers and the two phasemeters in parallel with the field strength of Jim Creek recorded on the ground station. It can be seen that it is very hard to distinguish the signal from the noise during the dash of transmission on the air for the first three seconds.

III.2 - Magnetic aspect data :

This data has been recorded during the first minute of the flight until the equipment be out of work.

Sketch 2 shows the value of the earth magnetic field along the two magnetometers of the nose cone (one is parallel to the main axis, the other one perpendicular).

Sketch 3 gives the roll position of the rocket around the main axis and the roll rate.

Sketch 4 gives the angle between the earth magnetic field and the main axis of the rocket.

.../...

IV - FUTURE WORK -

Three main problems have been pointed out during the described experimentation which must guide the future work.

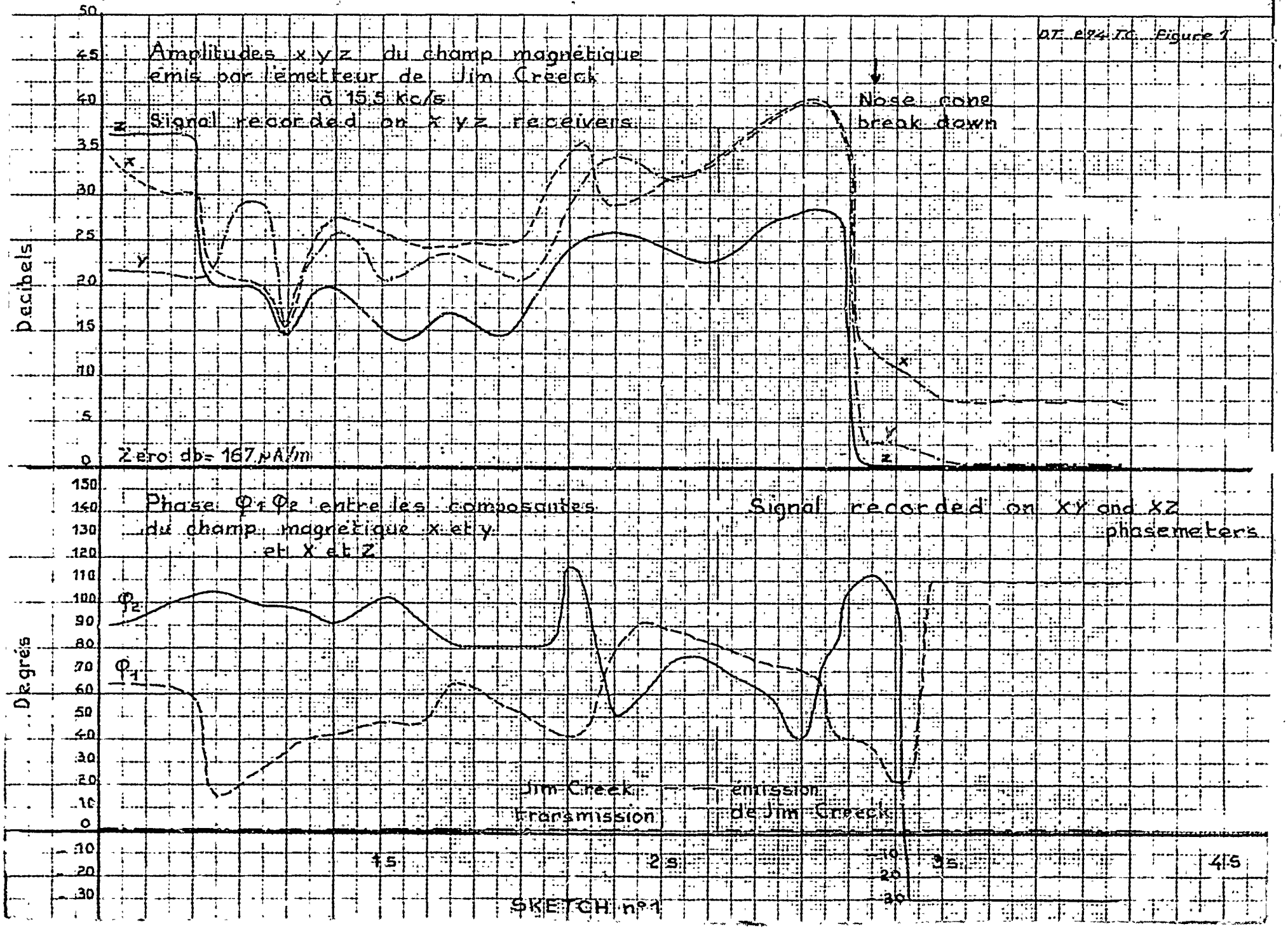
- The transmitter to be used must be located quite nearer from the launching area of the rockets. It is thought that a next firing should be made from WALLOPS-ISLAND using the very near transmitter of N.S.S. ANNAPOLIS (Maryland).

- The transmitting code of the transmitter must be appropriate to the band-pass of the V.L.F. receivers and to the experiment to process. It is thought that the best code would be made of long dashes CW of nine seconds with one second intervals.

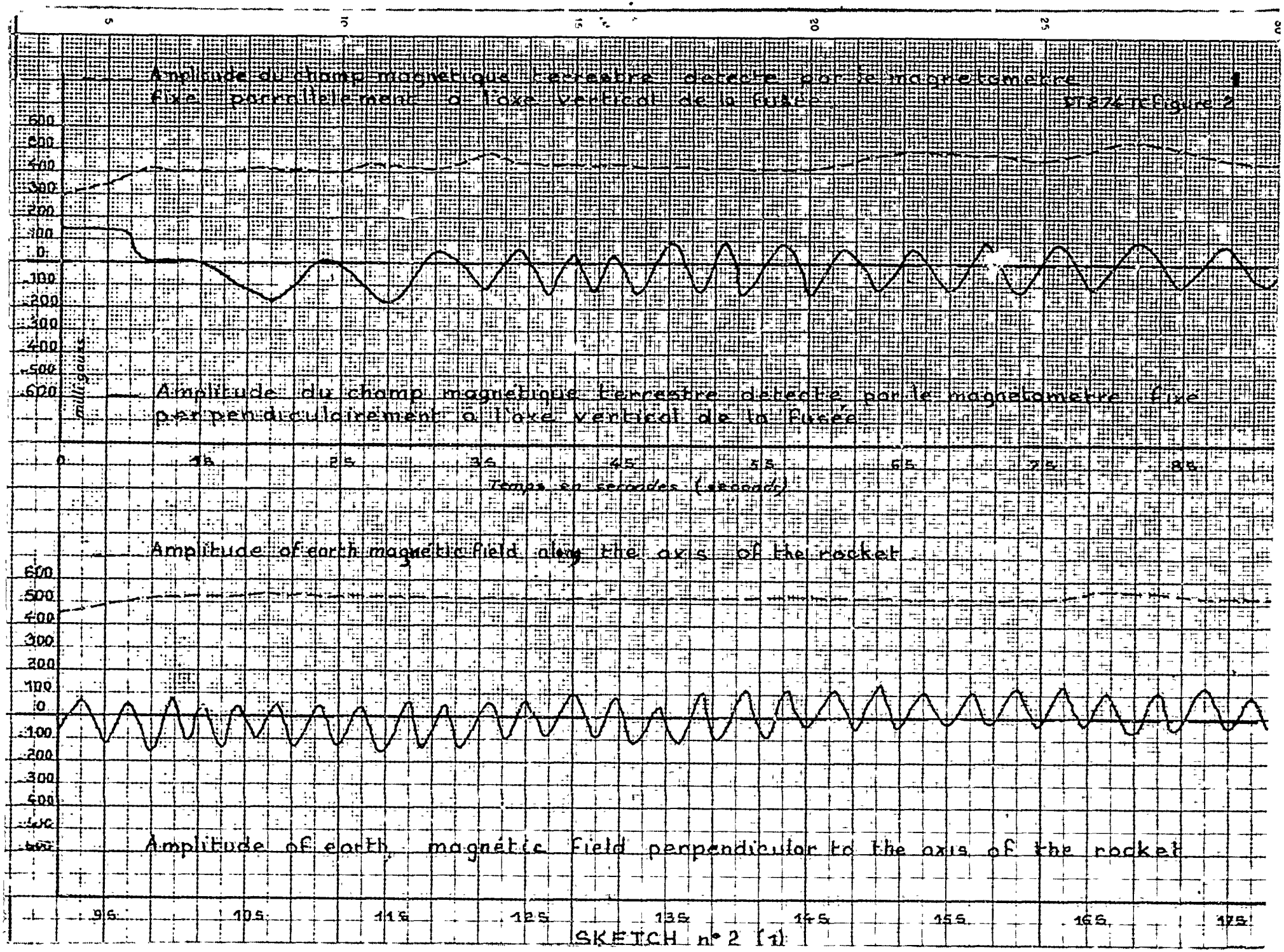
- The interference between the V.L.F. equipments and the others equipments must be carefully prevented. For this reason, it is thought that the total payload must be checked in C.N.E.T. Laboratories in FRANCE before going to the launching area and that every thing must be made for reducing the number of high level noise sources in the nose cone. For example, not to use transistorized converters but batteries, telemetry commutator but several subcarriers, beacons but tracking system with powerful radar like F.P.S. 16, ...

A new proposal is prepared by C.N.E.T. for a firing of a NIKE-CAJUN Rocket taking in account all these previous desires and first contacts with the Contractor let plan this experimentation for April 1962.

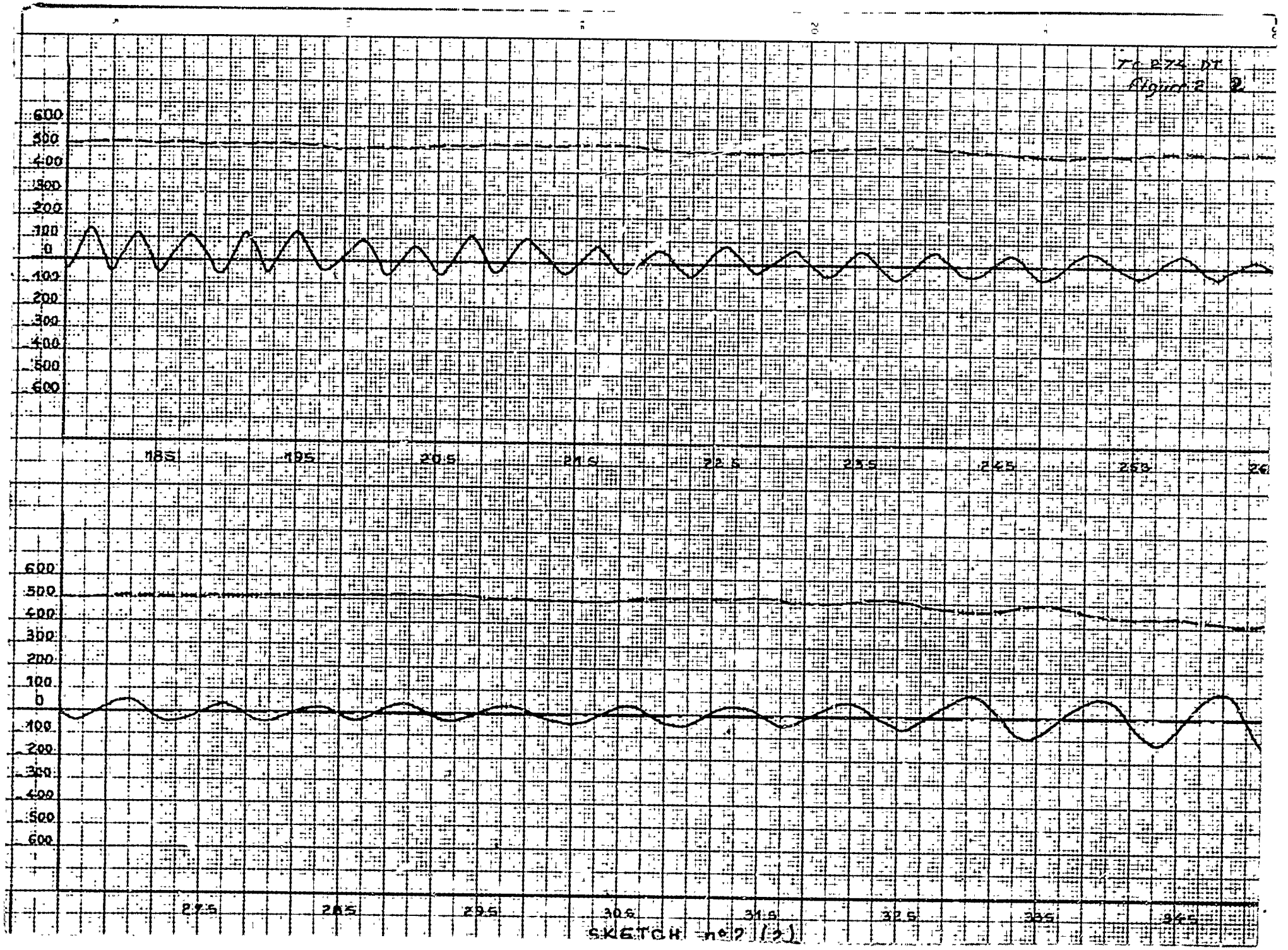
AT 694 TC Figure 1



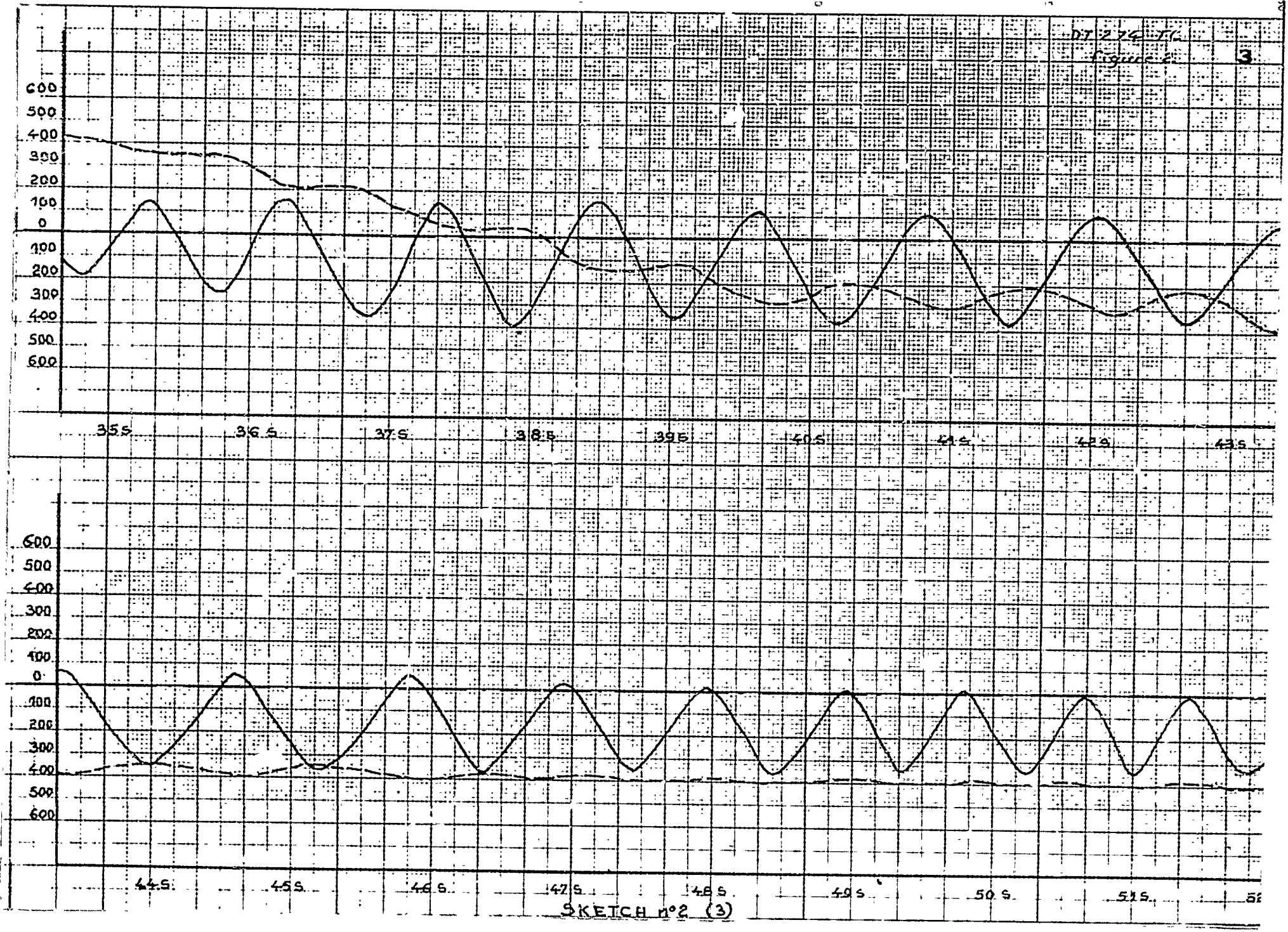
SKETCH n° 1


Amplitude du champ magnétique terrestre détecté par le magnétomètre fixé parallèlement à l'axe vertical de la fusée
ST 274 - figure 2
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
milli gauss
Amplitude du champ magnétique terrestre détecté par le magnétomètre fixé perpendiculairement à l'axe vertical de la fusée
0
10 s
20 s
30 s
40 s
50 s
60 s
70 s
80 s
Temps en secondes (seconds)
Amplitude of earth magnetic field along the axis of the rocket
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
Amplitude of earth magnetic field perpendicular to the axis of the rocket
90 s
100 s
110 s
120 s
130 s
140 s
150 s
160 s
170 s

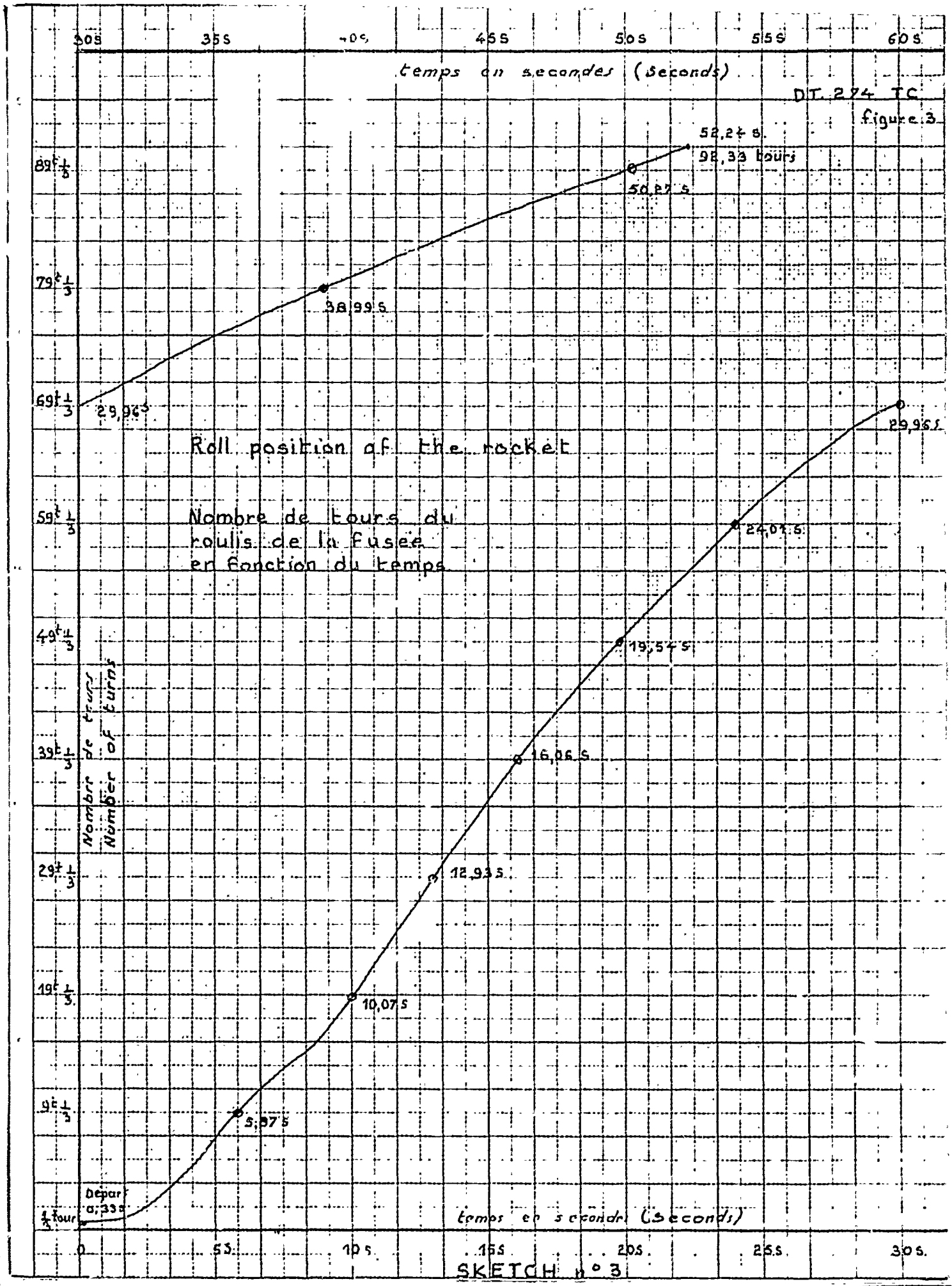
SKETCH n° 2 (1)


Tc 274 DT
Algues 2
600
500
400
300
200
100
0
100
200
300
400
500
600
18S
19S
20S
21S
22S
23S
24S
25S
26S
600
500
400
300
200
100
0
100
200
300
400
500
600
27S
28S
29S
30S
31S
32S
33S
34S

SKETCH n°2 (2)

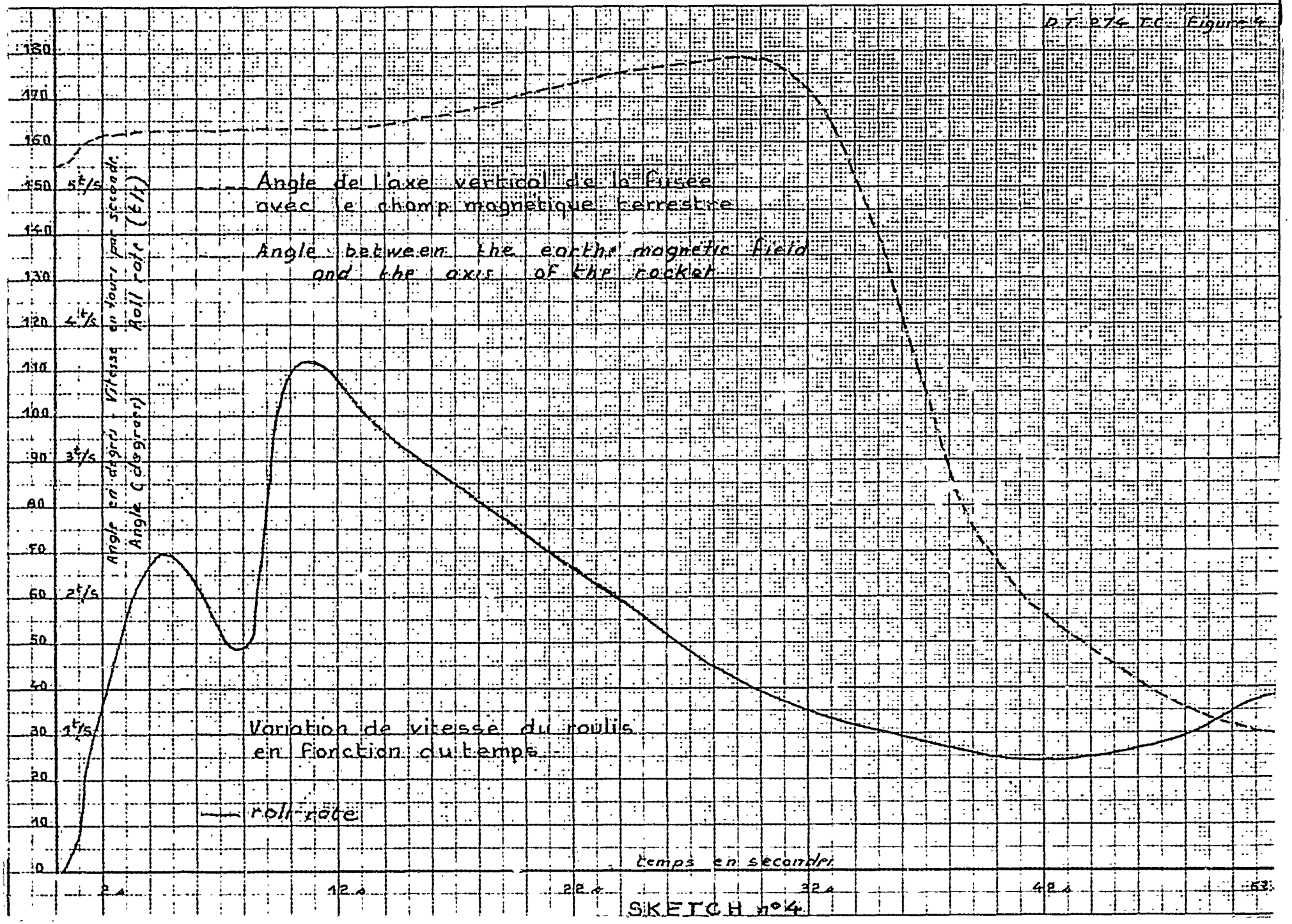

DT 274 TC
figure 2
3
600
500
400
300
200
100
0
100
200
300
400
500
600
35 S
36 S
37 S
38 S
39 S
40 S
41 S
42 S
43 S
600
500
400
300
200
100
0
100
200
300
400
500
600
44 S
45 S
46 S
47 S
48 S
49 S
50 S
51 S

SKETCH n°2 (3)


30s
35s
40s
45s
50s
55s
60s
temps en secondes (seconds)
DT 294 TC
figure 3
52,24 s.
98,33 tours
50,27 s
38,99 s
29,96 s
29,96 s
24,01 s
19,54 s
16,06 s
12,93 s
10,07 s
5,07 s
Départ
0,33 s
Roll position of the rocket
Nombre de tours du roulis de la fusée en fonction du temps
Nombre de tours
Number of turns
89 1/3
79 1/3
69 1/3
59 1/3
49 1/3
39 1/3
29 1/3
19 1/3
9 1/3
1/3 tour
temps en seconde (seconds)
0
5s
10s
15s
20s
25s
30s

SKETCH n° 3

D.T. 27 T.C. Figure 4



SKETCH n°4

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Contract n°AF 61(052)-436
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September 1961
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