RATLIEF

Final Report
for
ADVANCED TECHNOLOGICAL SATELLITE ELECTRO-MECHANICAL DESPUN ANTENNA

Appendices

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Prepared by

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Sylvania Electronic Systems

An Operating Group of Sylvania Electric Products, Inc.

for

National Aeronautics and Space Administration

Goddard Space Flight Center

Greenbelt, Maryland

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Final Report

for

ADVANCED TECHNOLOGICAL SATELLITE ELECTRO-MECHANICAL DESPUN ANTENNA

APPENDICES

19 October 1967

F181-1

Contract No. NAS 5-9521

Prepared By

SYLVANIA ELECTRONIC SYSTEMS EASTERN DIVISION

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
Greenbelt, Maryland

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APPENDIX A

RF PATTERN TEST DATA

Although the radiation performance of the deliverable mechanical despun antenna systems has been summarized in tabular form for each unit, this summary cannot give the reader a complete picture of the full, 360° radiation characteristics of the antenna. In the absence of a separate test report, copies of all the original RF pattern data are included in this appendix for completeness.

PRE-ENVIRONMENTAL RF PERFORMANCE SUMMARY

QUALIFICATION MODEL

	Transmit	Receive	Specification
Frequency (GHz)	4	6	
Gain (db)	17.1 - 17.7	17.2 - 17.5	17.0 nominal
3 db Beamwidth	20° + 0.2° -0.0°	20° +0.1° -0.0°	20° ± 2°
3 db Beamwidth Symmetry	0.1°	0.1°	-
VSWR (Max.)	1.26	1.29	1.35 Transmit 1.45 Receive
Cross-Polarization (db)	> 40	> 40	20 Min.
Decoupling (db min.)	34	32	None (Objective: 30)
Beam Squint (db max.)	0.2	0.2	0.4
Beam Ripple (db)	±0.1	±0.1	±0.5

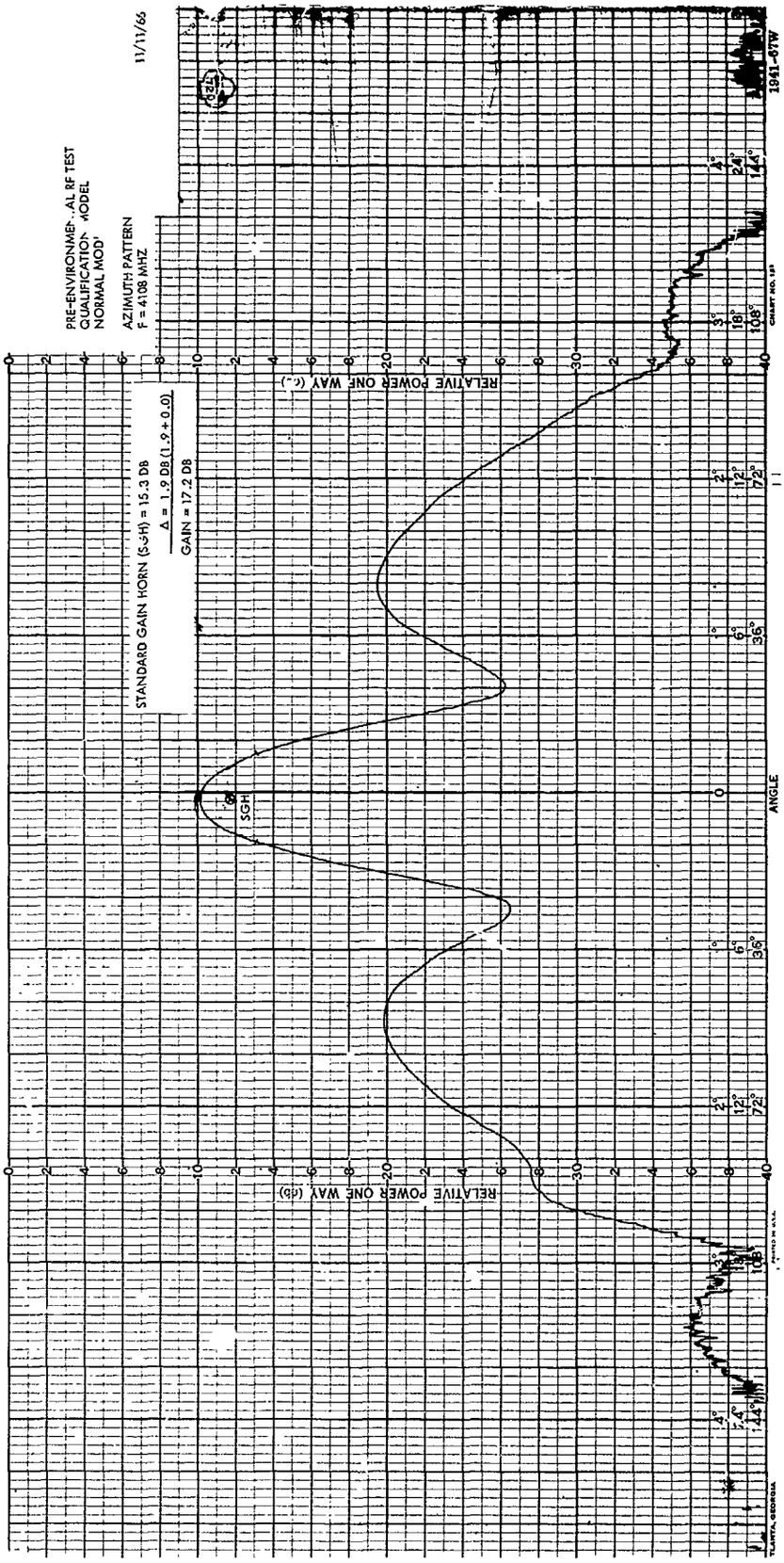
FLIGHT MODEL NO. 1

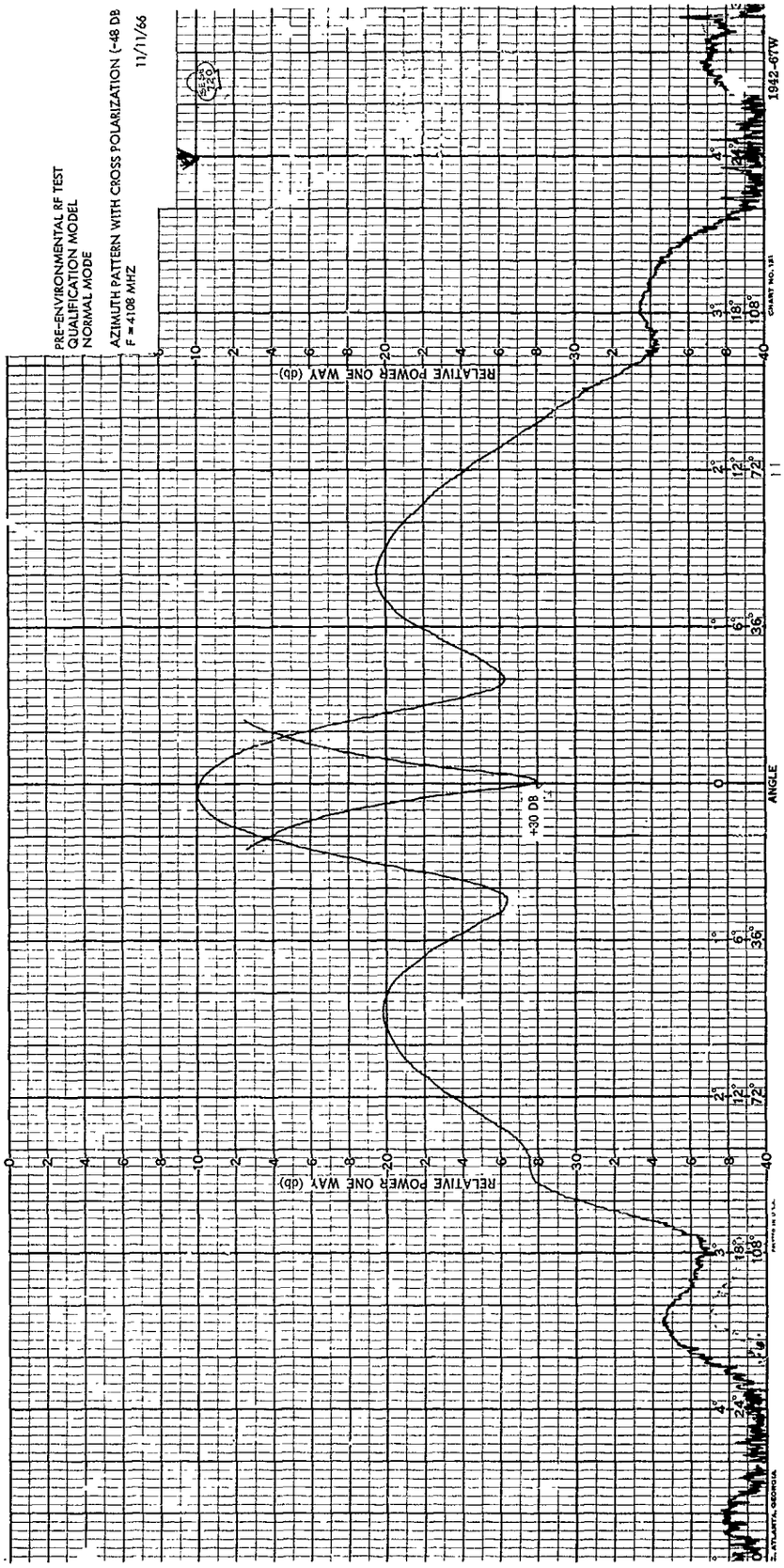
	Transmit	Receive	Specification
Frequency (MHz)	4150	6260	-
Peak Gain (db)	17.4	17.1	17.0 Nominal
3 db Beamwidth (degrees)	20° × 21.5°	19° × 20.5°	20° ± 2°
VSWR (max.)	1.34	1.26	1.35 max, transmit 1.45 max, receive
Cross Polarization (db)	47	37	20 min.
Beam Squint (db)	0	0.1	0.4 max.
Beam Ripple (db)	±0.1	±0.1	±0.5

PRE-ENVIRONMENTAL RF PERFORMANCE SUMMARY

FLIGHT MODEL NO. 2

	Transmit	Receive	Specification
Frequency (GHz)	4150	6260	-
Peak Gain (db)	17.4	17.7	17.0 Nominal
3 db Beamwidth (degrees)	20 × 21	20 × 20	20 ± 2
VSWR (max.)	1.35	1.28	1.35 max, transmit 1.45 max, receive
Cross-Polarization (db)	46.3	33.5	20 min.
Beam Squint (db)	0	0.4	0.4 max.
Beam Ripple (db)	0.1 total	0.1 total	±0.5


PRE-ENVIRONMEN..AL RF TEST
QUALIFICATION MODEL
NORMAL MOD'
AZIMUTH PATTERN
F = 4108 MHZ
11/11/66
STANDARD GAIN HORN (S-SH) = 15.3 DB
Δ = 1.9 DB (1.9 + 0.0)
GAIN = 17.2 DB
SGH
RELATIVE POWER ONE WAY (db)
ANGLE
1941-57W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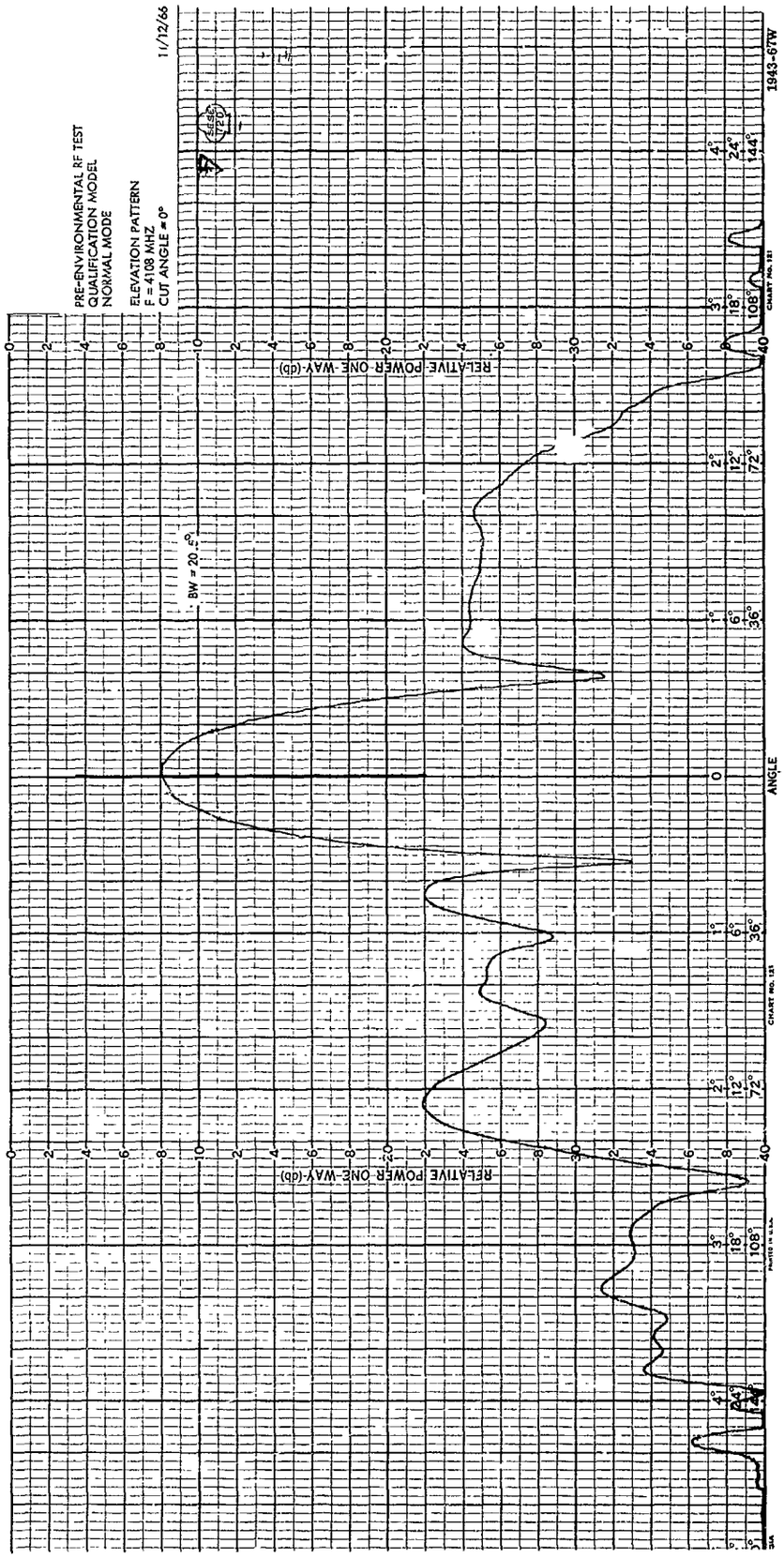
+30 DB
ANGLE
1942-67W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NORMAL MODE
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11/12/66
BW = 20.5°
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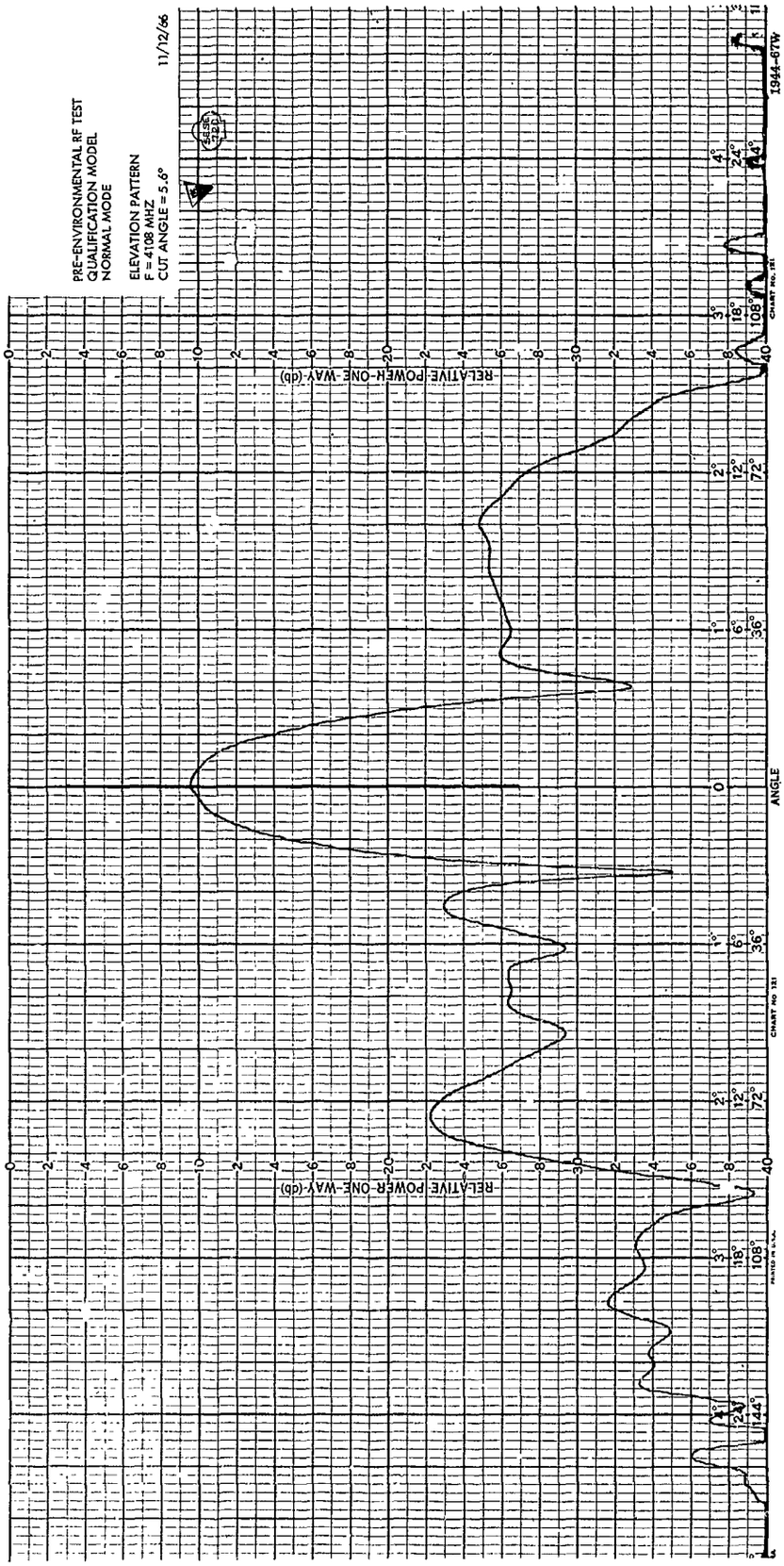
ANGLE
1943-67W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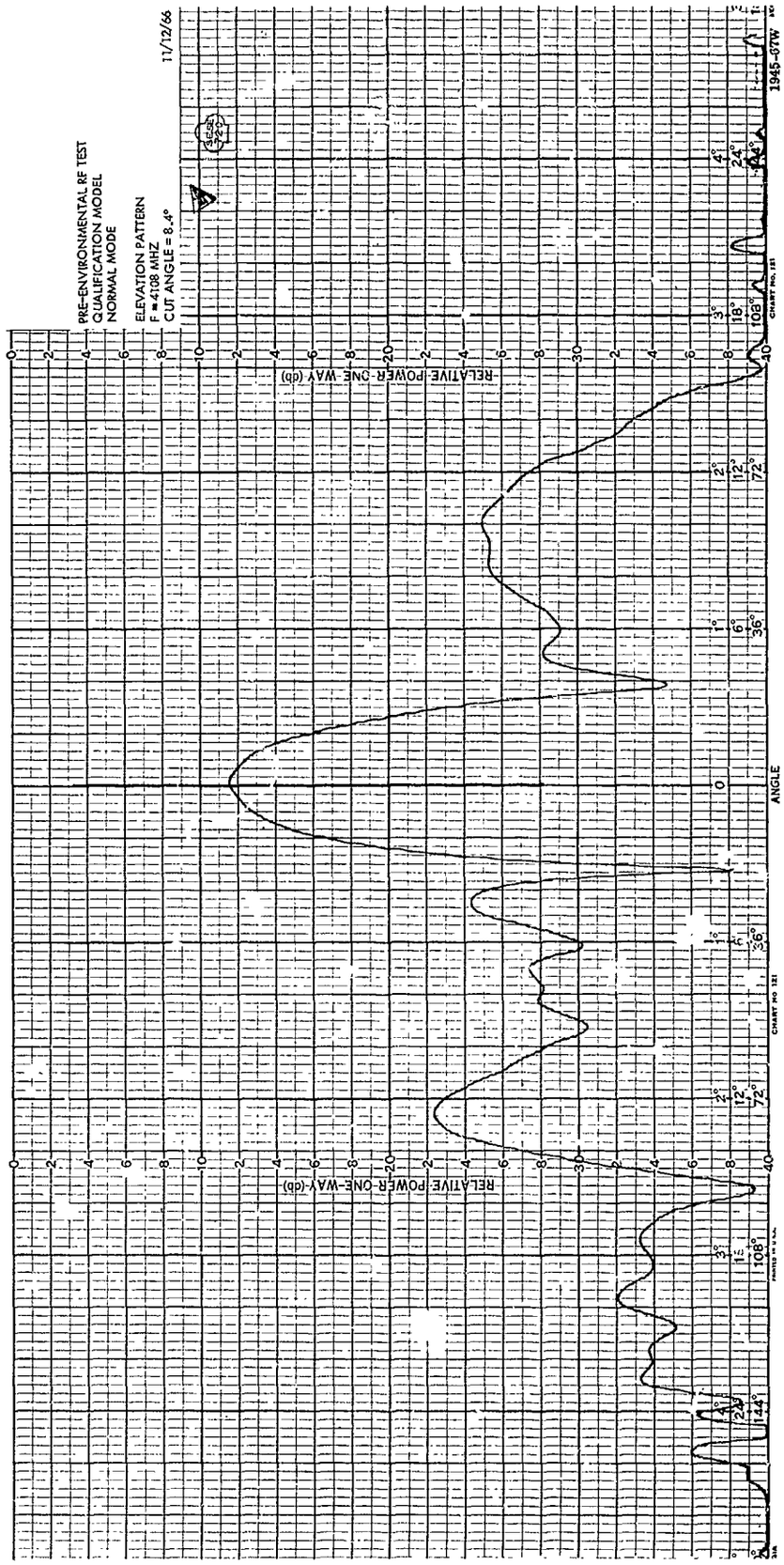
ANGLE
1944-67W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ELEVATION PATTERN
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11/12/66
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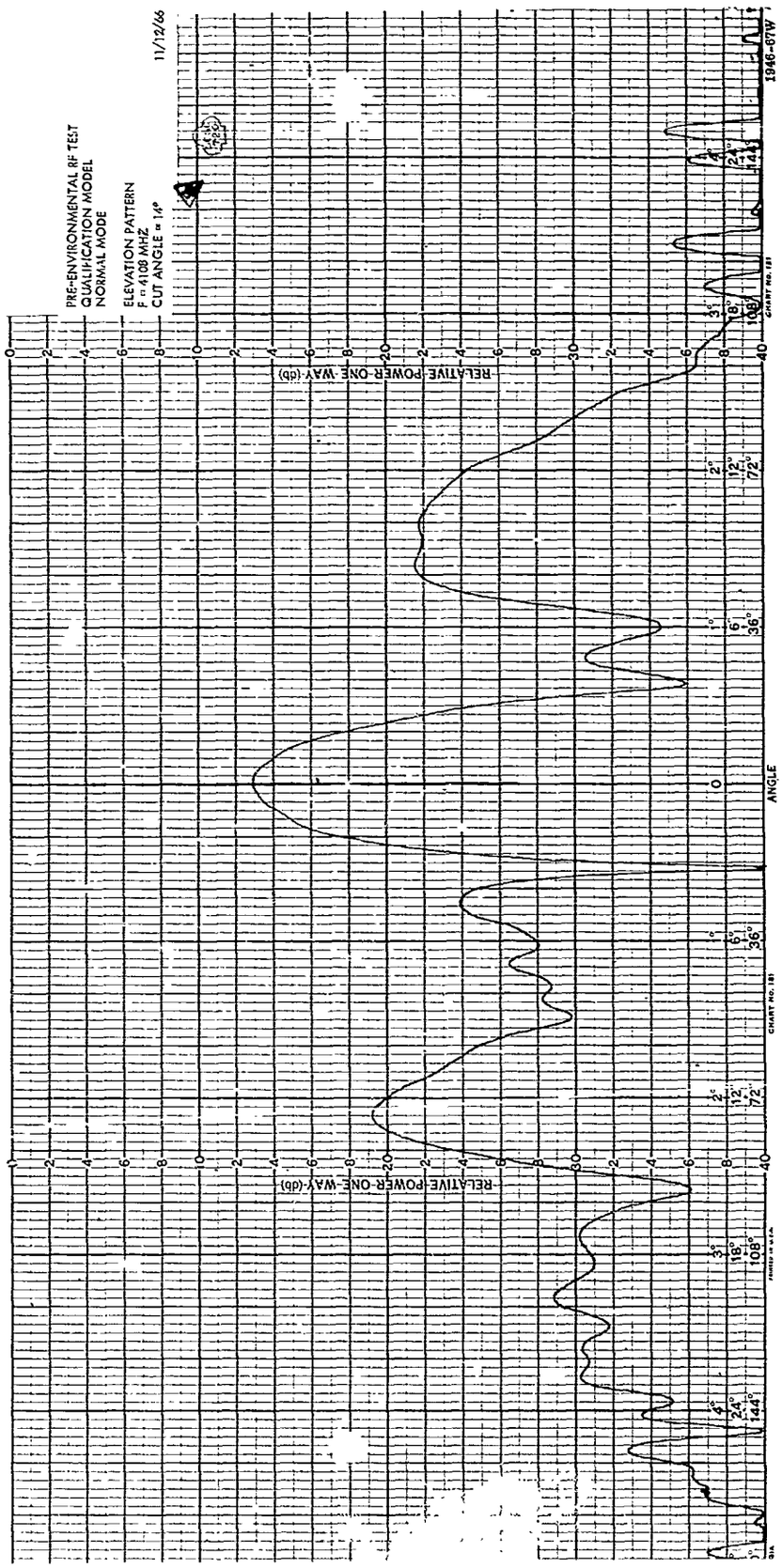
ANGLE
CHART NO. 121
1945-67W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QUALIFICATION MODEL
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11/12/66
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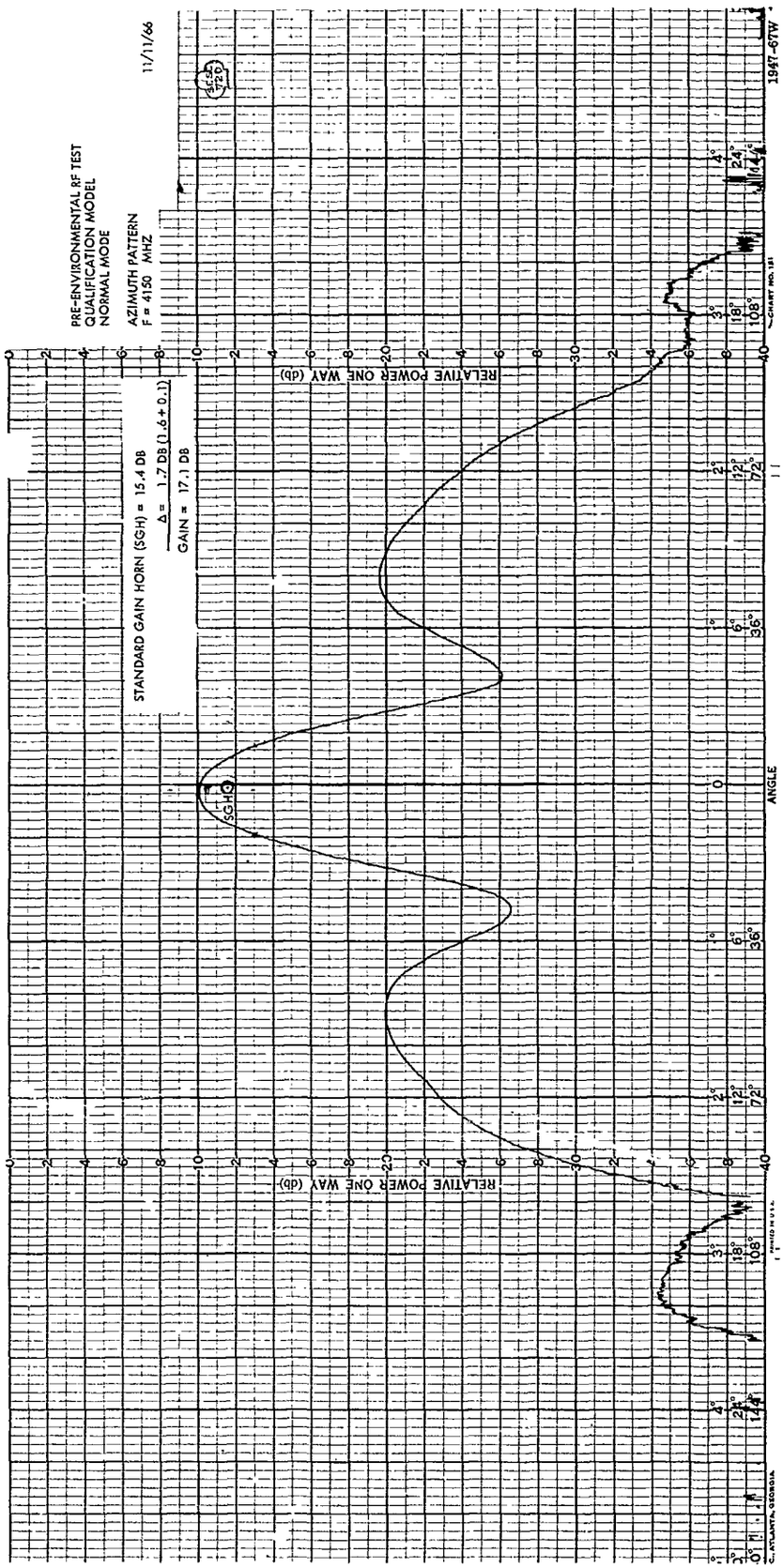
ANGLE
1946-67W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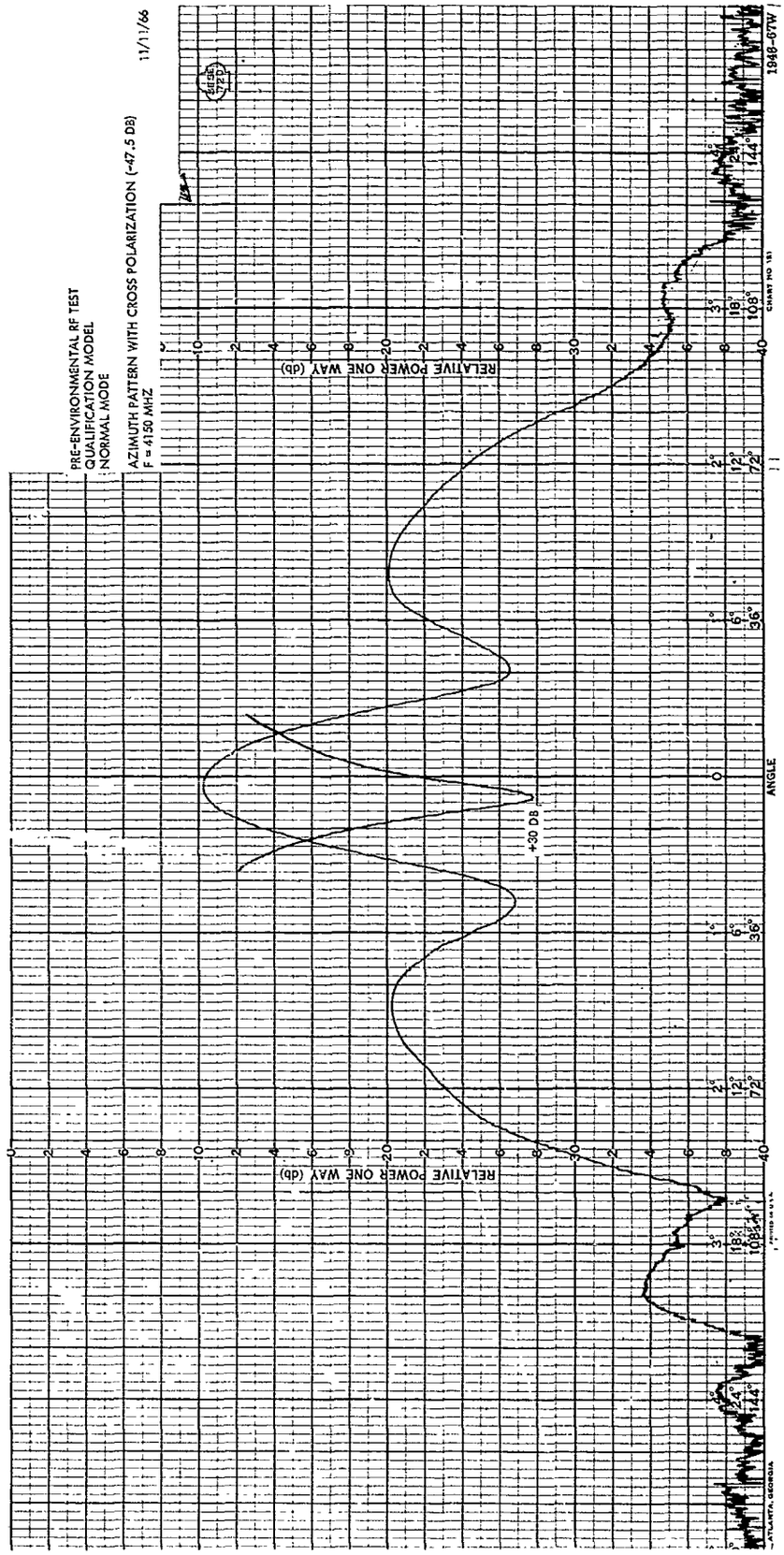
QUALIFICATION MODEL
NORMAL MODE
AZIMUTH PATTERN
F = 4150 MHZ
11/11/66
STANDARD GAIN HORN (SGH) = 15.4 DB
Δ = 1.7 DB (1.6 + 0.1)
GAIN = 17.1 DB
RELATIVE POWER ONE WAY (db)
ANGLE
SGH
1987-67W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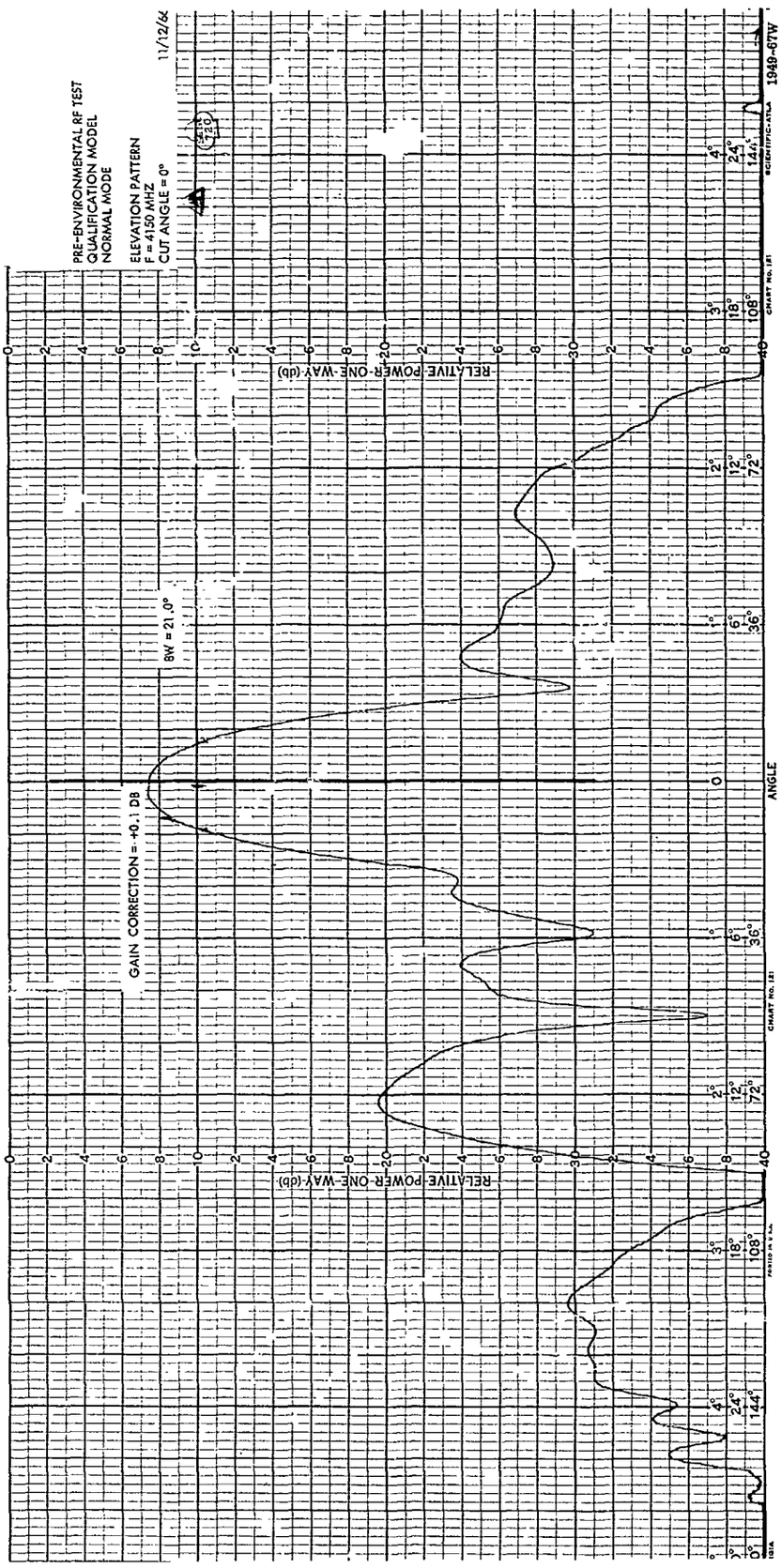
QUALIFICATION MODEL
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION (-47.5 DB)
F = 4150 MHZ
11/11/66
RELATIVE POWER ONE WAY (db)
+30 DB
ANGLE
1948-67W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NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 0°
11/12/64
GAIN CORRECTION = +0.1 DB
BW = 21.0°
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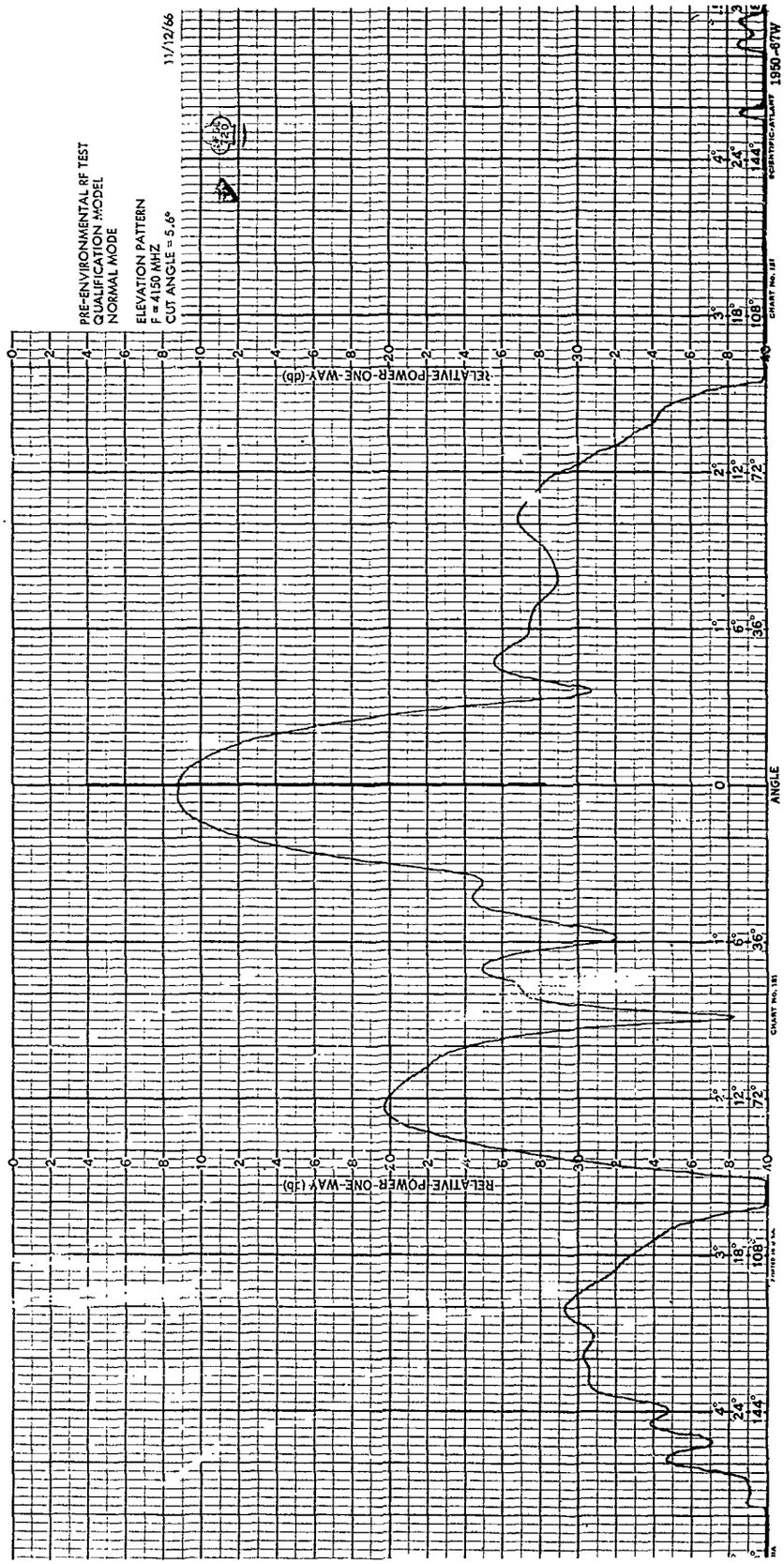
ANGLE
CHART NO. 121
1949-67W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QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
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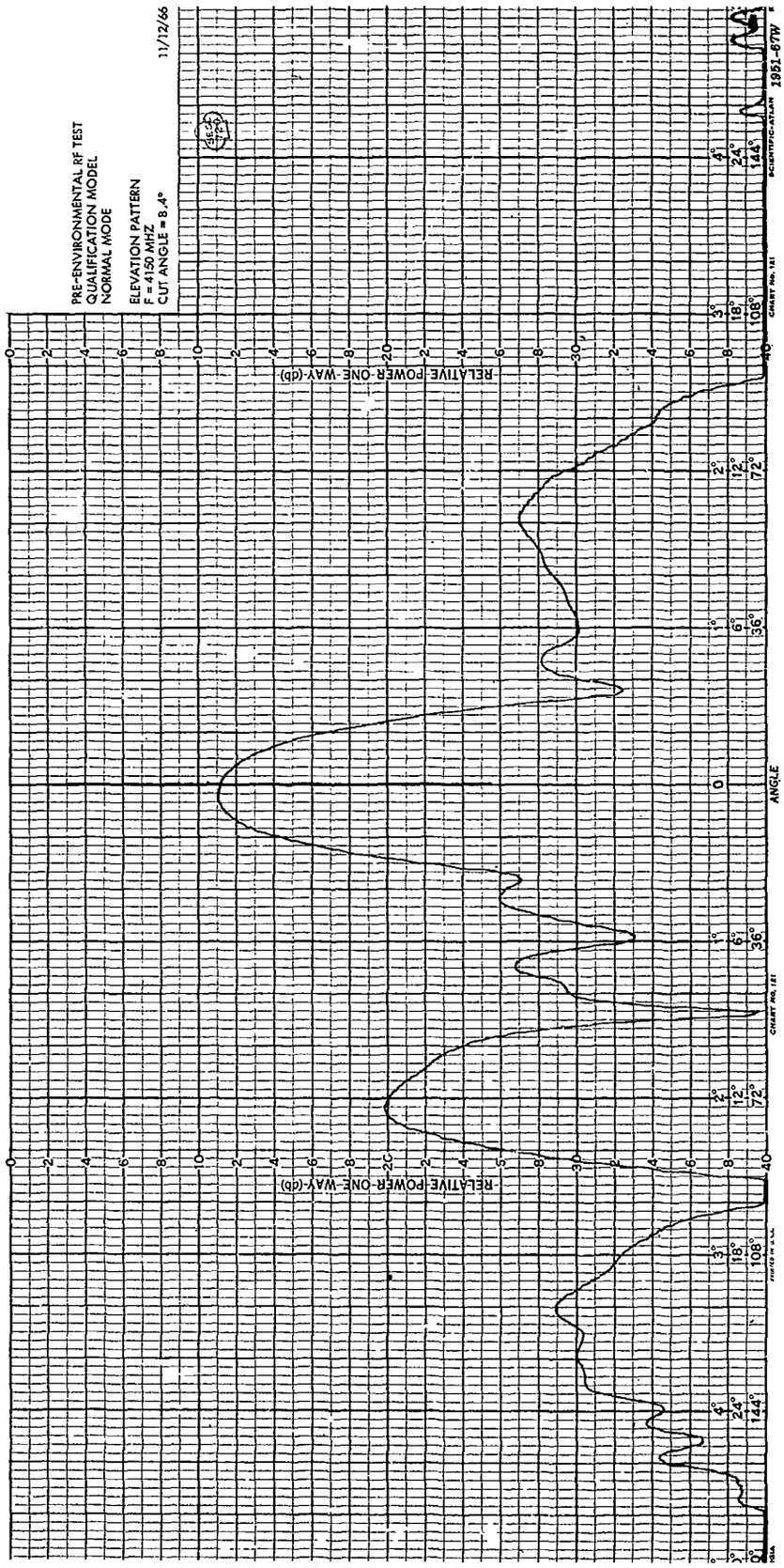
CUT ANGLE = 5.6°
11/12/66
RELATIVE POWER-ONE-WAY (db)
ANGLE
SCIENTIFIC-ATLANTA 1950-67W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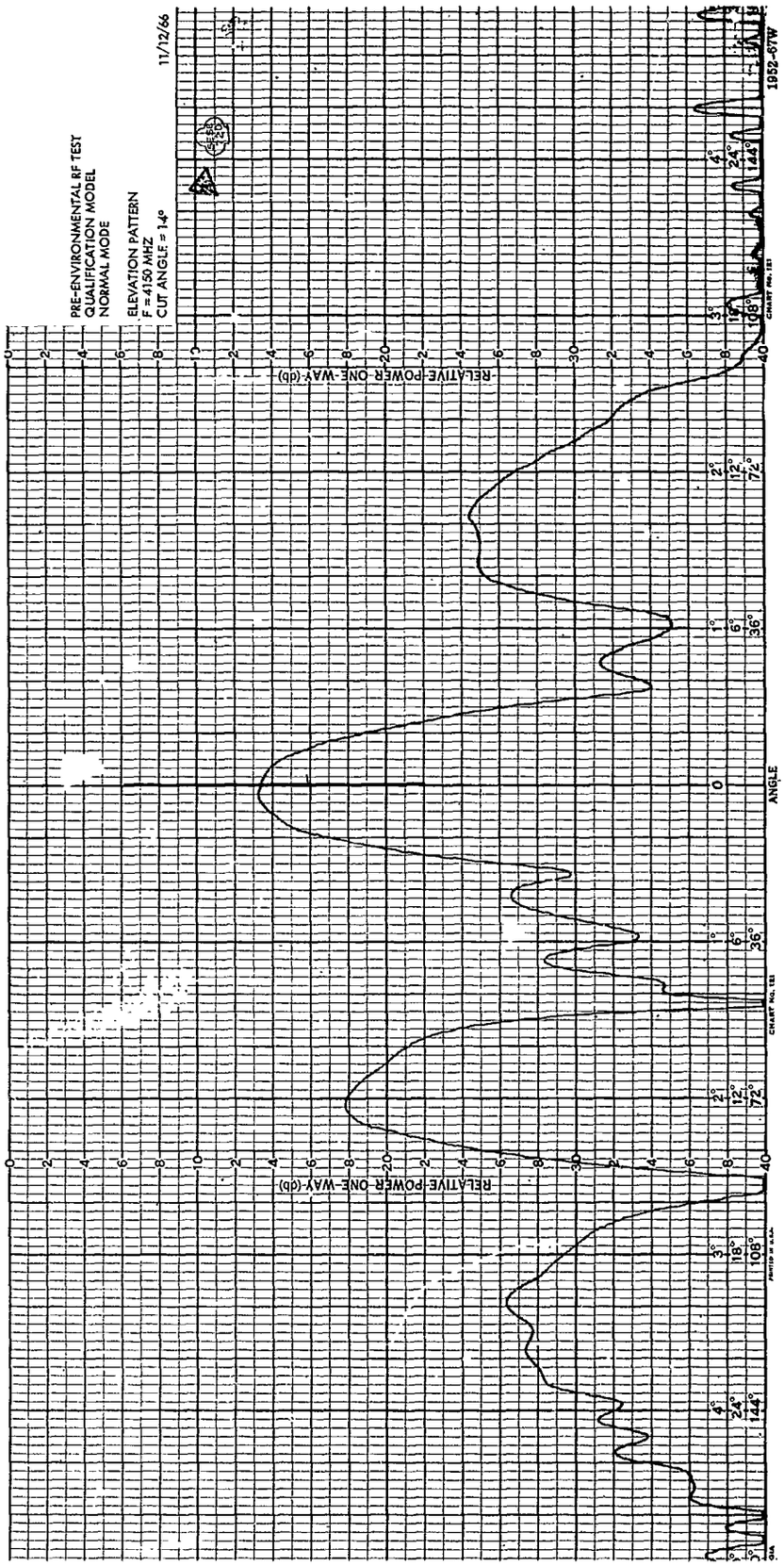
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 8.4°
11/12/66
RELATIVE POWER ONE-WAY (db)
ANGLE
CHART NO. 121
SCIENTIFIC-ATLANTA 1951-67W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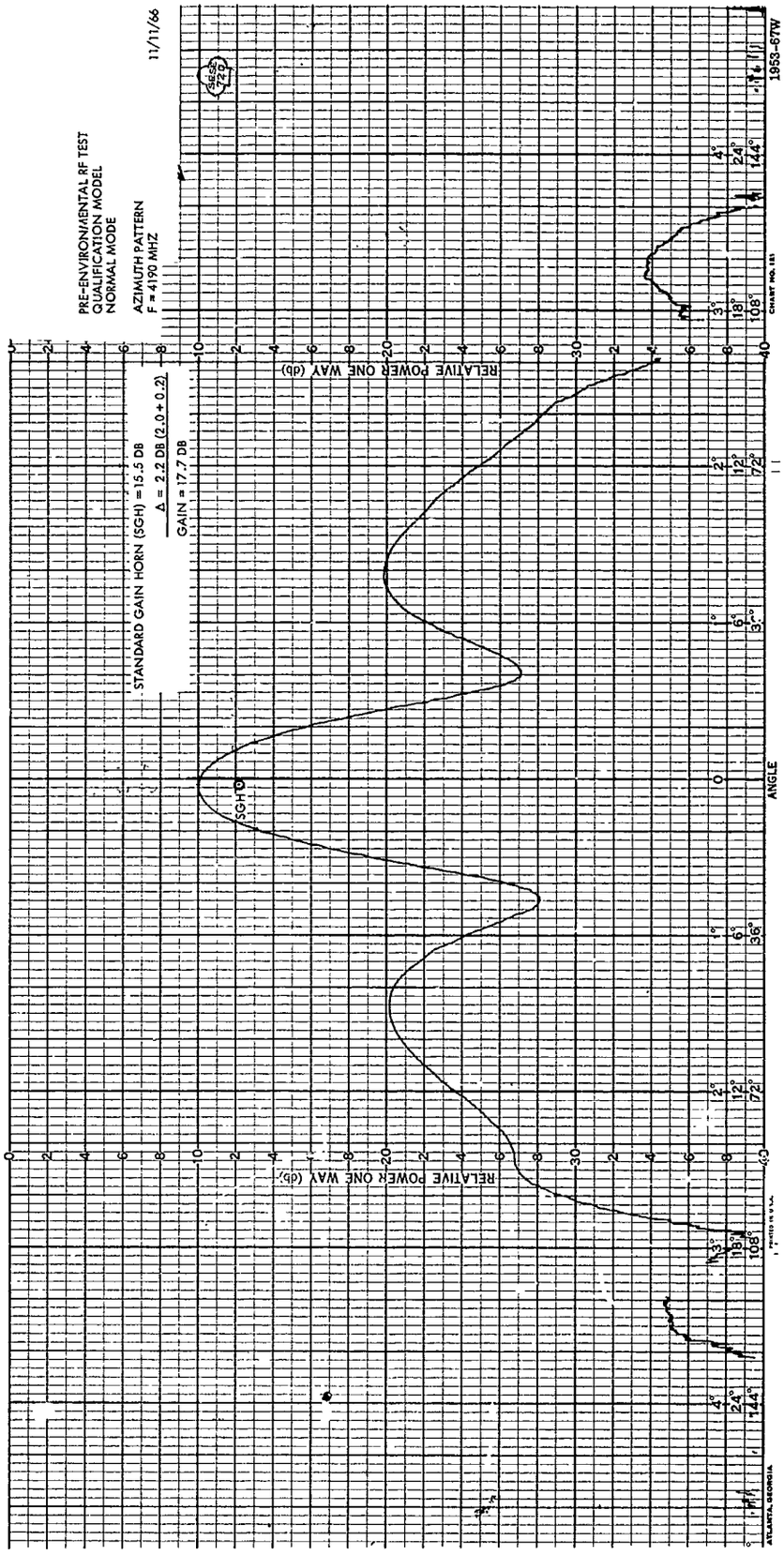
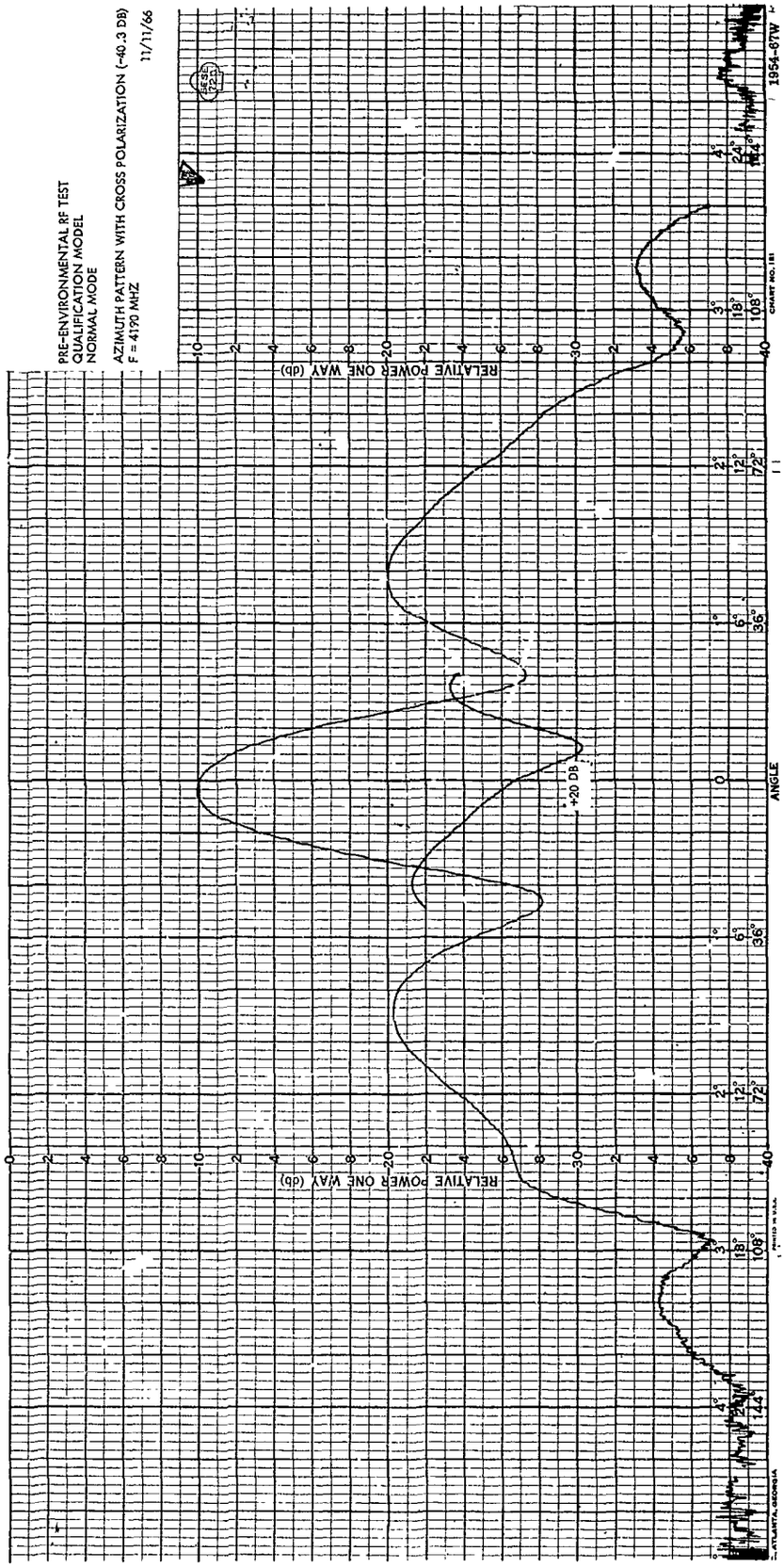
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 14°
11/12/66
RELATIVE POWER ONE-WAY (db)
ANGLE
1952-67W


PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
AZIMUTH PATTERN
F = 4190 MHZ
11/11/66
STANDARD GAIN HORN (SGH) = 15.5 DB
Δ = 2.2 DB (2.0 + 0.2)
GAIN = 17.7 DB
SGH
RELATIVE POWER ONE WAY (db)
ANGLE
1953-67W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QUALIFICATION MODEL
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION (-40.3 DB)
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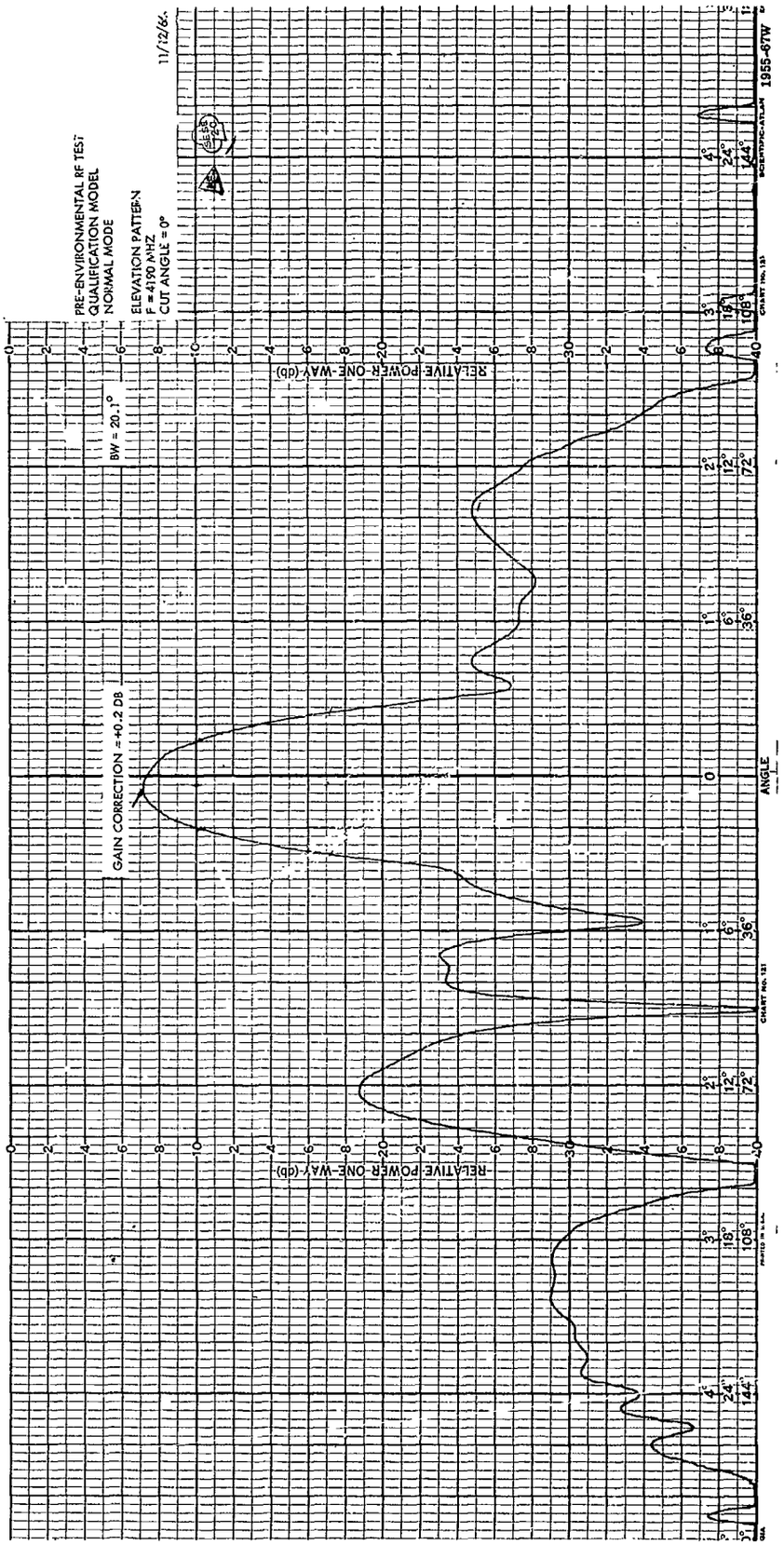
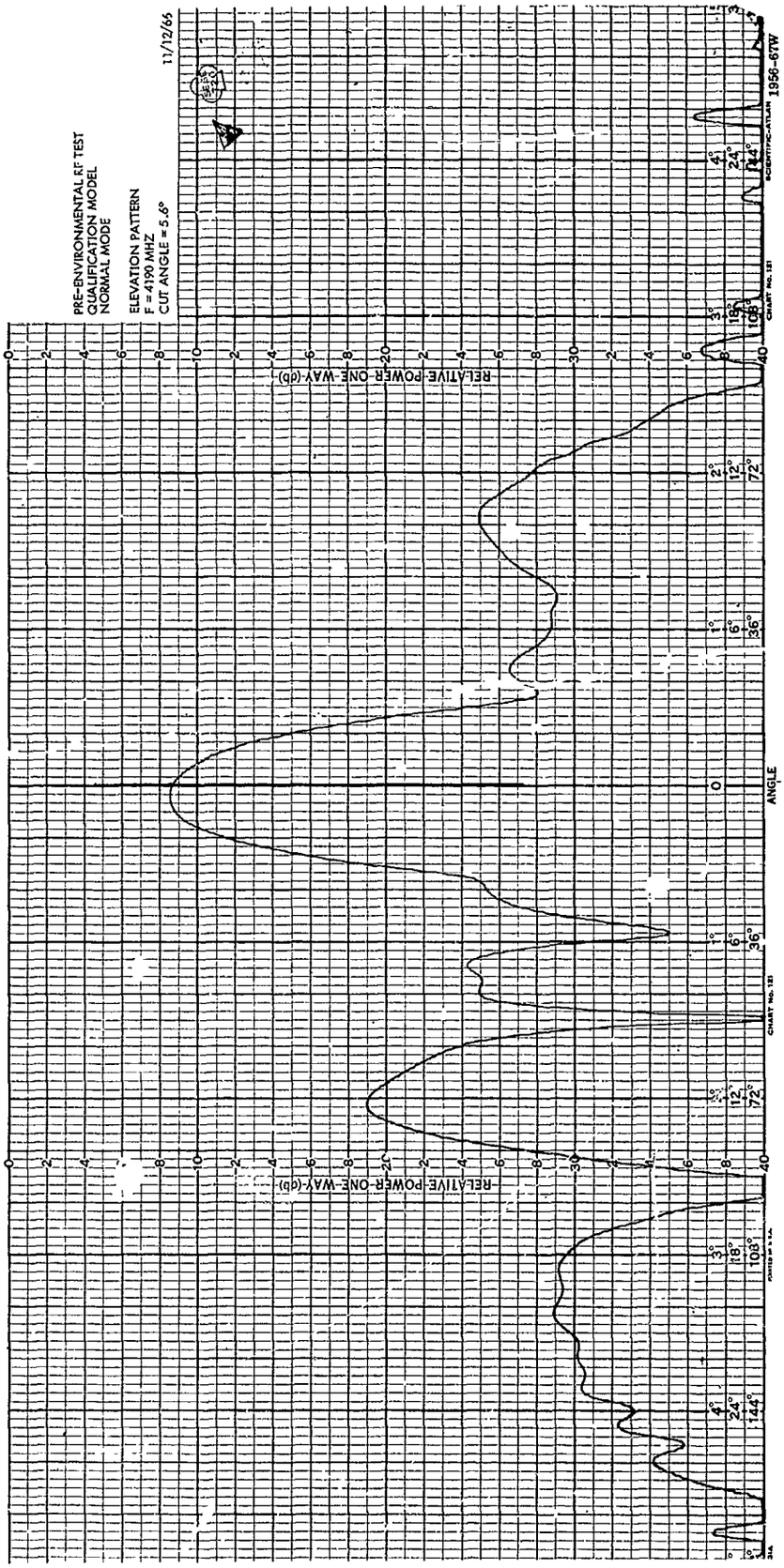
11/11/66
RELATIVE POWER ONE WAY (db)
+20 DB
ANGLE
CHART NO. 181
1954-67W


PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 4190 MHZ
CUT ANGLE = 0°
11/12/6
BW = 20.1°
GAIN CORRECTION = +0.2 DB
RELATIVE POWER-ONE-WAY (db)
ANGLE
SCIENTIFIC-ATLANTA 1955-97W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QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
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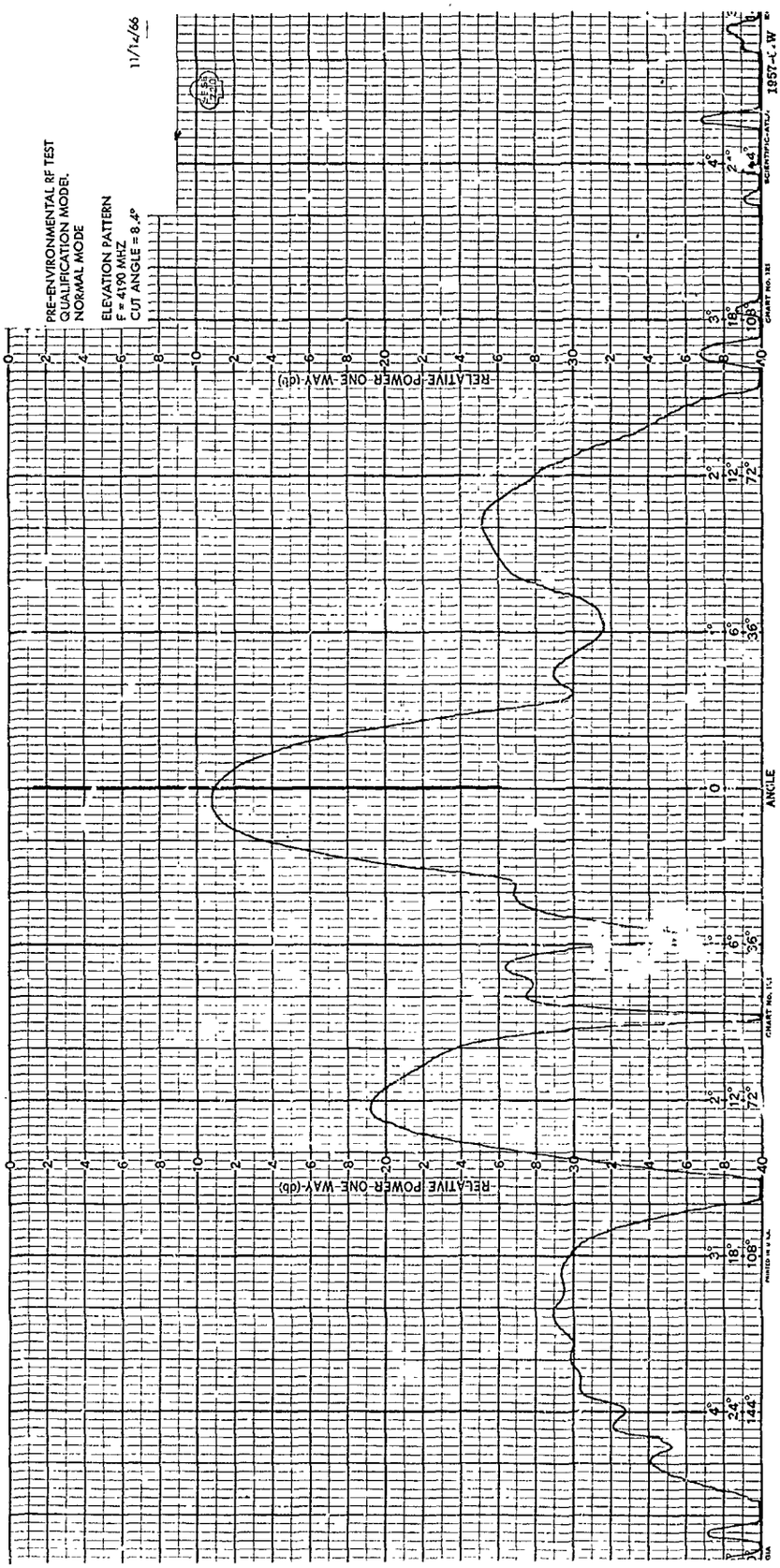
CUT ANGLE = 5.6°
11/12/65
RELATIVE POWER ONE WAY (db)
ANGLE
1956-67W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QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
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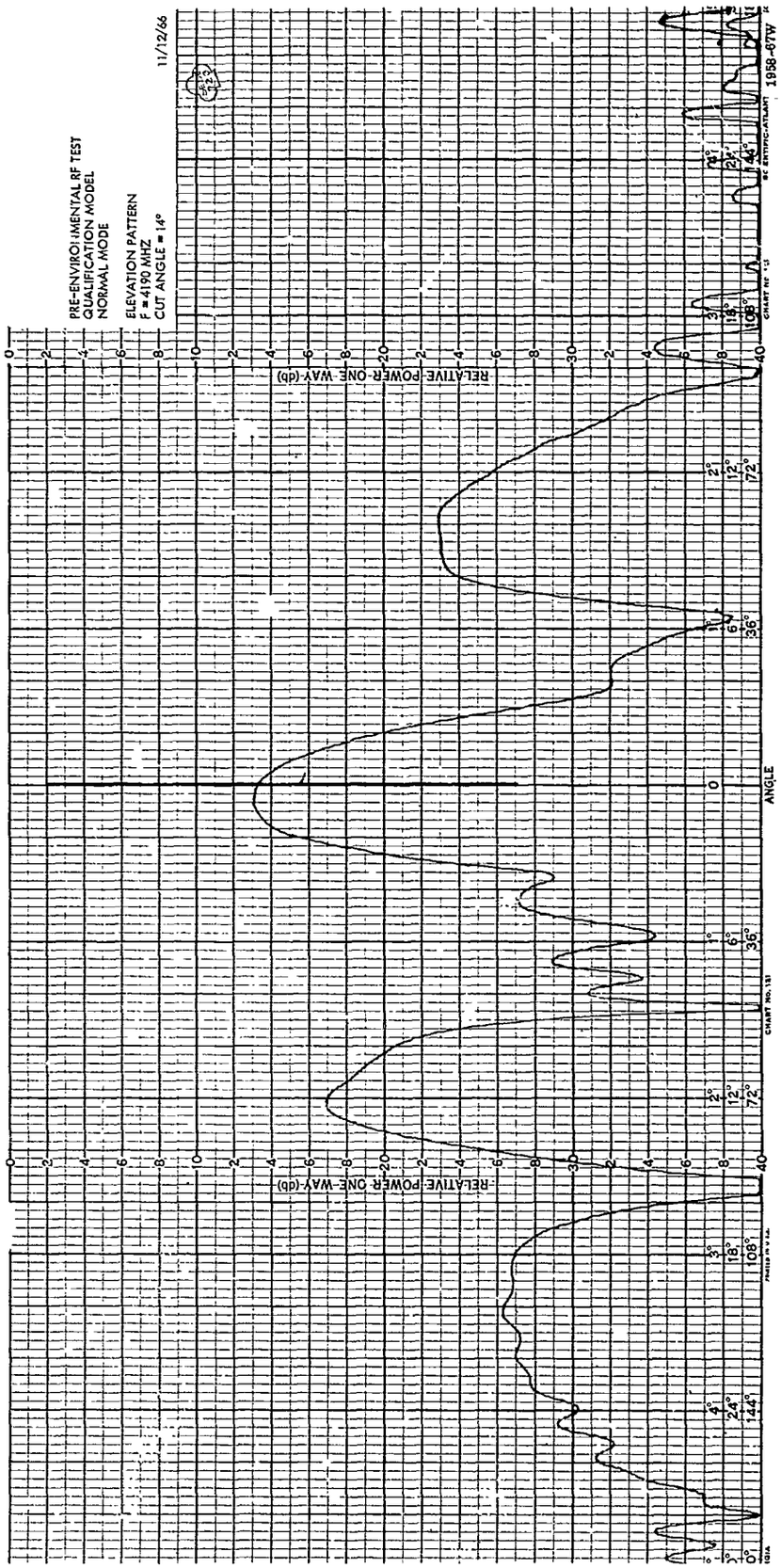
CUT ANGLE = 8.4°
11/14/66
RELATIVE POWER ONE WAY (db)
ANGLE
1957-C.W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ELEVATION PATTERN
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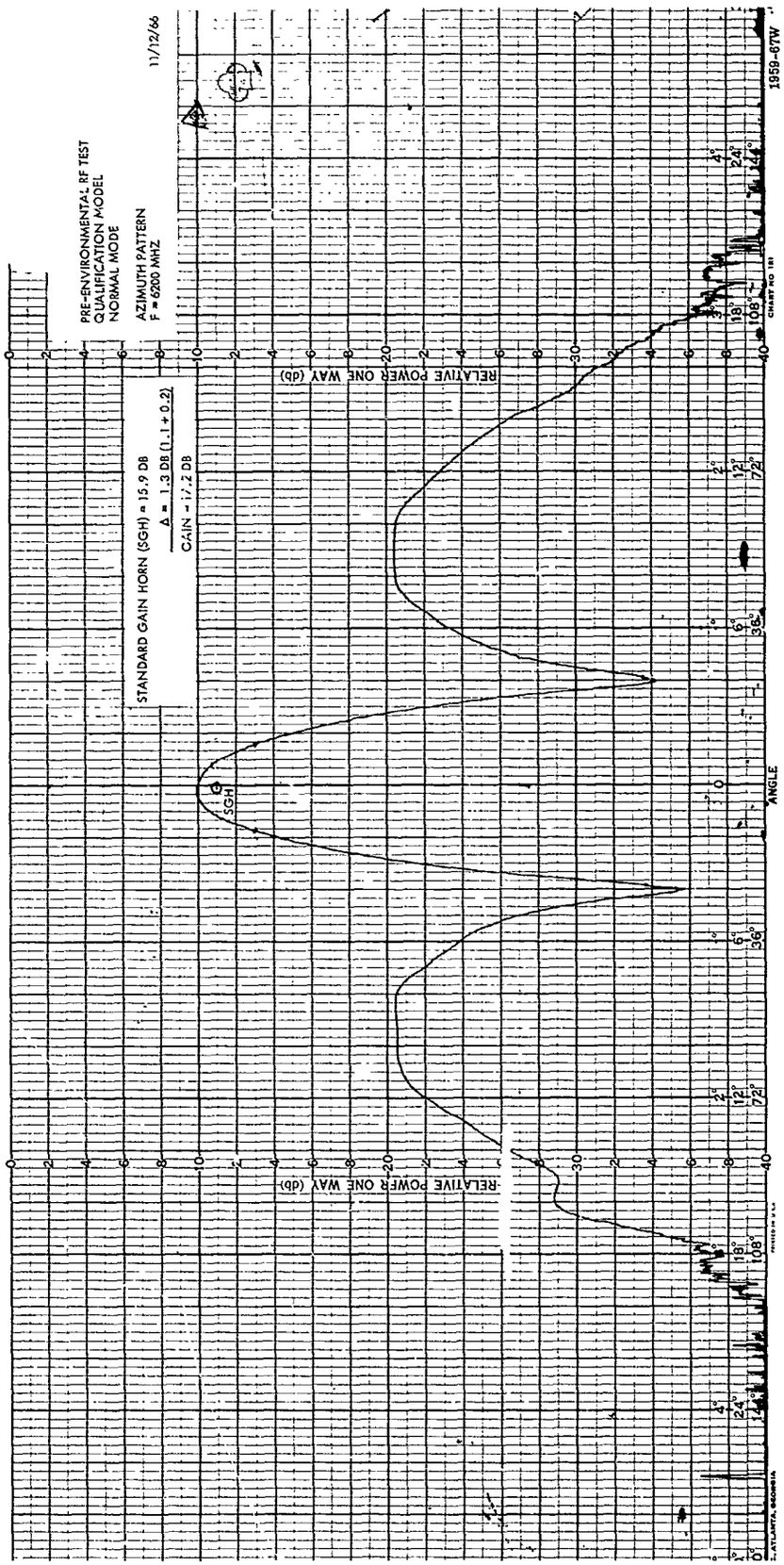
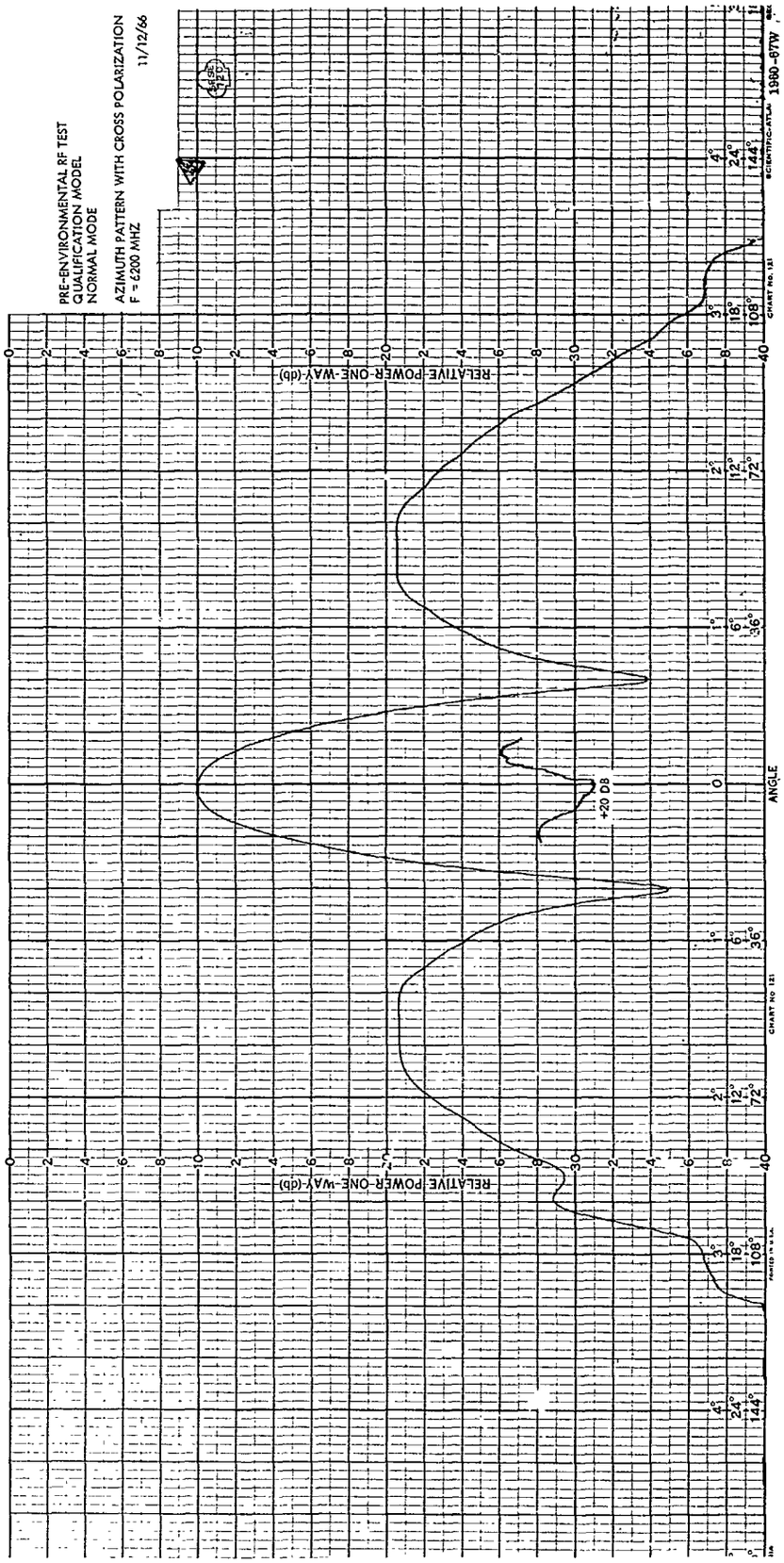
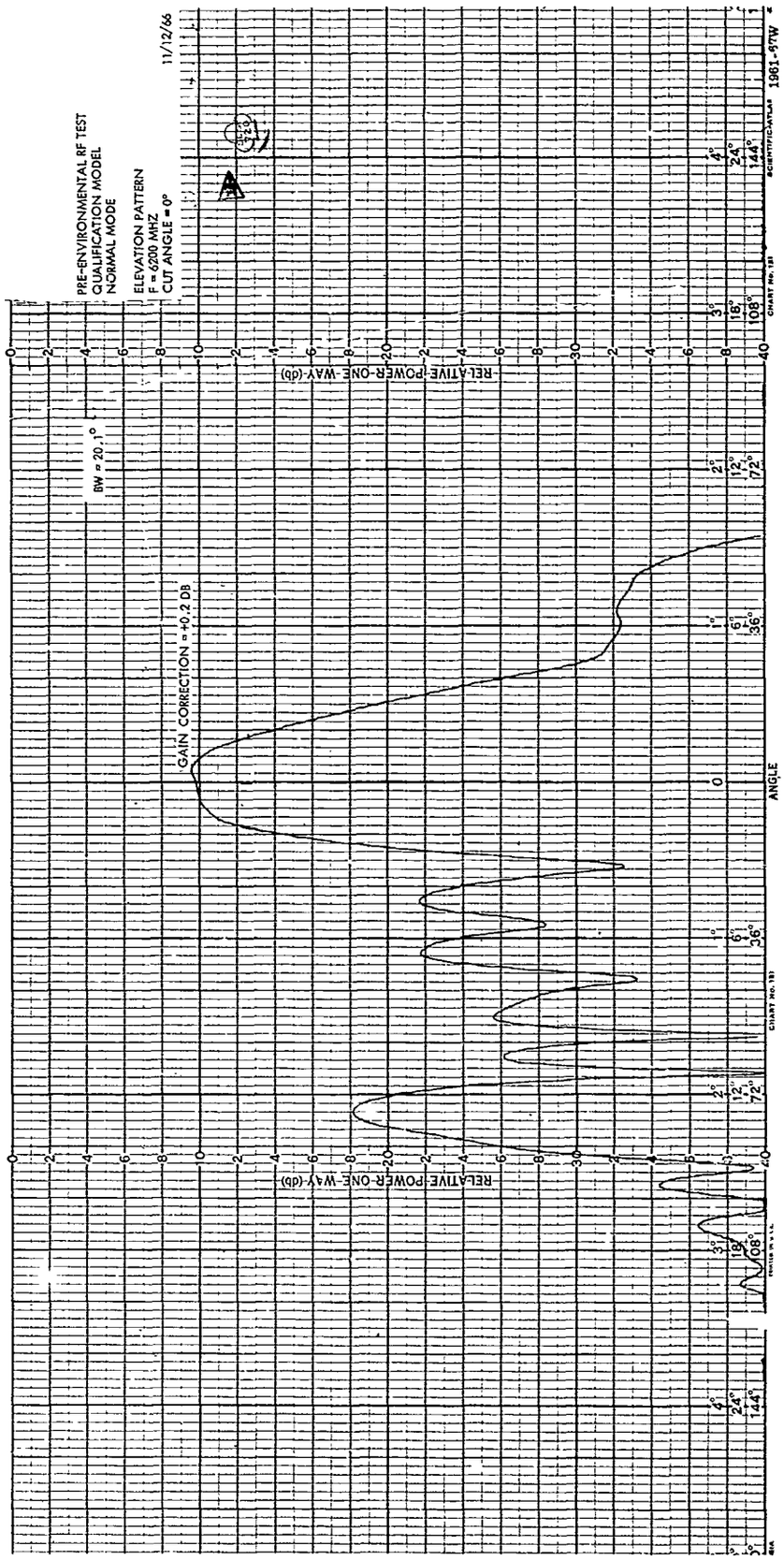
11/12/66
RELATIVE POWER ONE WAY (db)
ANGLE
1958-67W


PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
AZIMUTH PATTERN
F = 6200 MHZ
11/12/66
STANDARD GAIN HORN (SGH) = 15.9 DB
Δ = 1.3 DB (1.1 + 0.2)
GAIN = 17.2 DB
SGH
RELATIVE POWER ONE WAY (db)
ANGLE
1959-67W


PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION
F = 6200 MHZ
11/12/66
RELATIVE POWER-ONE-WAY (db)
ANGLE
+20 DB
1960-87W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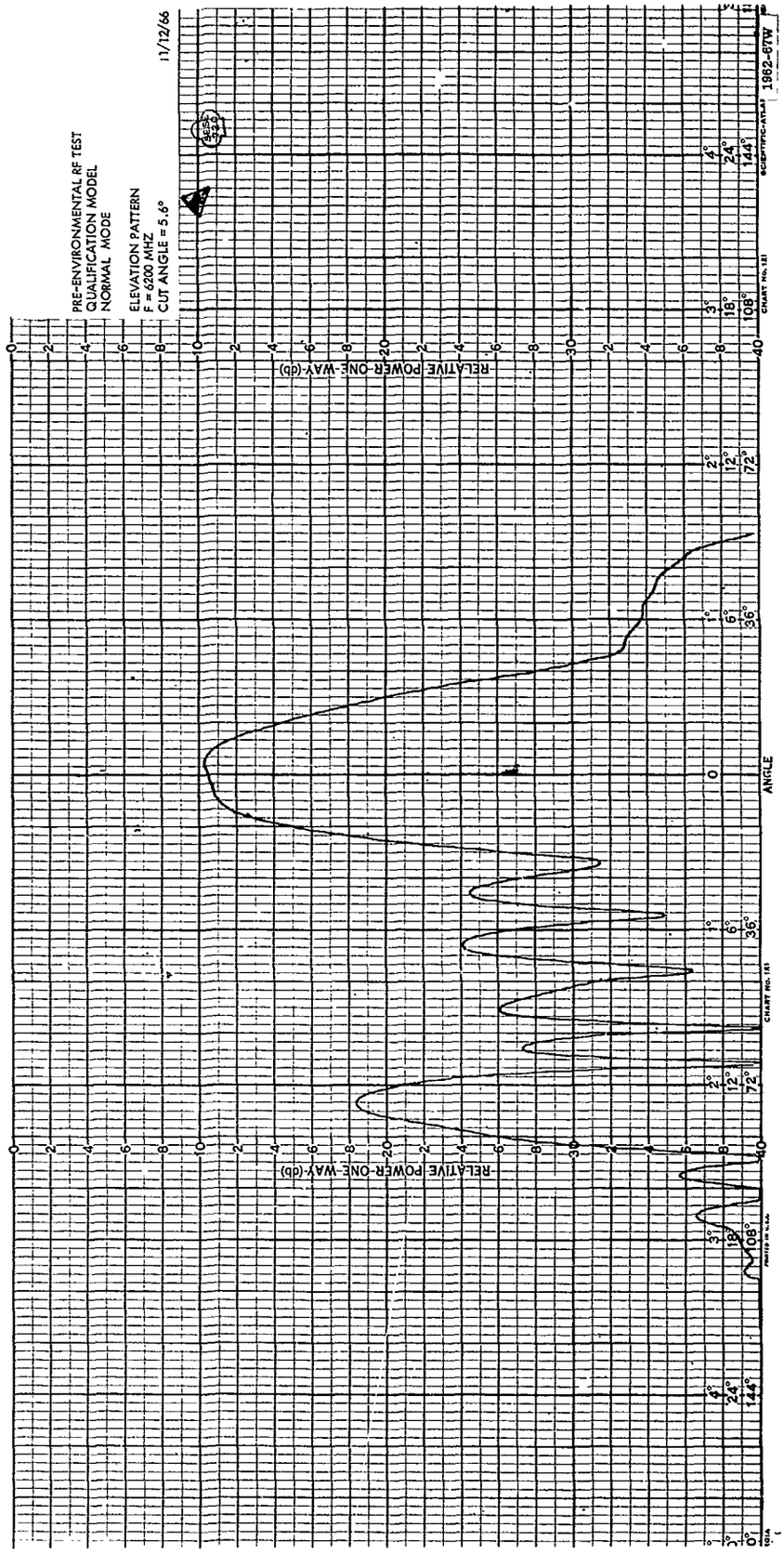
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 6200 MHZ
CUT ANGLE = 0°
11/12/66
BW = 20.1°
GAIN CORRECTION = +0.2 DB
RELATIVE POWER-ONE-WAY (db)
ANGLE
1981-67W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QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
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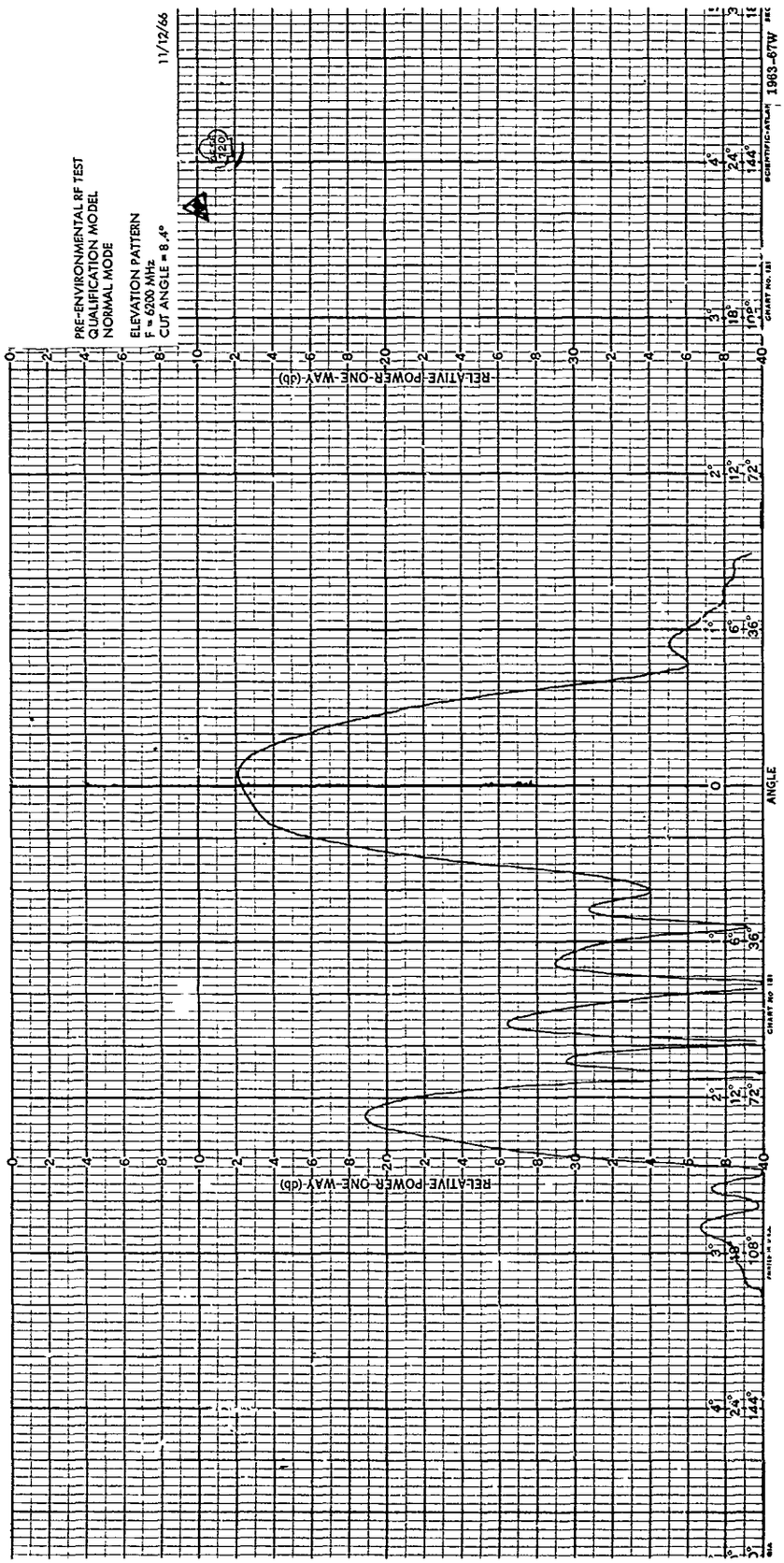
CUT ANGLE = 5.6°
11/12/66
RELATIVE POWER-ONE-WAY-(db)
ANGLE
1962-67W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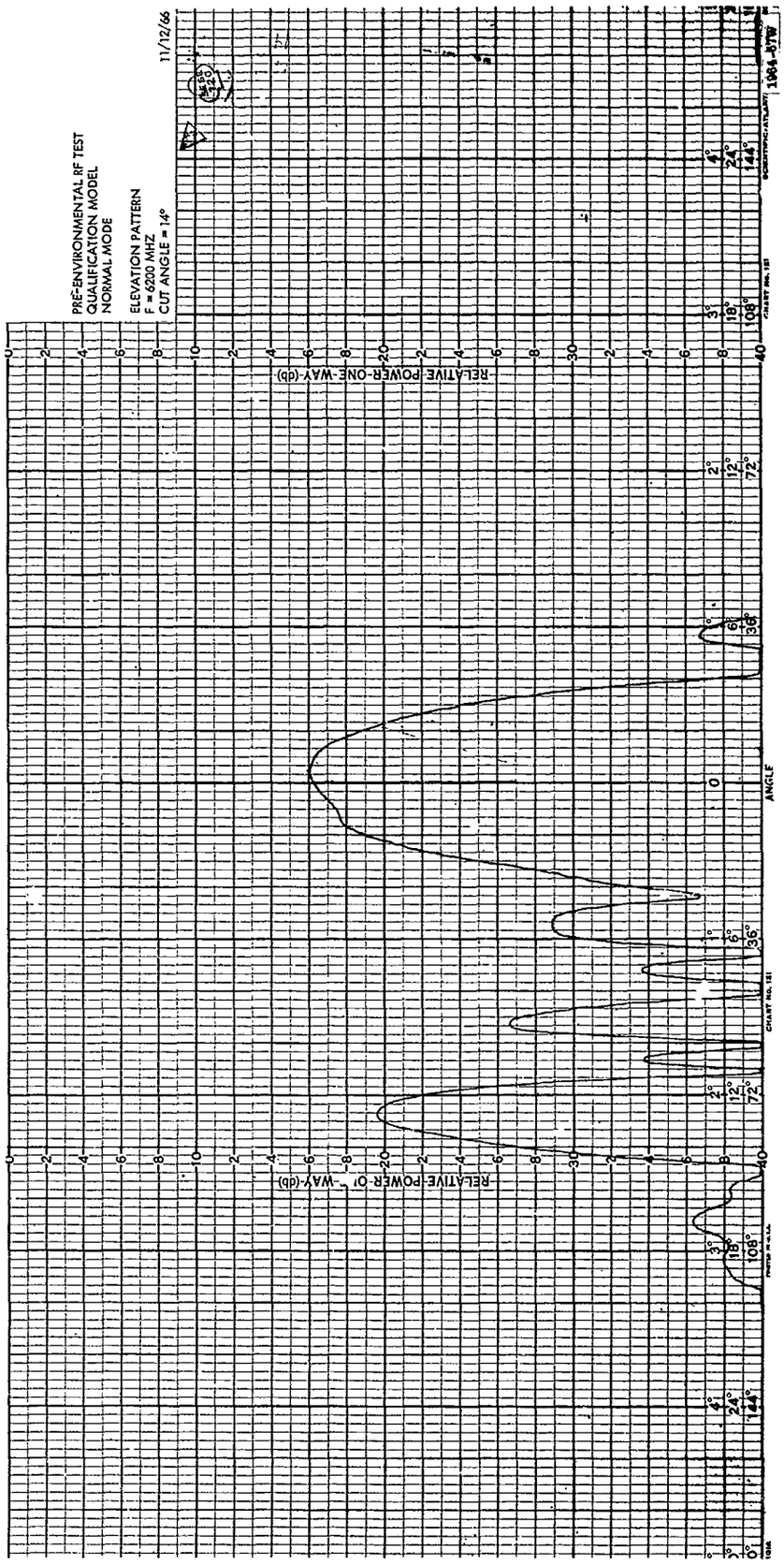
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 6200 MHz
CUT ANGLE = 8.4°
11/12/66
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO. 181
SCIENTIFIC-ATLANTA 1983-87W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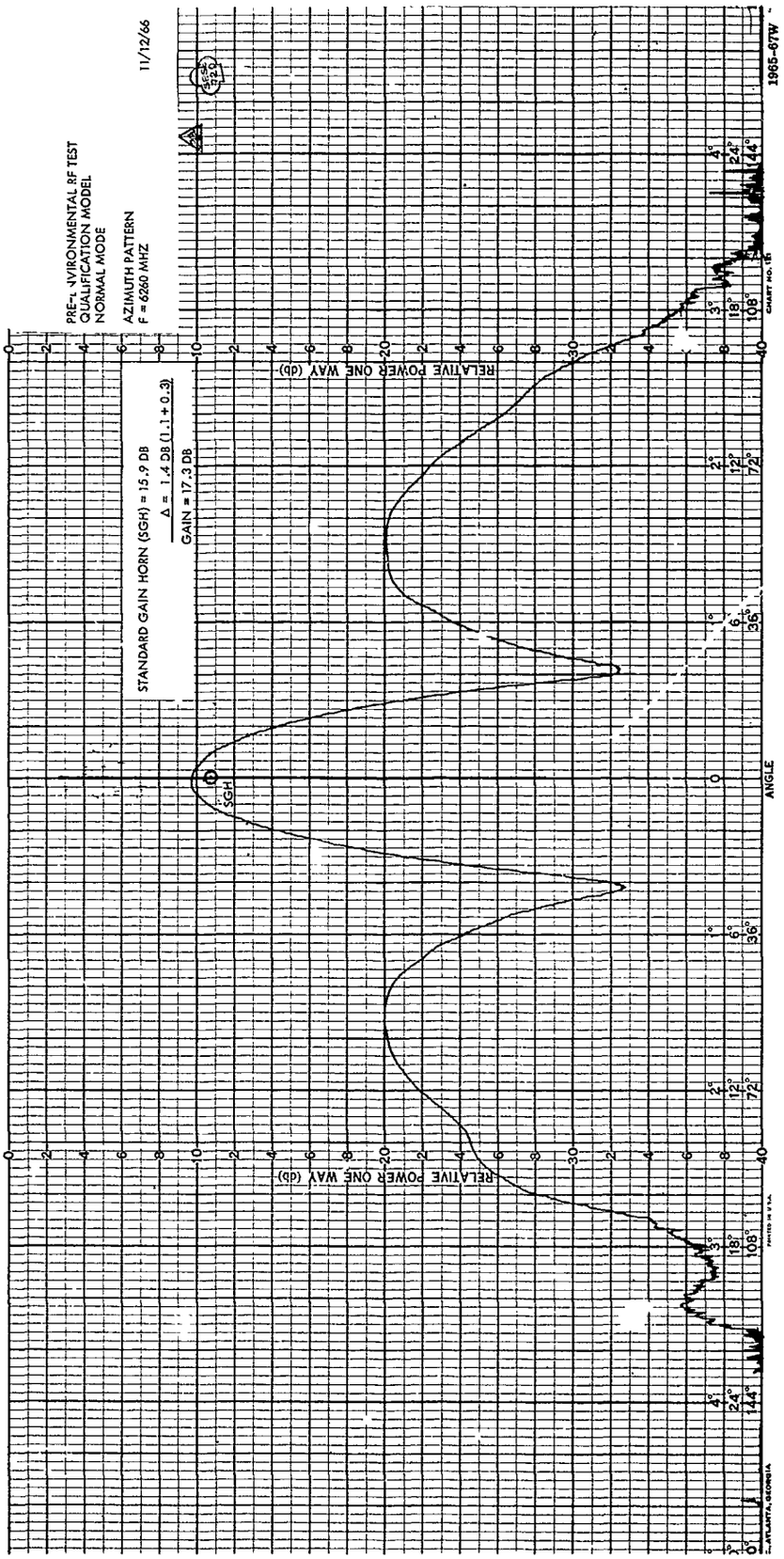
11/12/66
RELATIVE POWER-ONE-WAY-(db)
ANGLE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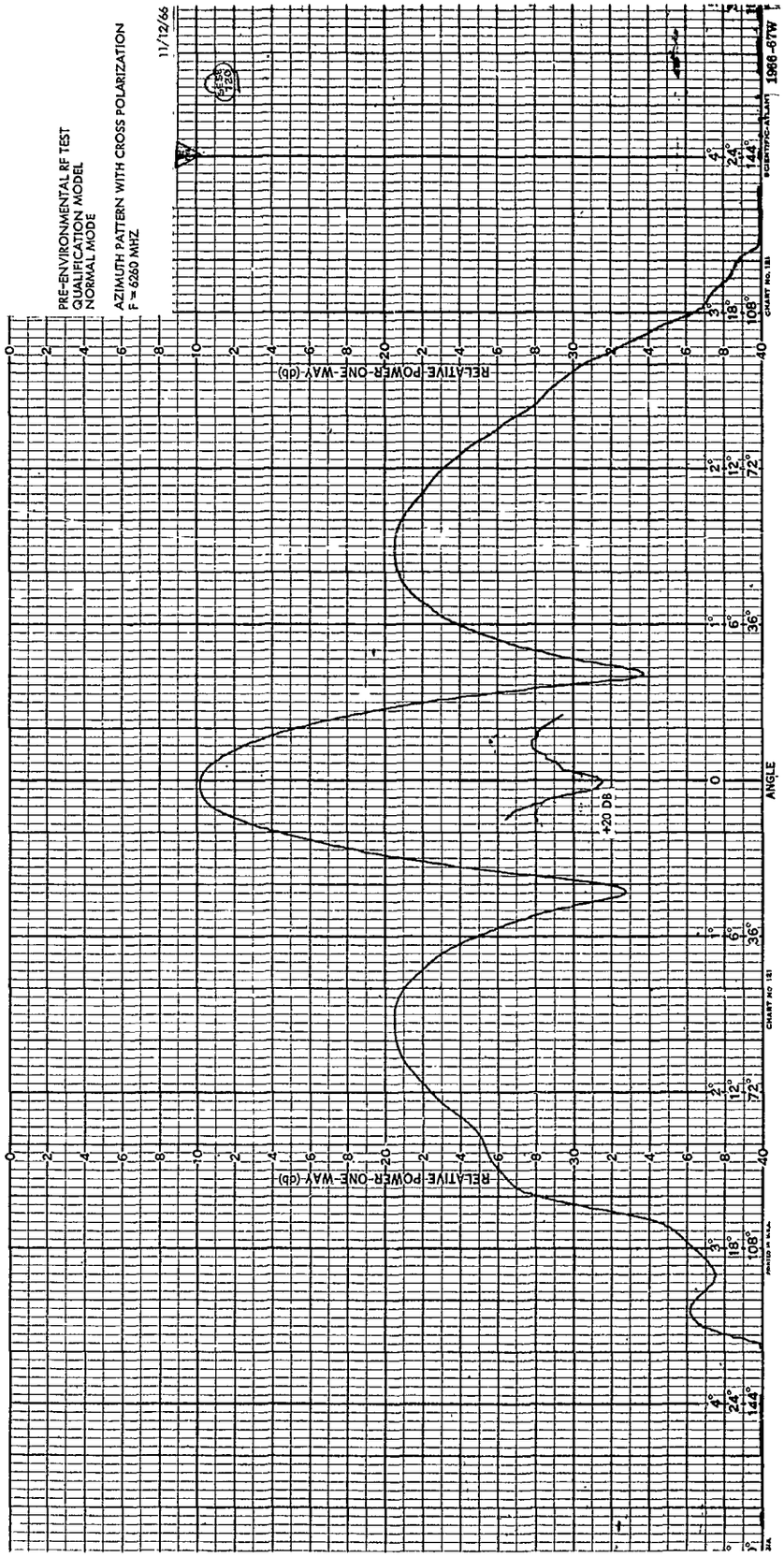
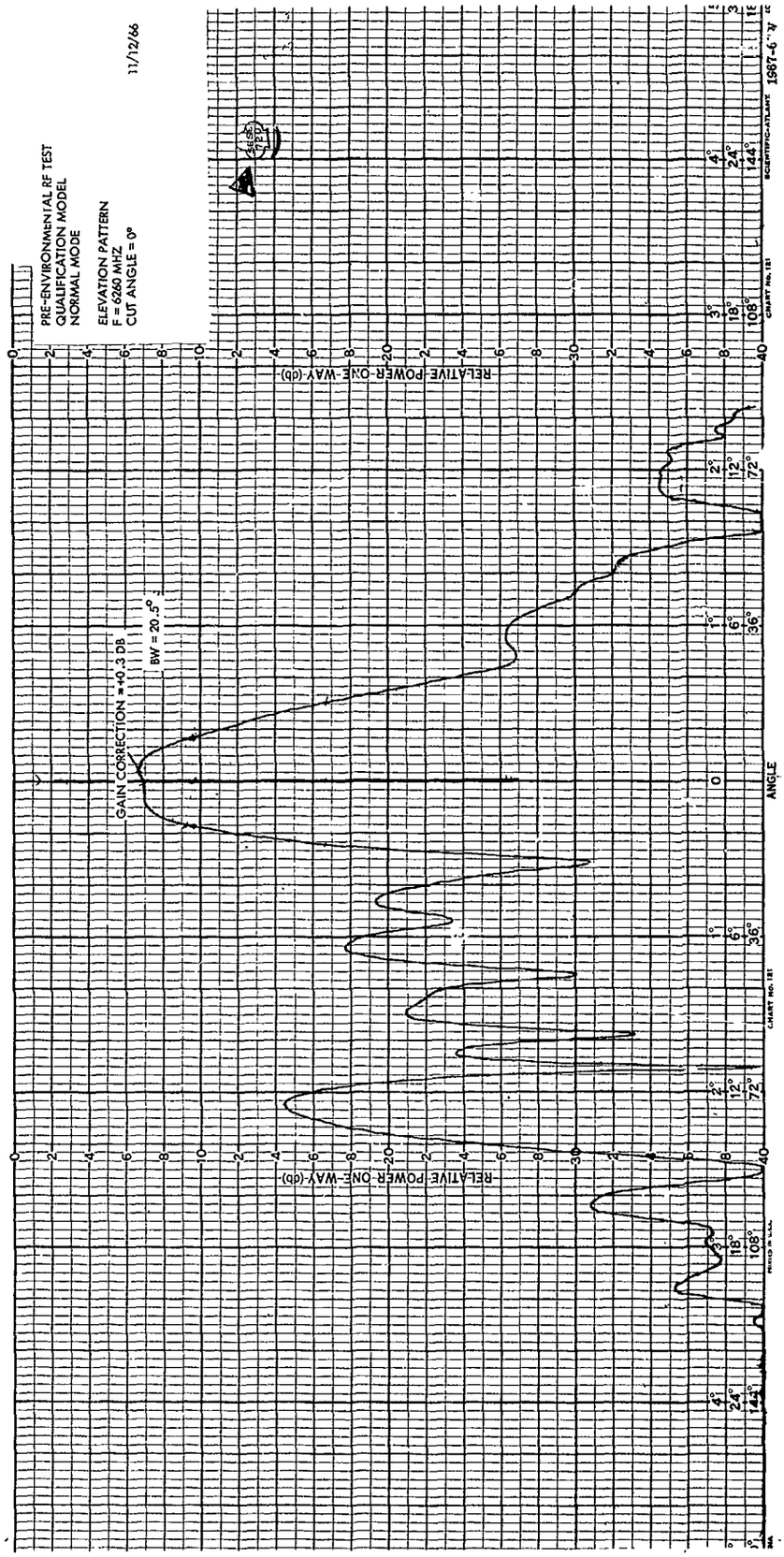
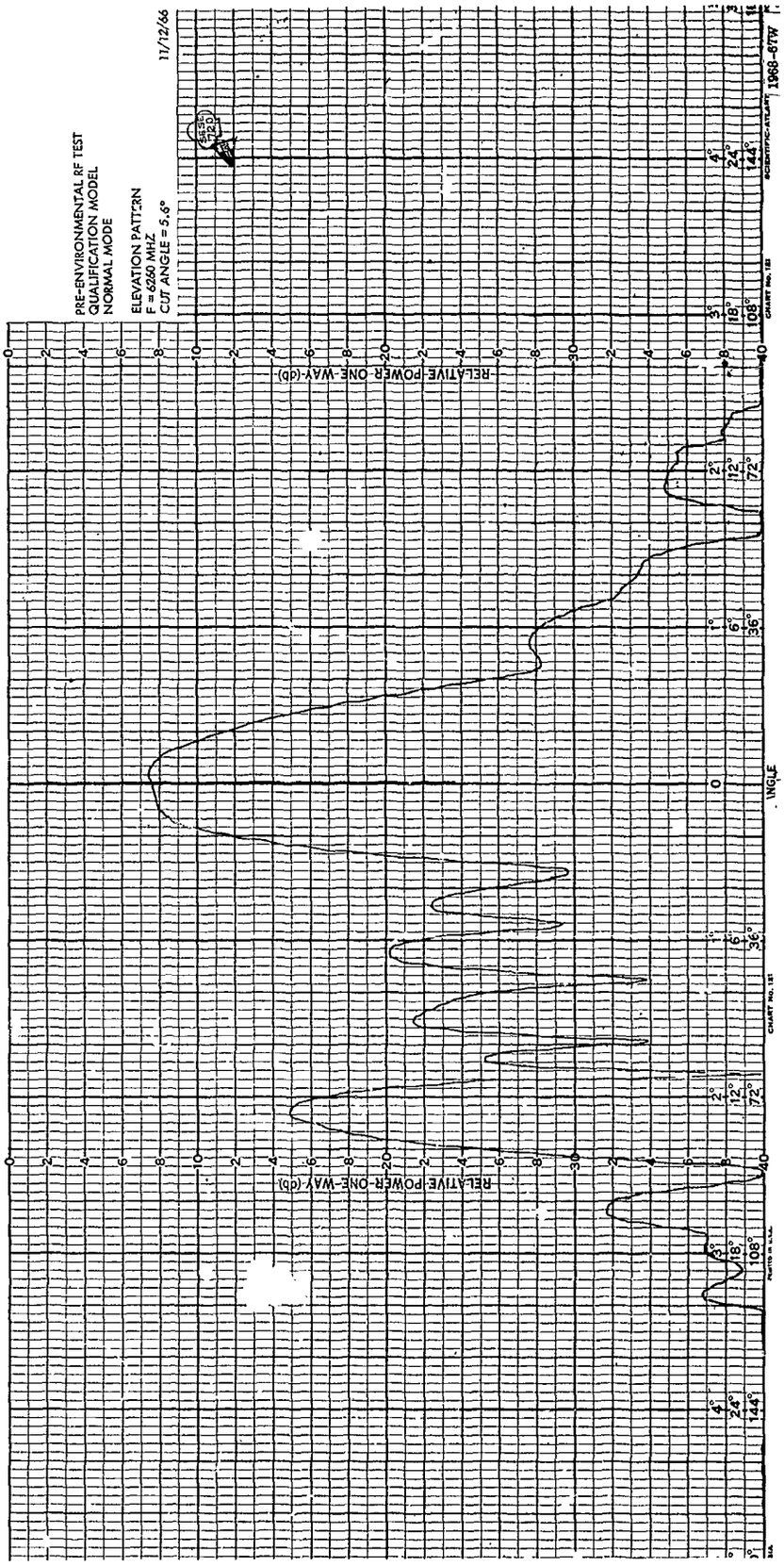
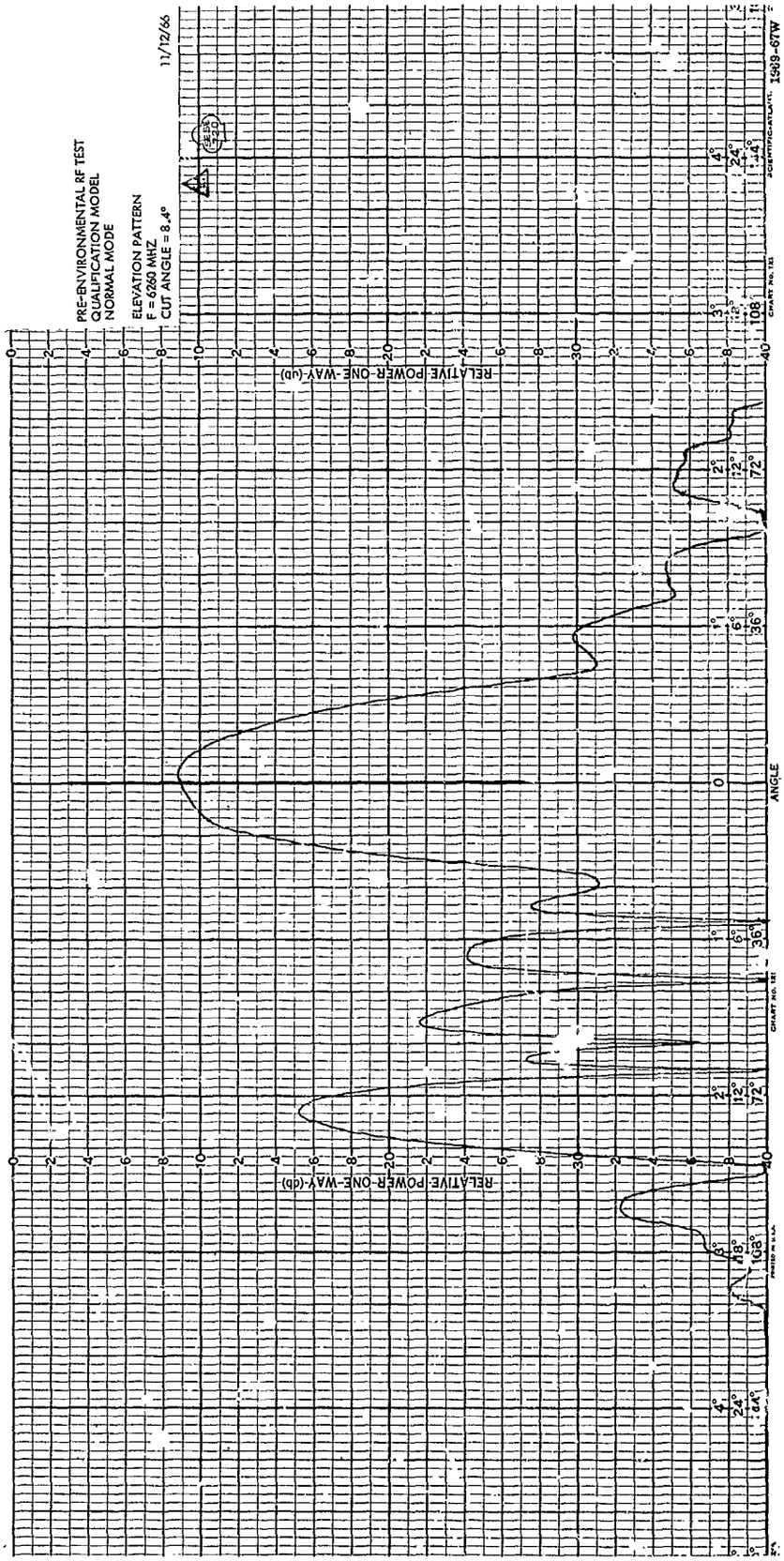
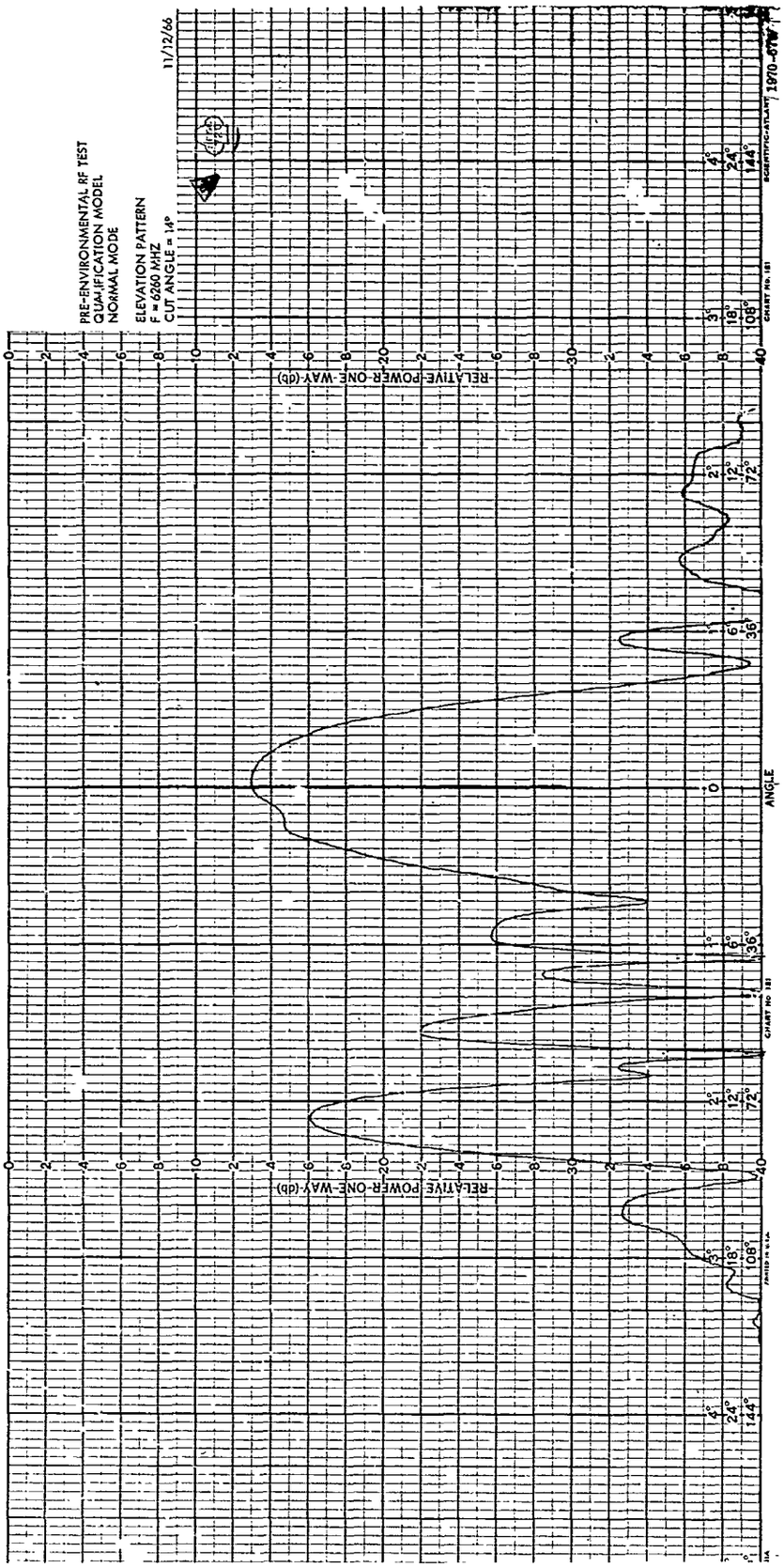
QUALIFICATION MODEL
NORMAL MODE
AZIMUTH PATTERN
F = 6260 MHZ
11/12/66
STANDARD GAIN HORN (SGH) = 15.9 DB
Δ = 1.4 DB (1.1 + 0.3)
GAIN = 17.3 DB
SGH
RELATIVE POWER ONE WAY (db)
ANGLE
1965-67W


PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION
F = 6260 MHZ
11/12/66
RELATIVE POWER-ONE-WAY (db)
ANGLE
+20 DB
1966-67W


PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 0°
11/12/66
GAIN CORRECTION = +0.3 DB
BW = 20.5°
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO. 181
SCIENTIFIC-ATLANTA 1967-6


PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 5.6°
11/12/66
RELATIVE POWER ONE-WAY (db)
RELATIVE POWER ONE-WAY (db)
ANGLE
CHART No. 181
CHART No. 181
SCIENTIFIC-ATLANTA 1968-87W


PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 8.4°
11/12/66
RELATIVE POWER ONE-WAY (db)
ANGLE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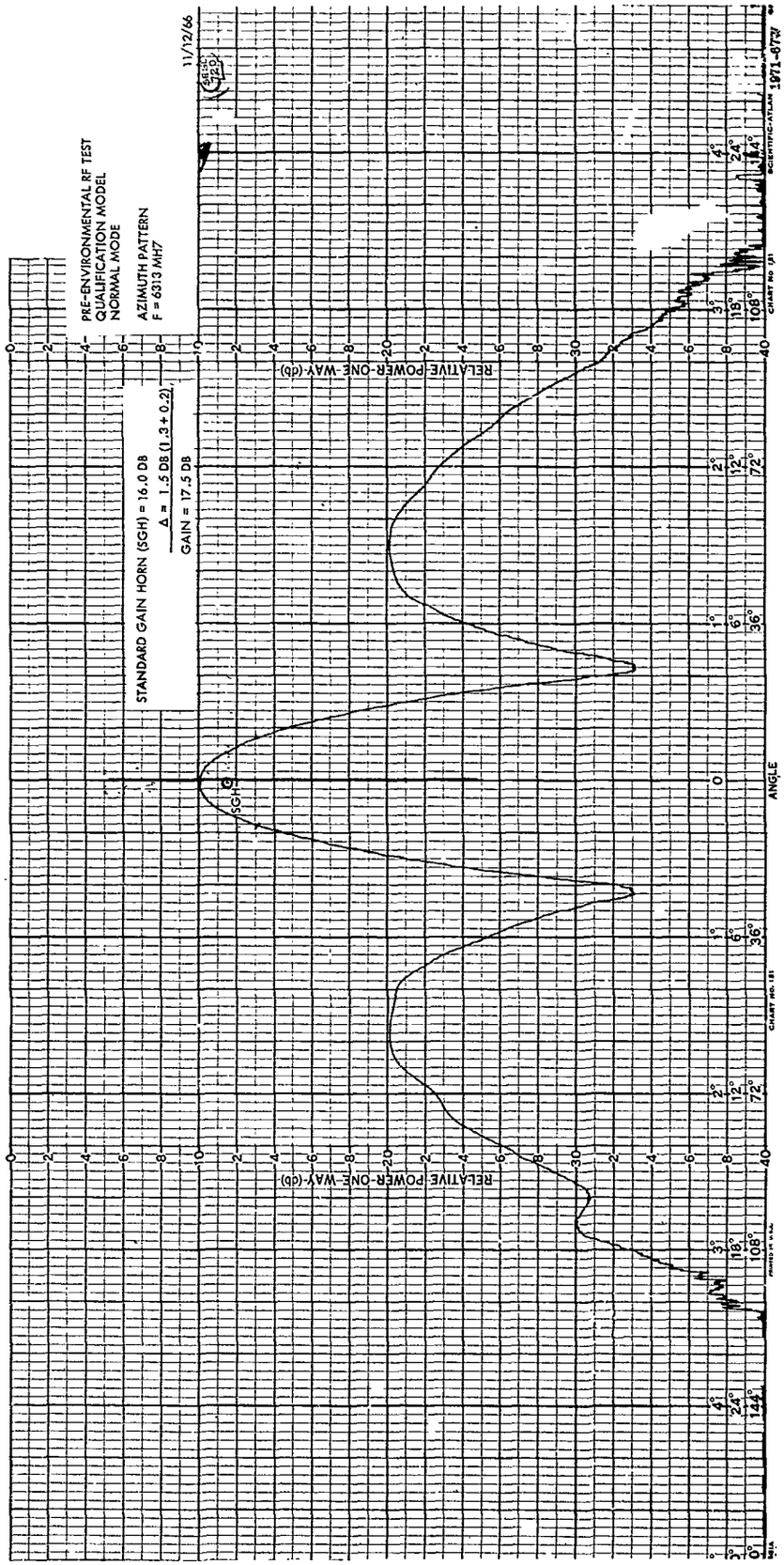
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 14°
11/12/66
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART No. 181
SCIENTIFIC-ATLANTA 1970-67W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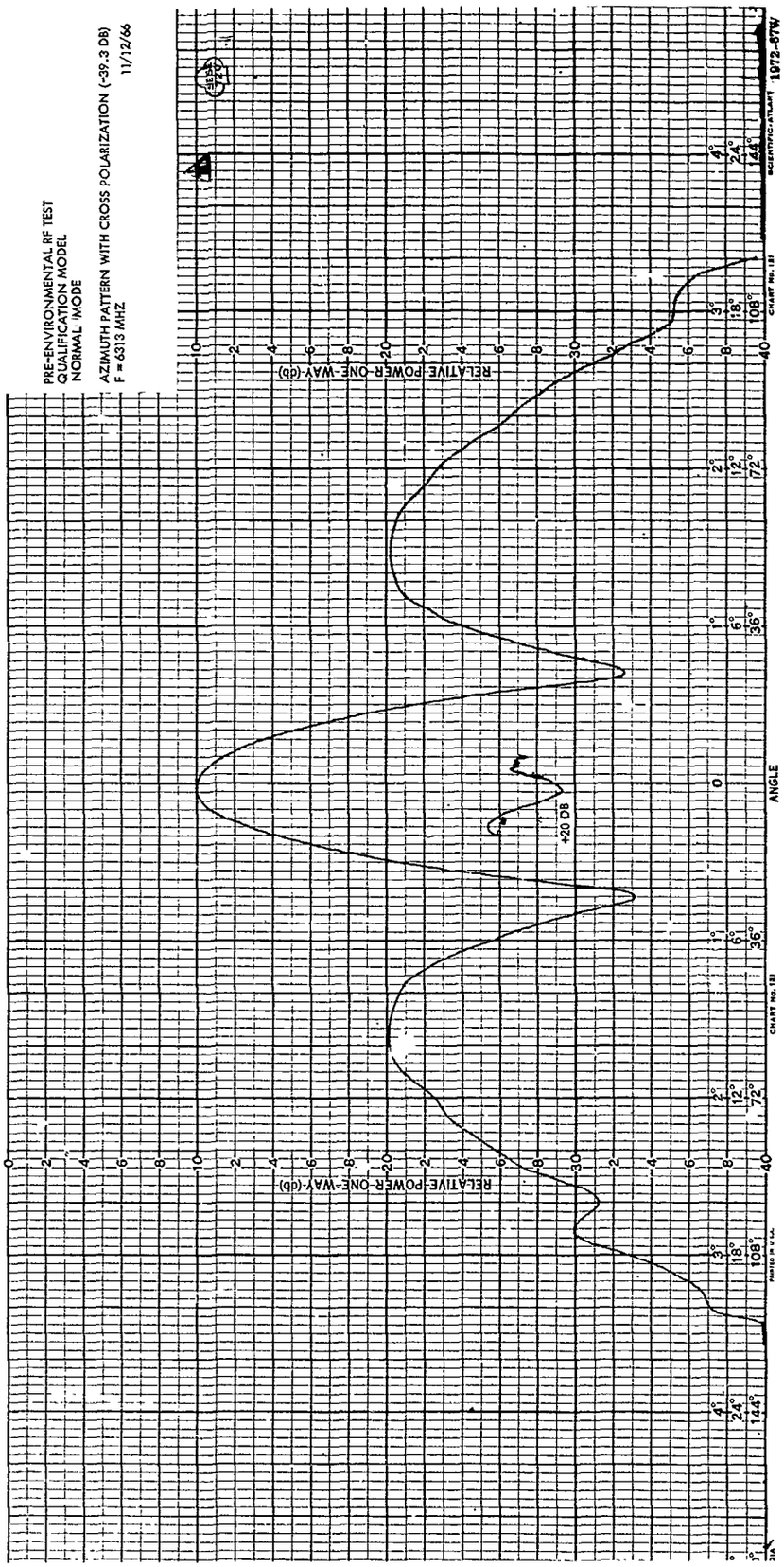
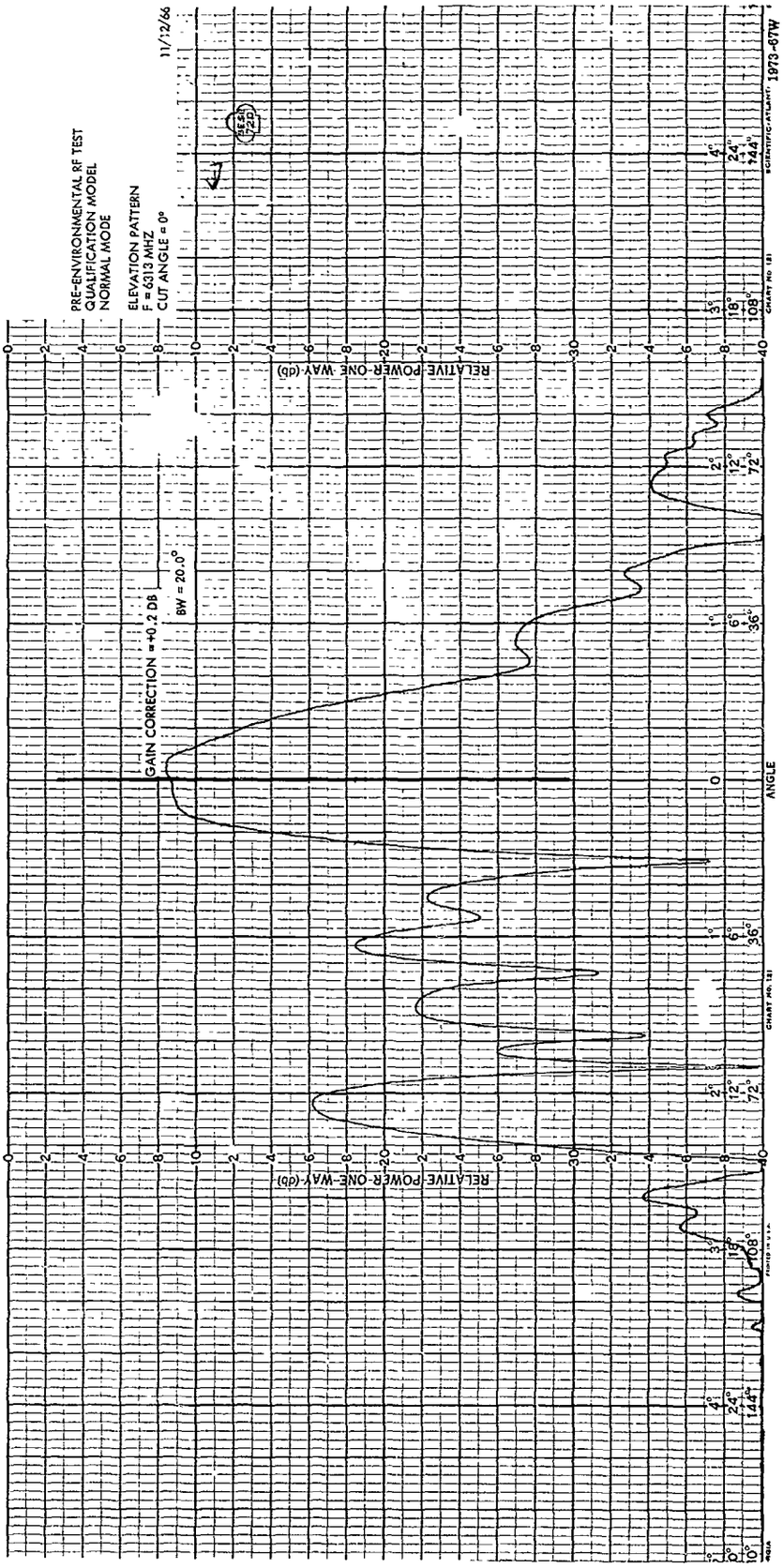
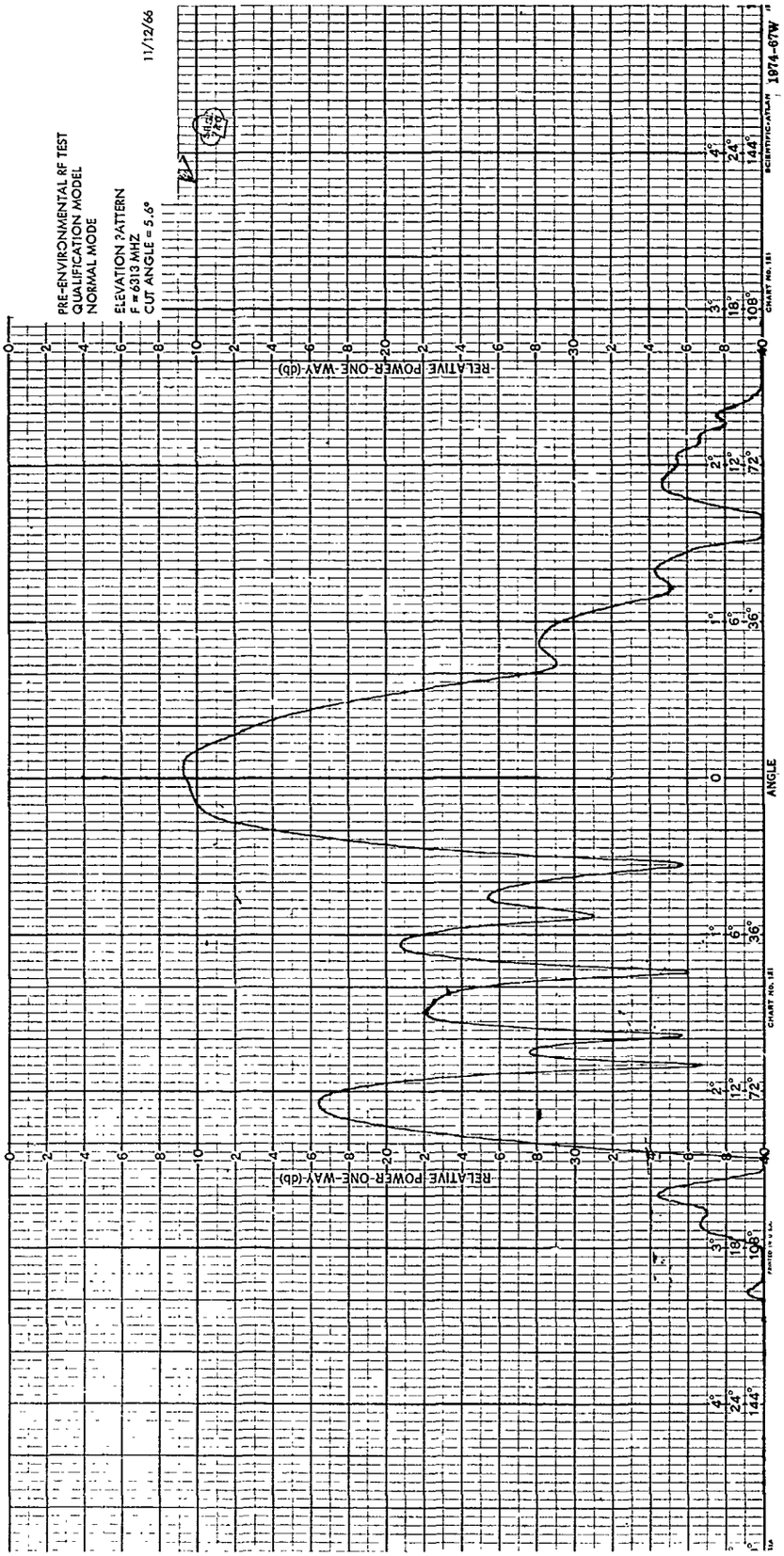
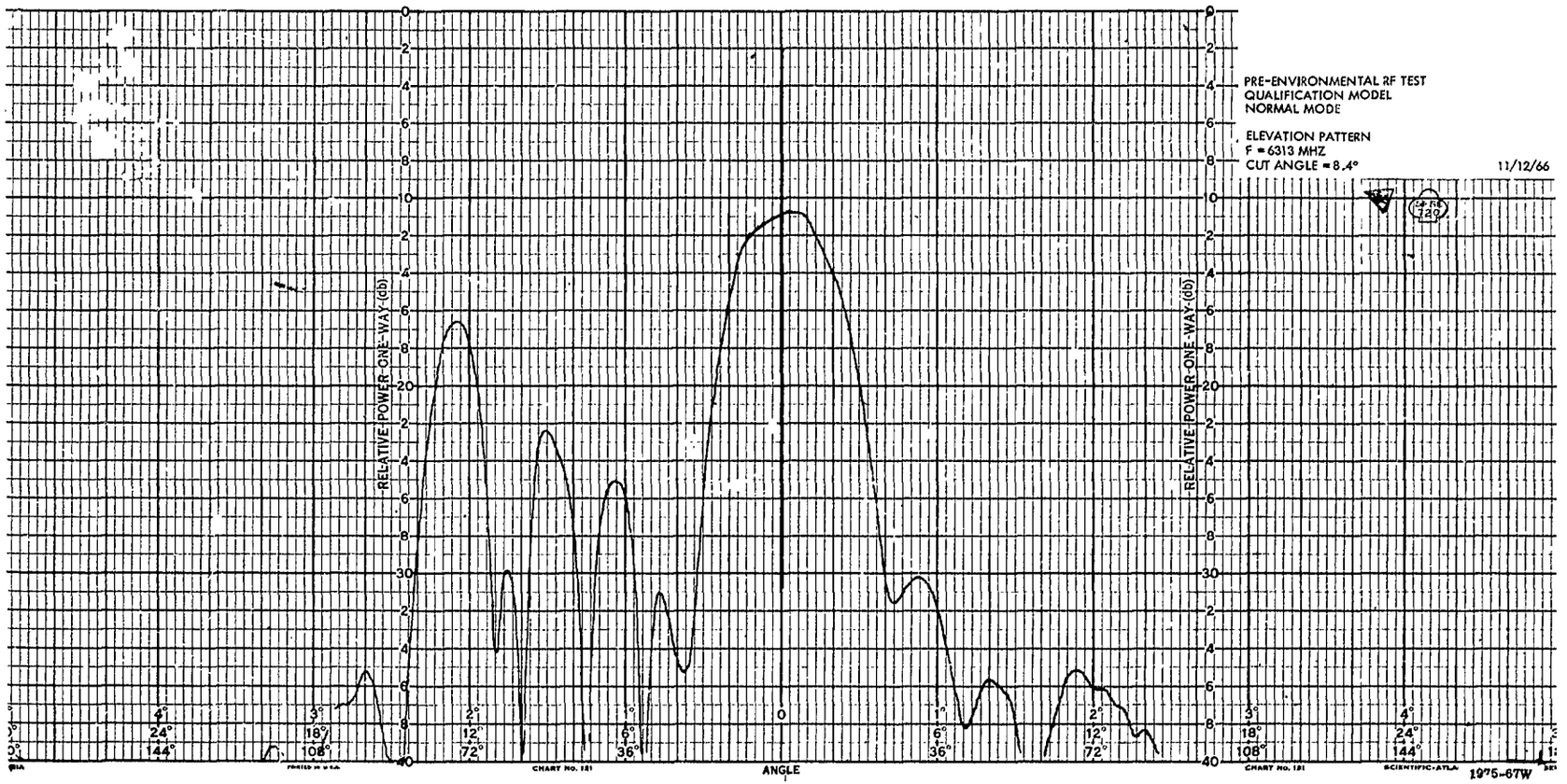
QUALIFICATION MODEL
NORMAL MODE
AZIMUTH PATTERN
F = 6313 MH7
STANDARD GAIN HORN (SGH) = 16.0 DB
Δ = 1.5 DB (1.3 + 0.2)
GAIN = 17.5 DB
11/12/66
RELATIVE POWER-ONE-WAY-(db)
SGH
ANGLE

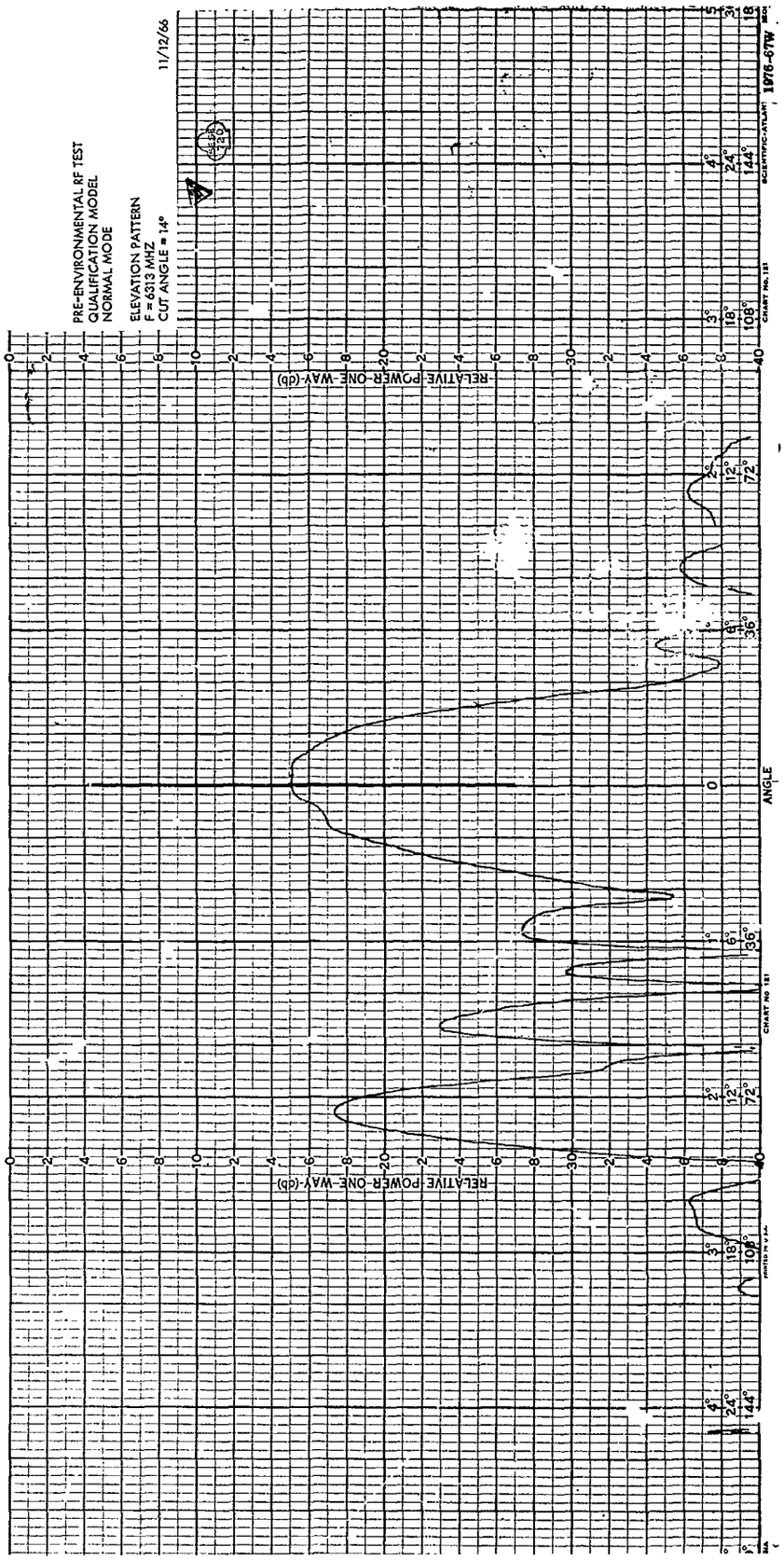

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION (-39.3 DB)
F = 6313 MHZ
11/12/66
RELATIVE POWER-ONE-WAY-(db)
+20 DB
ANGLE
CHART No. 181
SCIENTIFIC-ATLANTA 1972-STW

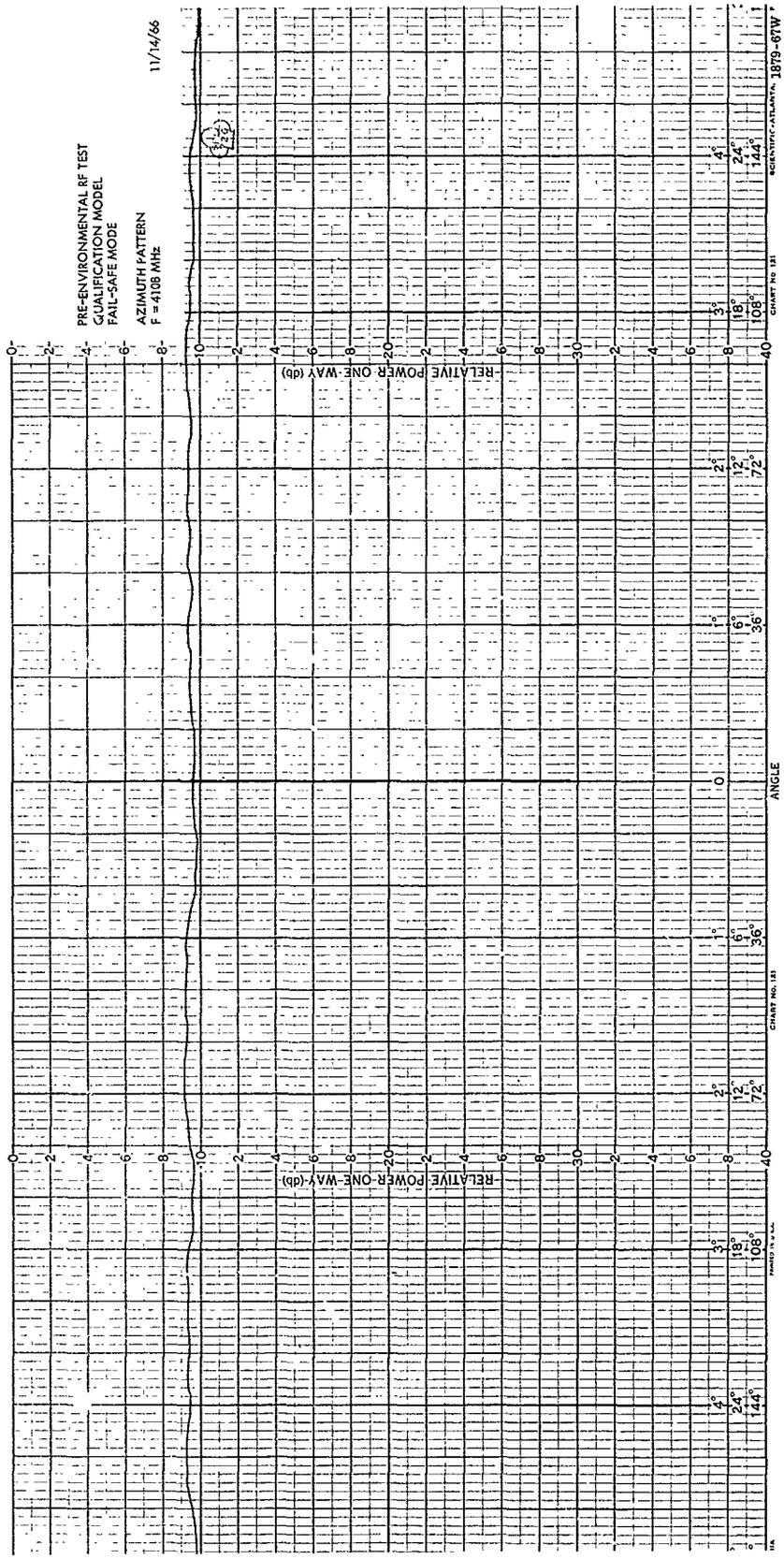

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 6313 MHZ
CUT ANGLE = 0°
11/12/66
GAIN CORRECTION = +0.2 DB
BW = 20.0°
RELATIVE POWER-ONE-WAY-(db)
ANGLE
CHART NO. 181
SCIENTIFIC-ATLANTA 1973-67W

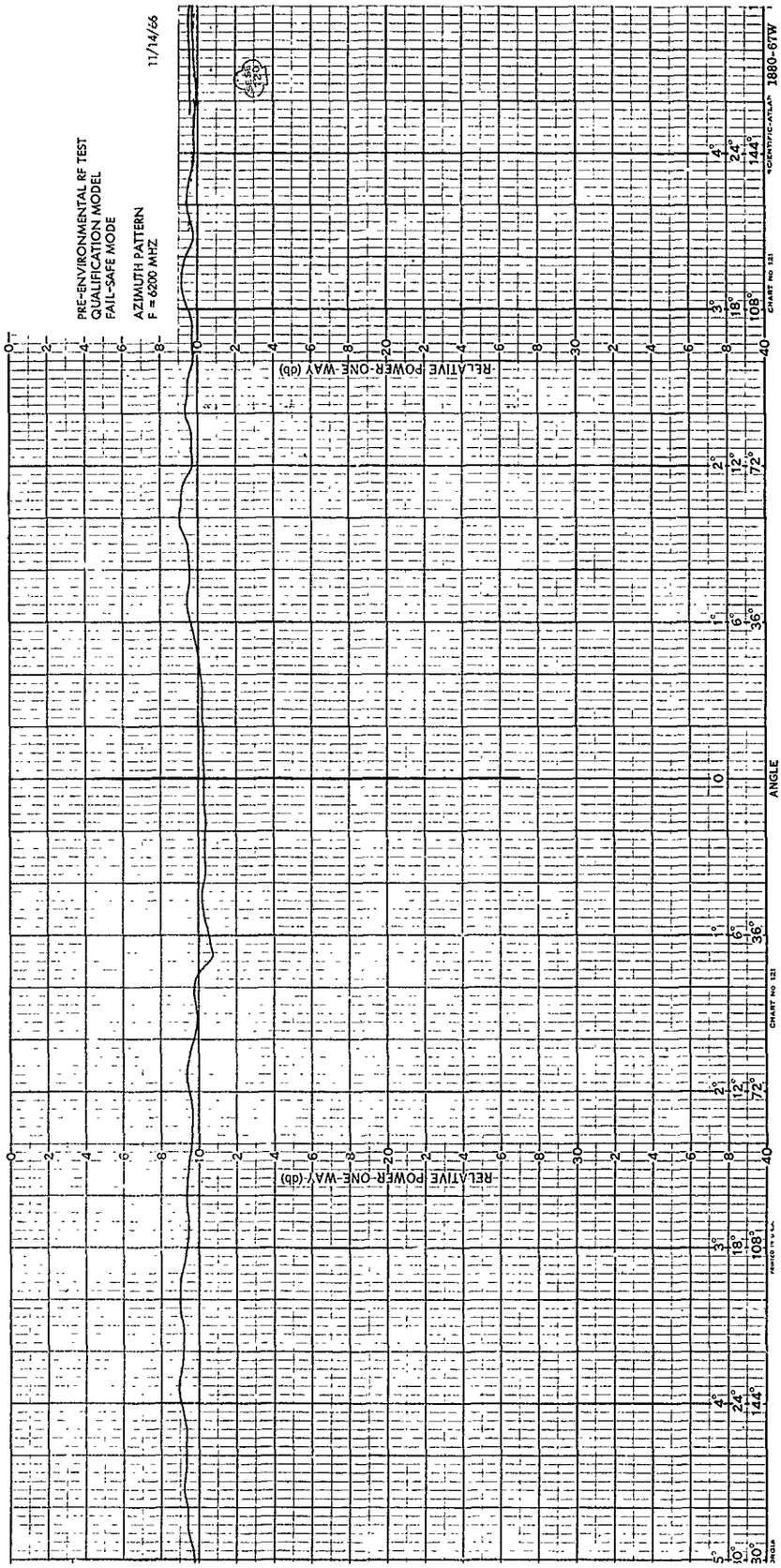

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 6313 MHZ
CUT ANGLE = 5.6°
11/12/66
RELATIVE POWER-ONE-WAY-(db)
ANGLE
CHART NO. 181
SCIENTIFIC-ATLANTA 1974-67W

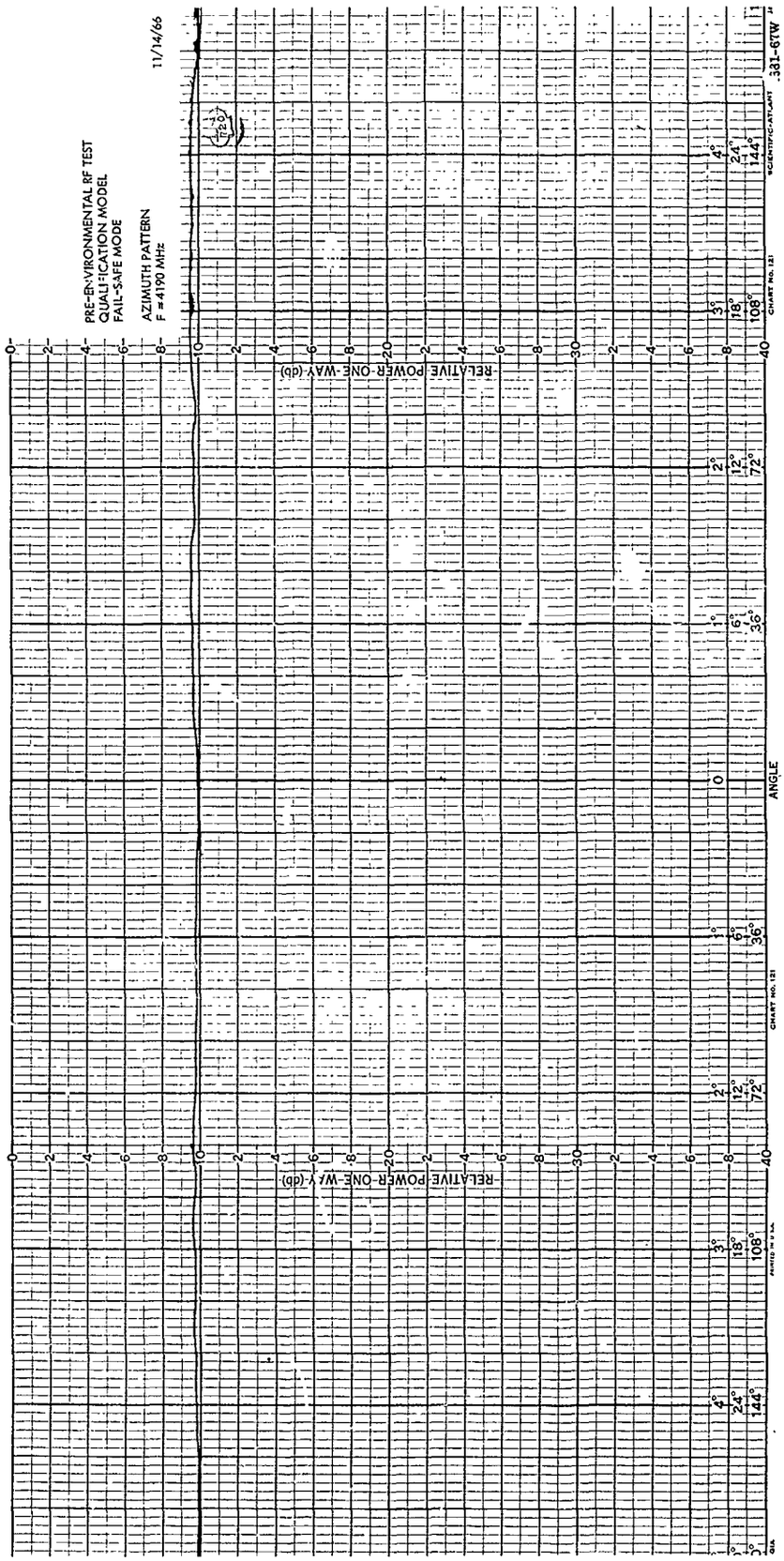
F181-1

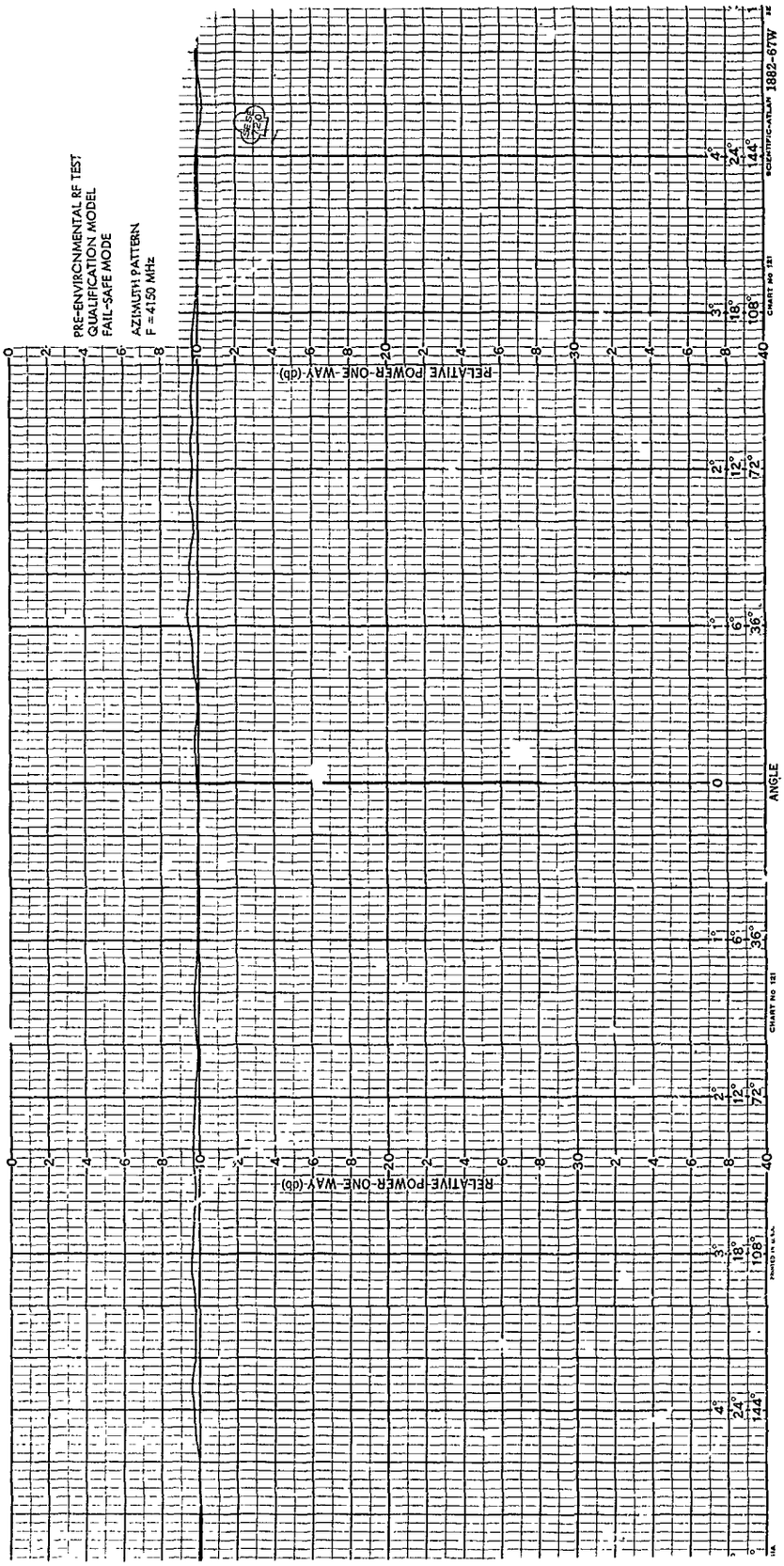

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 6313 MHZ
CUT ANGLE = 8.4°
11/12/66
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO. 121
SCIENTIFIC-ATLA
1975-67W

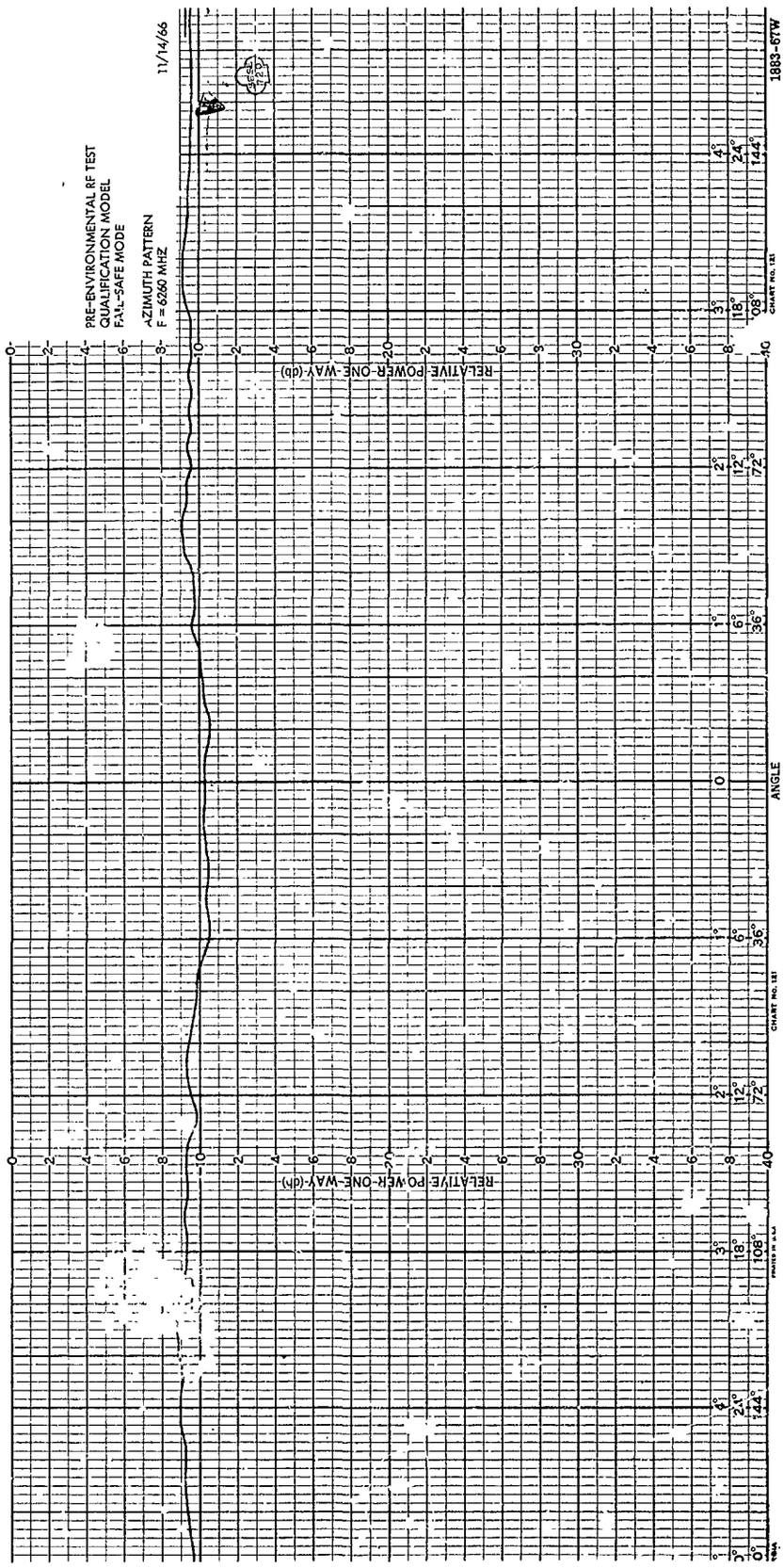

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
NORMAL MODE
ELEVATION PATTERN
F = 6313 MHZ
CUT ANGLE = 14°
11/12/66
RELATIVE POWER-ONE-WAY-(db)
ANGLE
CHART NO. 181
SCIENTIFIC-ATLANTA 1976-67W

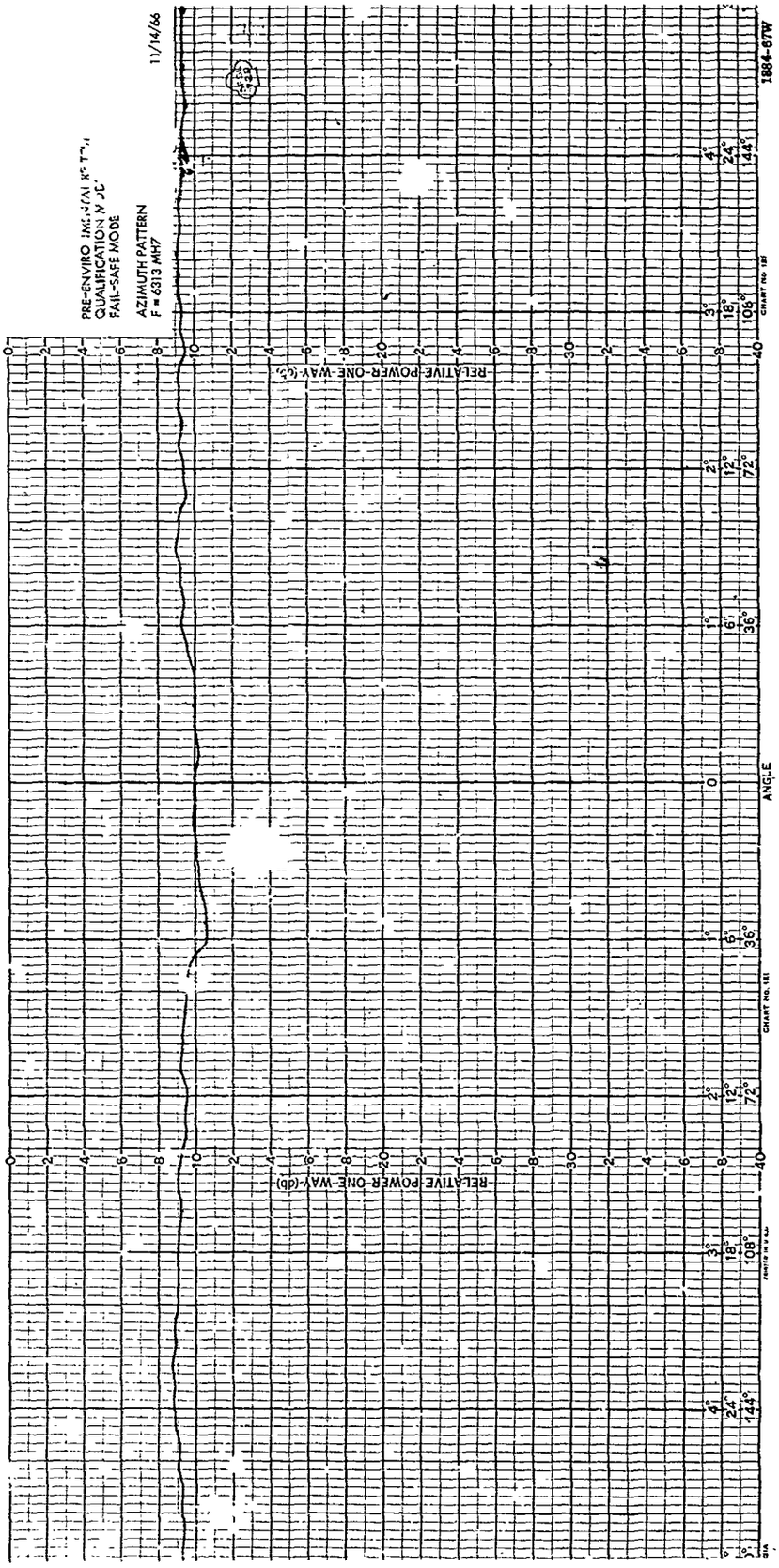

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 4108 MHz
11/14/66
RELATIVE POWER ONE-WAY (db)
ANGLE
SCIENTIFIC-ATLANTA 1879-67W

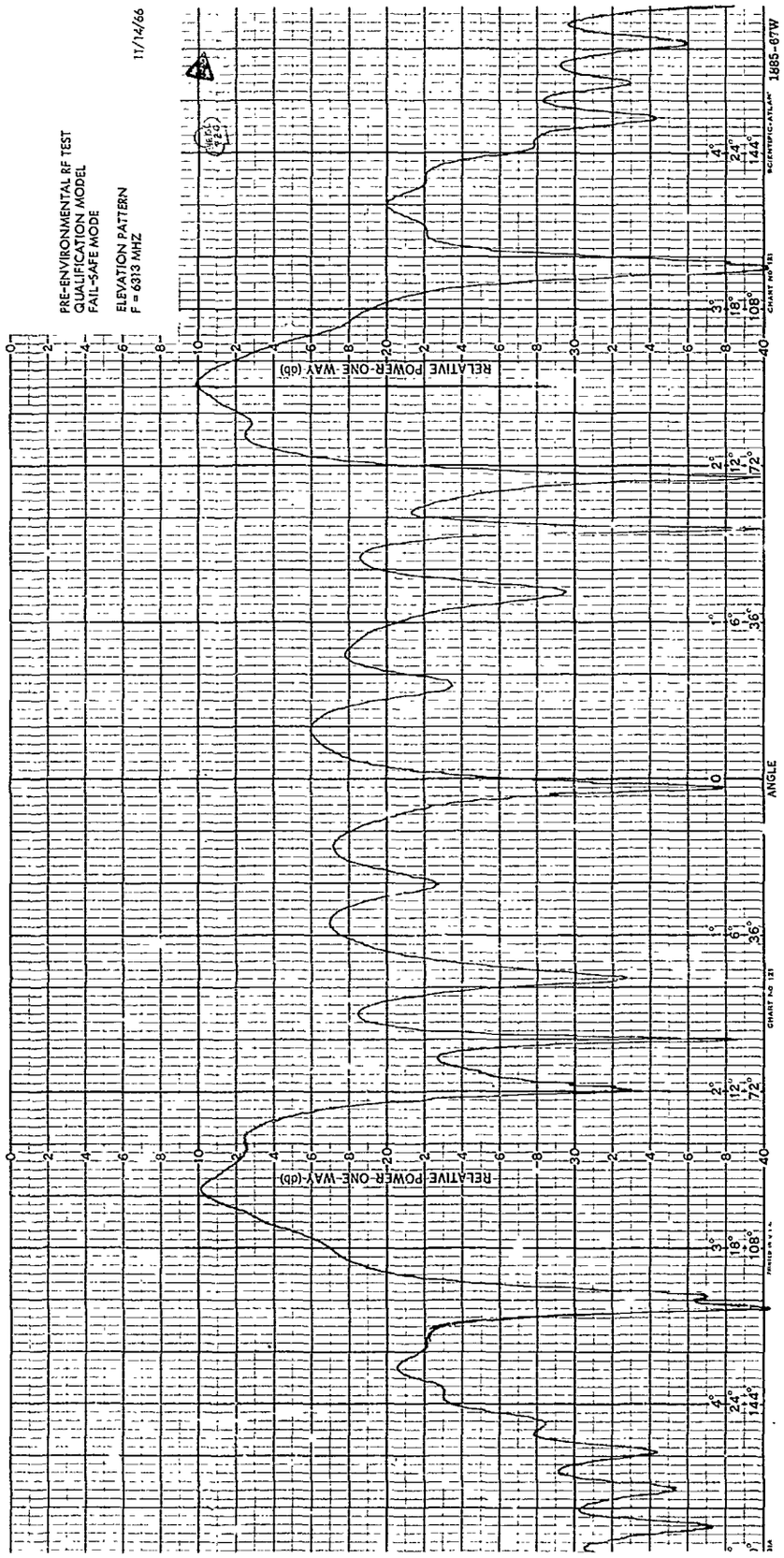

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 6200 MHZ
11/14/66
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO 121
1880-67W

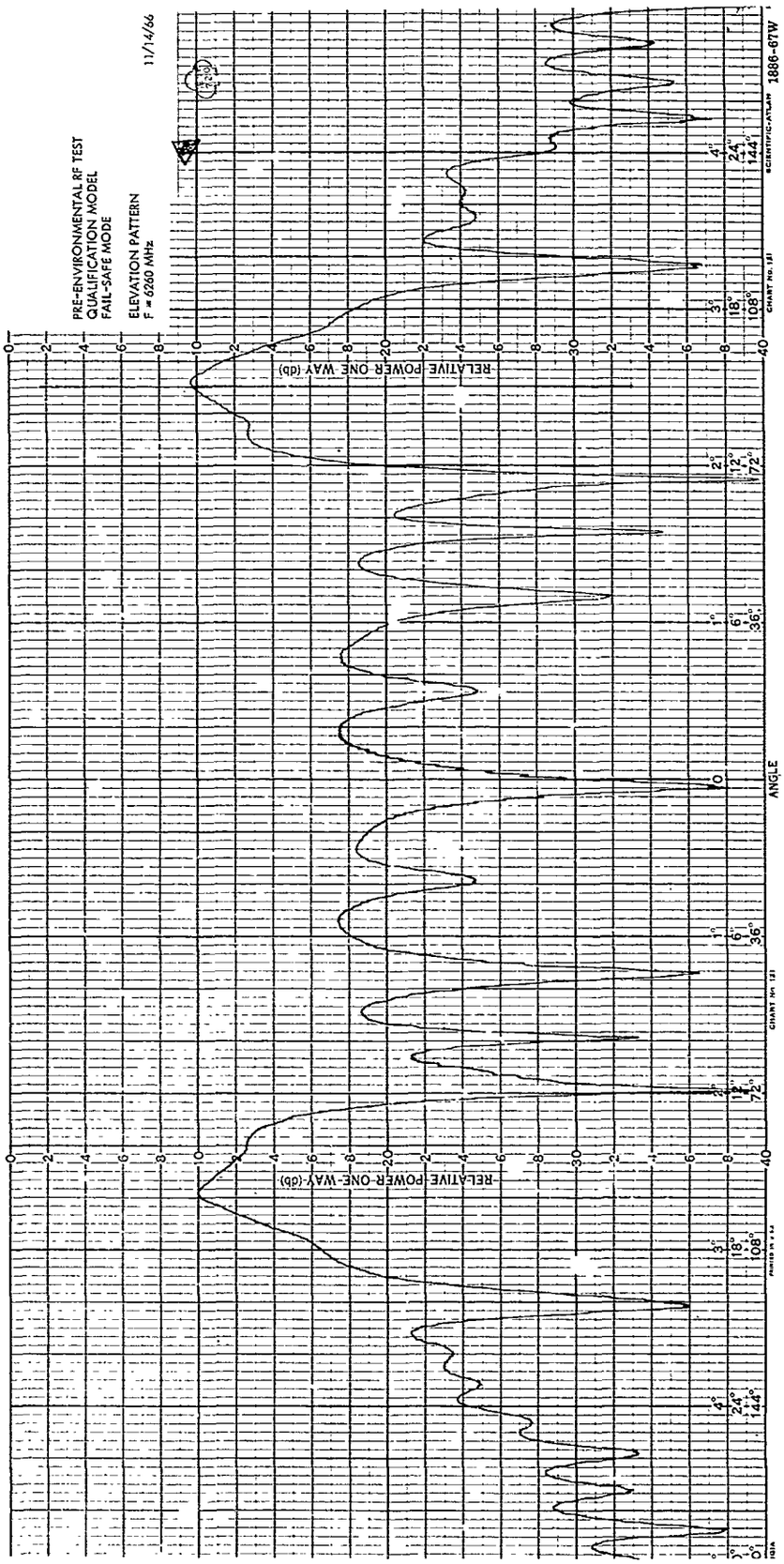

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 4190 MHz
11/14/66
RELATIVE POWER-ONE-WAY-(db)
ANGLE
CHART NO. 121
SCIENTIFIC-ATLANTA
331-6TW

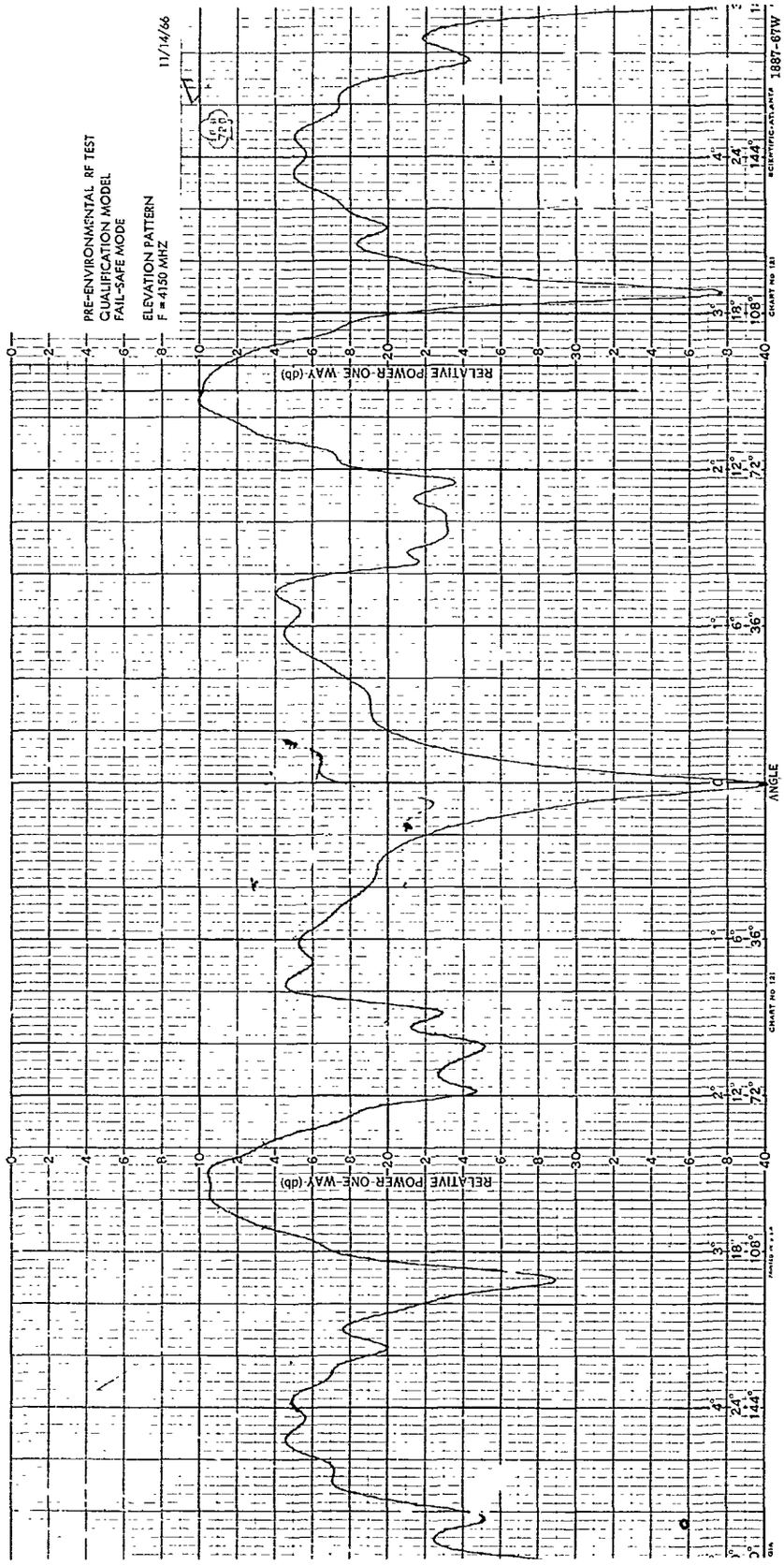

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 4150 MHz
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO 121
SCIENTIFIC-ATLANTA 1882-67W

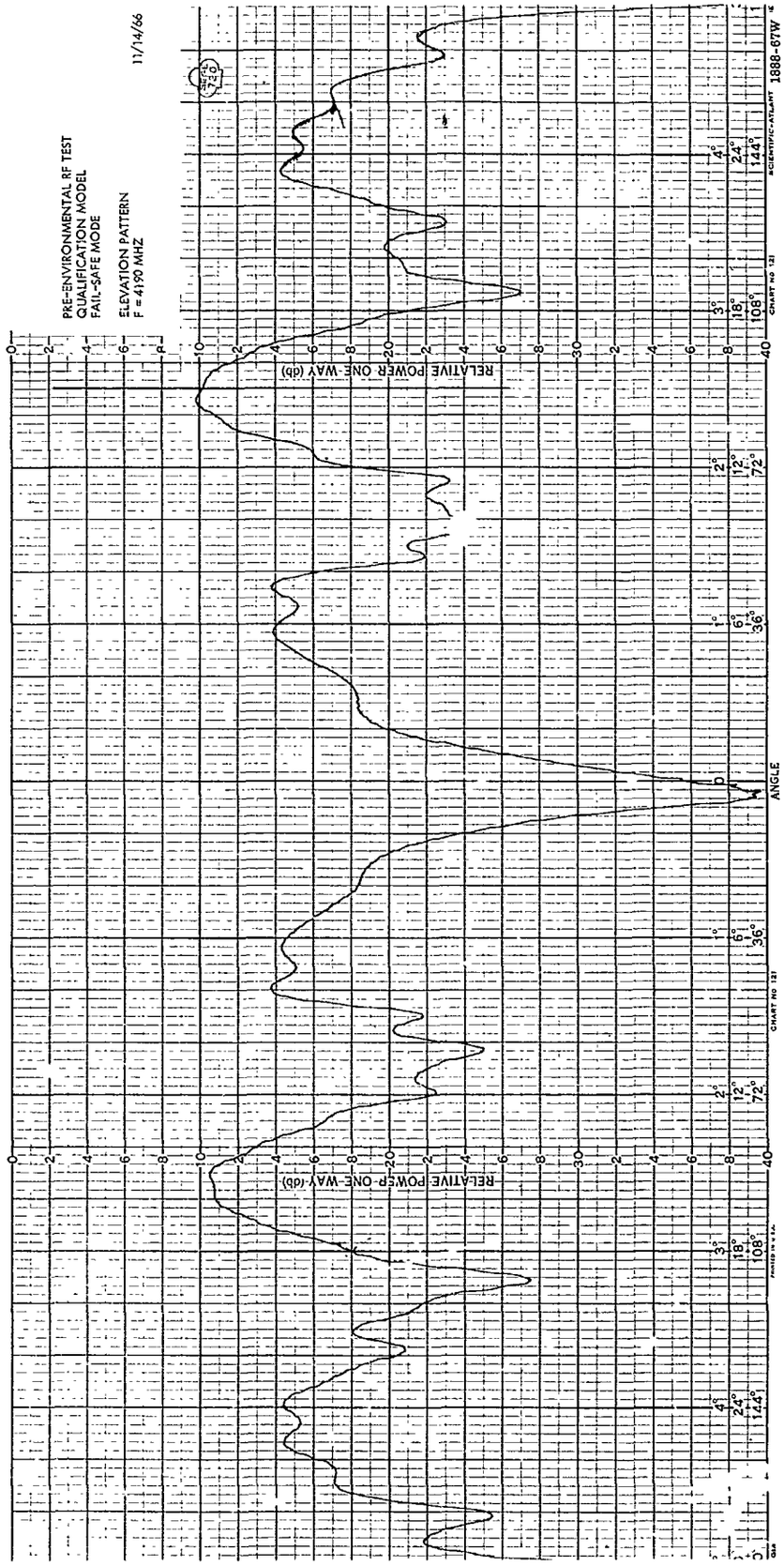

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 6260 MHZ
11/14/66
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO. 181
1883-6TW

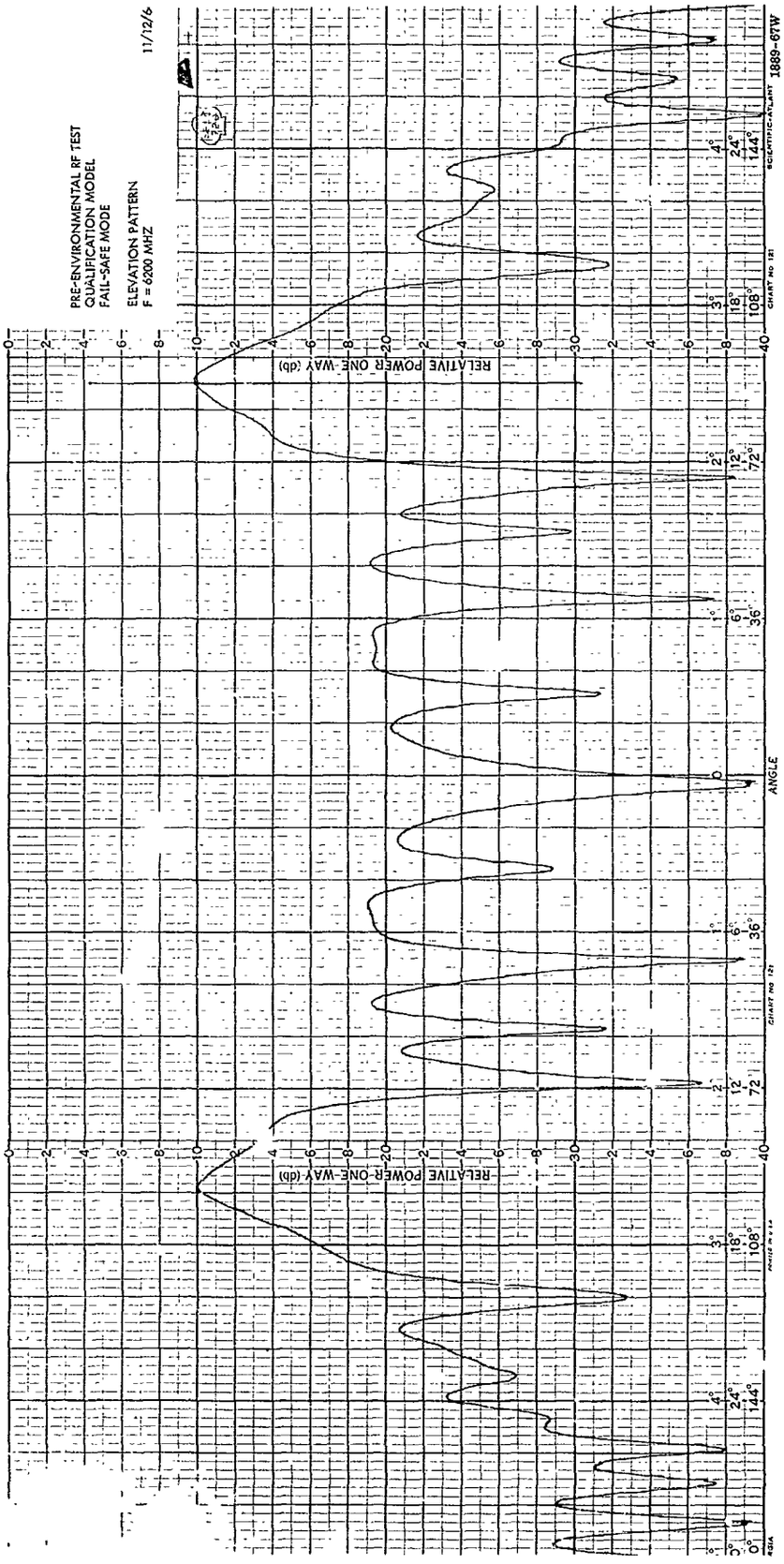

PRE-ENVIRO
QUALIFICATION
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 6313 MHZ
11/14/66
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO. 181
1884-67W

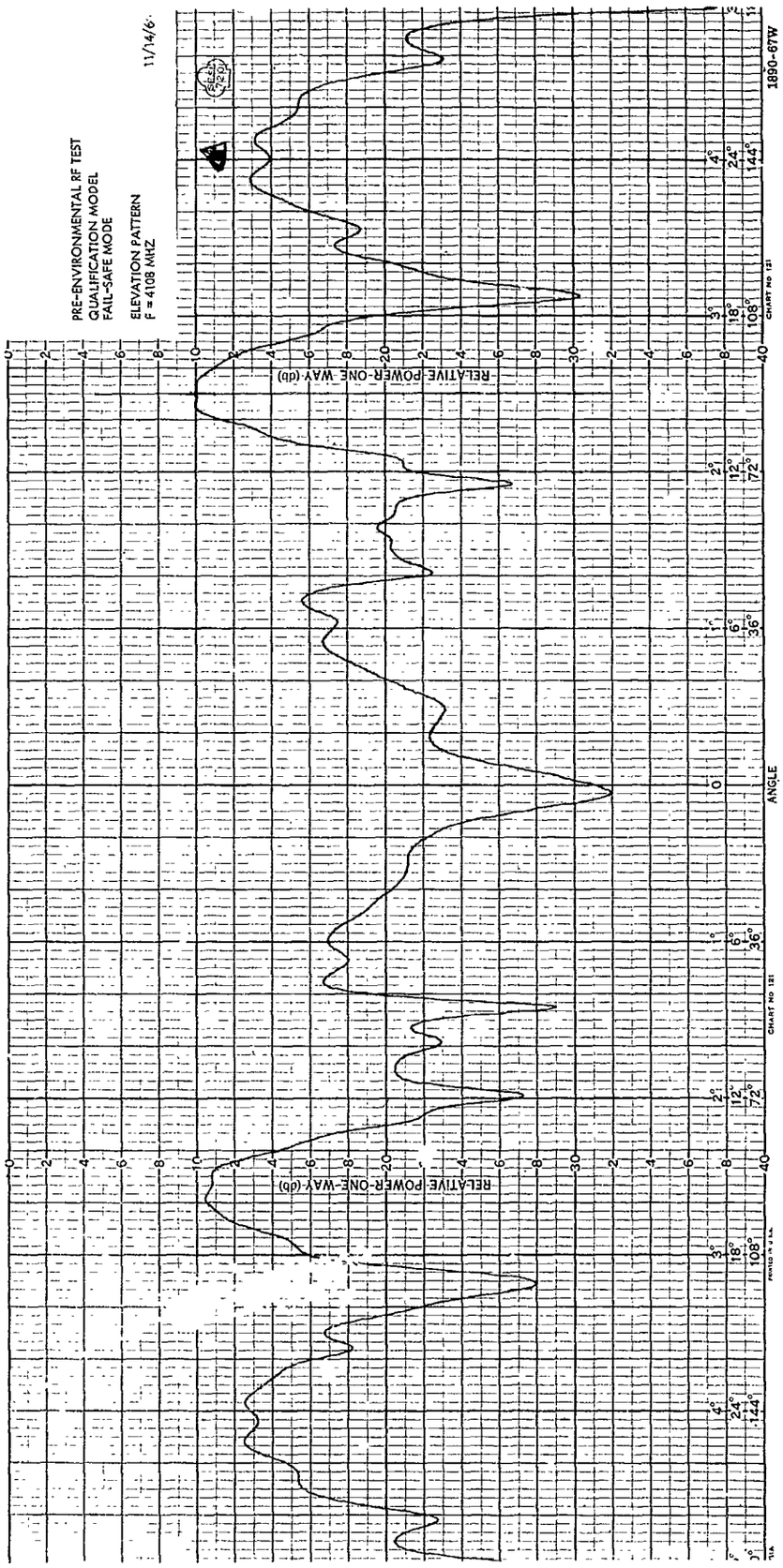

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
FAIL-SAFE MODE
ELEVATION PATTERN
F = 6313 MHZ
11/14/66
RELATIVE POWER-ONE-WAY (db)
ANGLE
1885-87W

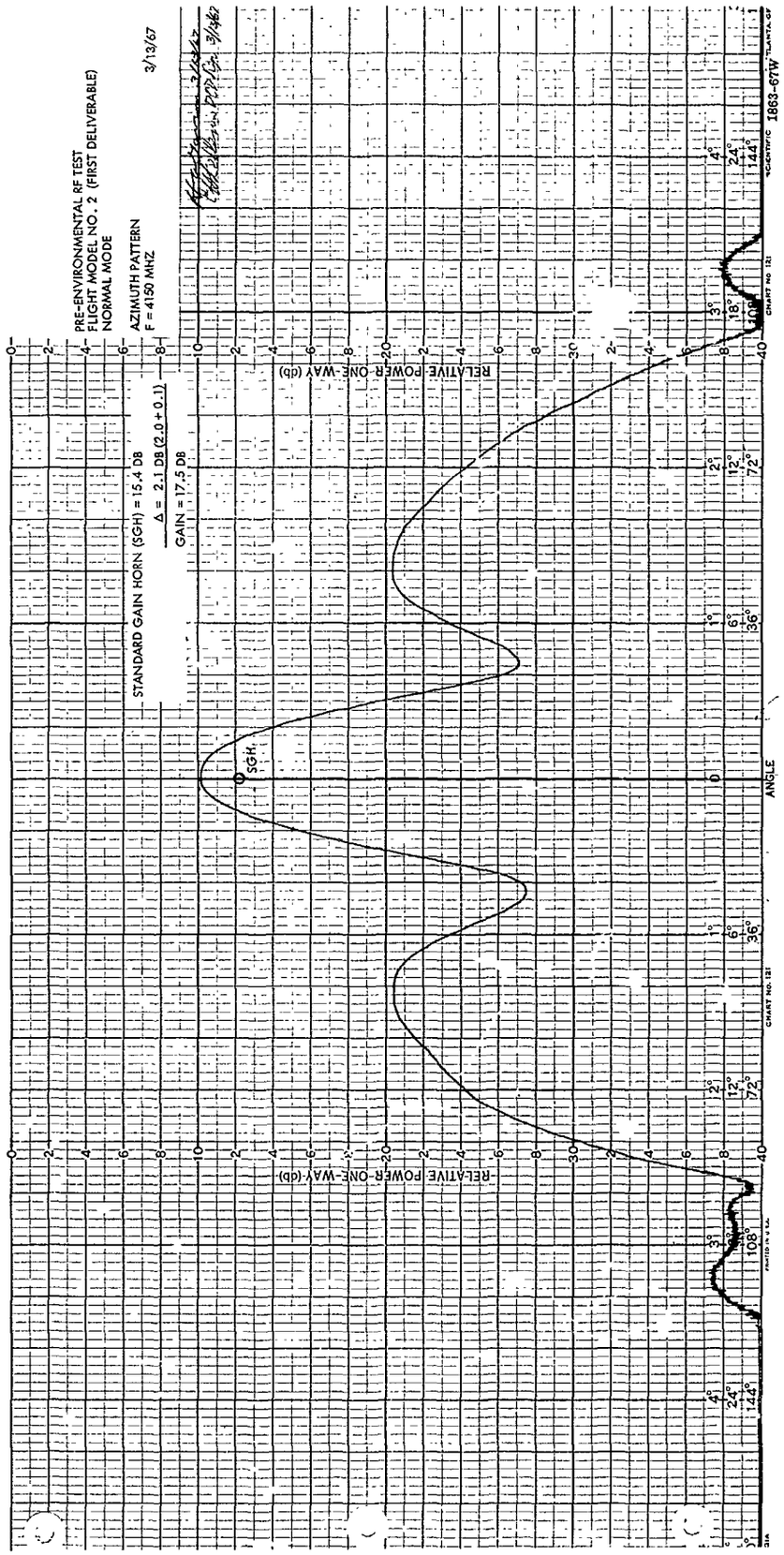

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
FAIL-SAFE MODE
ELEVATION PATTERN
F = 6260 MHz
11/14/66
RELATIVE POWER ONE WAY (db)
ANGLE
1886-67W

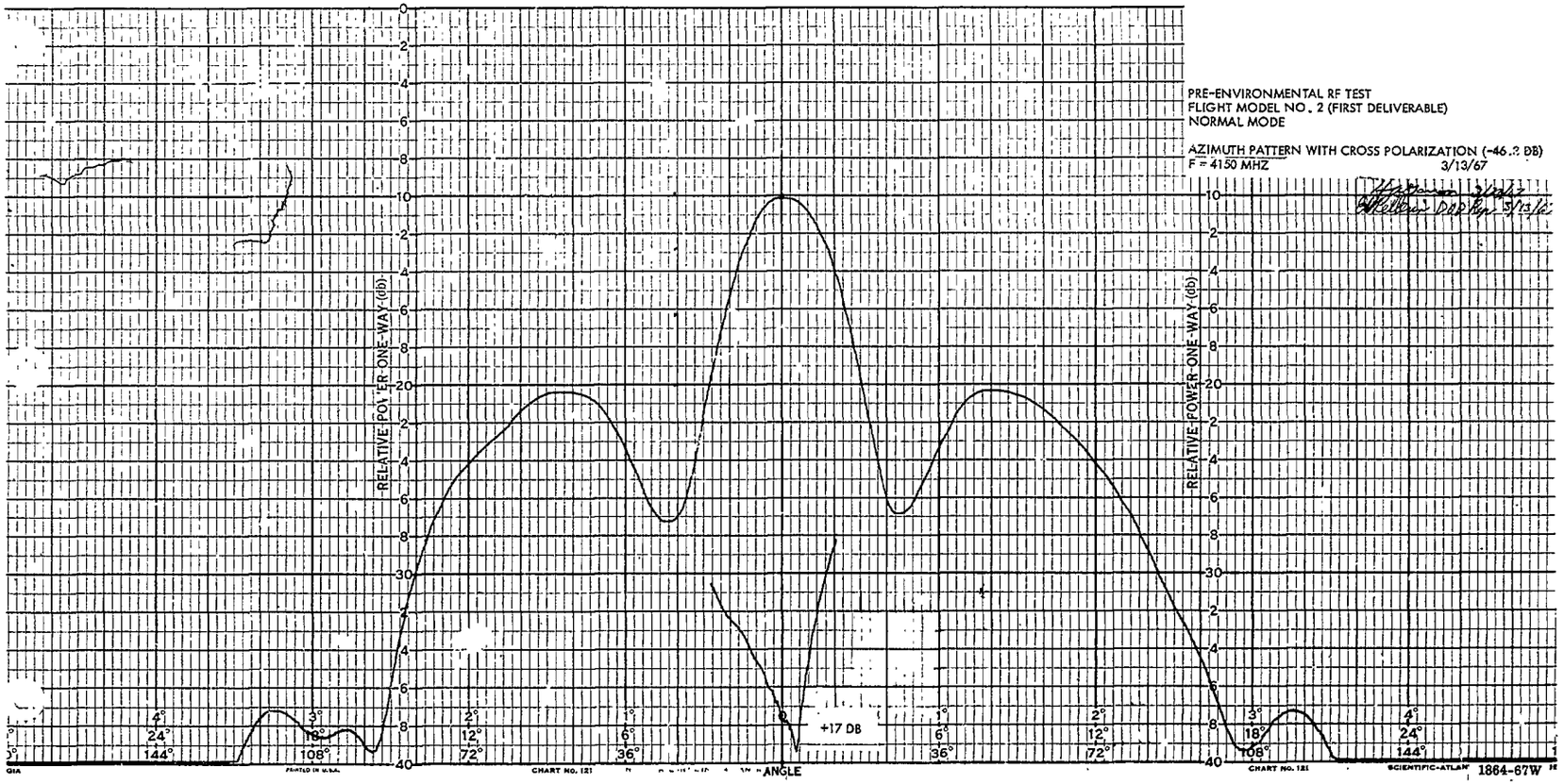

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
FAIL-SAFE MODE
ELEVATION PATTERN
F = 4150 MHZ
11/14/66
RELATIVE POWER-ONE-WAY (db)
ANGLE
1887-67W

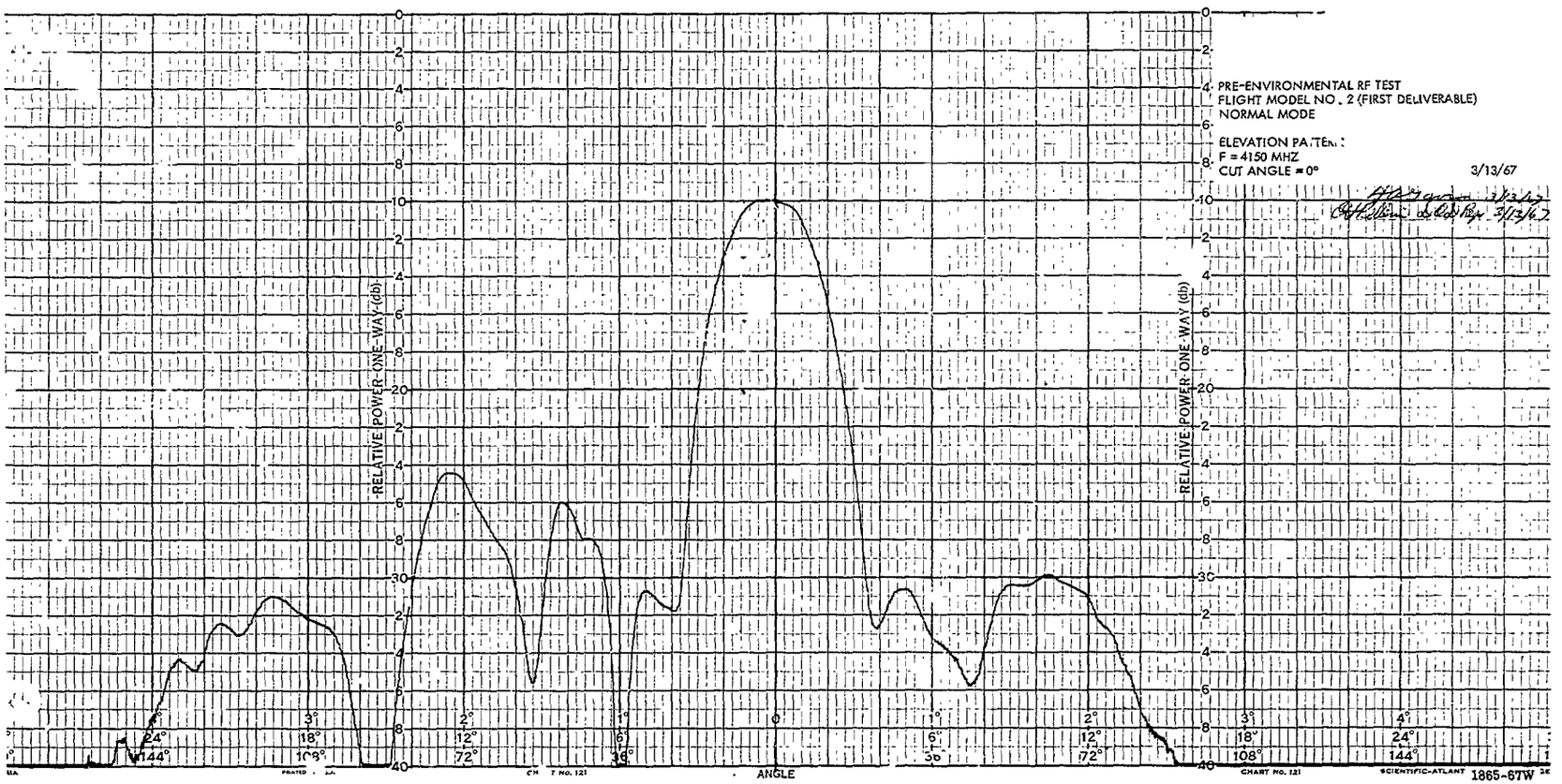

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
FAIL-SAFE MODE
ELEVATION PATTERN
F = 4190 MHZ
11/14/66
RELATIVE POWER ONE-WAY (db)
ANGLE
CHART NO 121
SCIENTIFIC-ATLANTA 1888-67W

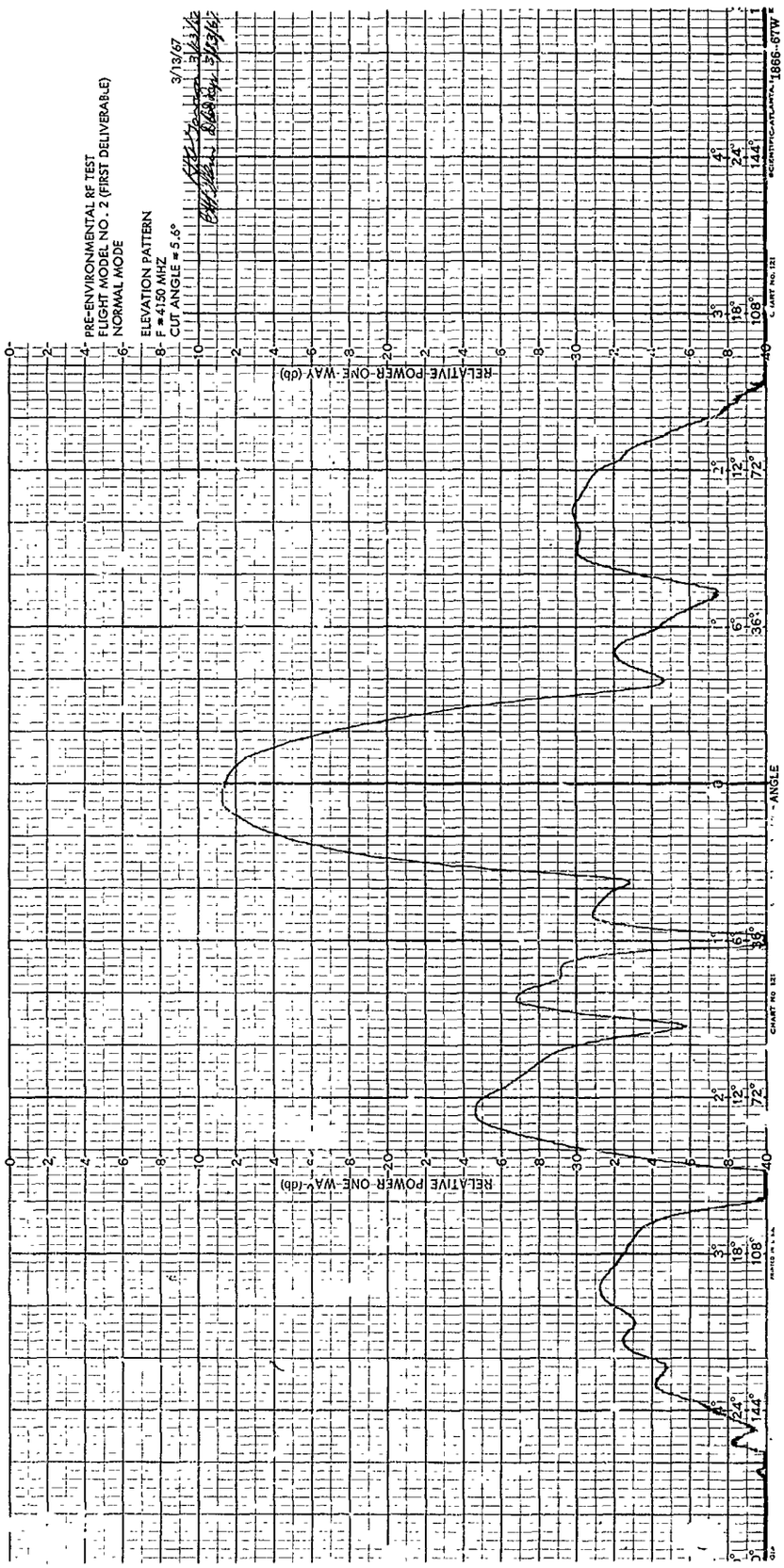

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
FAIL-SAFE MODE
ELEVATION PATTERN
F = 6200 MHZ
11/12/6
RELATIVE POWER ONE-WAY (db)
ANGLE
1889-67W

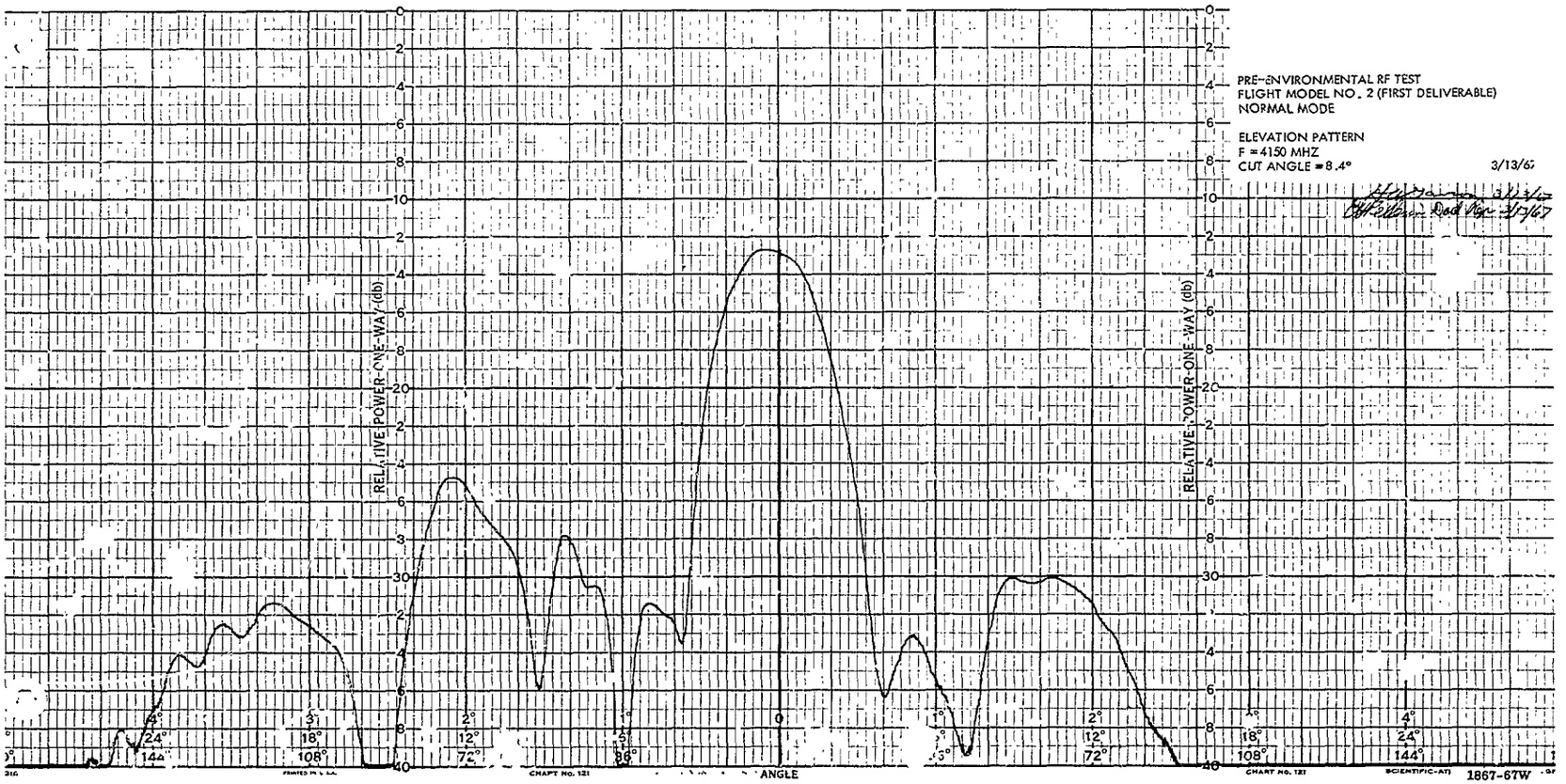

PRE-ENVIRONMENTAL RF TEST
QUALIFICATION MODEL
FAIL-SAFE MODE
ELEVATION PATTERN
F = 4108 MHZ
11/14/6
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO 121
1890-67W

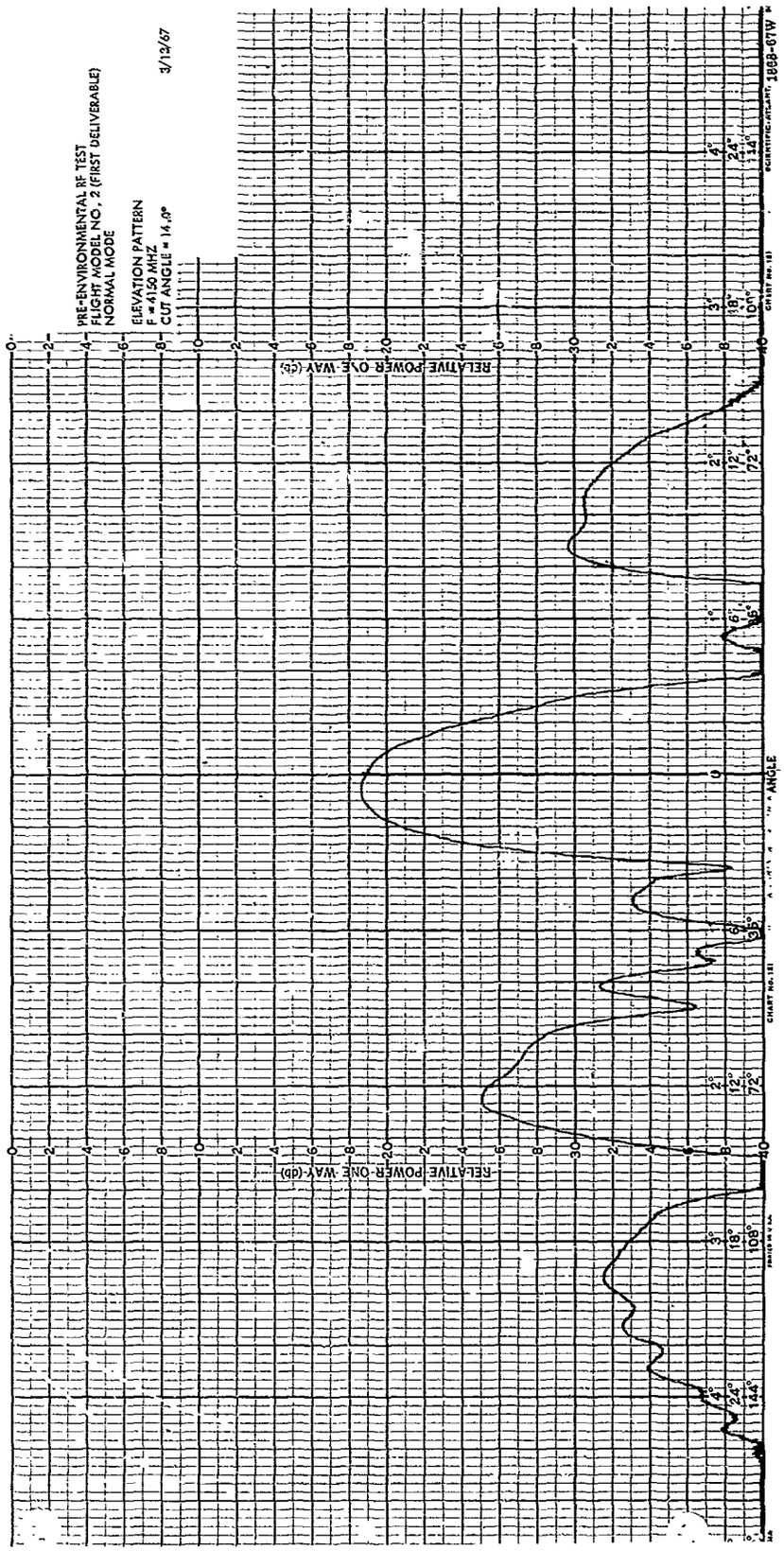

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN
F = 4150 MHZ
3/13/67
STANDARD GAIN HORN (SGH) = 15.4 DB
Δ = 2.1 DB (2.0 ± 0.1)
GAIN = 17.5 DB
SGH
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO. 121
1863-67W

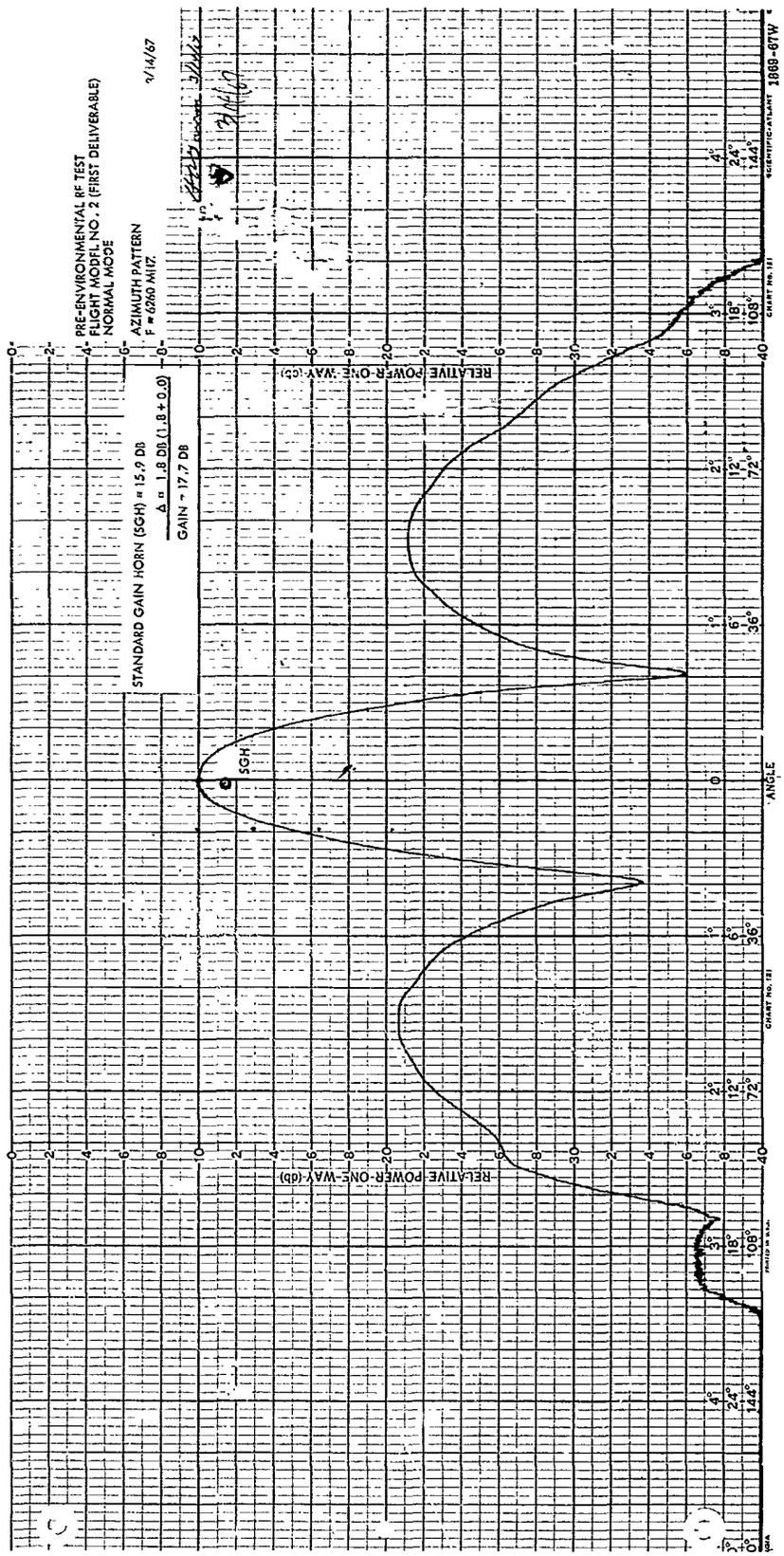

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION (-46.? DB)
F = 4150 MHZ
3/13/67
RELATIVE POWER-ONE-WAY (db)
+17 DB
ANGLE
CHART NO. 121
SCIENTIFIC-ATLANTA
1864-67W

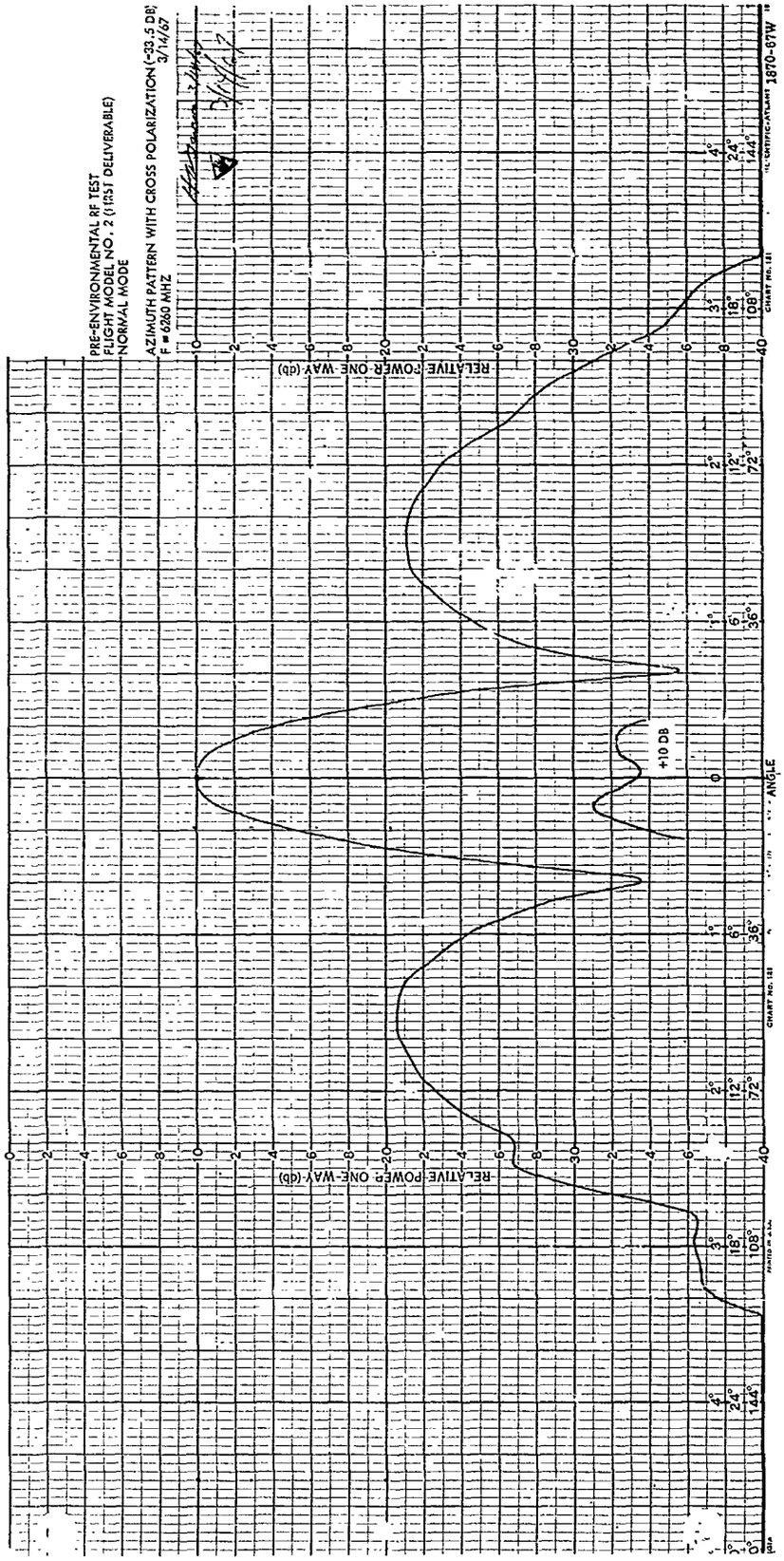

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 0°
3/13/67
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART No. 121
SCIENTIFIC-ATLANTA 1865-67W

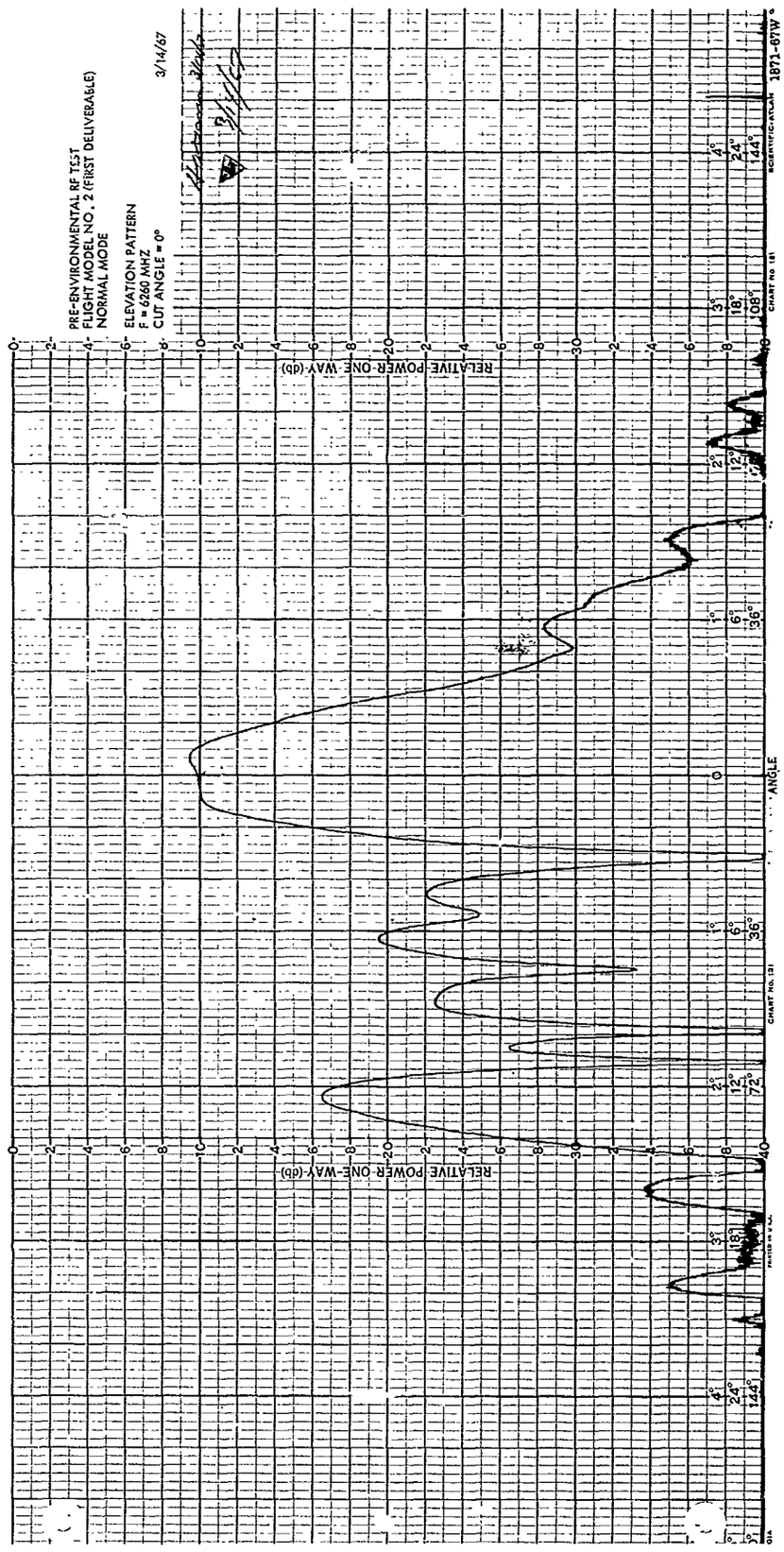

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 5.6°
3/13/67
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO. 121
SCIENTIFIC ATLANTA 1866-67TW

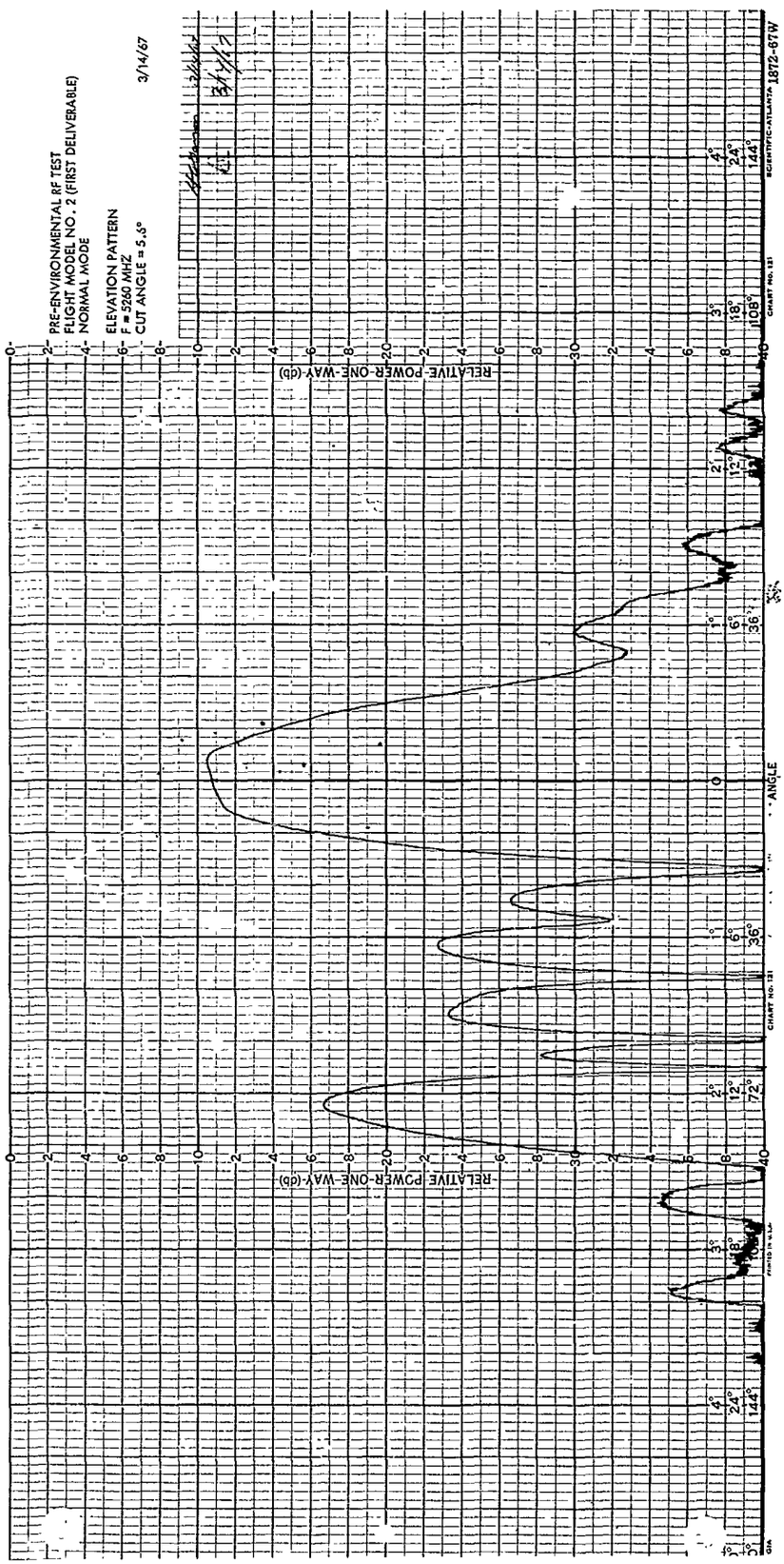

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 8.4°
3/13/67
RELATIVE POWER-ONE-WAY (db)
ANGLE
1867-67W

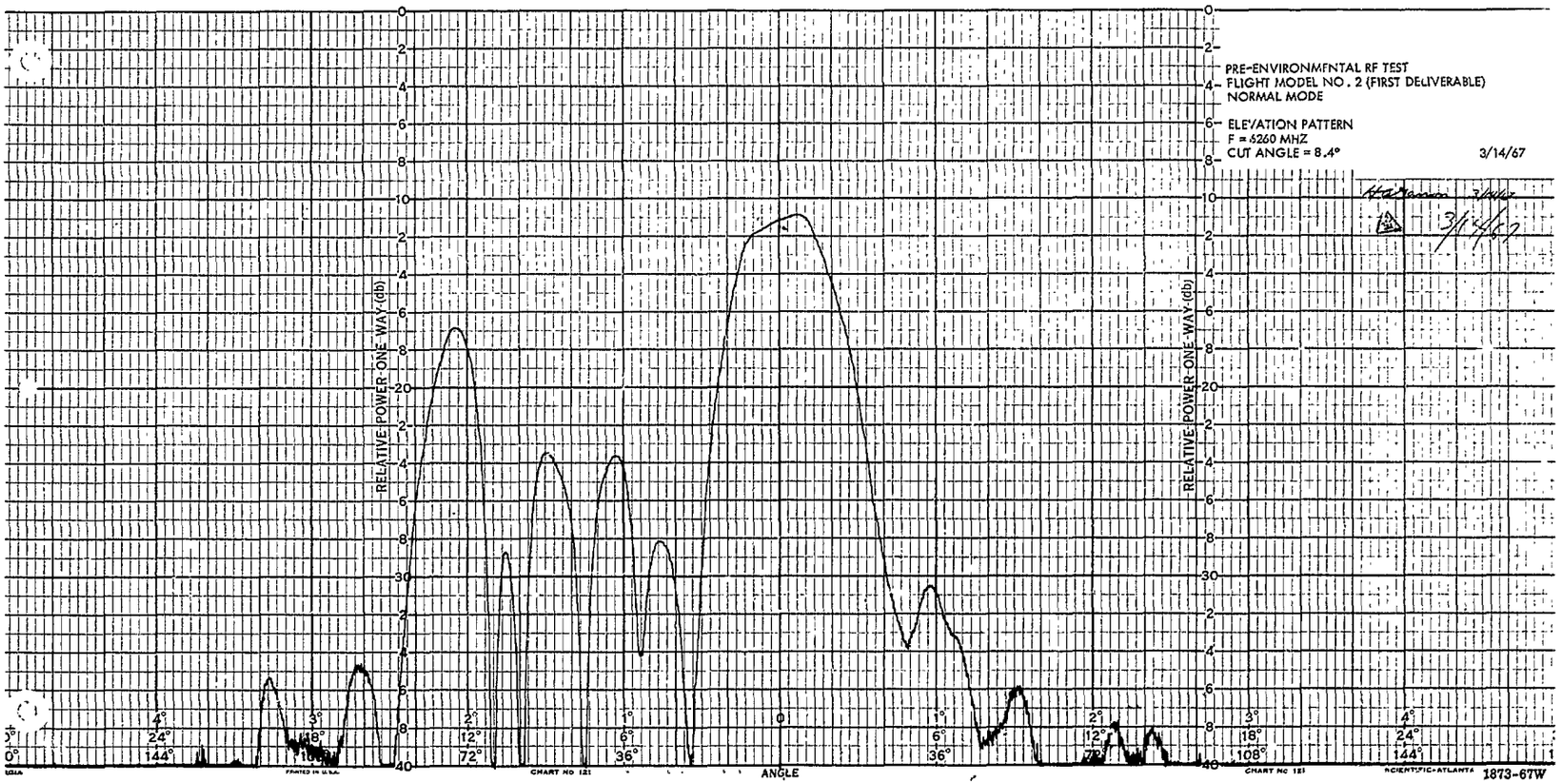

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 14.0°
3/12/67
RELATIVE POWER ONE WAY (db)
RELATIVE POWER ONE WAY (db)
ANGLE

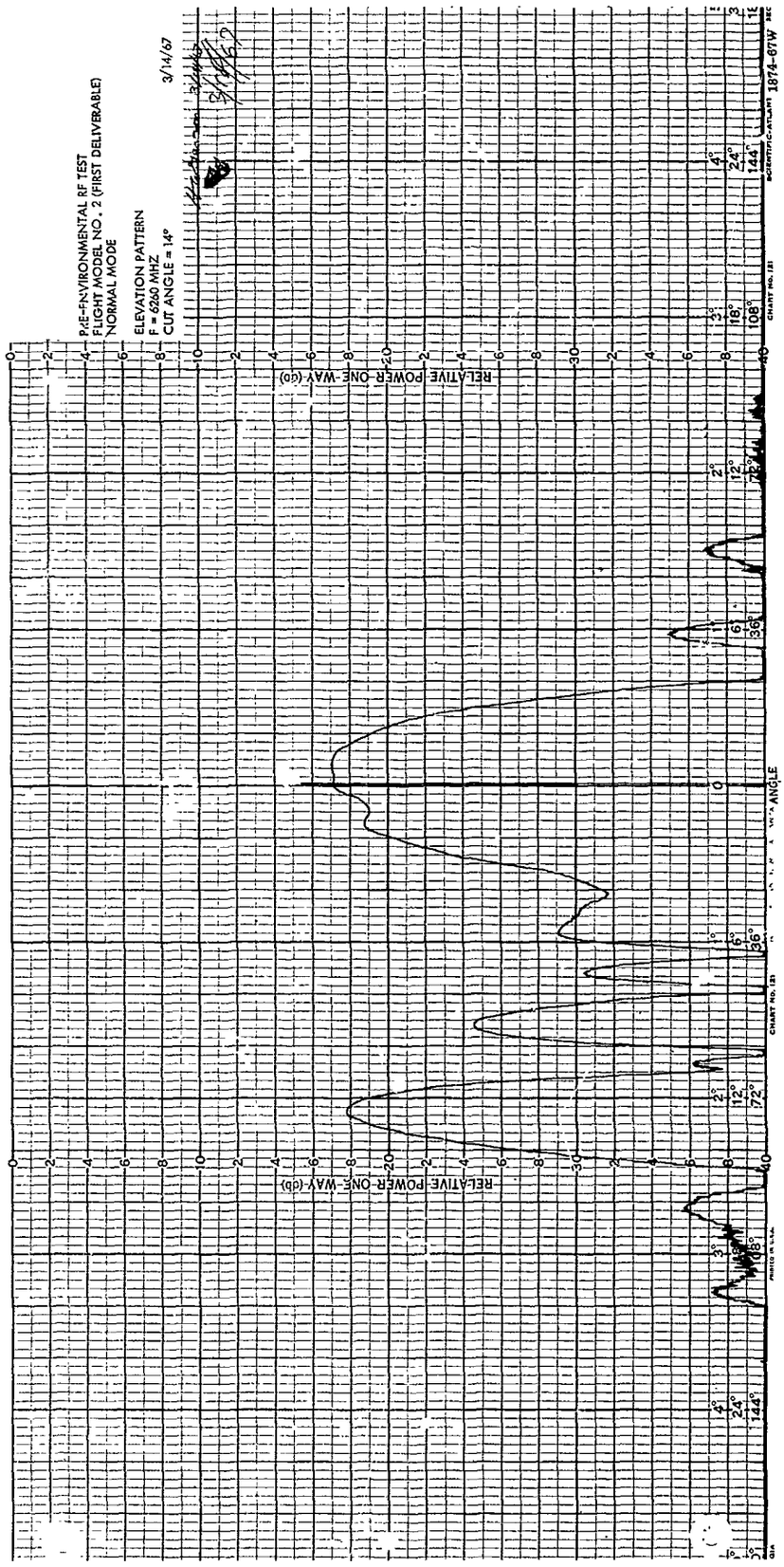

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN
F = 6260 MHZ
STANDARD GAIN HORN (SGH) = 15.9 DB
Δ = 1.8 DB (1.8 + 0.0)
GAIN = 17.7 DB
SGH
RELATIVE POWER-ONE-WAY (db)
ANGLE
1869-67W

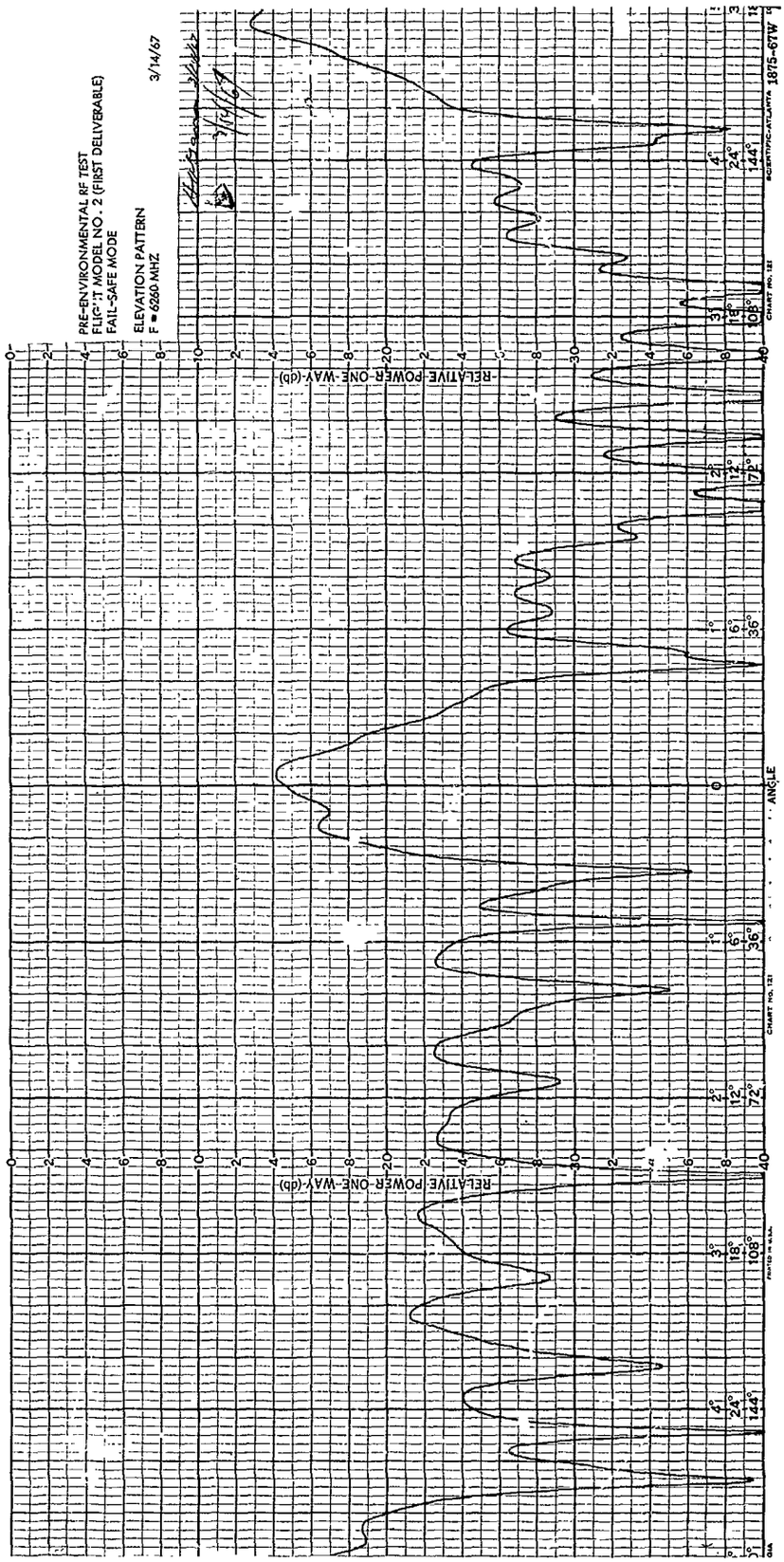

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION (-33.5 DB)
F = 6260 MHZ
3/14/67
RELATIVE POWER ONE-WAY (db)
+10 DB
ANGLE
CHART NO. 181
1870-67W

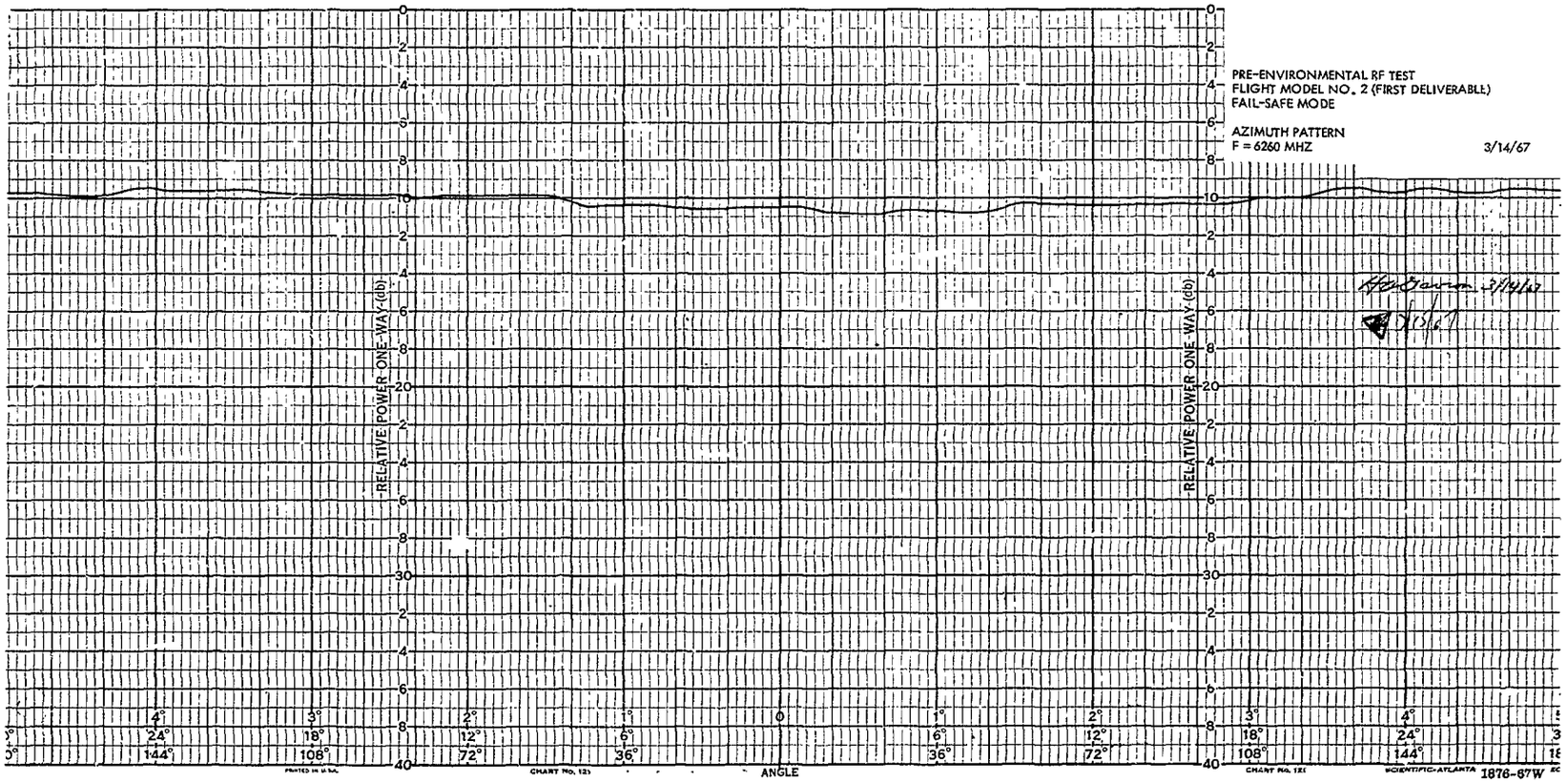

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 0°
3/14/67
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO. 131
SCIENTIFIC-ATLANTA 1871-67W

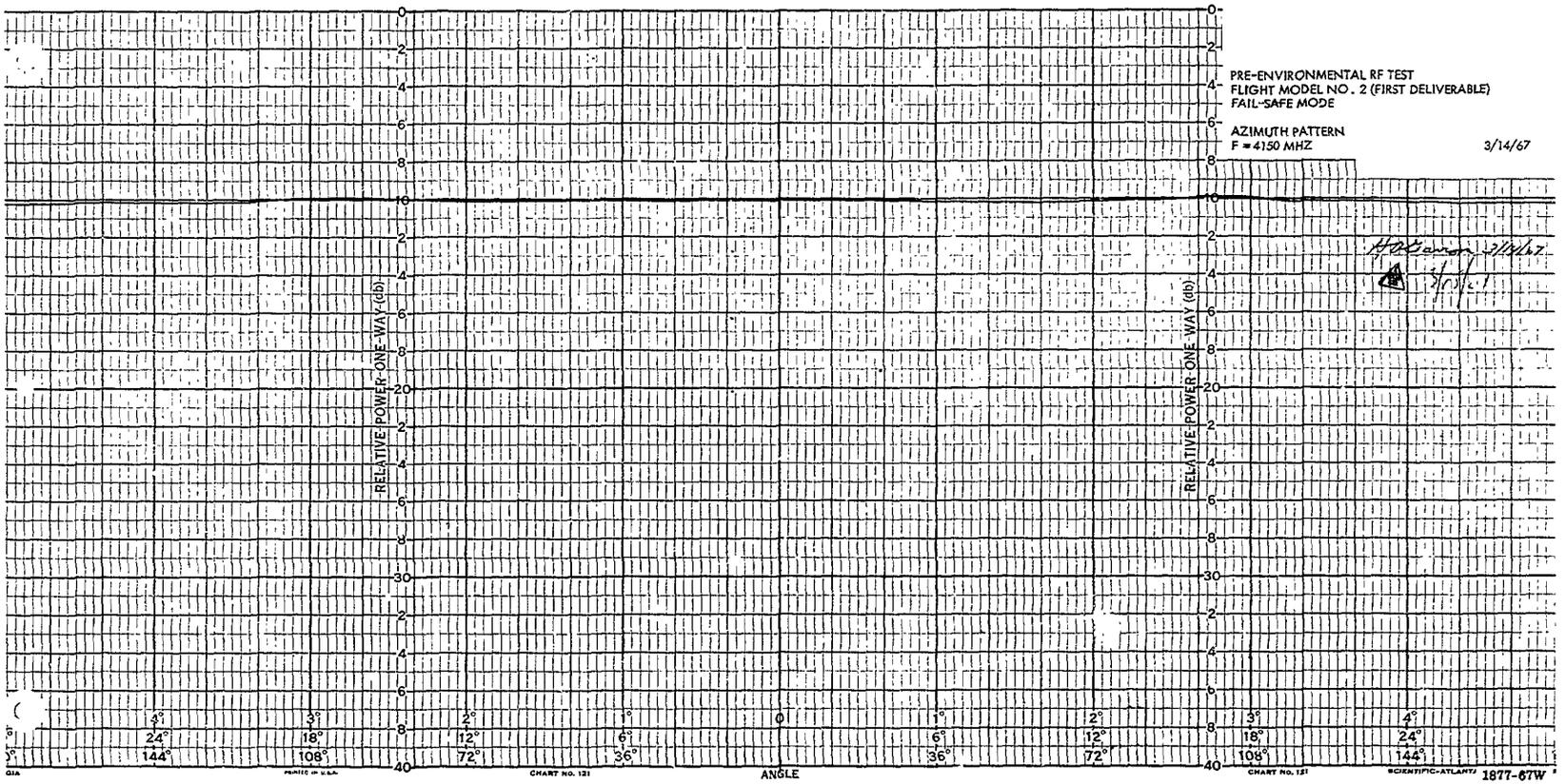

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 5240 MHZ
CUT ANGLE = 5.5°
3/14/67
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO. 131
SCIENTIFIC-ATLANTA 1872-67W

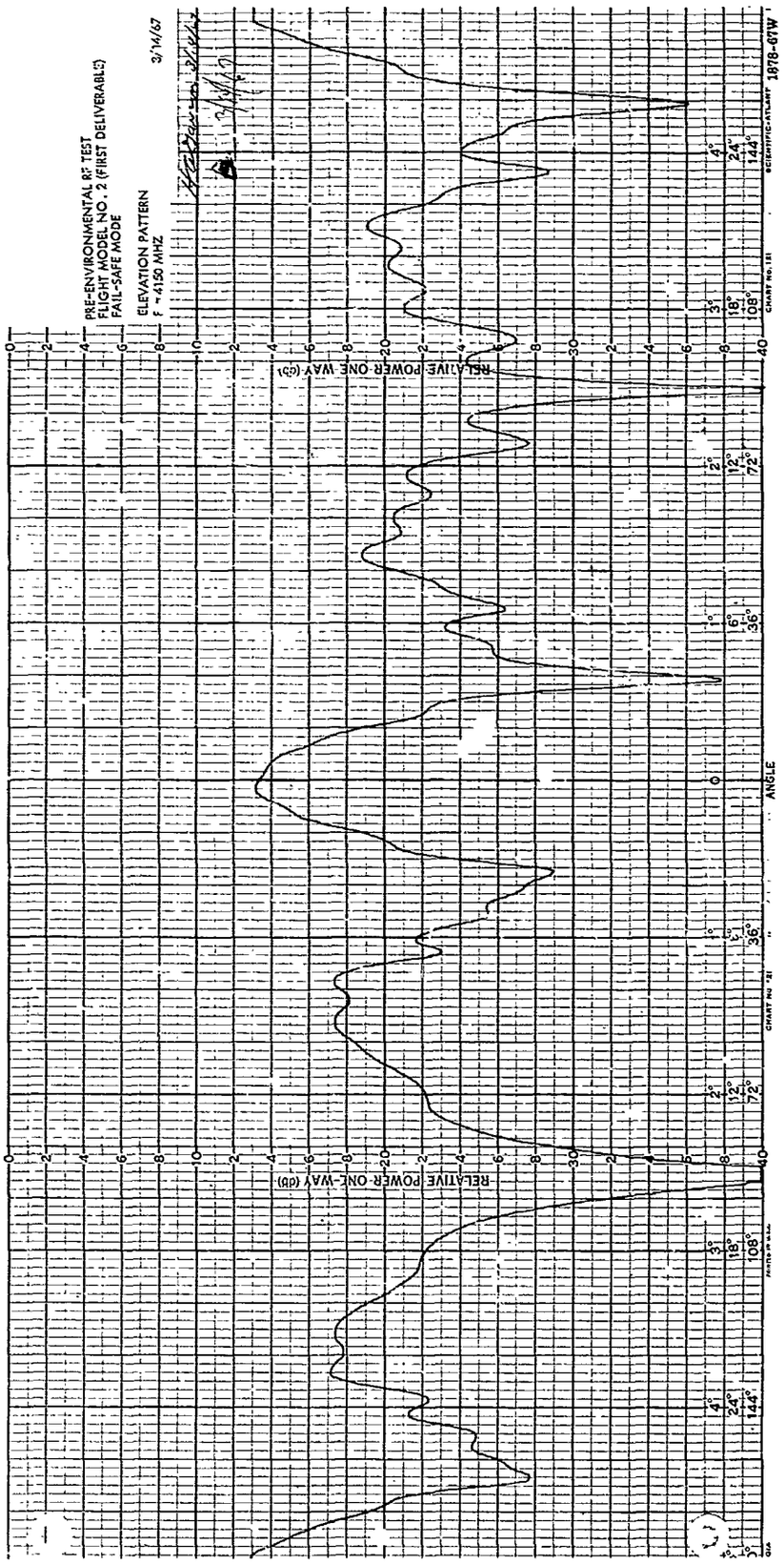

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 8.4°
3/14/67
RELATIVE POWER-ONE WAY (db)
ANGLE
CHART NO 121
SCIENTIFIC-ATLANTA
1873-67W

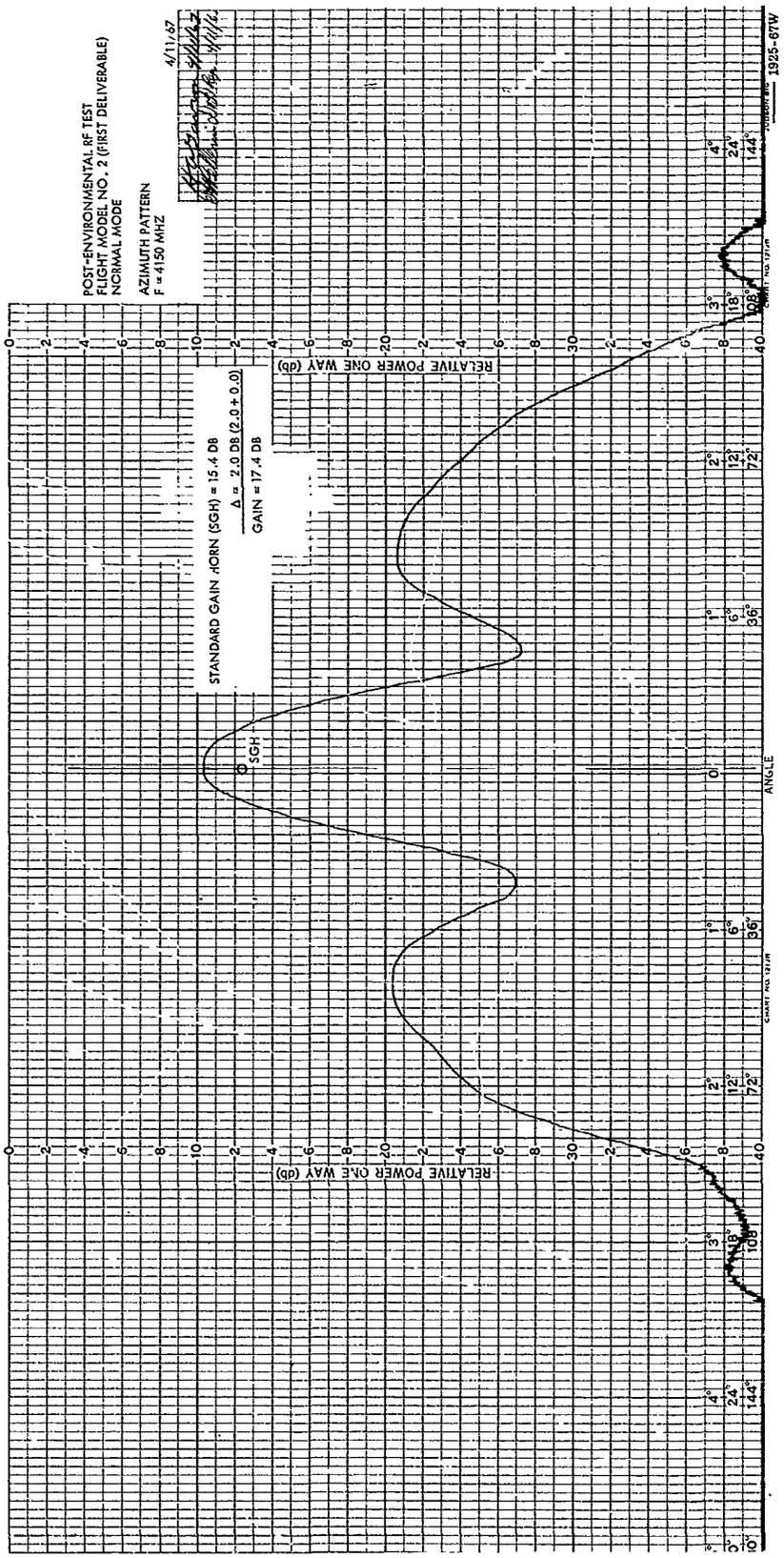

P/E-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 14°
3/14/67
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO. 131
SCIENTIFIC-ATLANTA 1874-67W

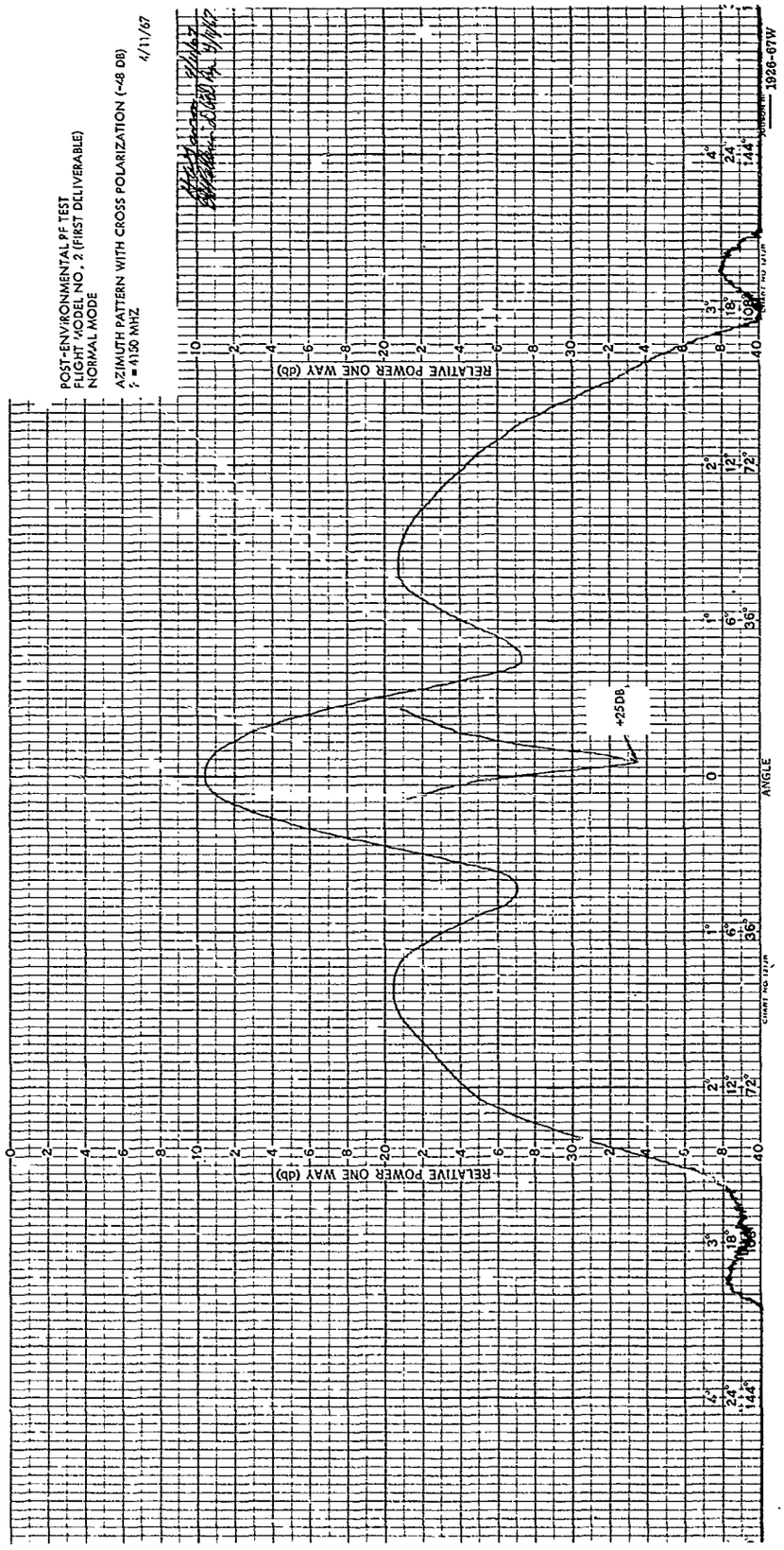

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
FAIL-SAFE MODE
ELEVATION PATTERN
F = 6260 MHZ
3/14/67
RELATIVE POWER-ONE-WAY-(db)
ANGLE
CHART NO. 121
SCIENTIFIC-ATLANTA 1875-67W

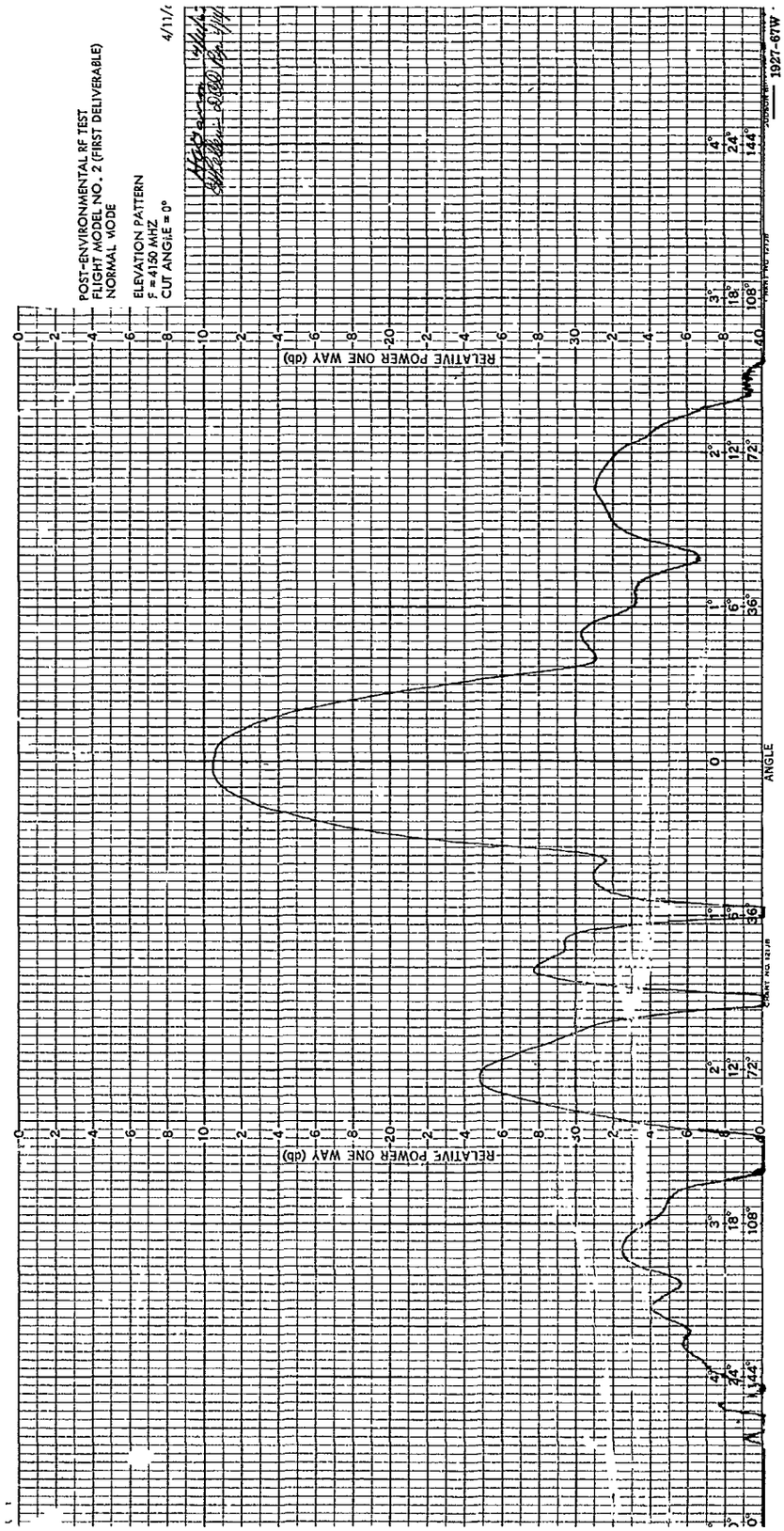

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 6260 MHZ
3/14/67
RELATIVE POWER ONE-WAY (db)
ANGLE
CHART NO. 121
SCIENTIFIC-ATLANTA
1876-87W

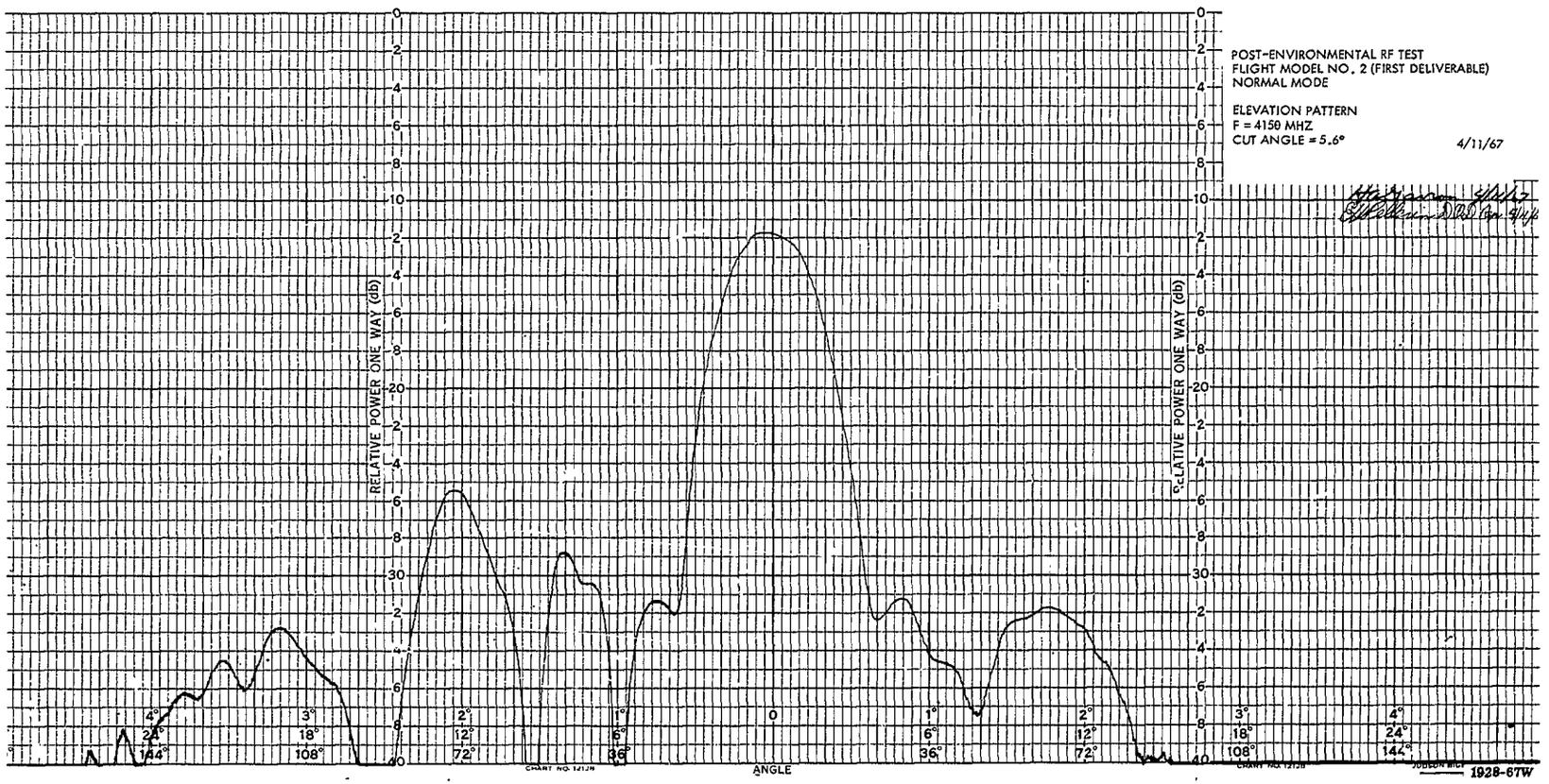

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 4150 MHZ
3/14/67
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO. 121
SCIENTIFIC-ATLANTA
1877-67W

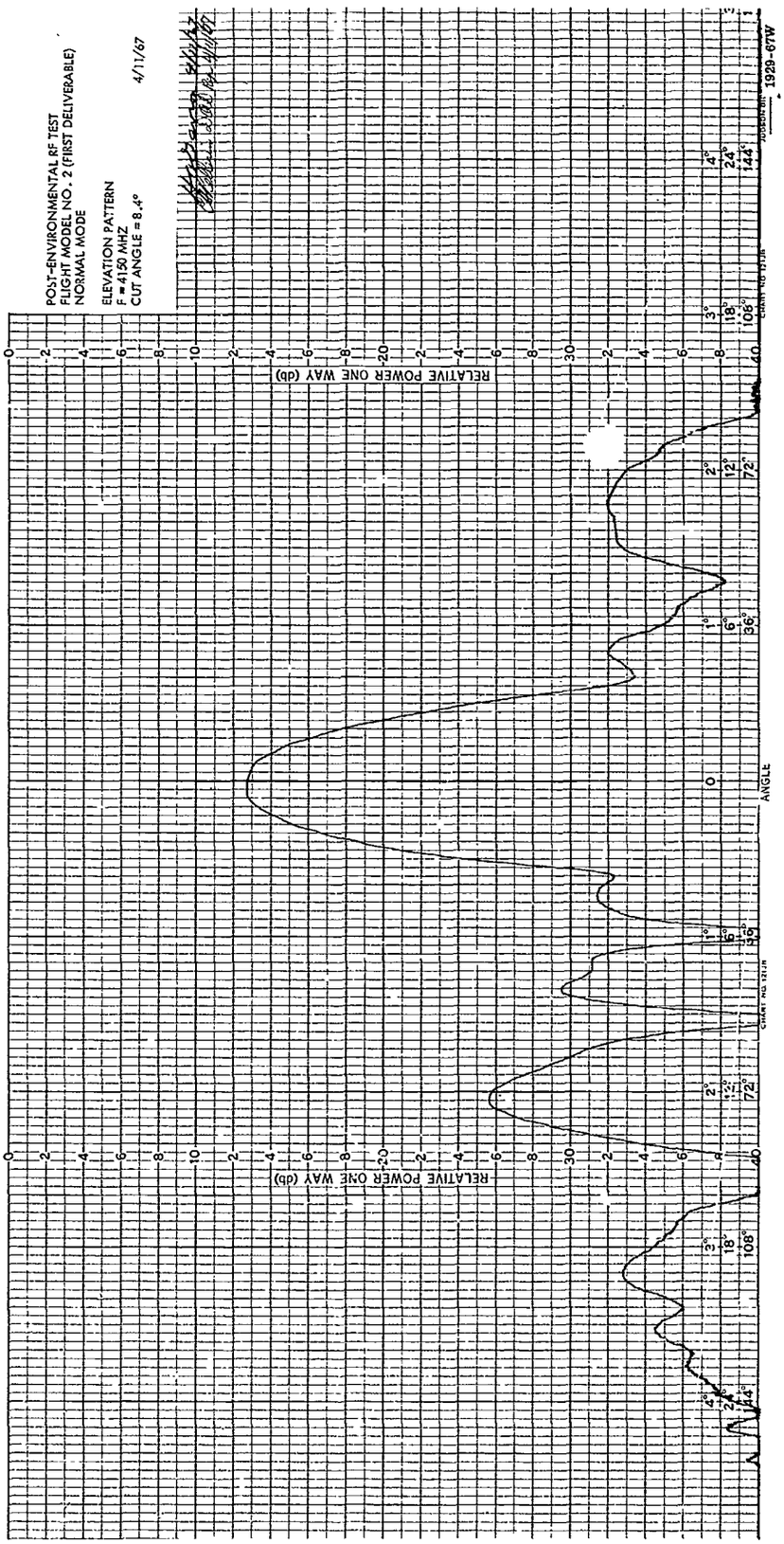

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
FAIL-SAFE MODE
ELEVATION PATTERN
F ~ 4150 MHZ
3/14/67
RELATIVE POWER-ONE-WAY (db)
ANGLE
SCIENTIFIC-ATLANTA 1878-67W

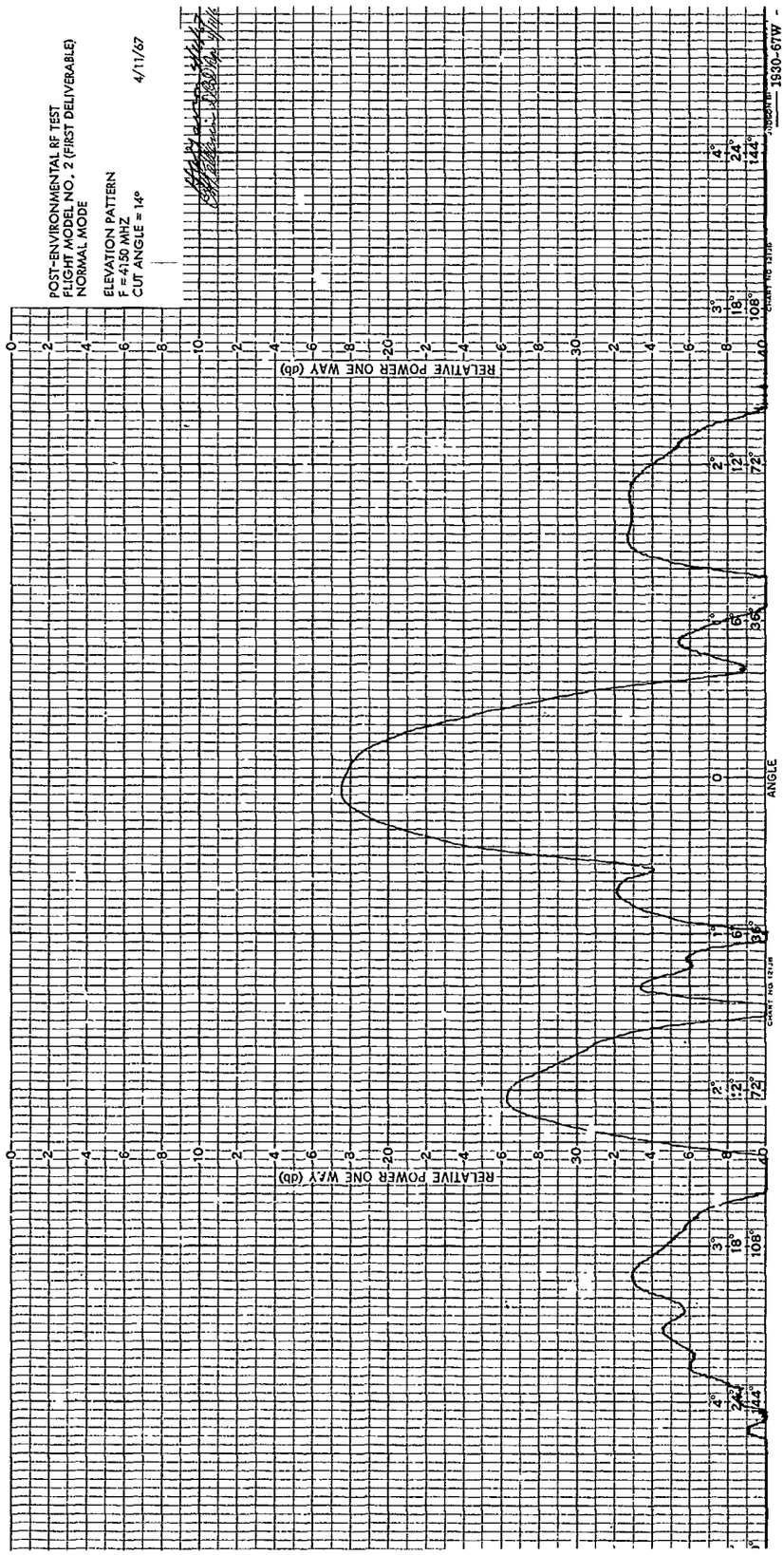

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN
F = 4150 MHZ
4/11/67
STANDARD GAIN HORN (SGH) = 15.4 DB
Δ = 2.0 DB (2.0 + 0.0)
GAIN = 17.4 DB
SGH
RELATIVE POWER ONE WAY (db)
RELATIVE POWER ONE WAY (db)
ANGLE
1925-67W

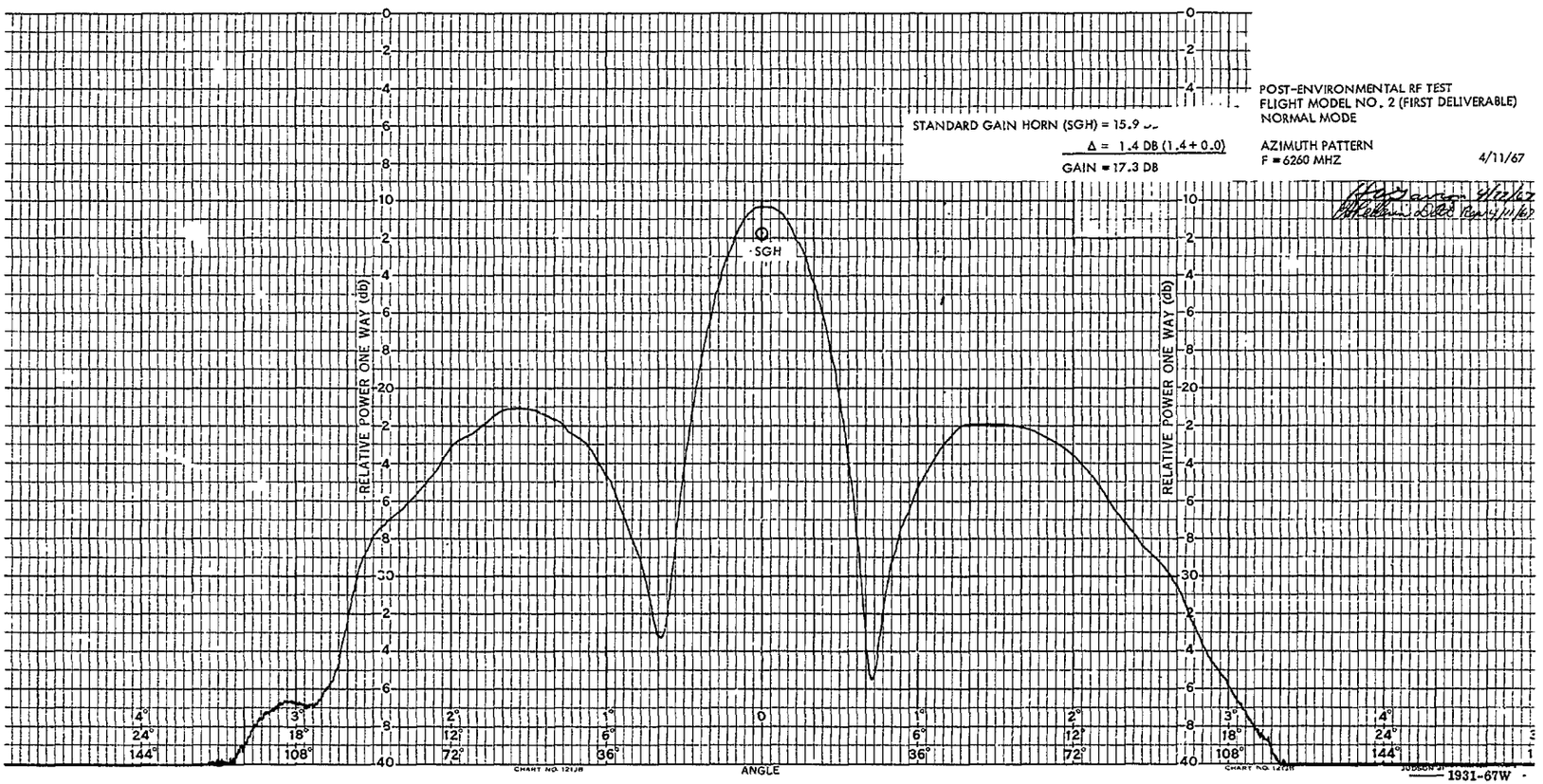

POST-ENVIRONMENTAL PF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION (-48 DB)
f = 4150 MHZ
4/11/67
RELATIVE POWER ONE WAY (db)
+25DB
ANGLE
1926-67W

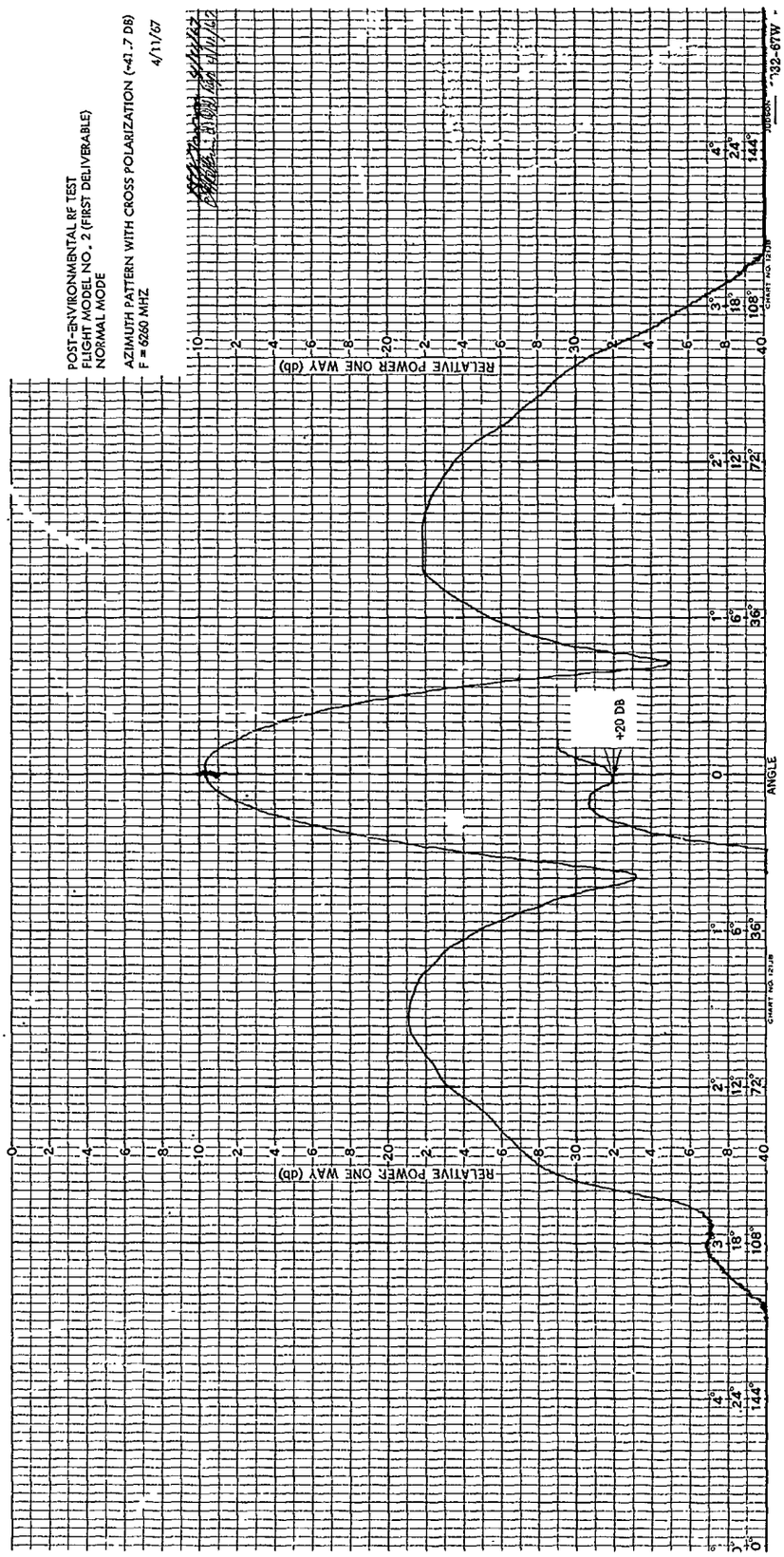

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4130 MHZ
CUT ANGLE = 0°
4/11/
RELATIVE POWER ONE WAY (db)
ANGLE
1927-67W

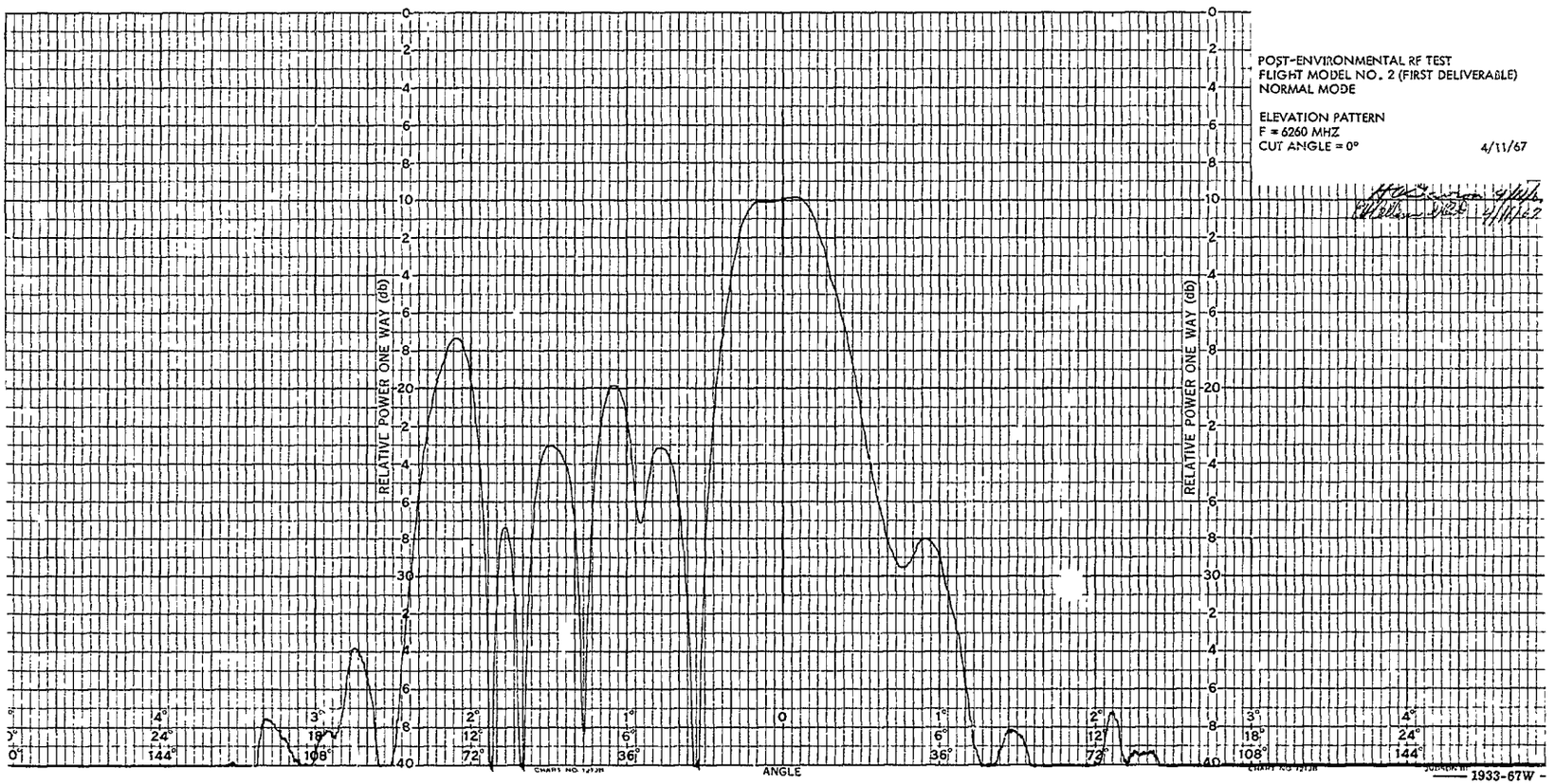

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 5.6°
4/11/67
RELATIVE POWER ONE WAY (db)
ANGLE
1928-67W

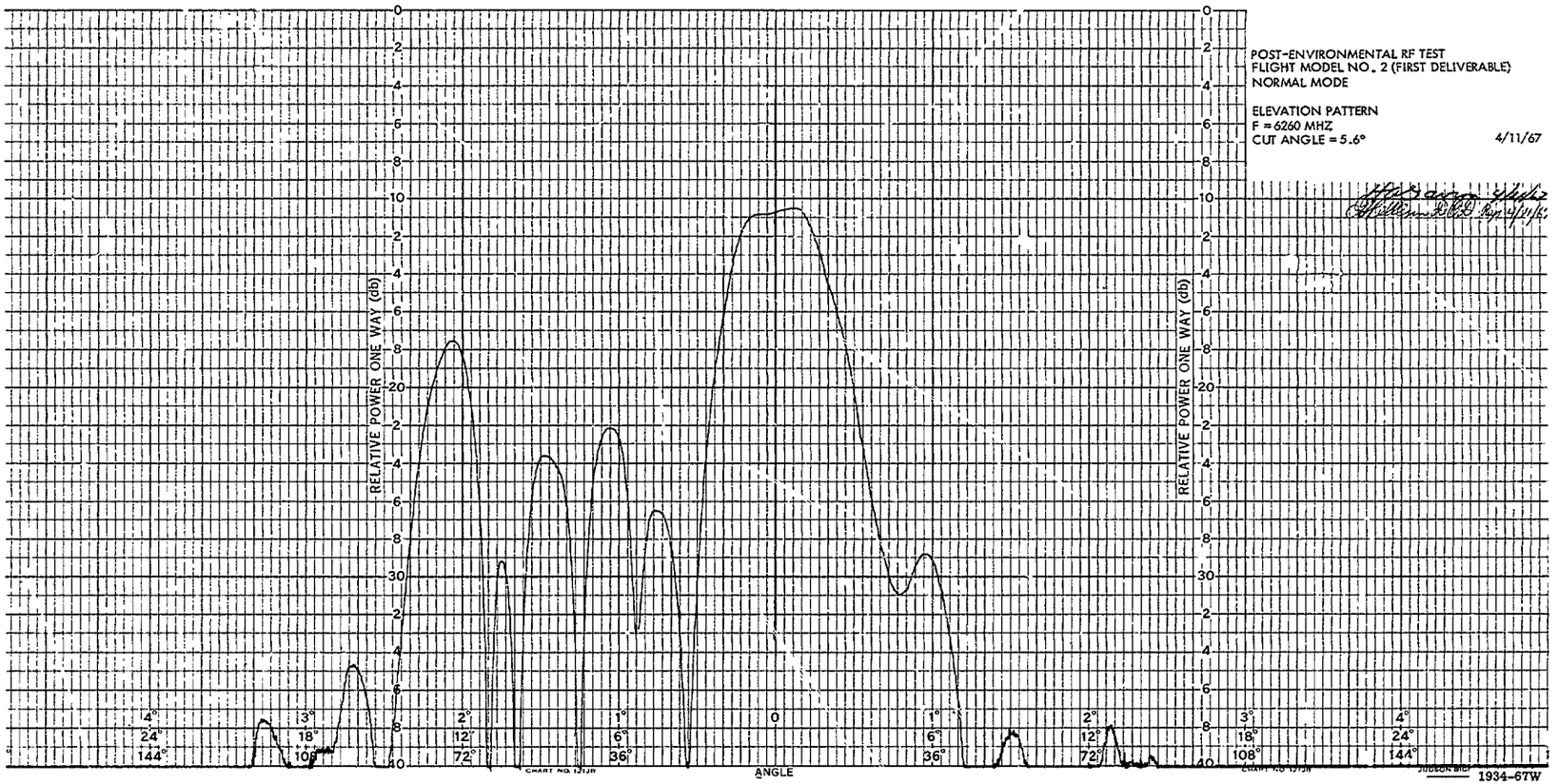

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 8.4°
4/11/67
RELATIVE POWER ONE WAY (db)
ANGLE
1929-67W

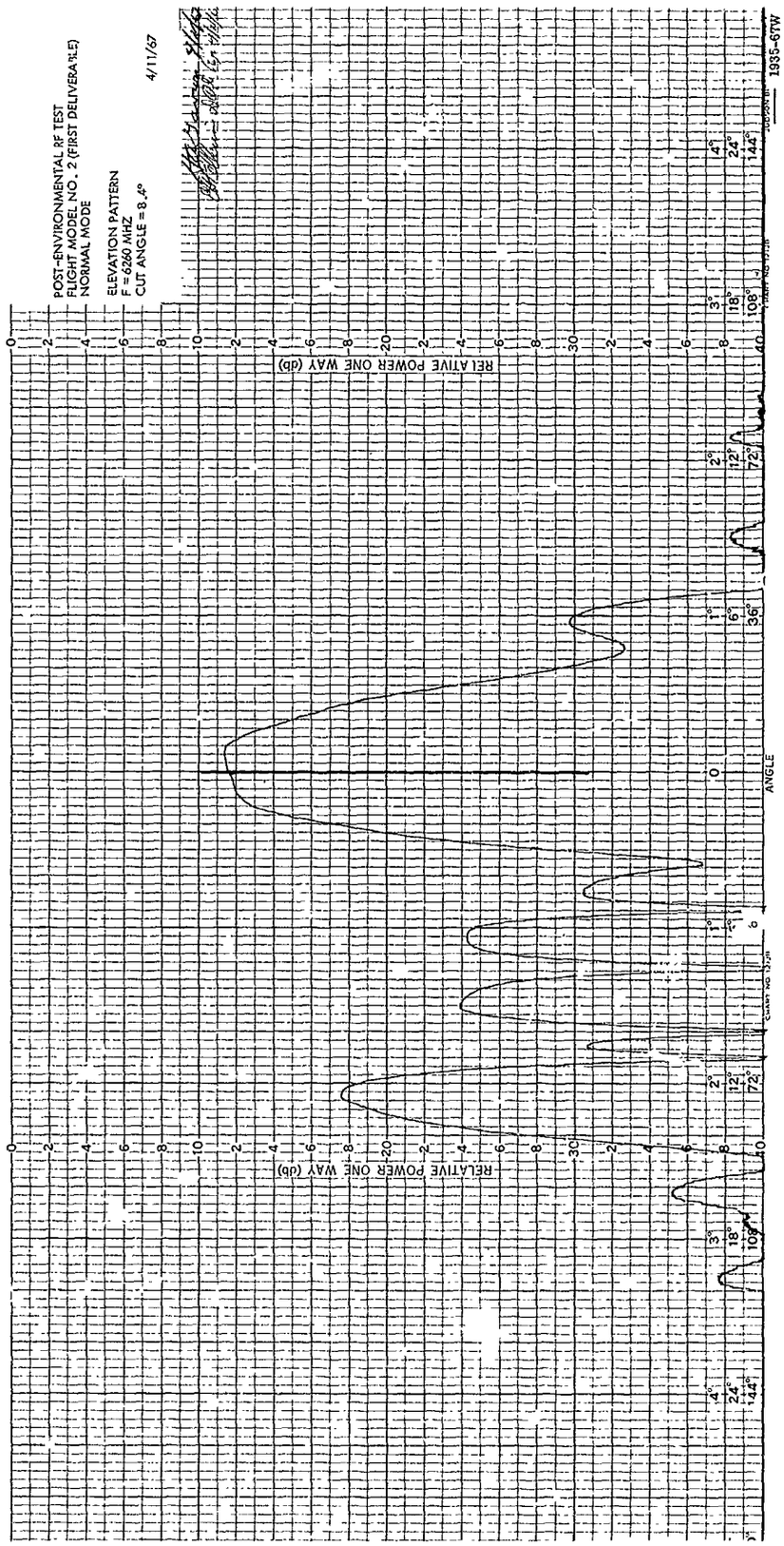

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 14°
4/11/67
RELATIVE POWER ONE WAY (db)
ANGLE
3930-67W

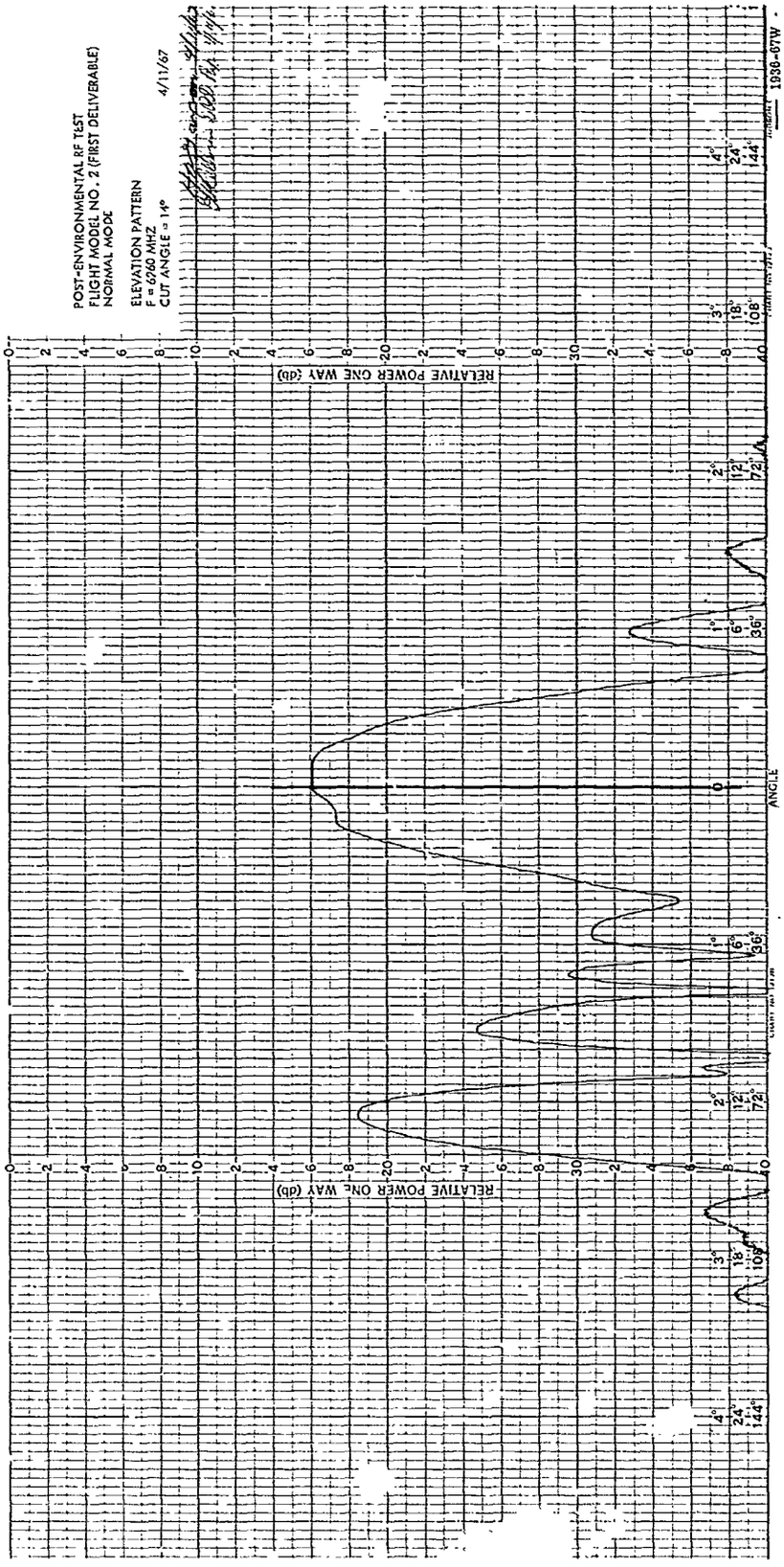

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN
F = 6260 MHZ
4/11/67
STANDARD GAIN HORN (SGH) = 15.9
Δ = 1.4 DB (1.4 + 0.0)
GAIN = 17.3 DB
SGH
RELATIVE POWER ONE WAY (db)
ANGLE
1931-67W

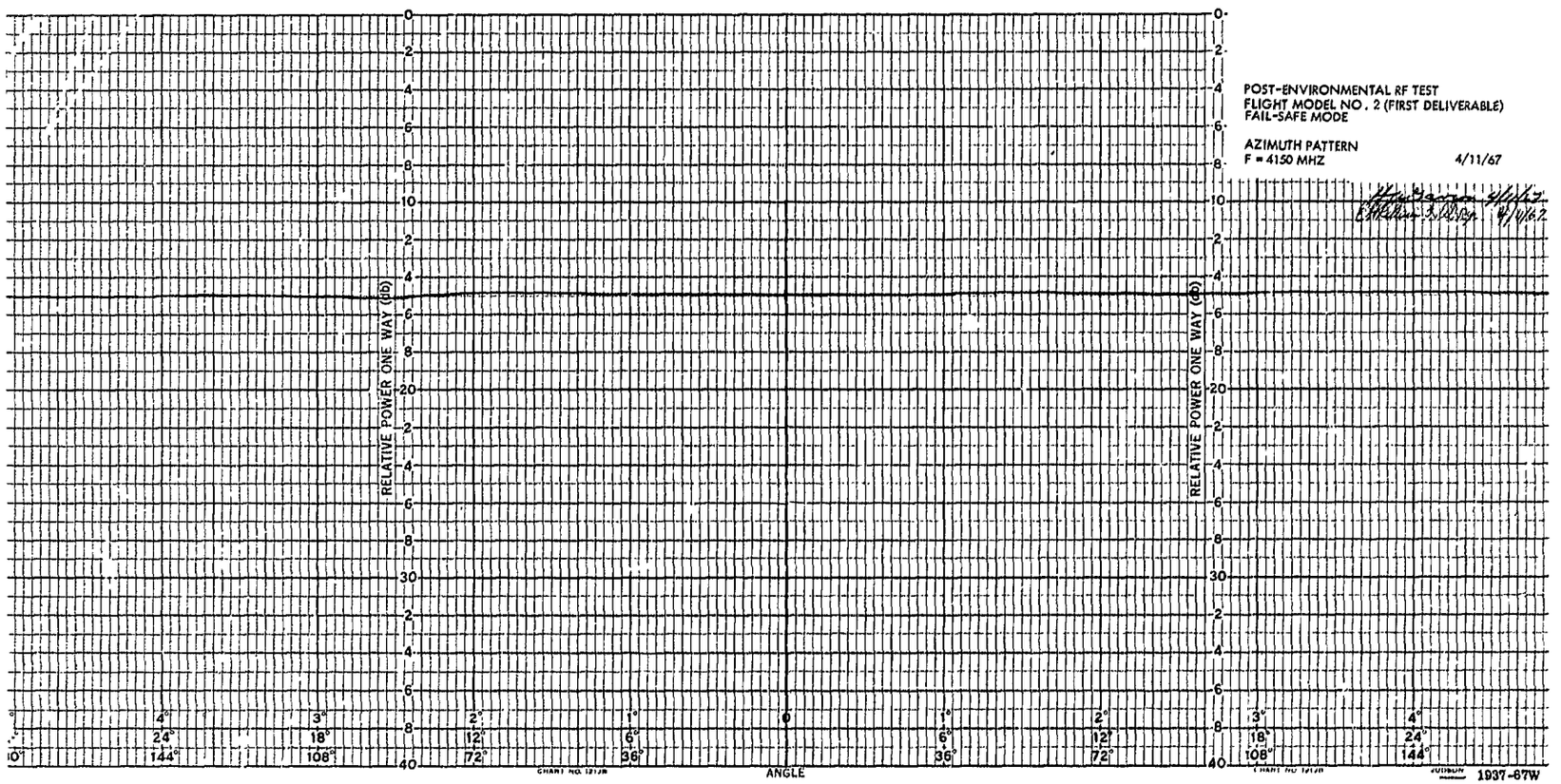

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION (-41.7 DB)
F = 6260 MHZ
4/11/67
RELATIVE POWER ONE WAY (db)
ANGLE
+20 DB
JUDSON
CHART NO. 121JB

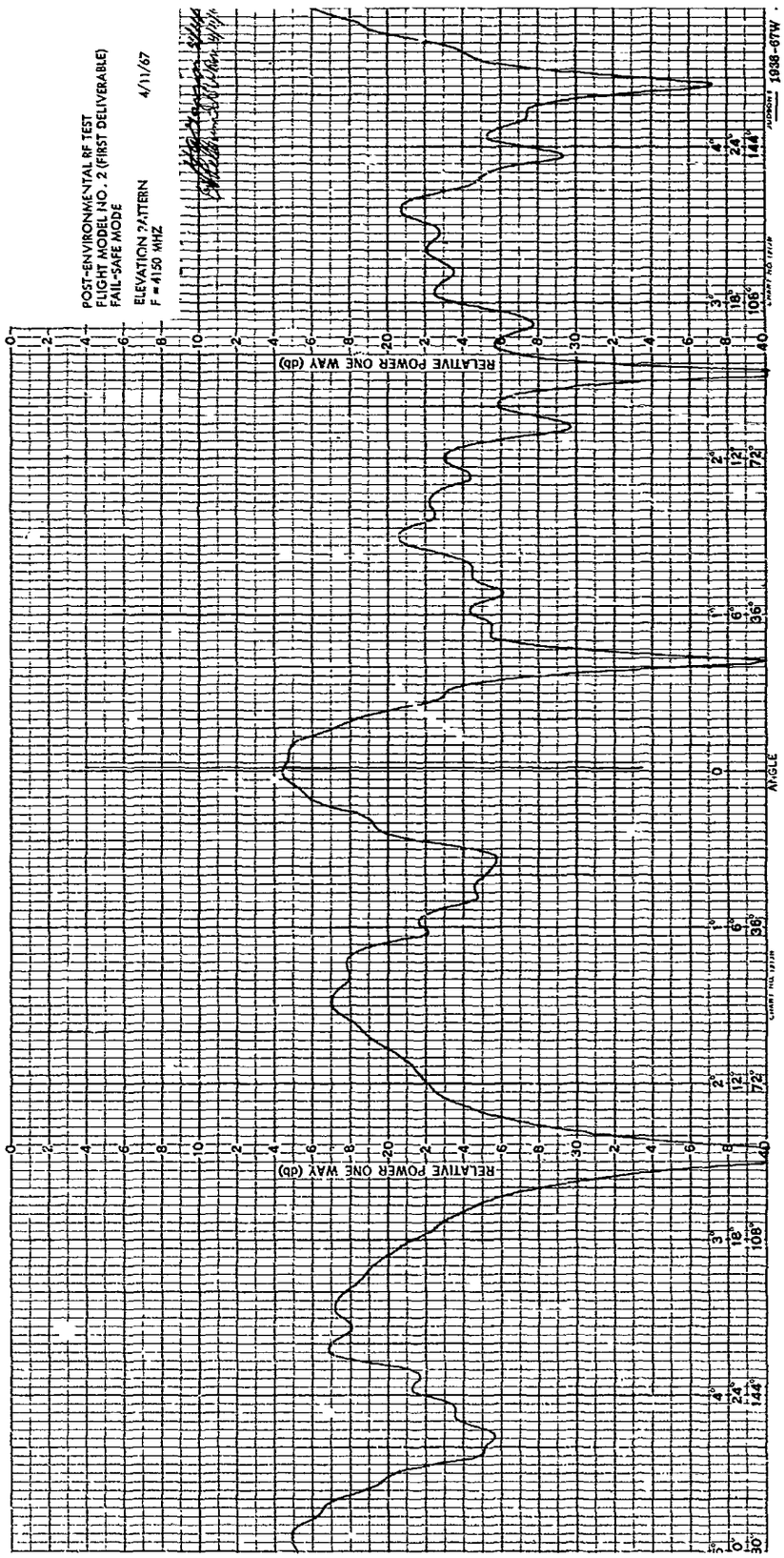

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 0°
4/11/67
RELATIVE POWER ONE WAY (db)
ANGLE
1933-67W

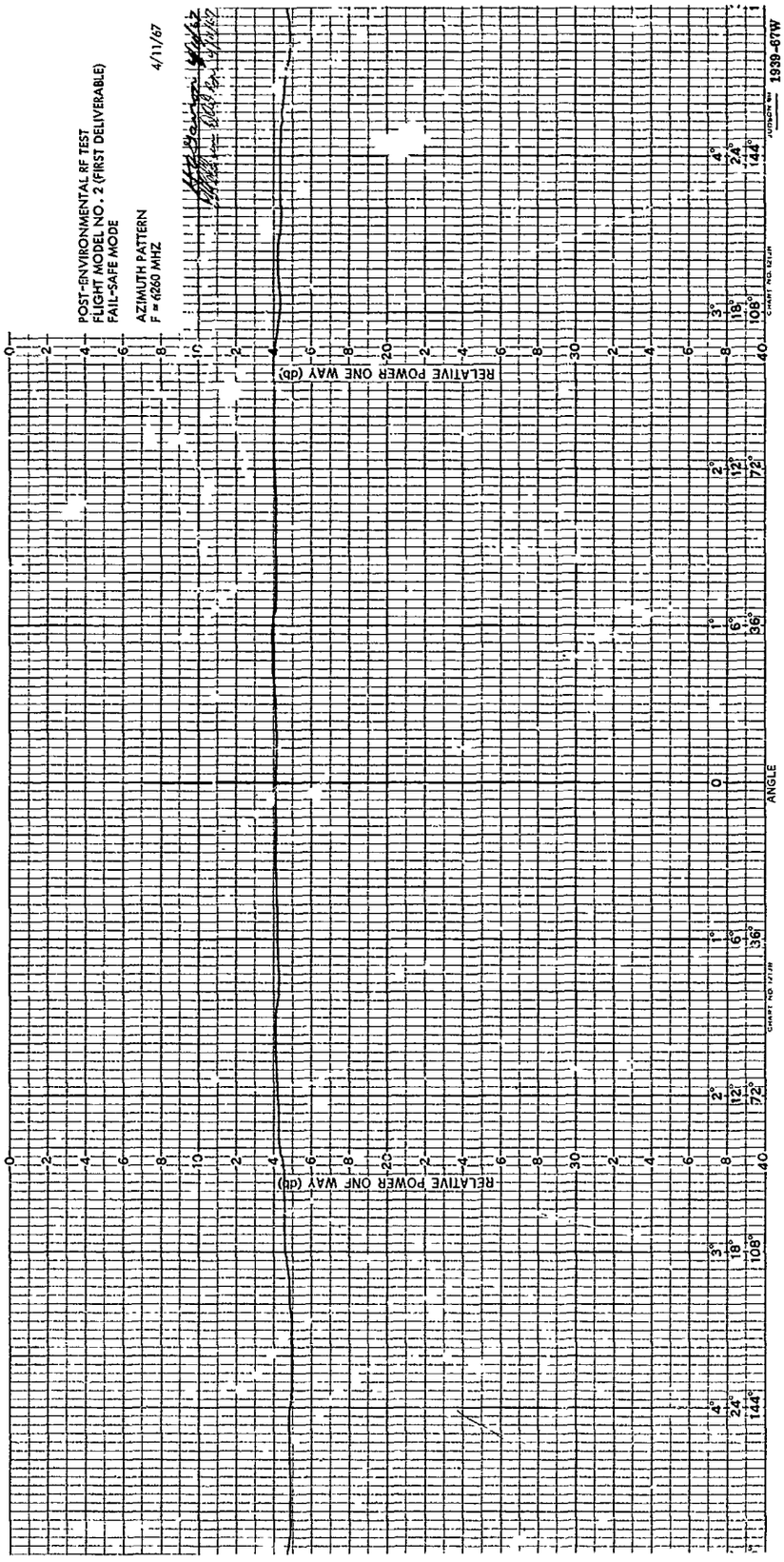

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 5.6°
4/11/67
RELATIVE POWER ONE WAY (db)
ANGLE
4° 24° 144°
3° 18° 108°
2° 12° 72°
1° 6° 36°
0
1934-67W

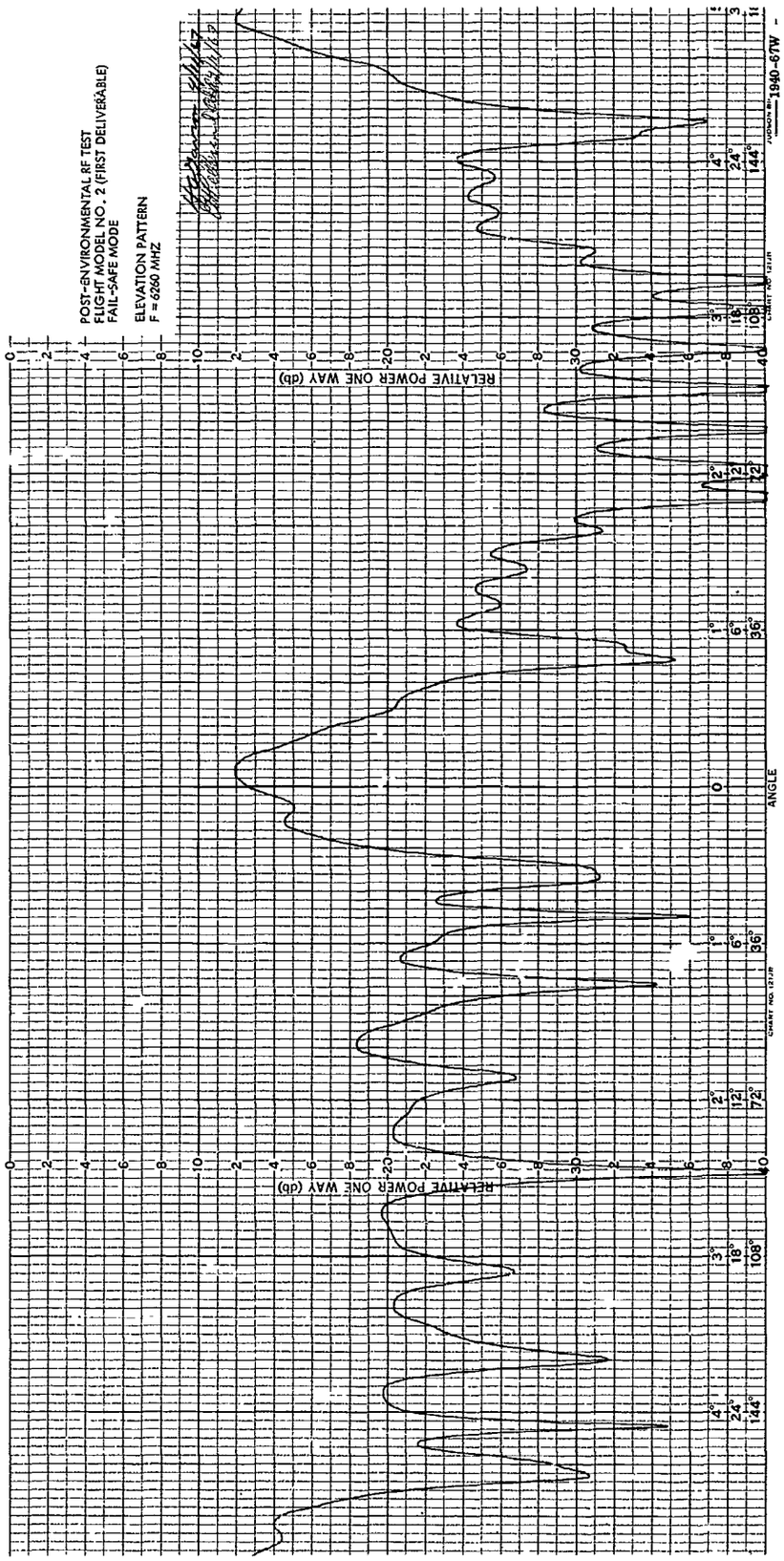

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 8.4°
4/11/67
RELATIVE POWER ONE WAY (db)
ANGLE
1935-6TW

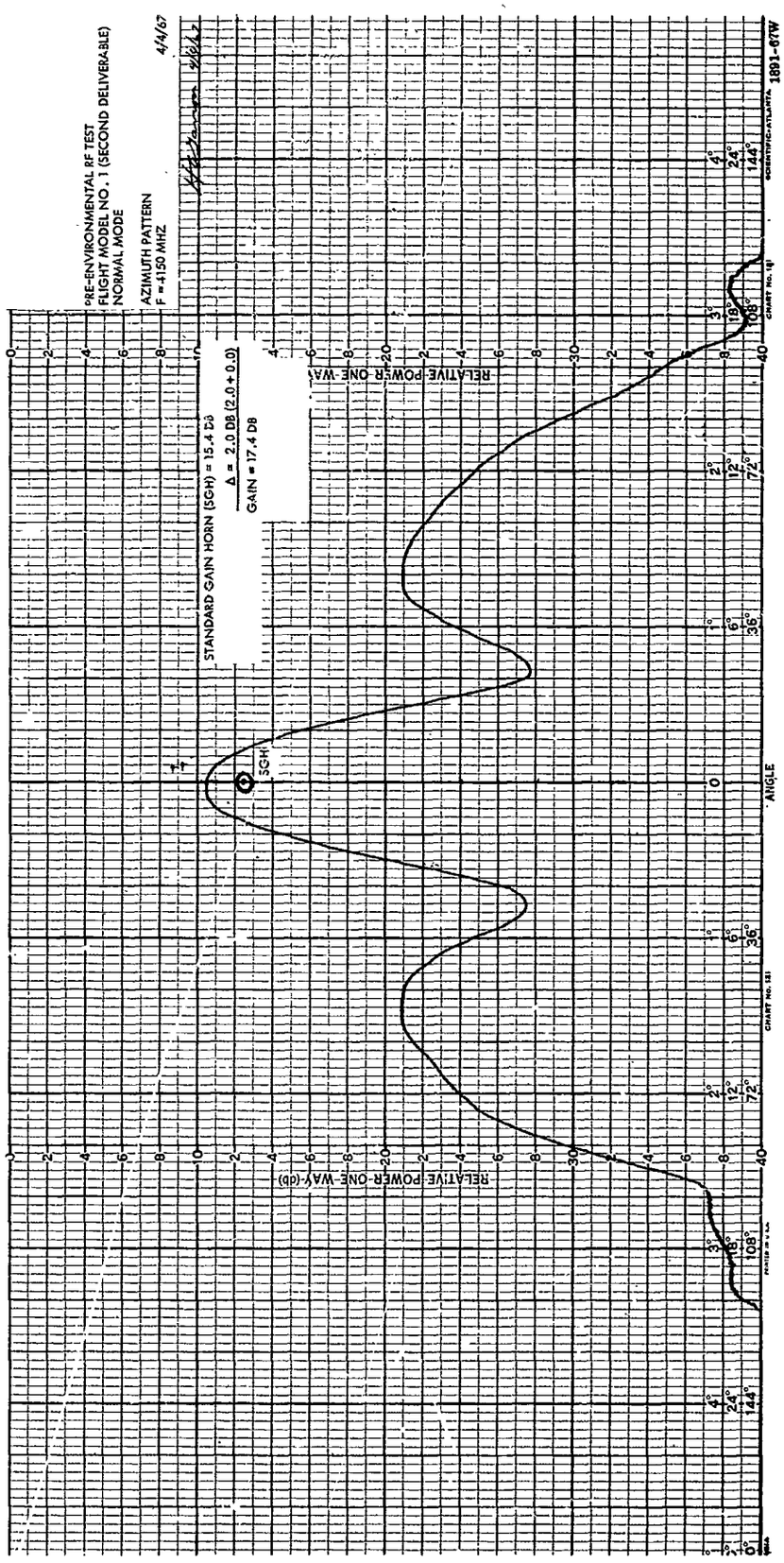

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6780 MHZ
CUT ANGLE = 14°
4/11/67
RELATIVE POWER ONE WAY (db)
RELATIVE POWER ONE WAY (db)
ANGLE
1936-67W

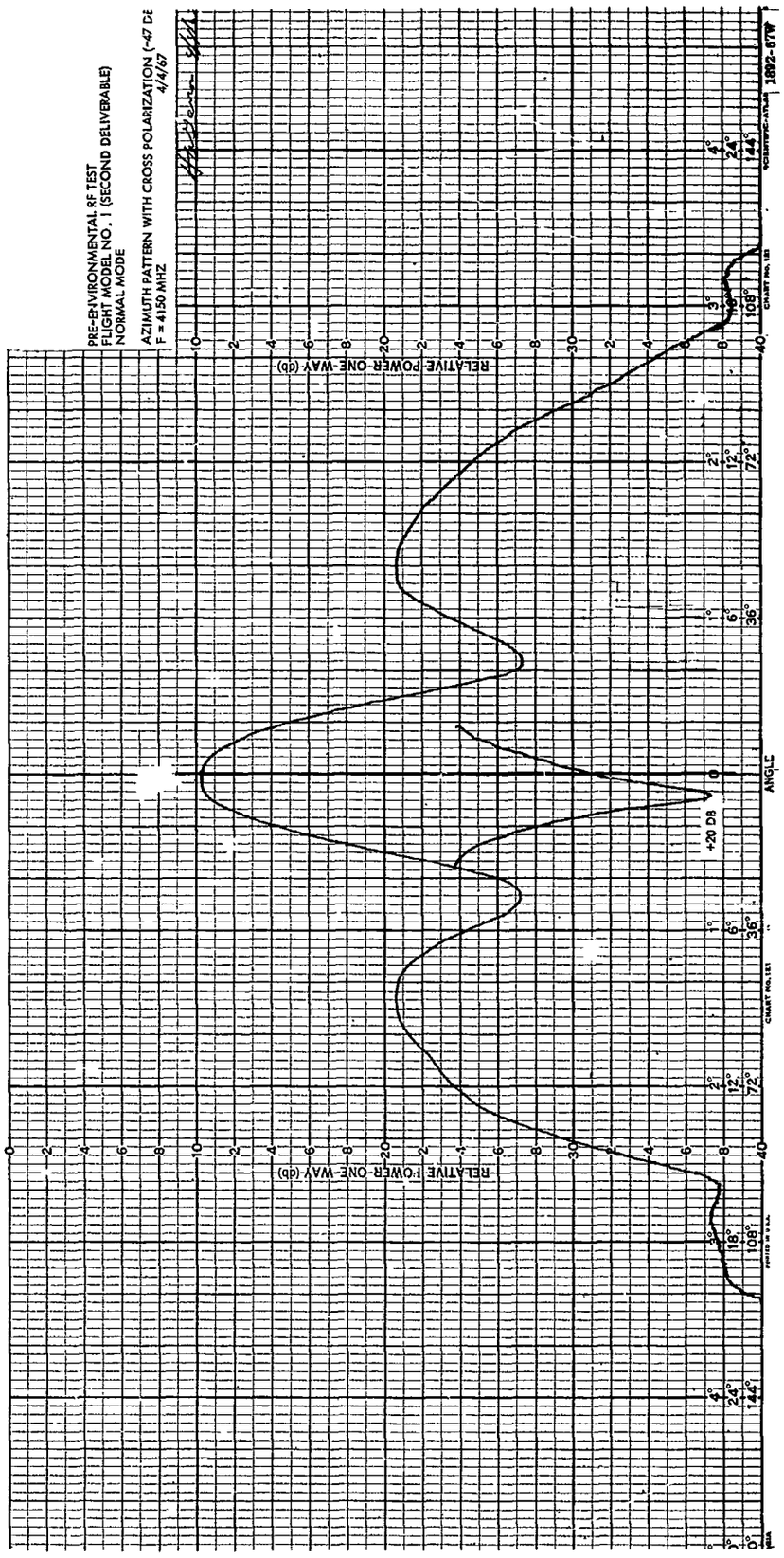

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 4150 MHZ
4/11/67
RELATIVE POWER ONE WAY (db)
ANGLE
1937-67W

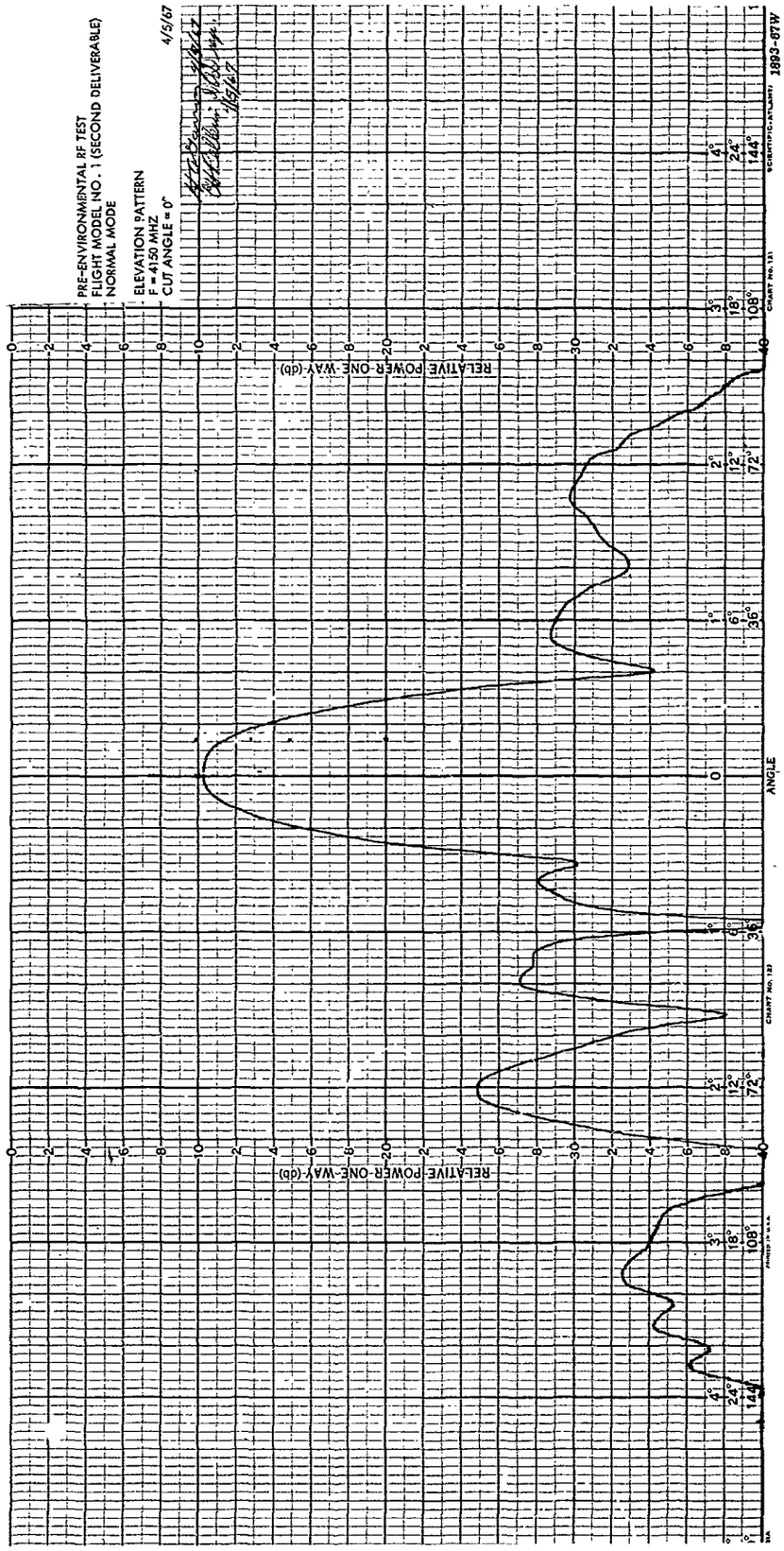

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
FAIL-SAFE MODE
ELEVATION PATTERN
F = 4150 MHZ
4/11/67
RELATIVE POWER ONE WAY (db)
RELATIVE POWER ONE WAY (db)
ANGLE
1938-67W

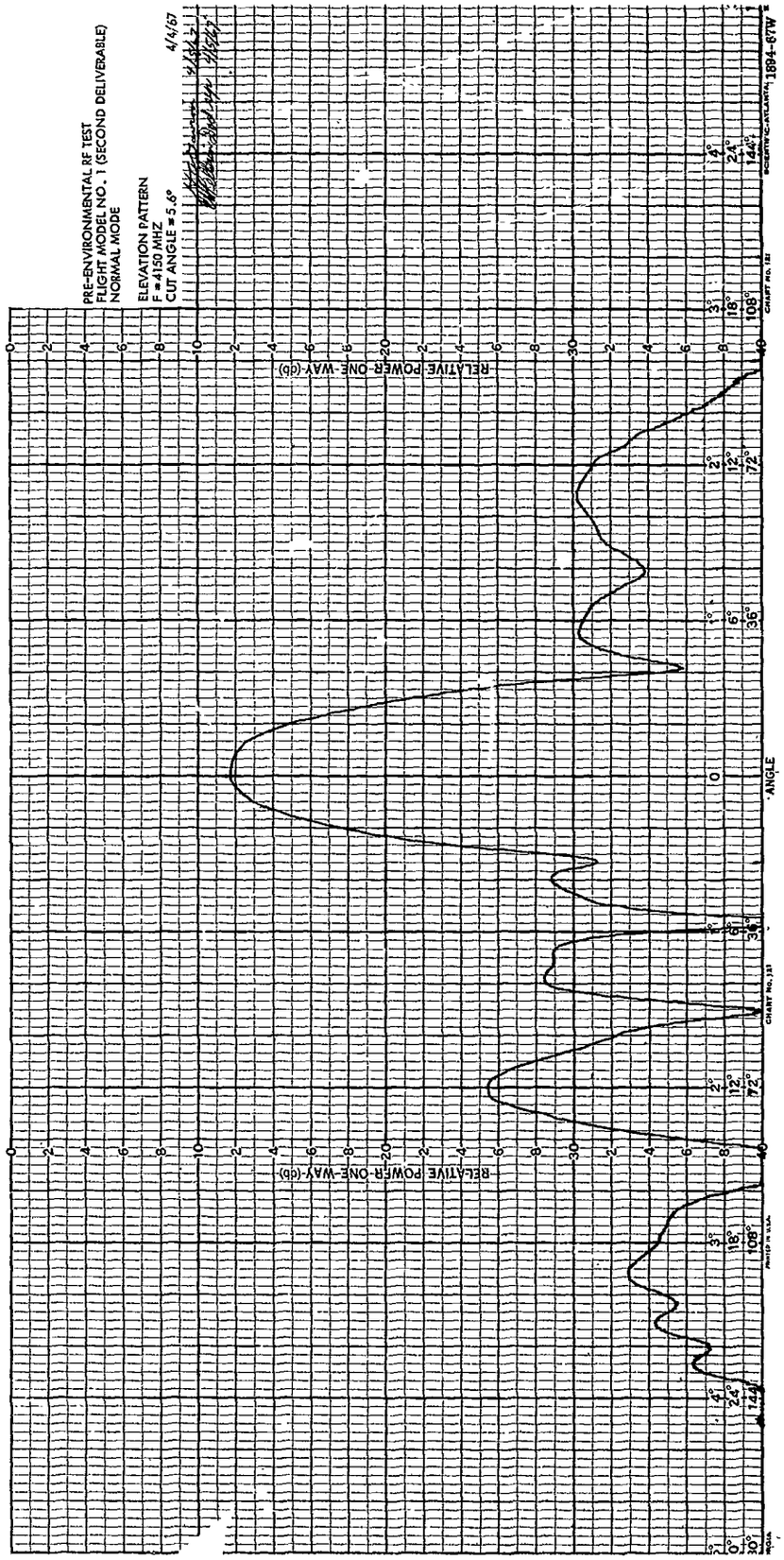

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 6260 MHZ
4/11/67
RELATIVE POWER ONE WAY (db)
ANGLE
1939-67W

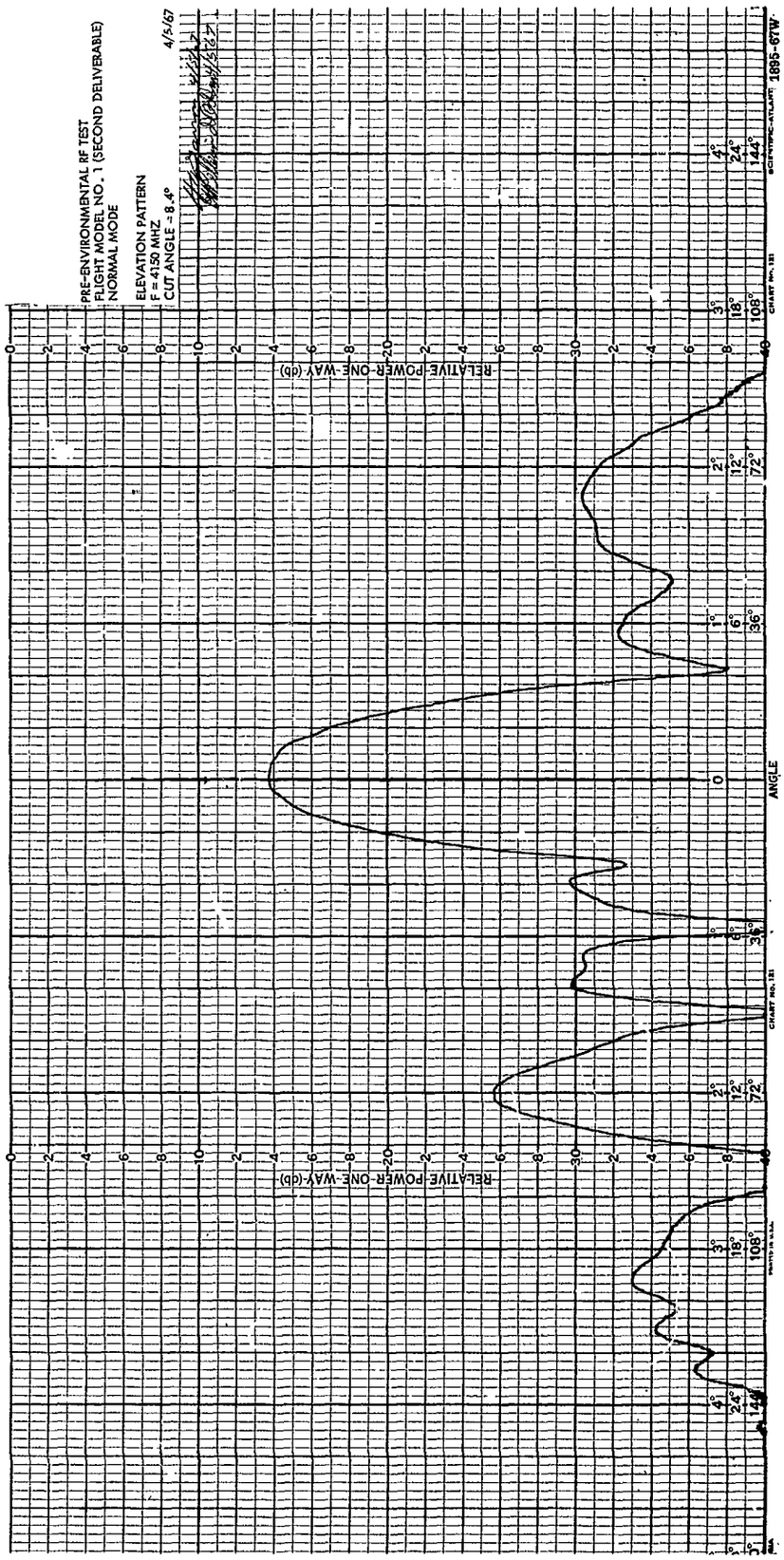

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 2 (FIRST DELIVERABLE)
FAIL-SAFE MODE
ELEVATION PATTERN
F = 6260 MHZ
RELATIVE POWER ONE WAY (db)
ANGLE
1940-67W

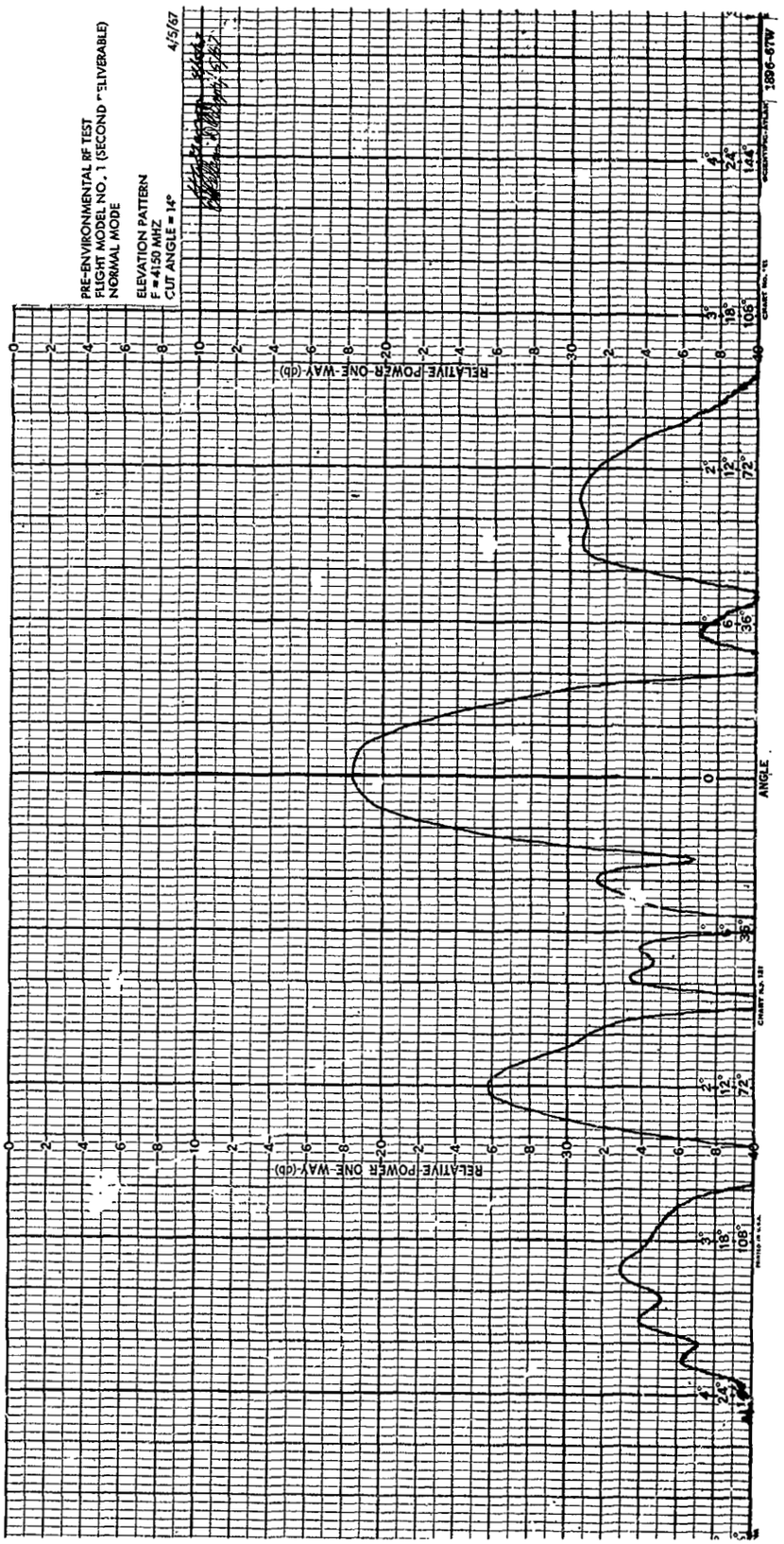

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN
F = 4150 MHZ
4/4/67
STANDARD GAIN HORN (SGH) = 15.4 DB
Δ = 2.0 DB (2.0 + 0.0)
GAIN = 17.4 DB
SGH
RELATIVE POWER ONE WAY (db)
ANGLE
1891-67W

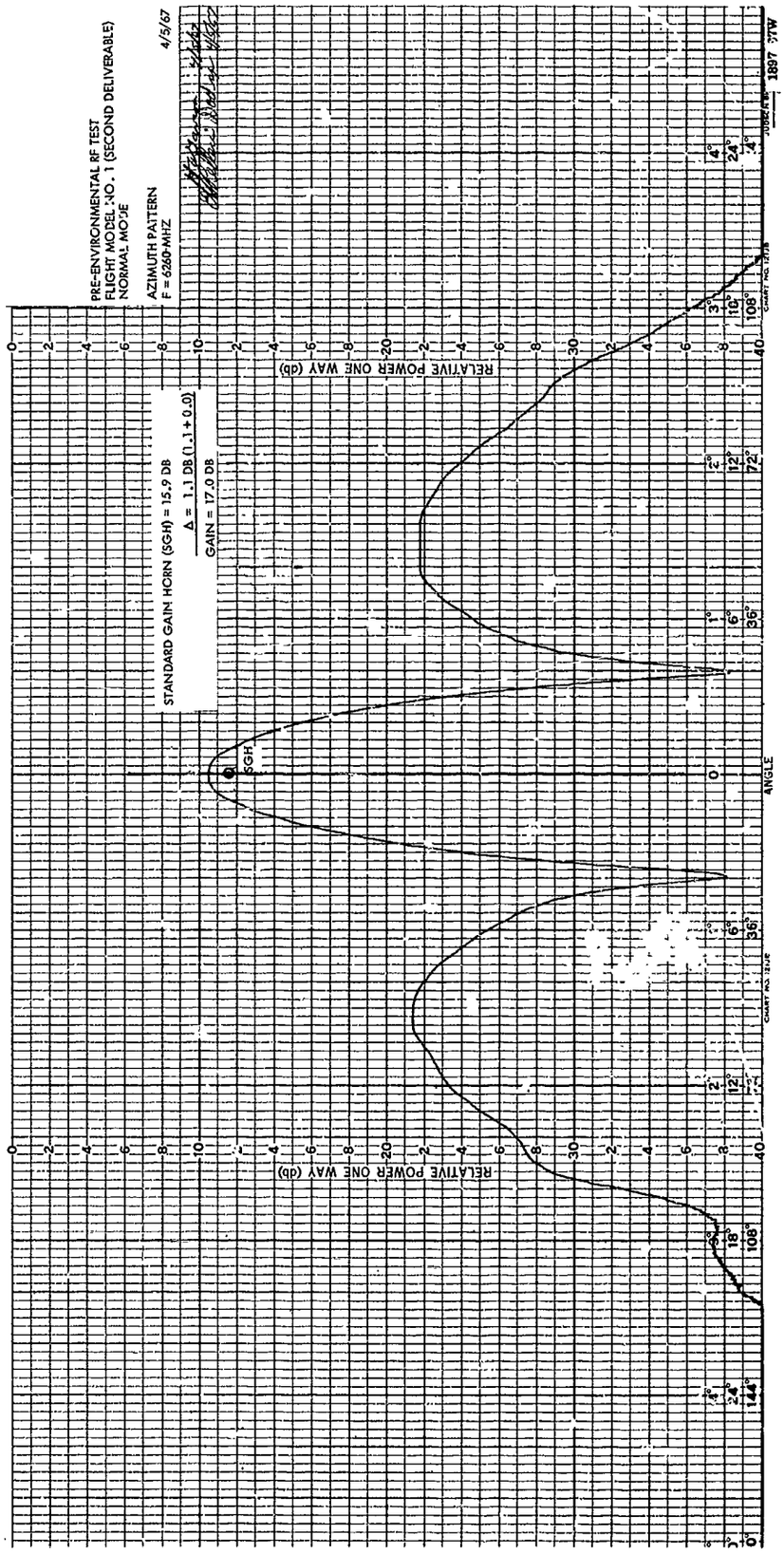

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION (-47 DB
F = 4150 MHZ
4/4/67
RELATIVE POWER ONE-WAY (db)
ANGLE
+20 DB
1892-67W

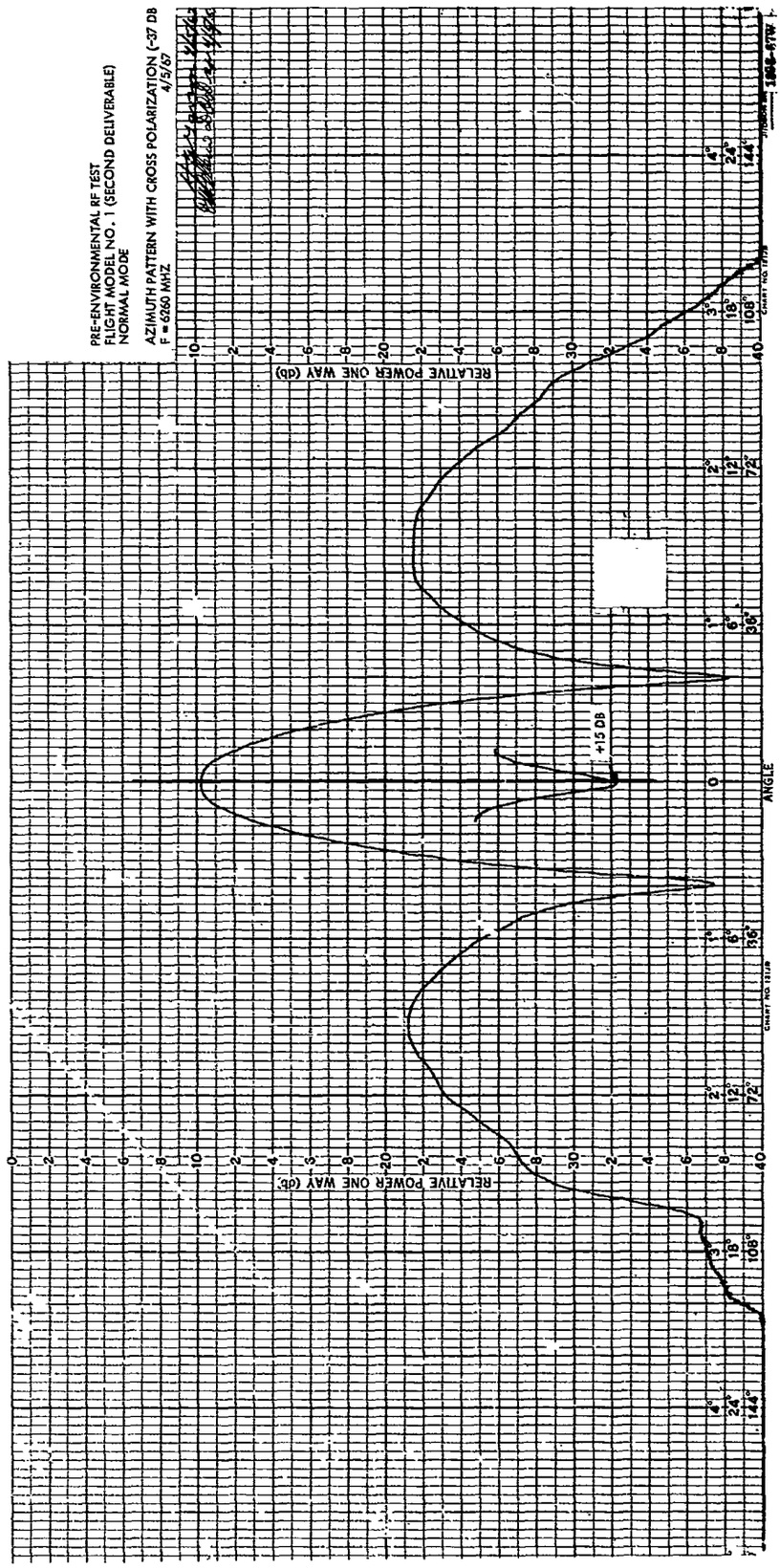

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 0°
4/5/67
RELATIVE POWER-ONE-WAY (db)
ANGLE

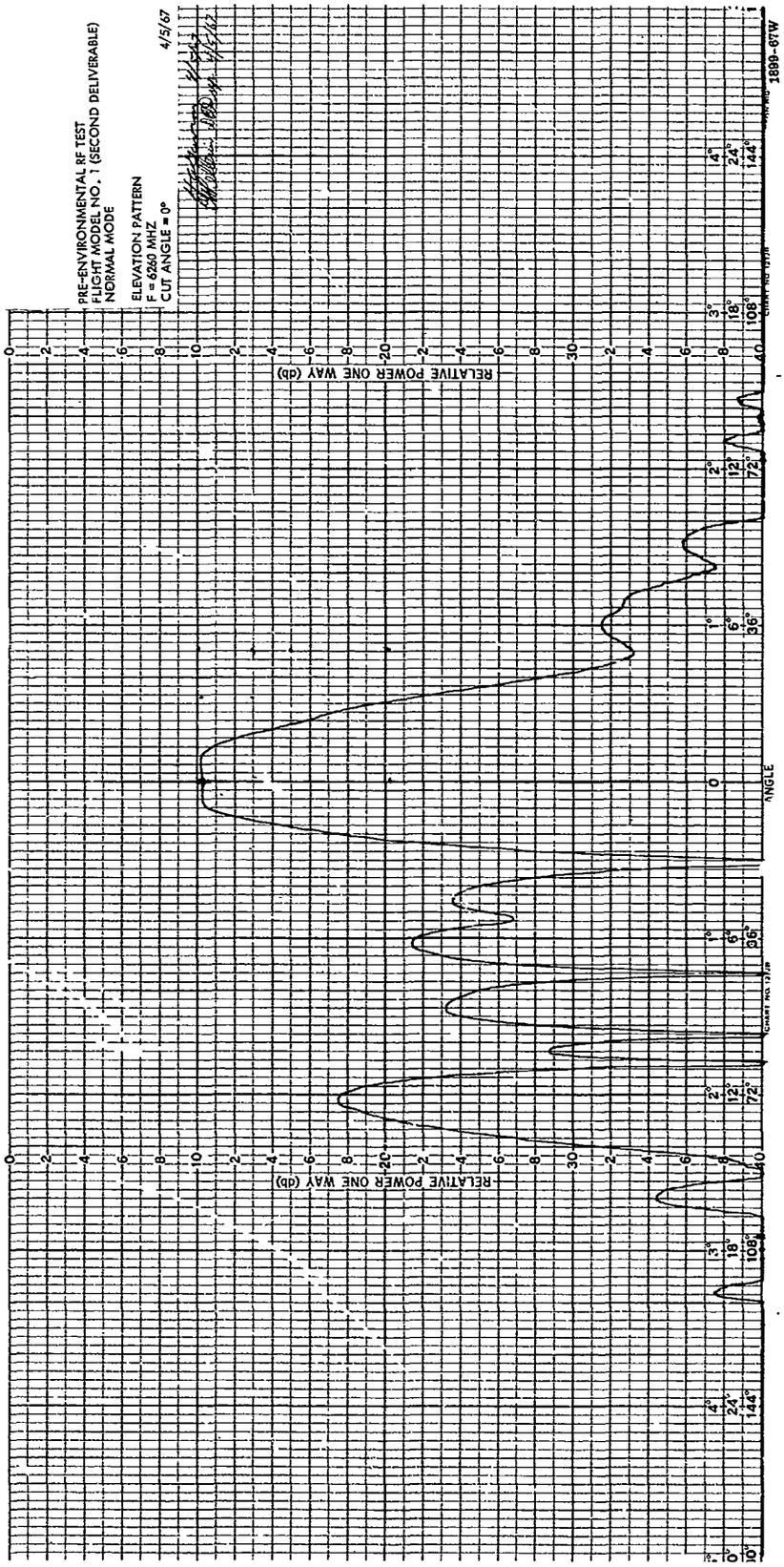

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 5.6°
4/4/67
RELATIVE POWER ONE-WAY (db)
RELATIVE POWER ONE-WAY (db)
ANGLE
CHART NO. 181
CHART NO. 181
PRINTED IN U.S.A.
SCIENTIFIC-ATLANTA 1894-67W

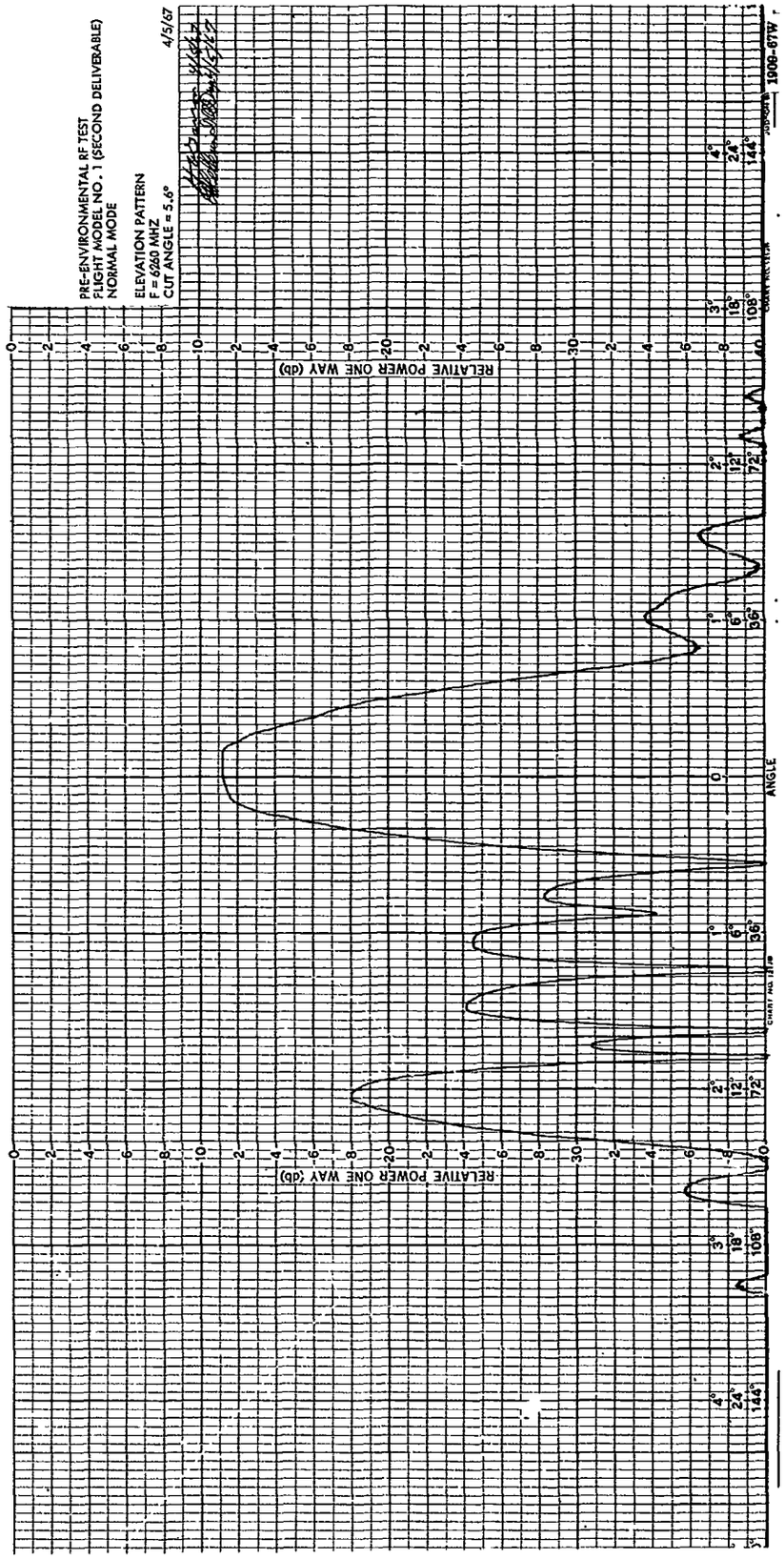

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 8.4°
4/5/67
RELATIVE POWER-ONE-WAY (db)
ANGLE
CHART NO. 121
SCIENTIFIC-ATLANTA 1895-67W

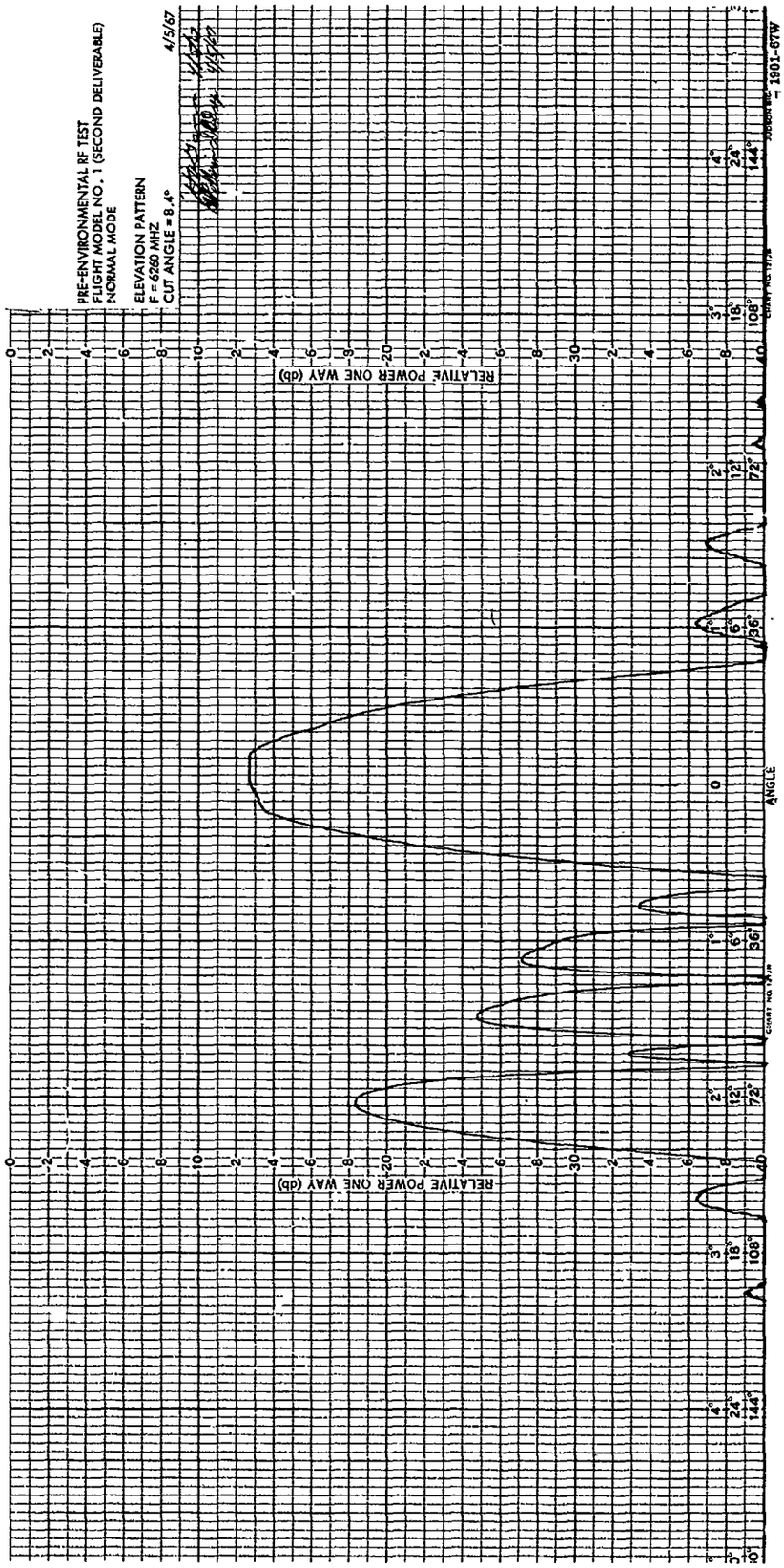

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 14°
4/5/67
RELATIVE POWER ONE-WAY (db)
ANGLE

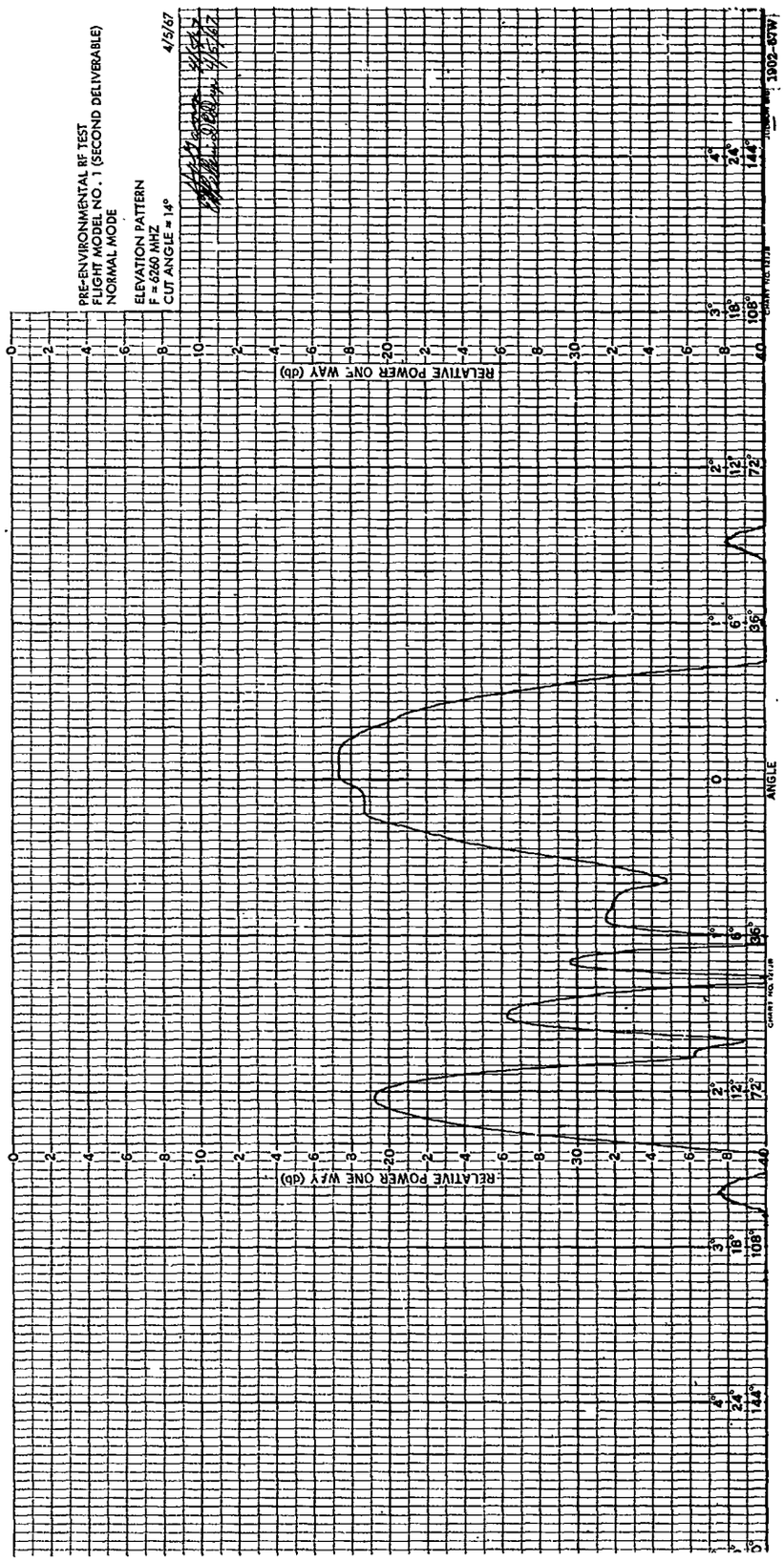

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN
F = 6260 MHZ
4/5/67
STANDARD GAIN HORN (SGH) = 15.9 DB
Δ = 1.1 DB (1.1 + 0.0)
GAIN = 17.0 DB
SGH
RELATIVE POWER ONE WAY (db)
ANGLE

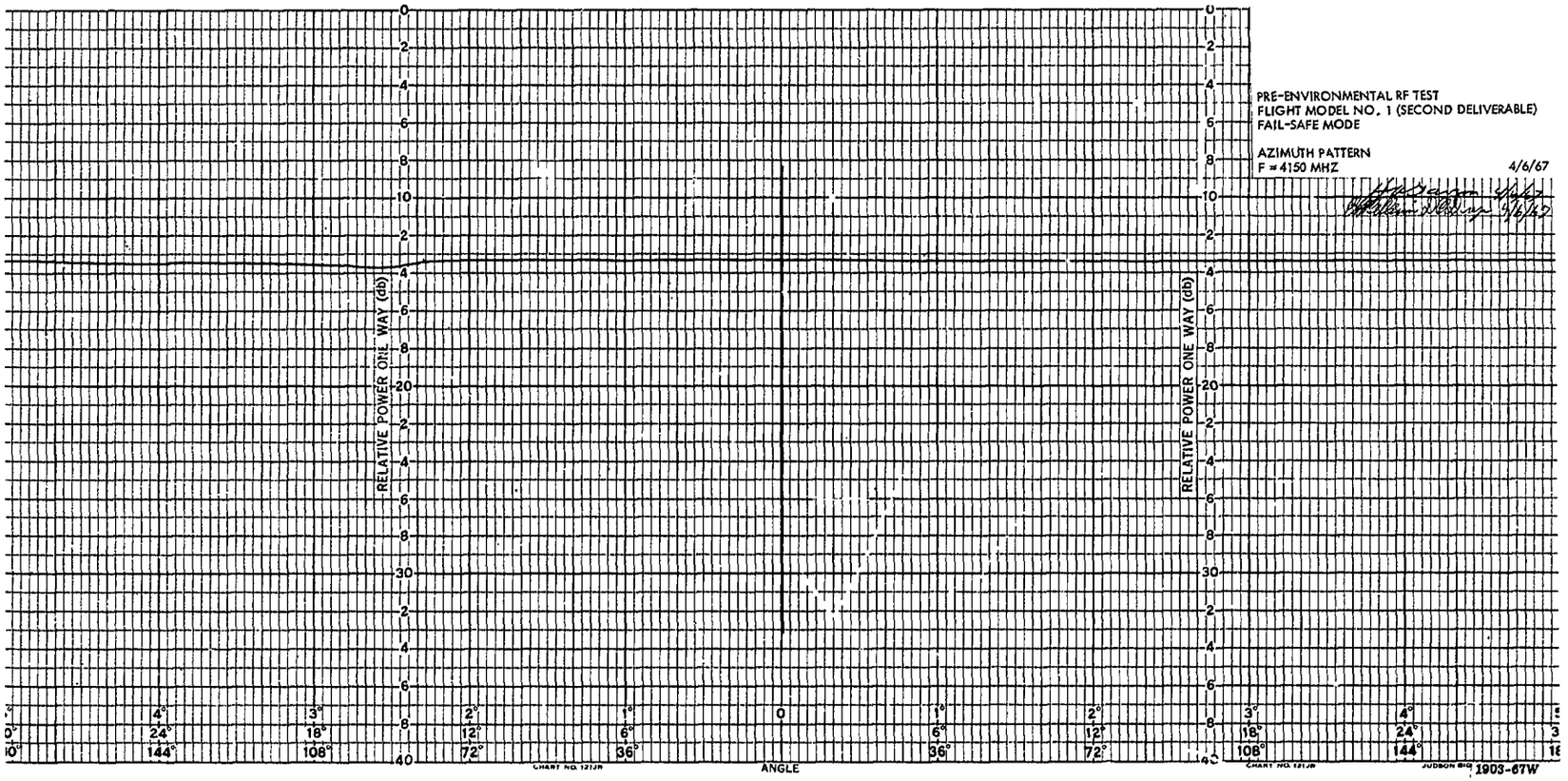

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION (-37 DB
F = 6260 MHZ
4/5/67
RELATIVE POWER ONE WAY (db)
RELATIVE POWER ONE WAY (db)
+15 DB
ANGLE

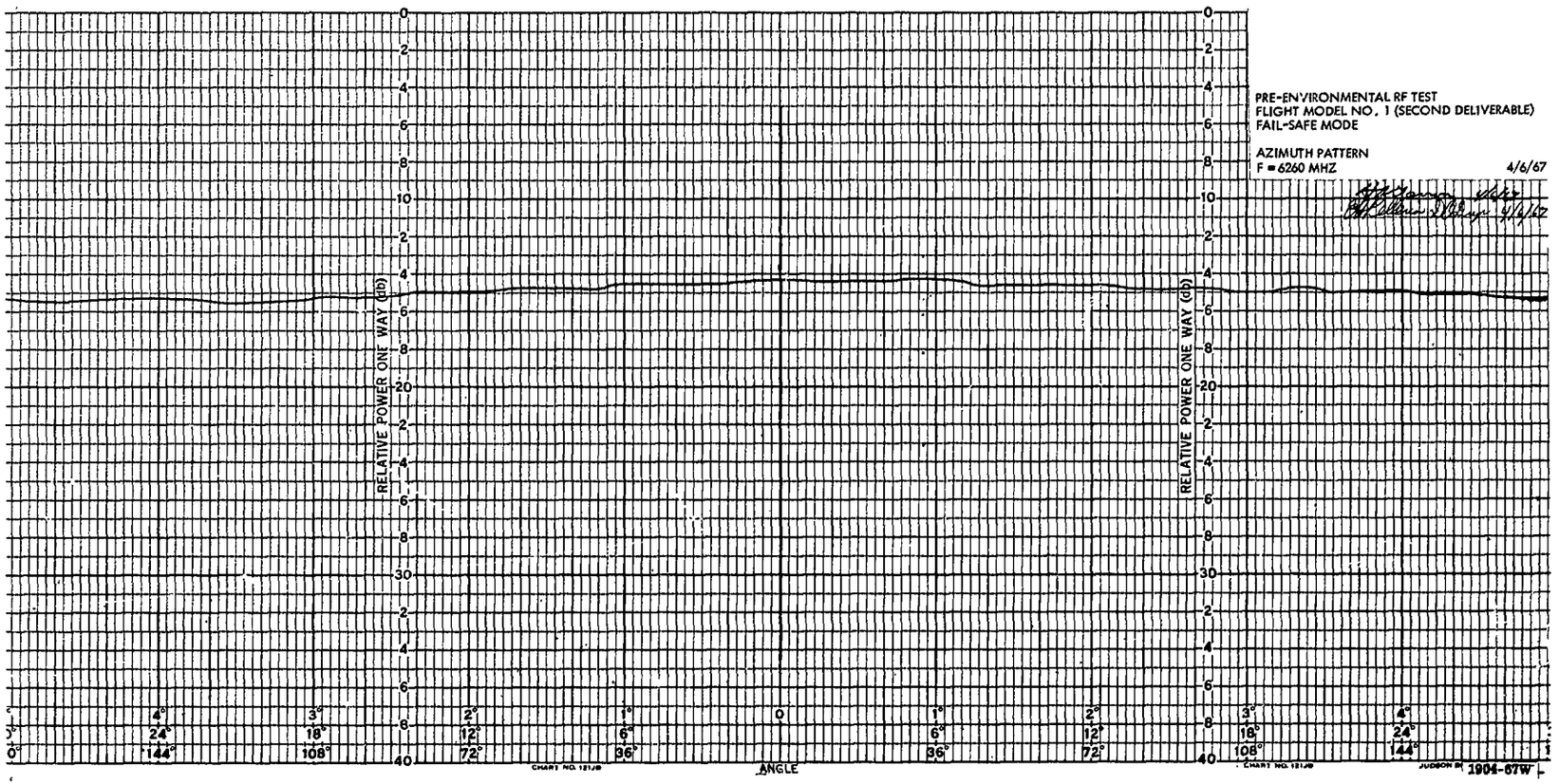

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 0°
4/5/67
RELATIVE POWER ONE WAY (db)
RELATIVE POWER ONE WAY (db)
ANGLE
1899-67W

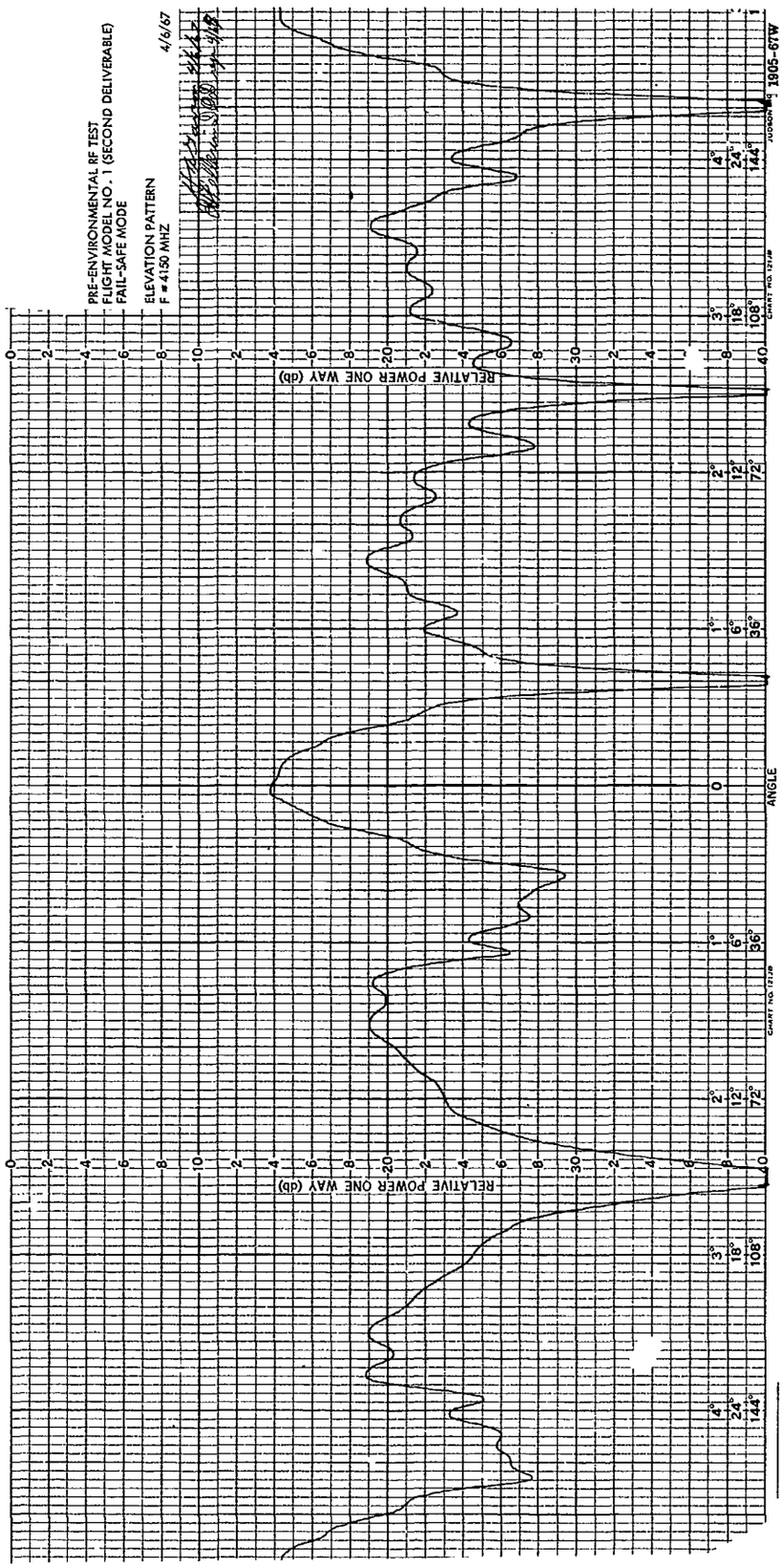

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 5.6°
4/5/67
RELATIVE POWER ONE WAY (db)
ANGLE
1906-67W

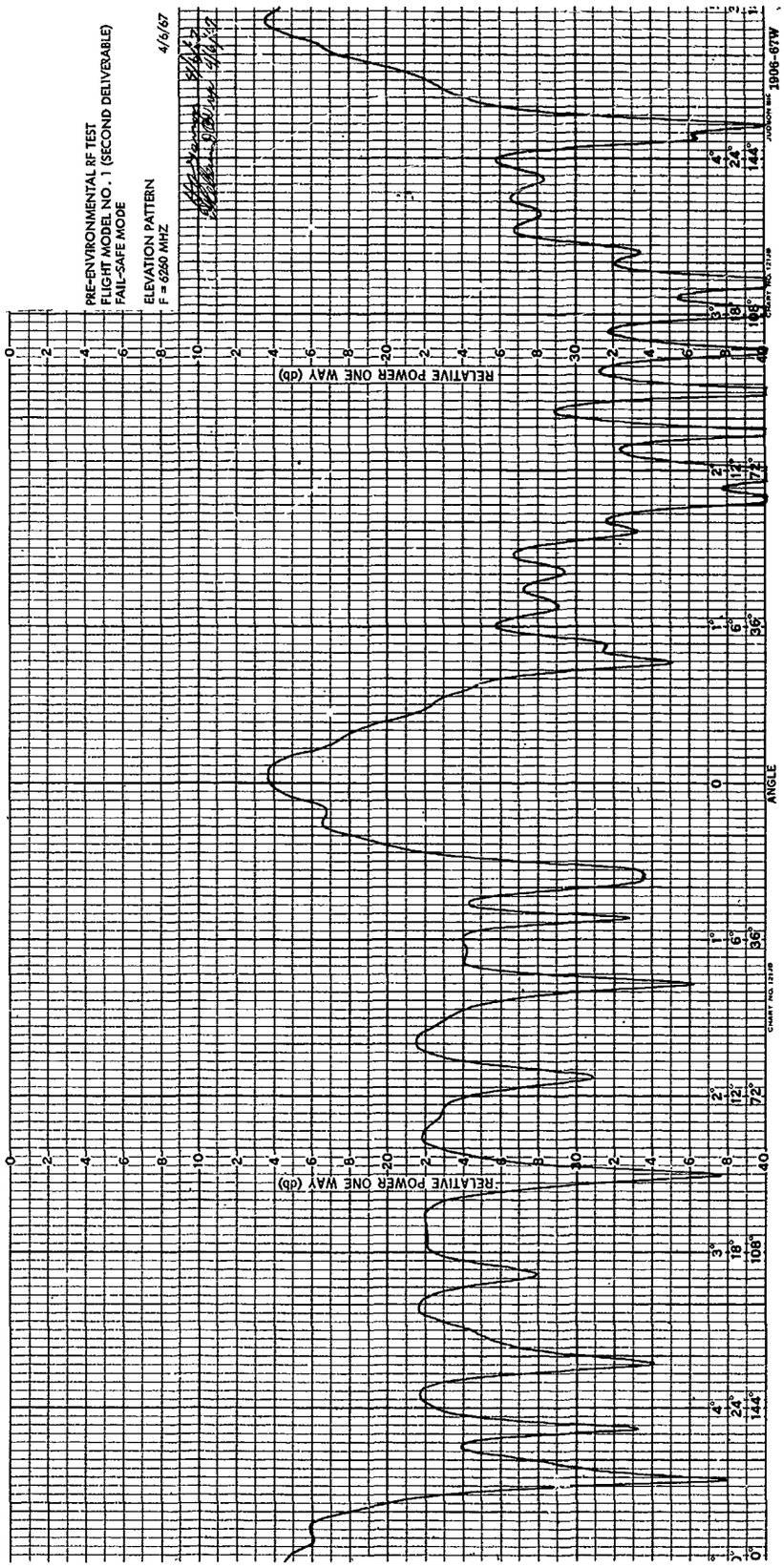

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 8.4°
4/5/67
RELATIVE POWER ONE WAY (db)
ANGLE
1901-67W

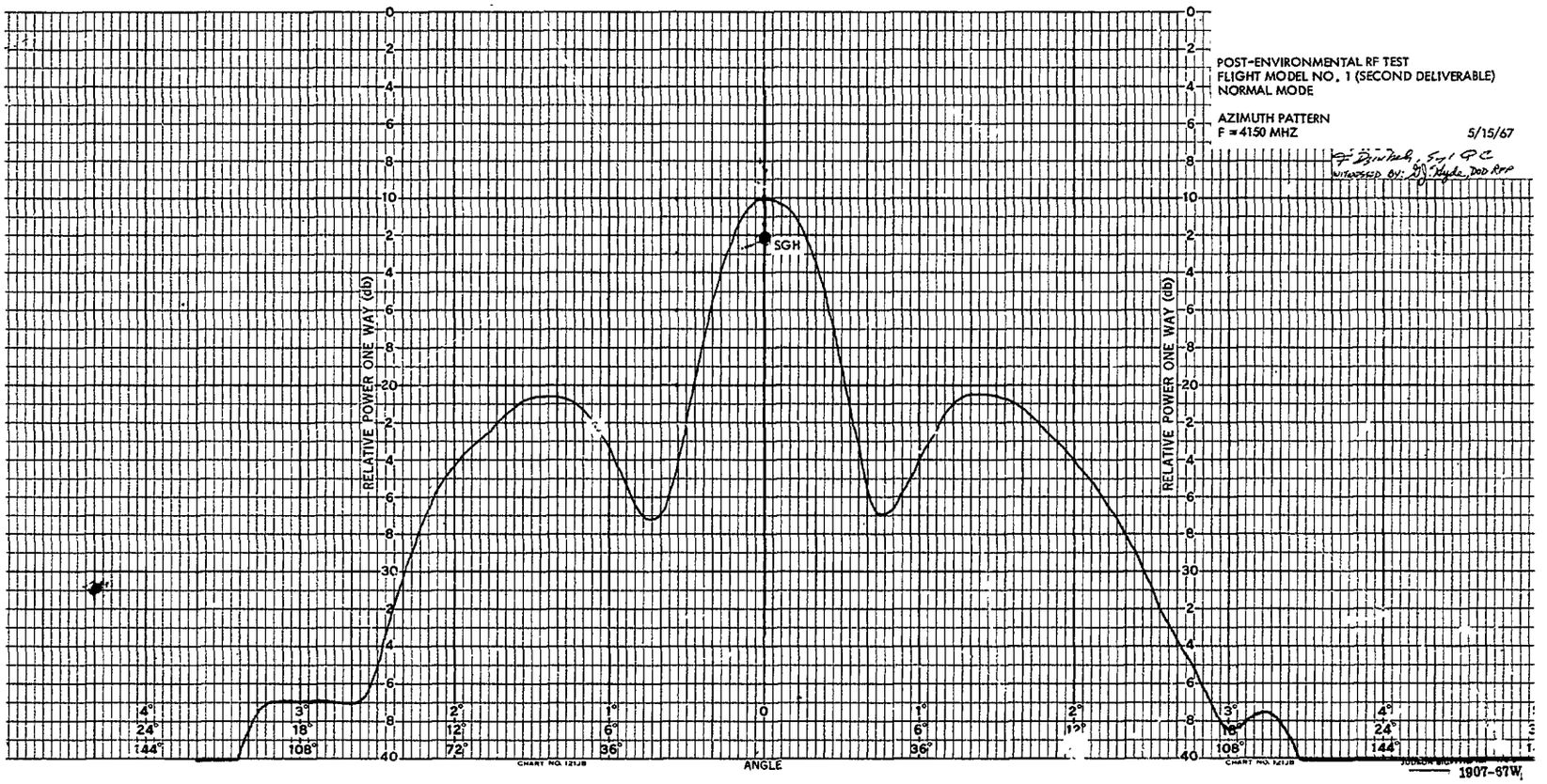

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 14°
4/5/67
RELATIVE POWER ONE WAY (db)
ANGLE
RELATIVE POWER ONE WAY (db)

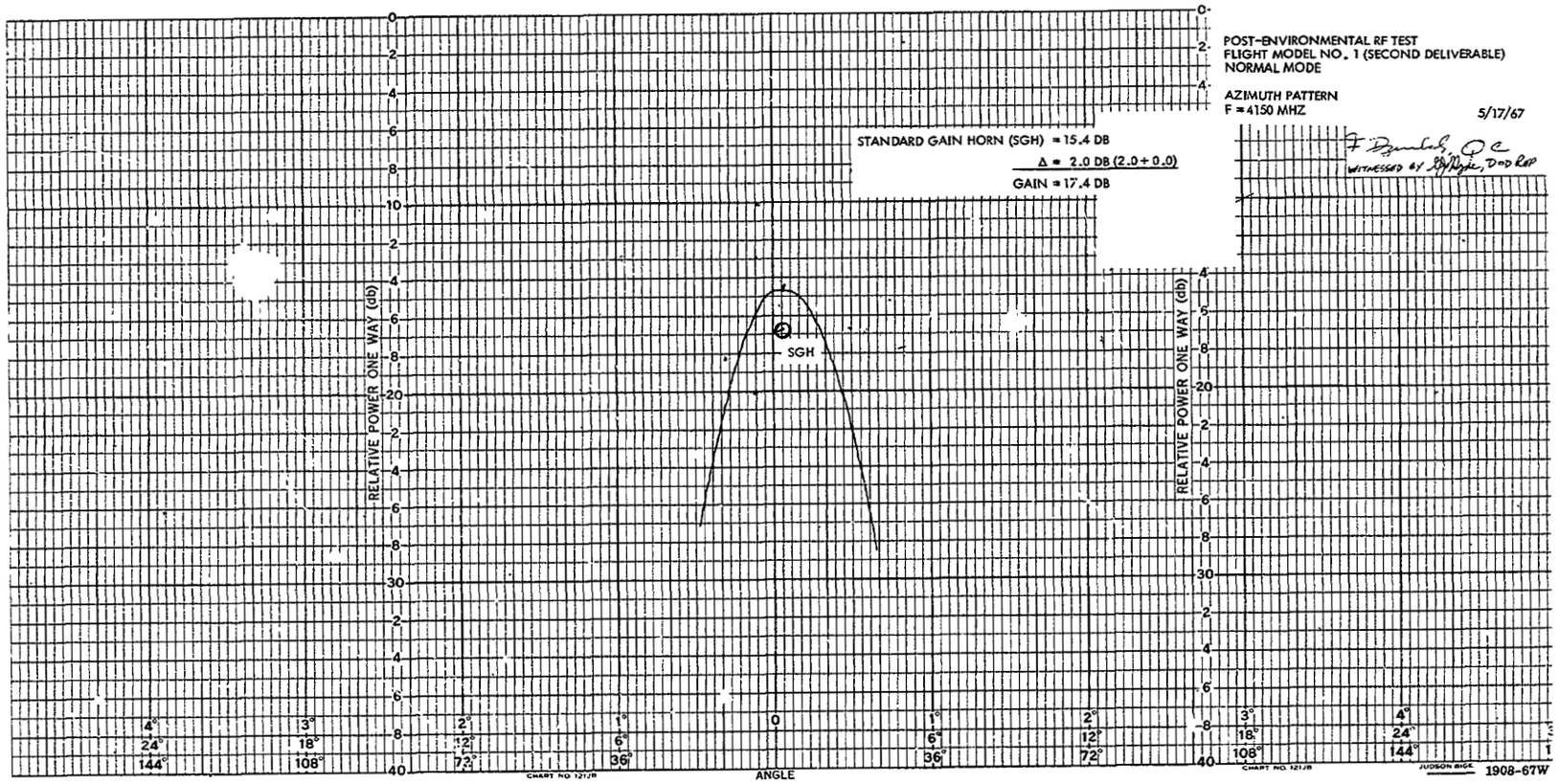

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 4150 MHZ
4/6/67
RELATIVE POWER ONE WAY (db)
ANGLE
1903-67W

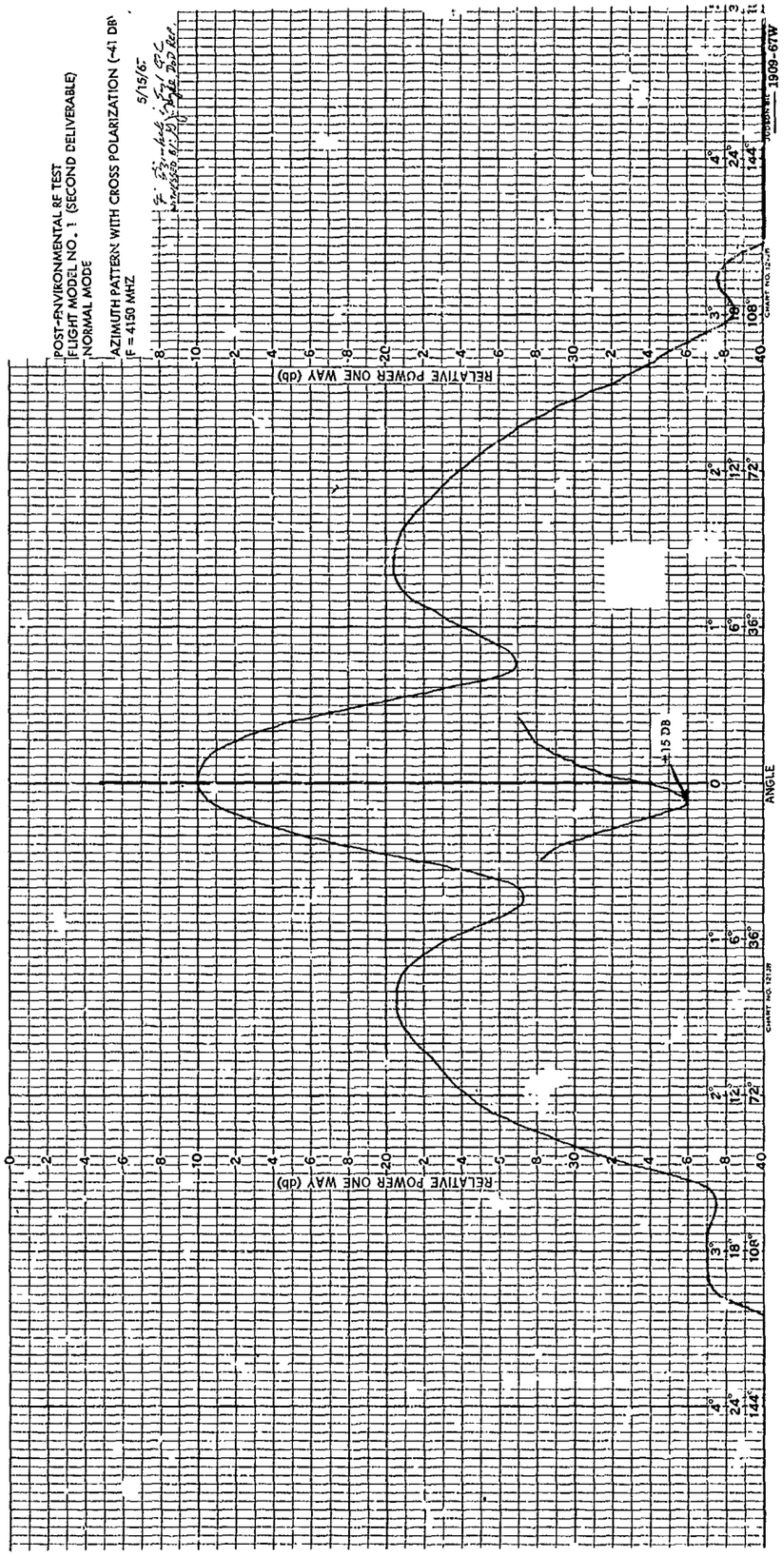

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 6260 MHZ
4/6/67
RELATIVE POWER ONE WAY (db)
ANGLE
CHART NO. 121J8
JUDSON R 1904-67W

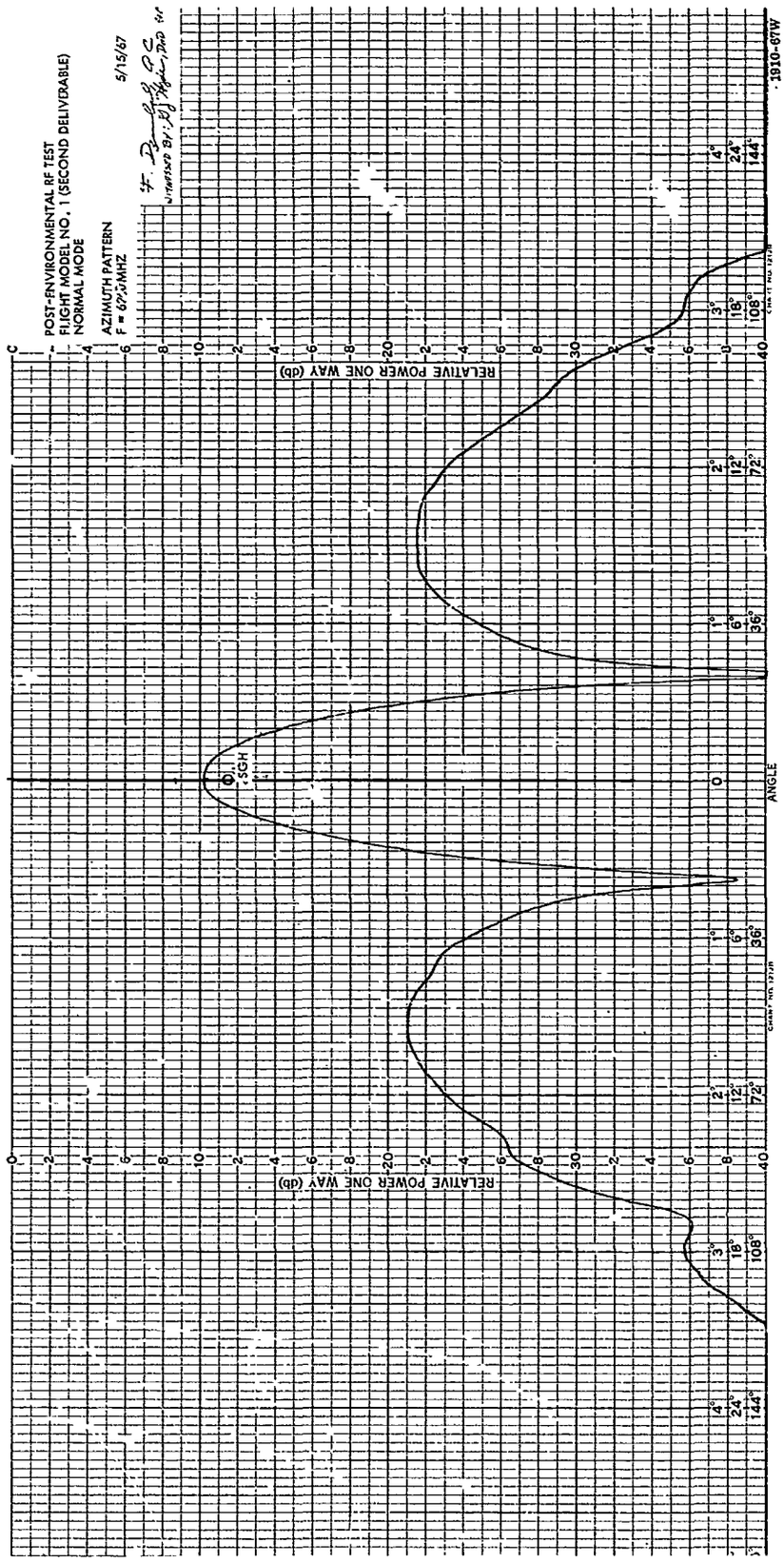

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
FAIL-SAFE MODE
ELEVATION PATTERN
F = 4150 MHZ
4/6/67
RELATIVE POWER ONE WAY (db)
ANGLE
1905-67W

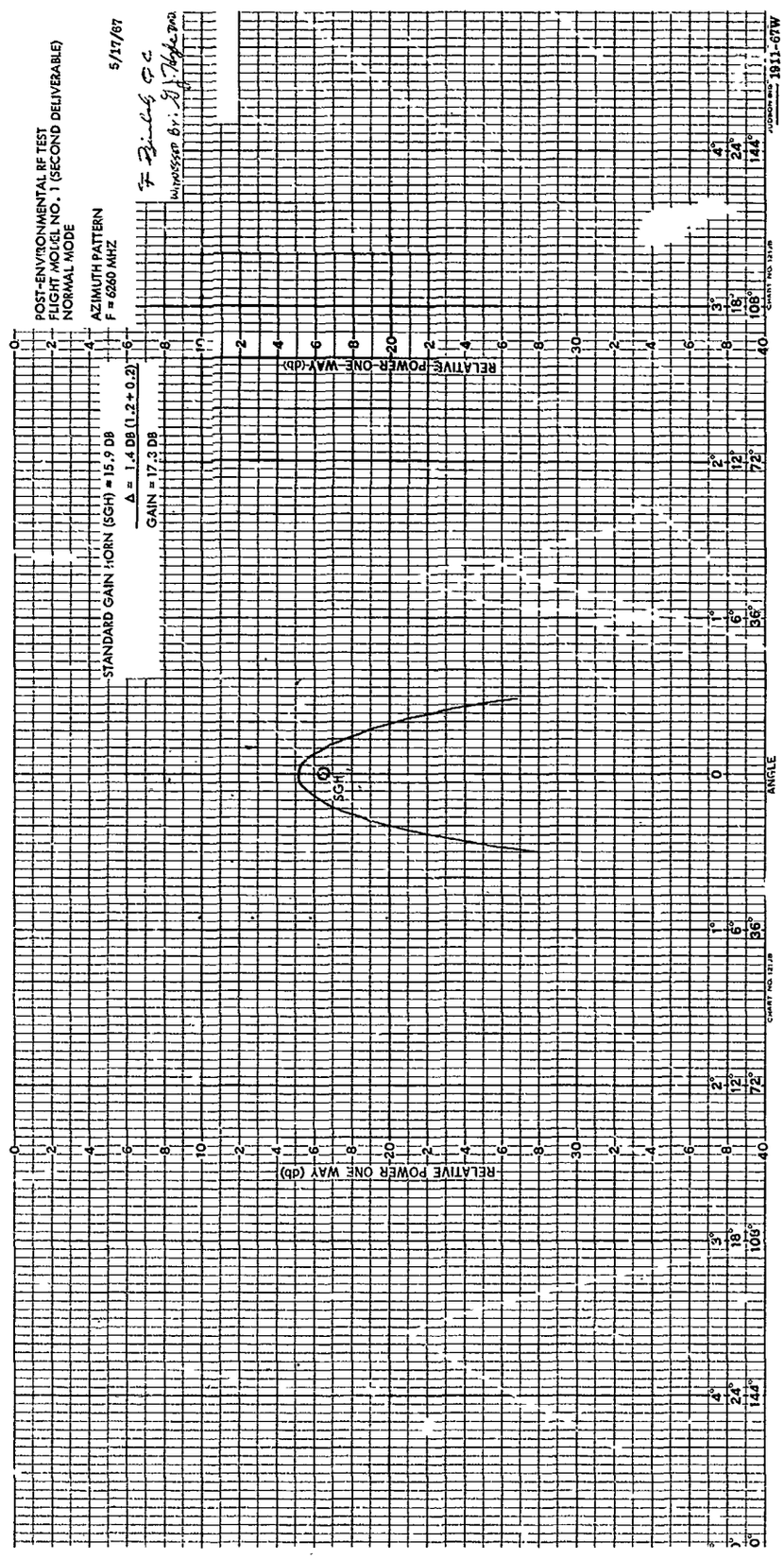

PRE-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
FAIL-SAFE MODE
ELEVATION PATTERN
F = 6260 MHZ
4/6/67
RELATIVE POWER ONE WAY (db)
ANGLE
1906-67W

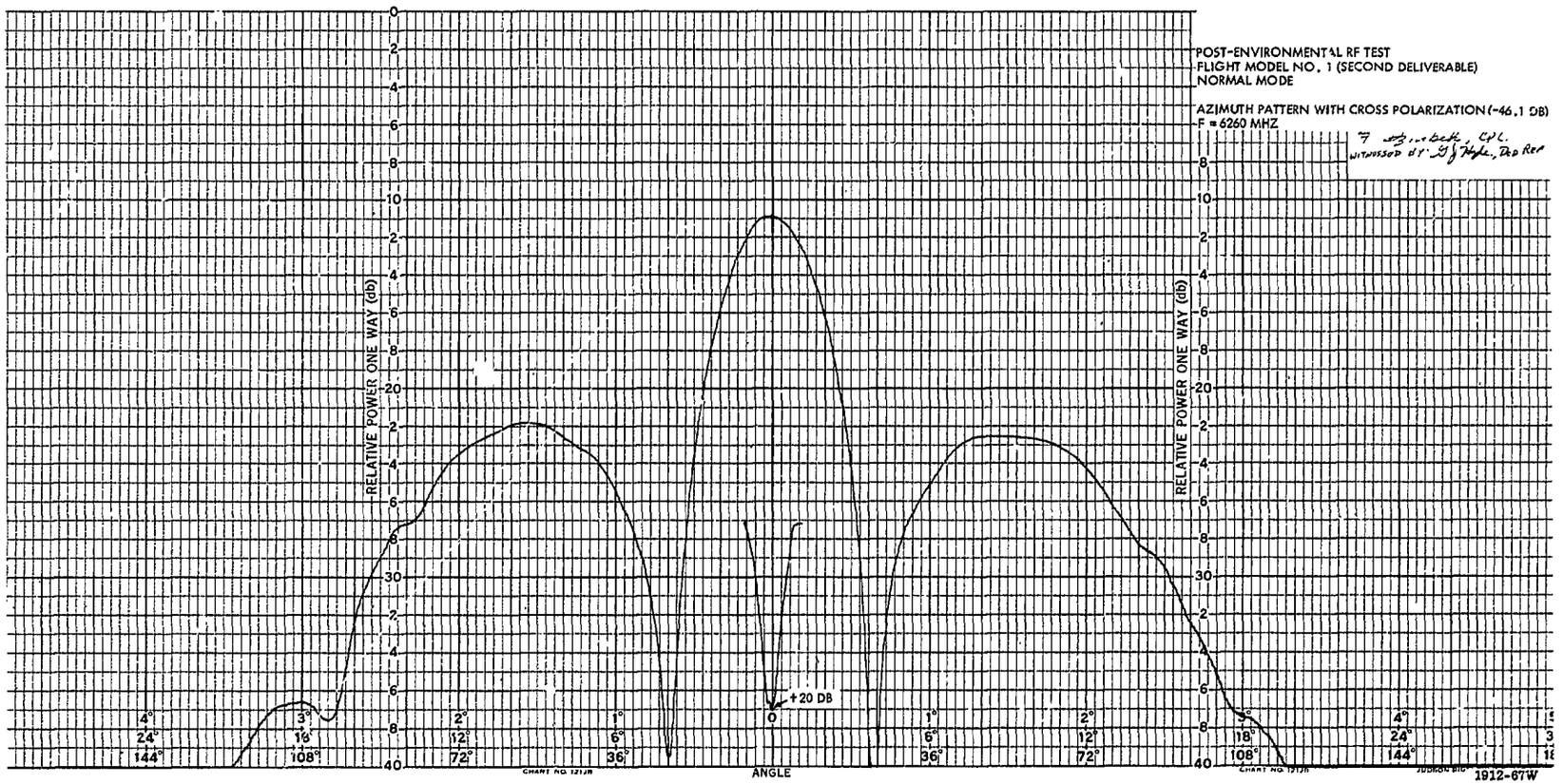

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN
F = 4150 MHZ
5/15/67
SGH
RELATIVE POWER ONE WAY (db)
ANGLE
0
1°
2°
3°
4°
6°
12°
18°
24°
36°
72°
108°
144°
CHART NO. 121JB
1907-67W

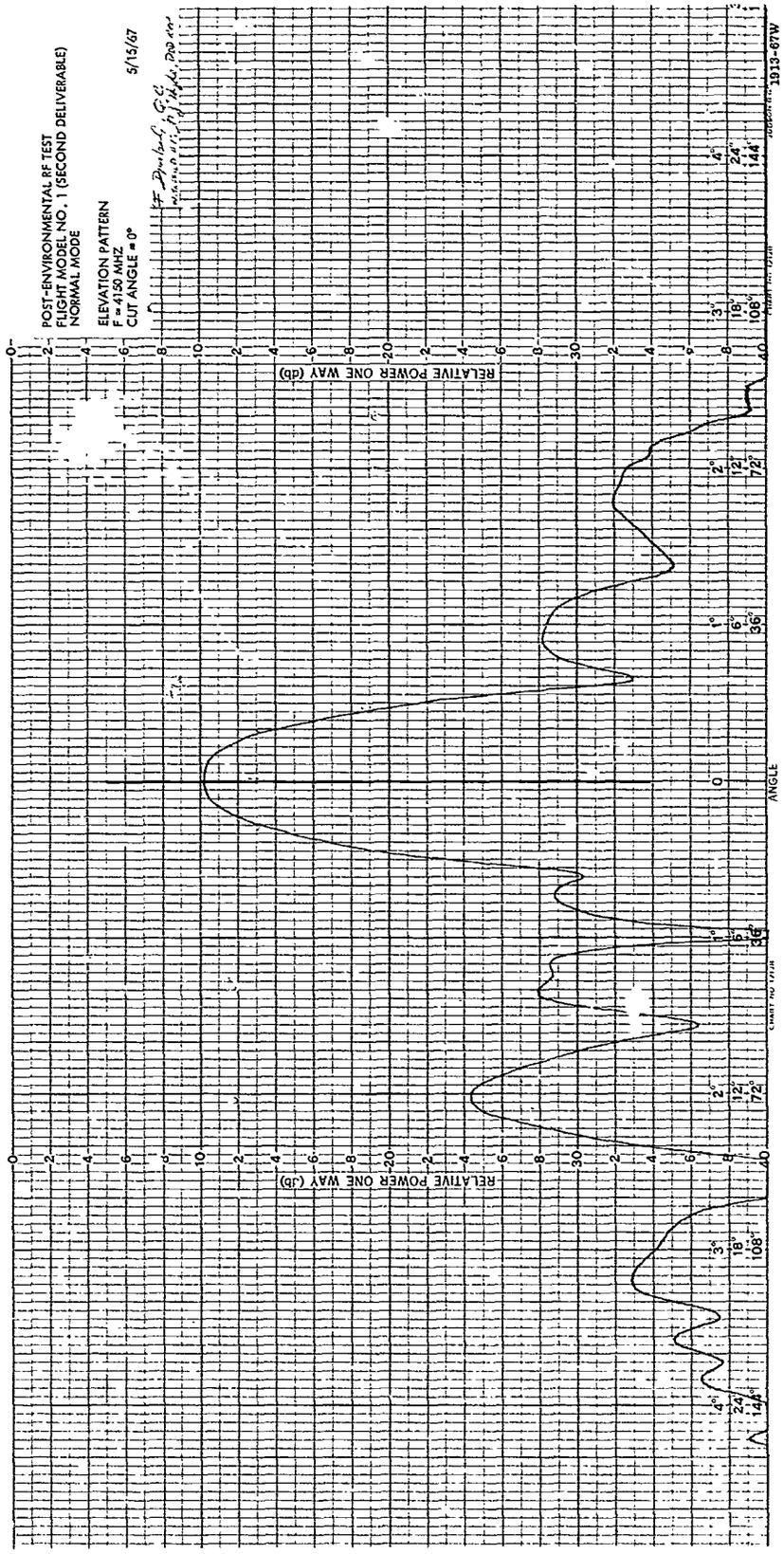

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN
F = 4150 MHZ
5/17/67
STANDARD GAIN HORN (SGH) = 15.4 DB
Δ = 2.0 DB (2.0 + 0.0)
GAIN = 17.4 DB
SGH
RELATIVE POWER ONE WAY (db)
ANGLE
1908-67W

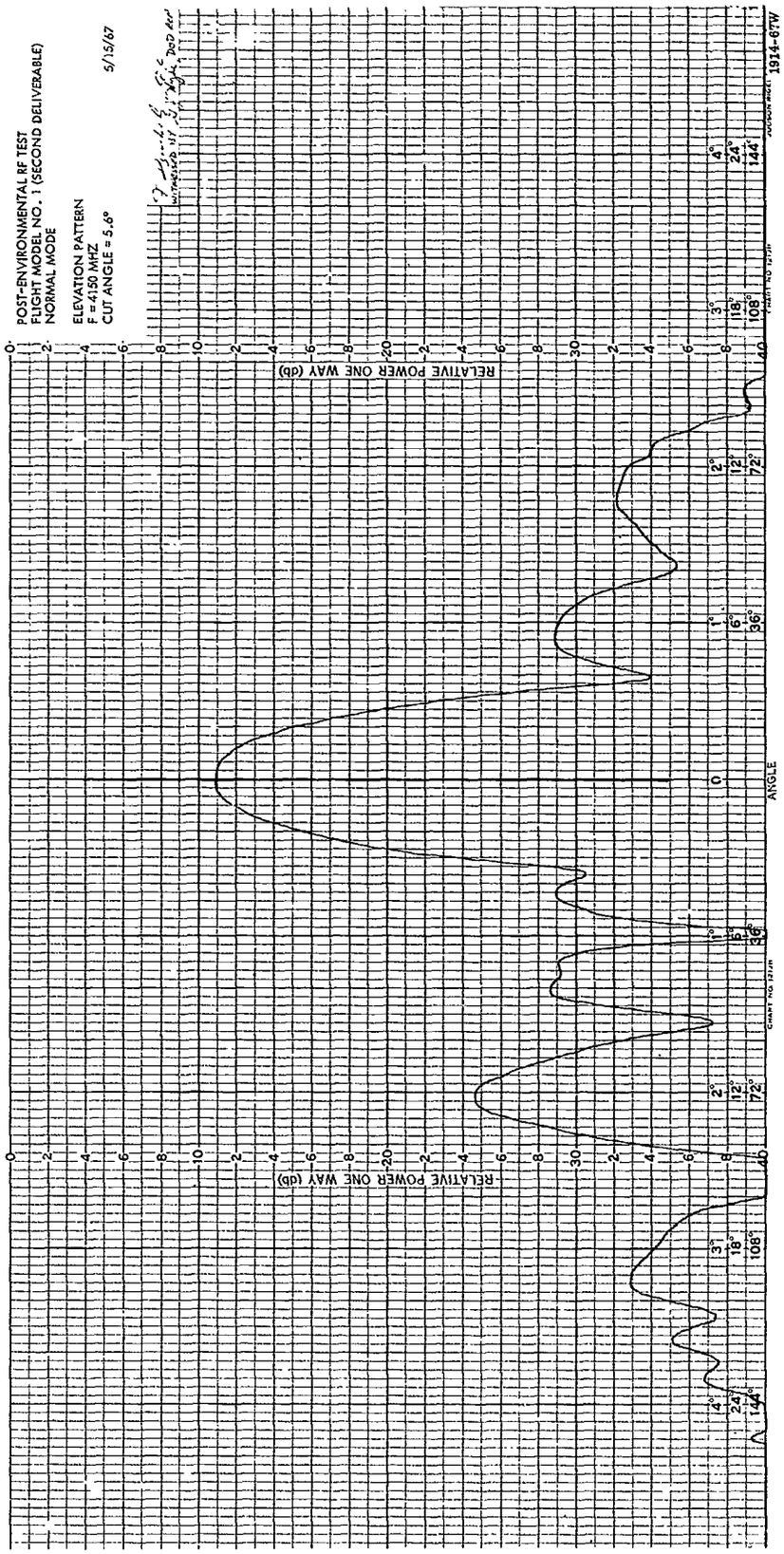

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION (-41 DB
F = 4150 MHZ
5/15/67
RELATIVE POWER ONE WAY (db)
RELATIVE POWER ONE WAY (db)
-15 DB
ANGLE
1909-67W

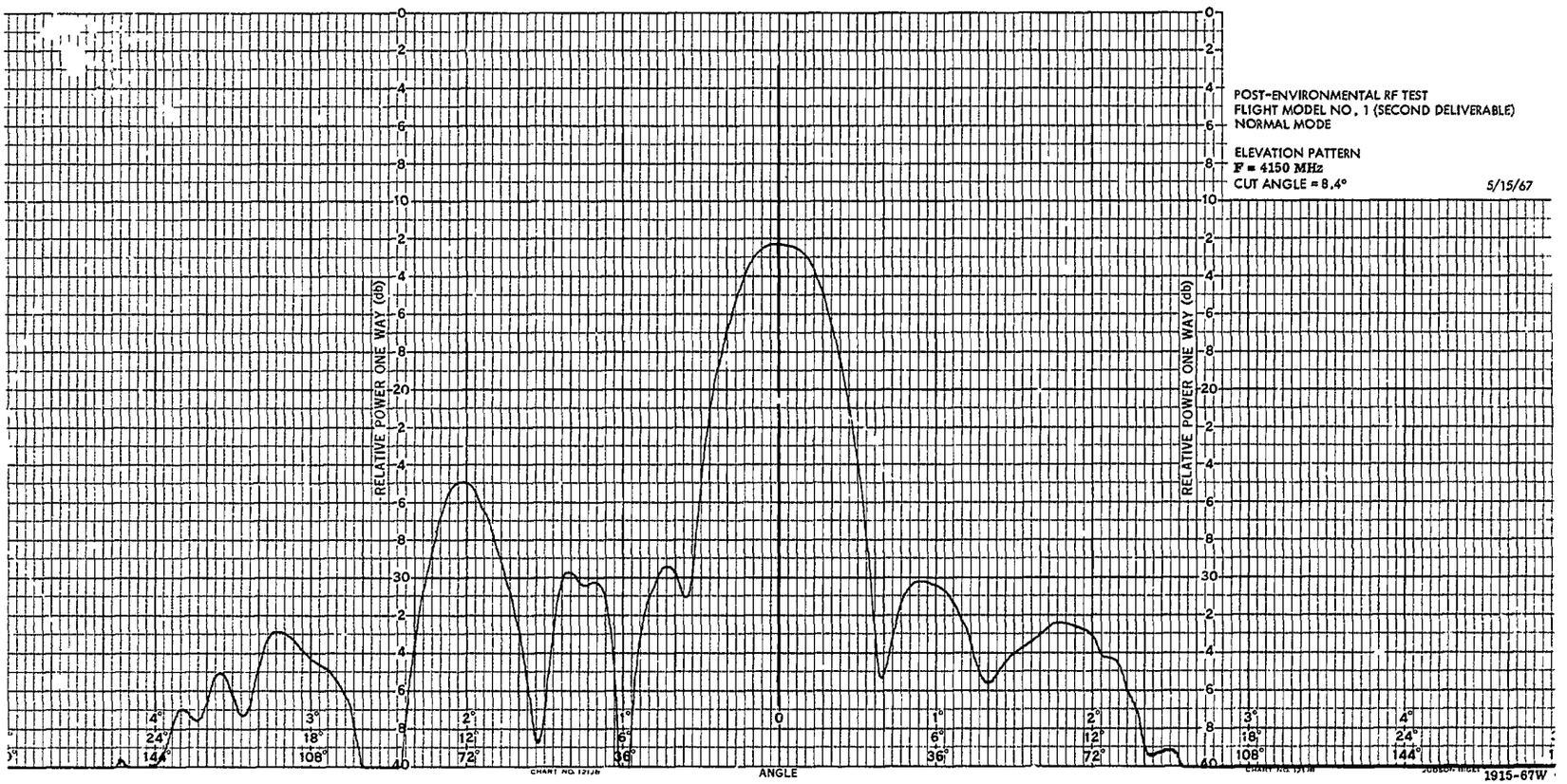

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN
5/15/67
RELATIVE POWER ONE WAY (db)
ANGLE
SGH
1910-67W

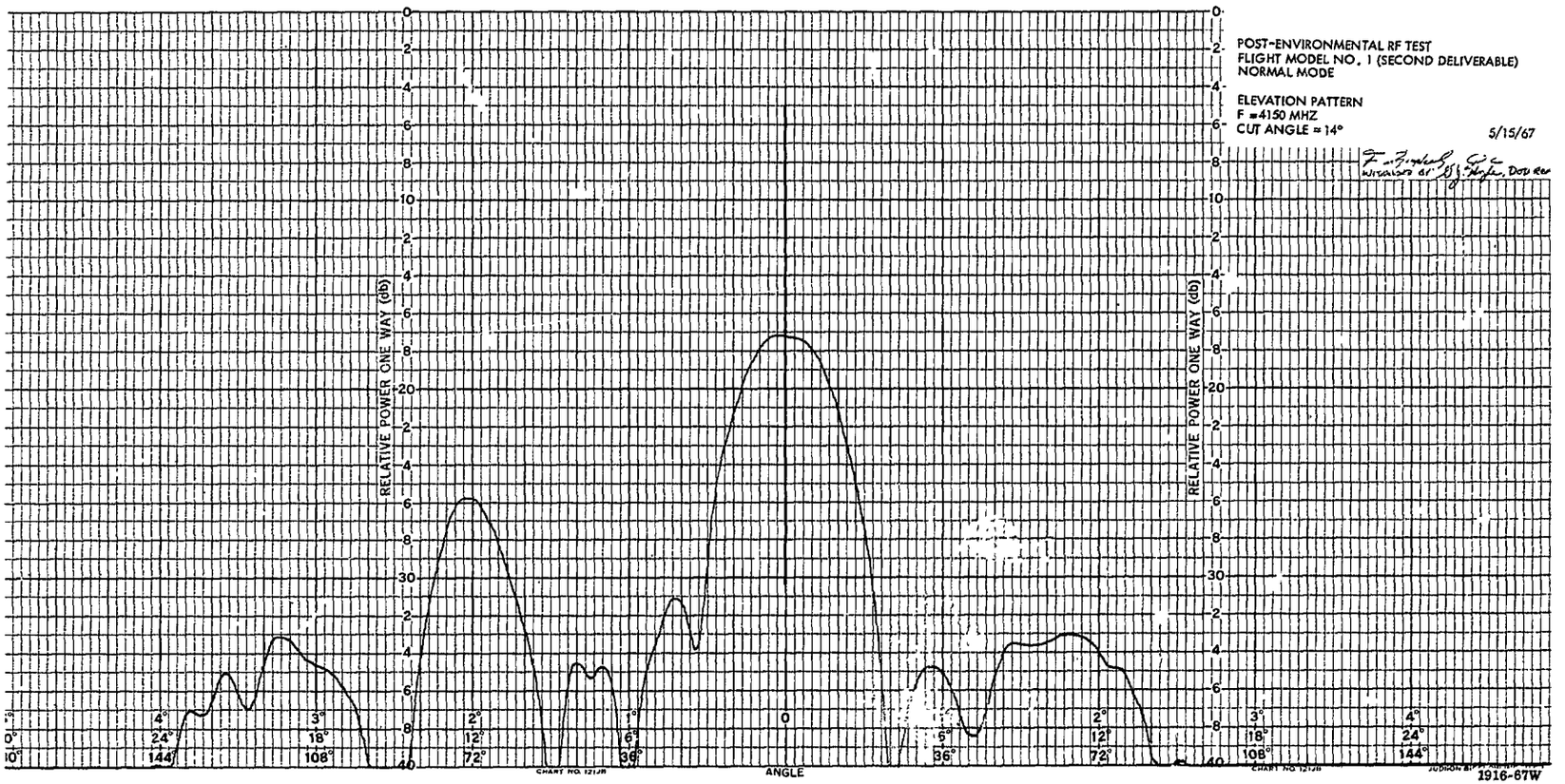

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN
F = 6260 MHZ
5/17/87
STANDARD GAIN HORN (SGH) = 15.9 DB
Δ = 1.4 DB (1.2 + 0.2)
GAIN = 17.3 DB
RELATIVE POWER ONE WAY (db)
SGH
ANGLE
1911-67W

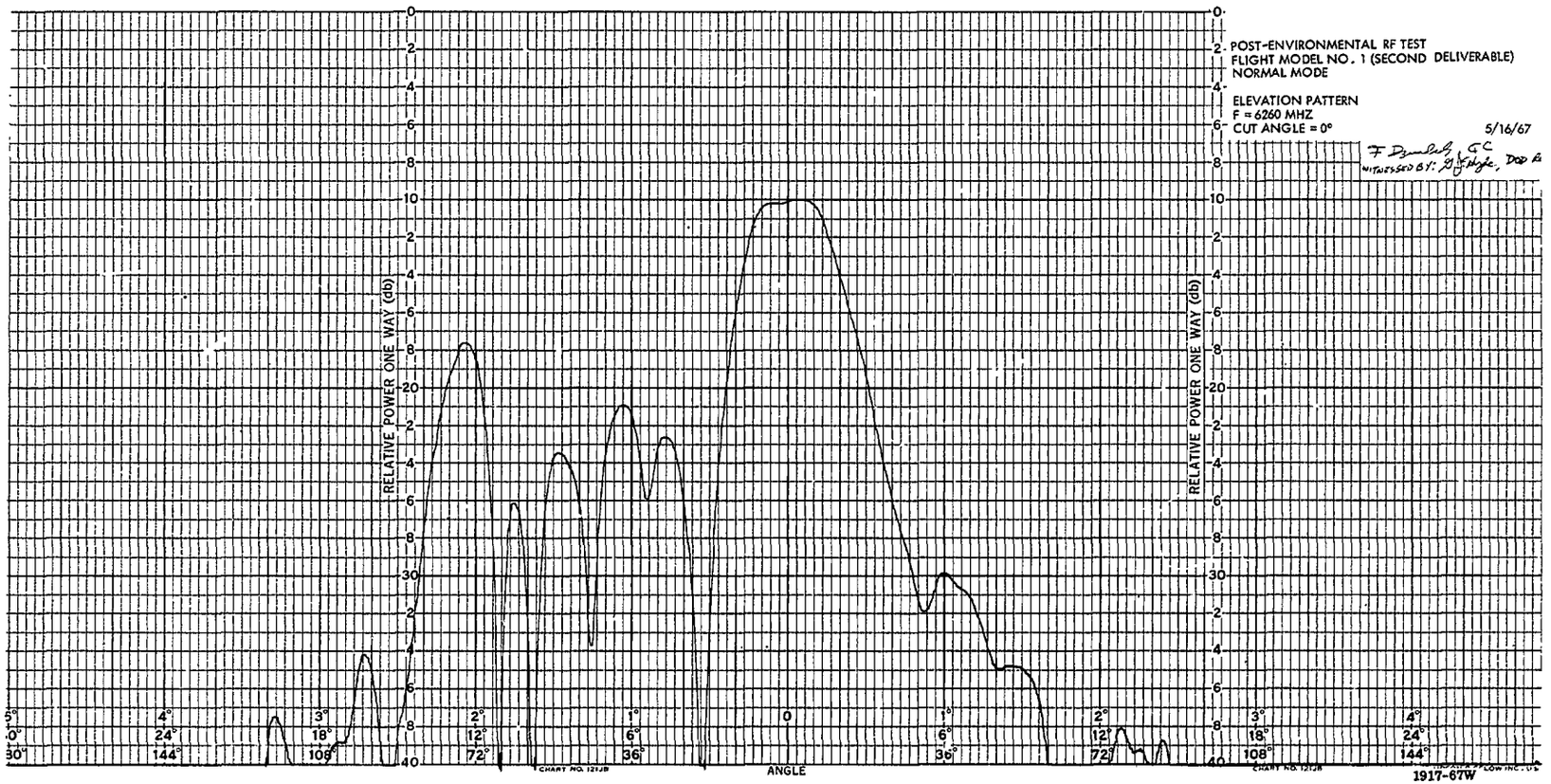

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
AZIMUTH PATTERN WITH CROSS POLARIZATION (-46.1 DB)
F = 6260 MHZ
RELATIVE POWER ONE WAY (db)
+20 DB
ANGLE
1912-67W

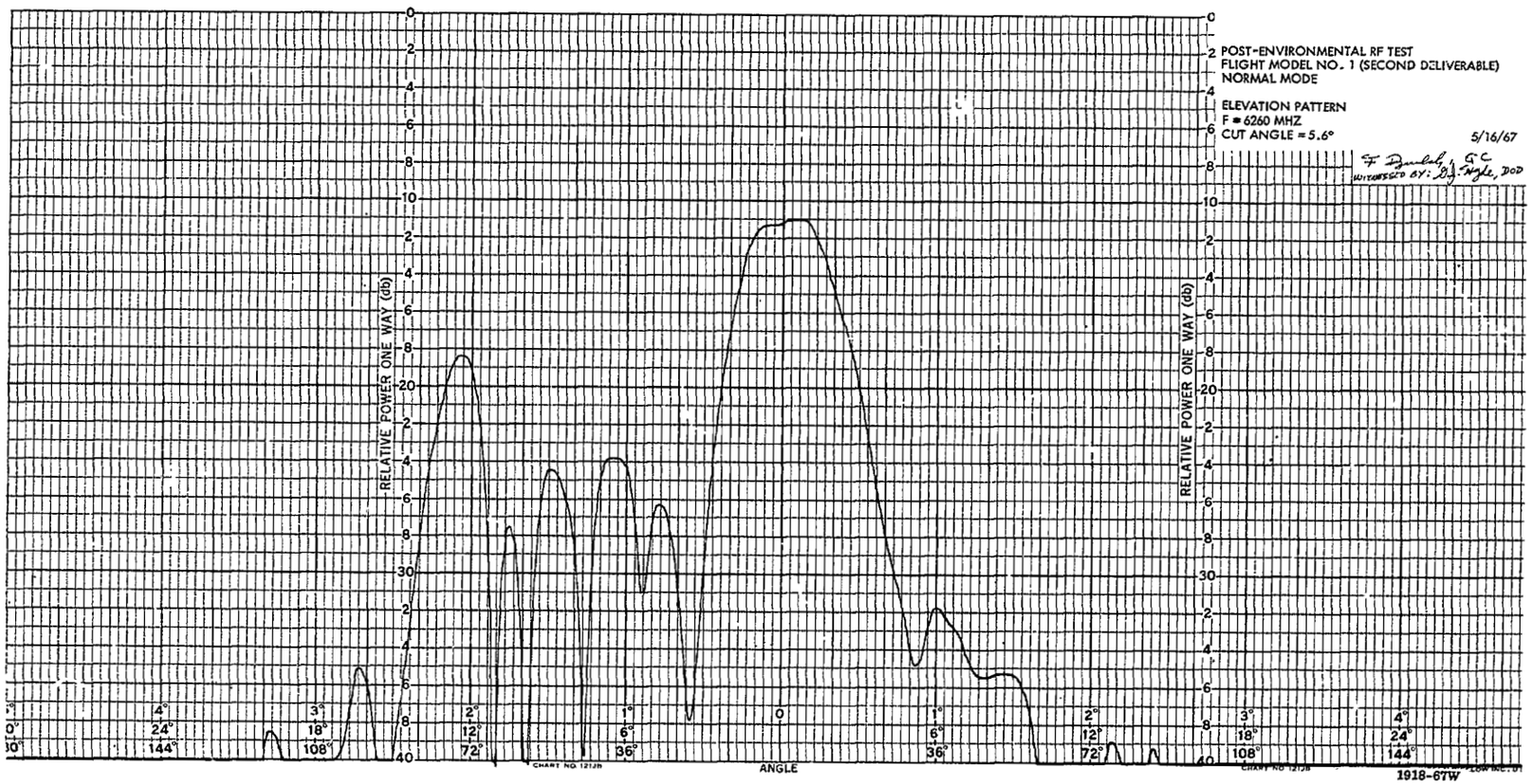

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 0°
5/15/67
RELATIVE POWER ONE WAY (db)
ANGLE
1913-67W

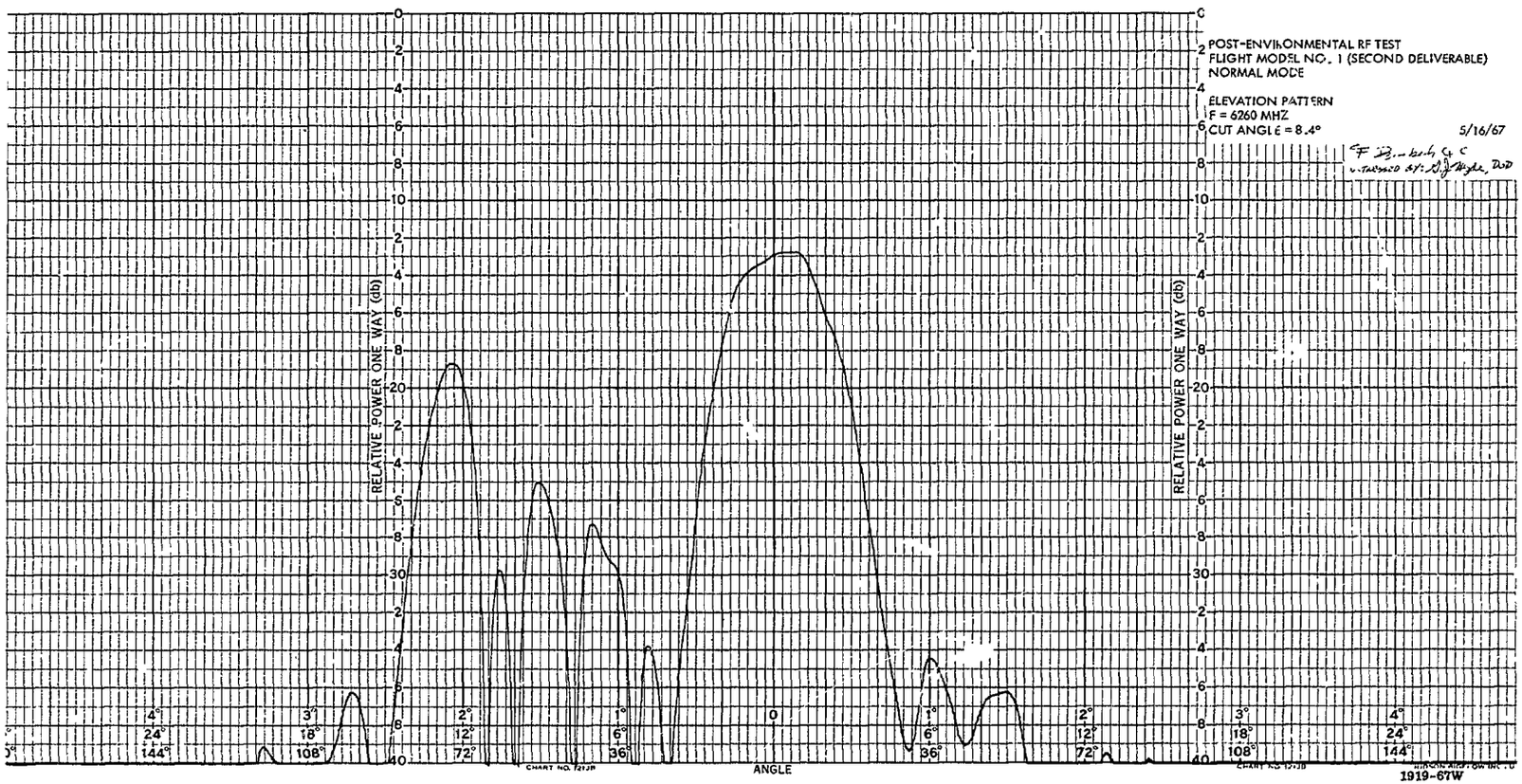

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE = 5.6°
5/15/67
RELATIVE POWER ONE WAY (db)
ANGLE
1914-67W

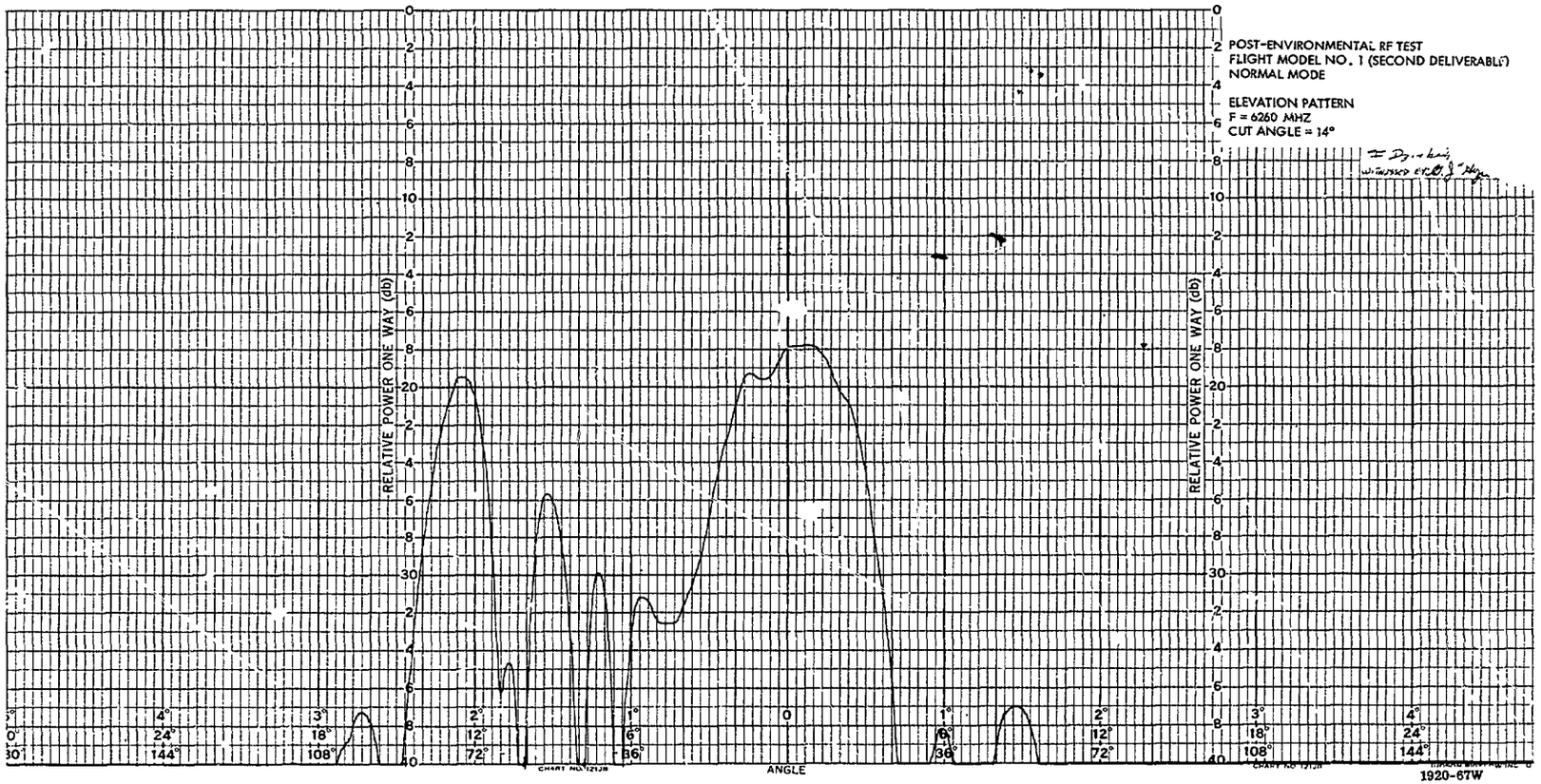

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHz
CUT ANGLE = 8.4°
5/15/67
RELATIVE POWER ONE WAY (db)
ANGLE
0
1°
6°
36°
2°
12°
72°
3°
18°
108°
4°
24°
144°
1915-67W

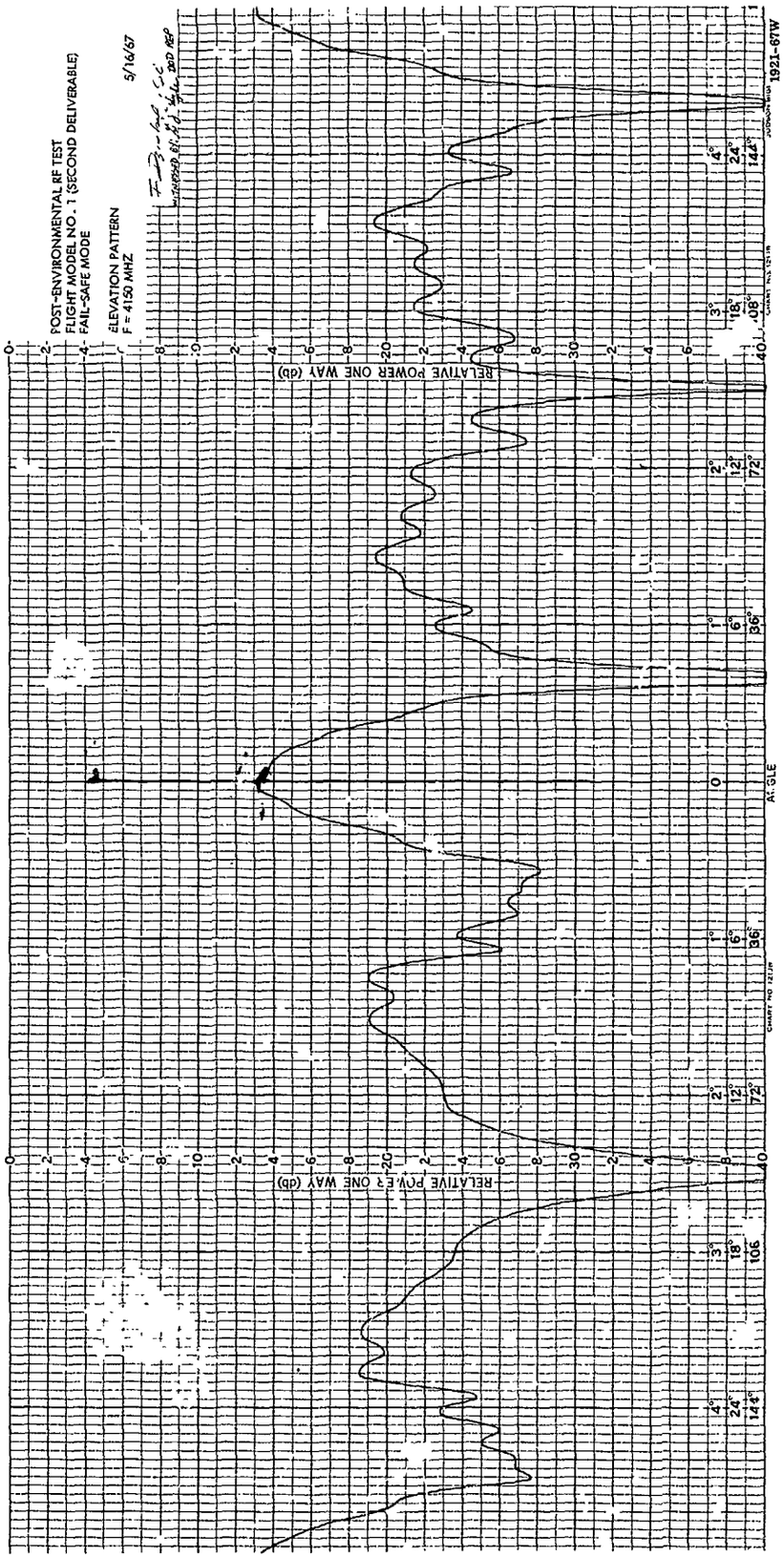

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 4150 MHZ
CUT ANGLE ≈ 14°
5/15/67
RELATIVE POWER ONE WAY (db)
ANGLE
1916-67W

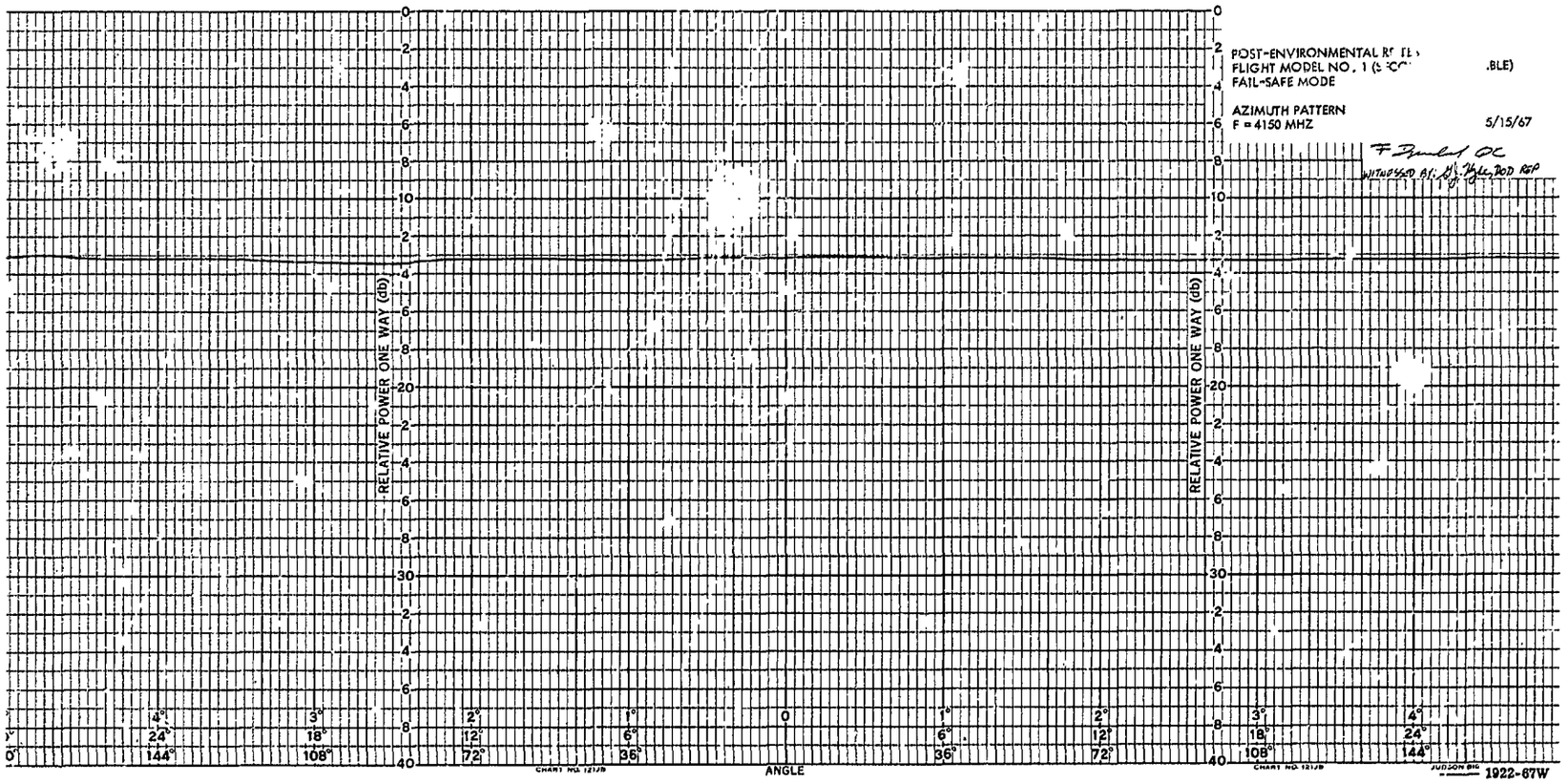

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 0°
5/16/67
RELATIVE POWER ONE WAY (db)
ANGLE
1917-67W

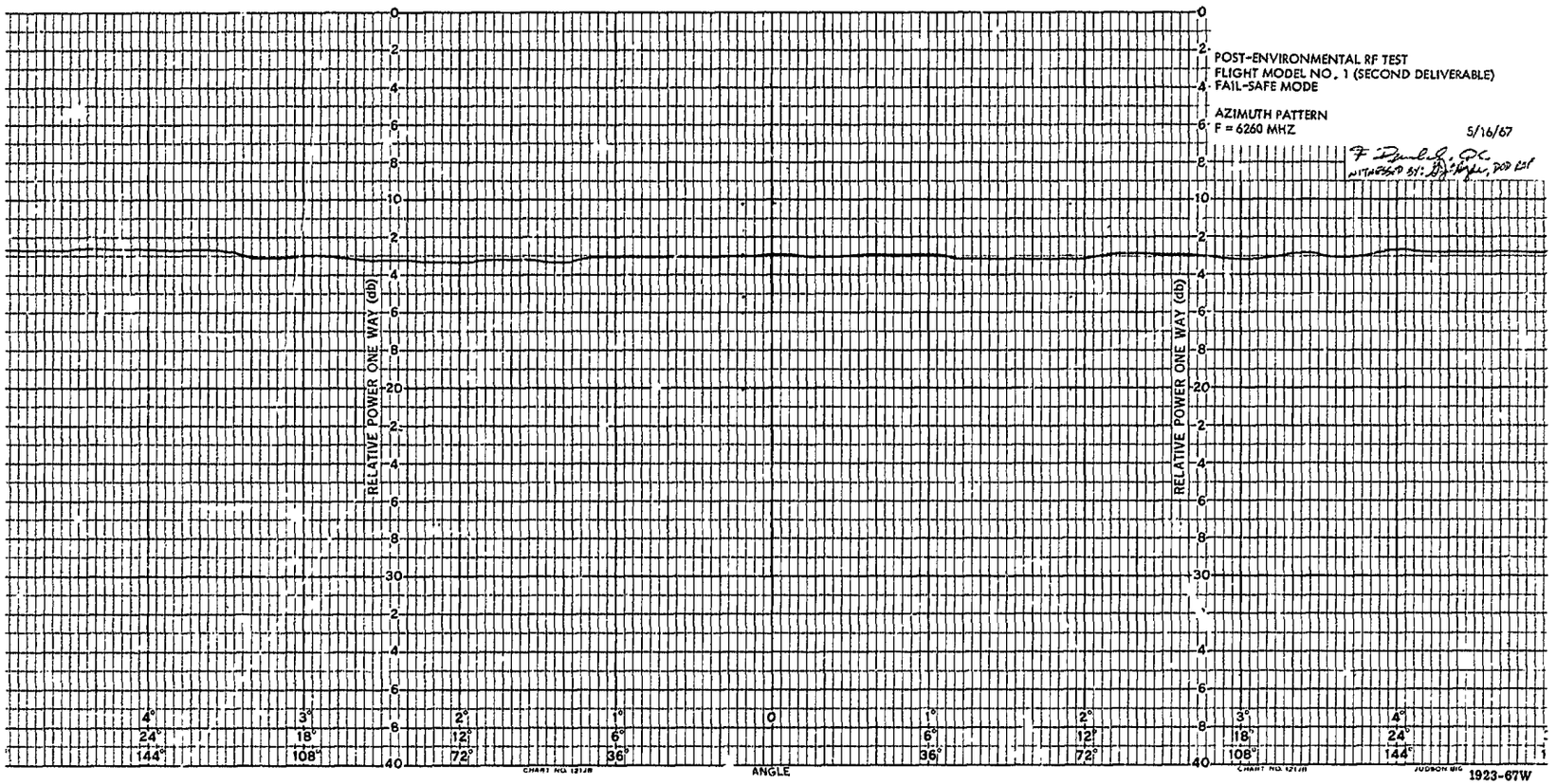

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 5.6°
5/16/67
WITNESSED BY: D.J. Angle, DOD
RELATIVE POWER ONE WAY (db)
ANGLE
4° 24° 144°
3° 18° 108°
2° 12° 72°
1° 6° 36°
0
1° 6° 36°
2° 12° 72°
3° 18° 108°
4° 24° 144°
1918-67W

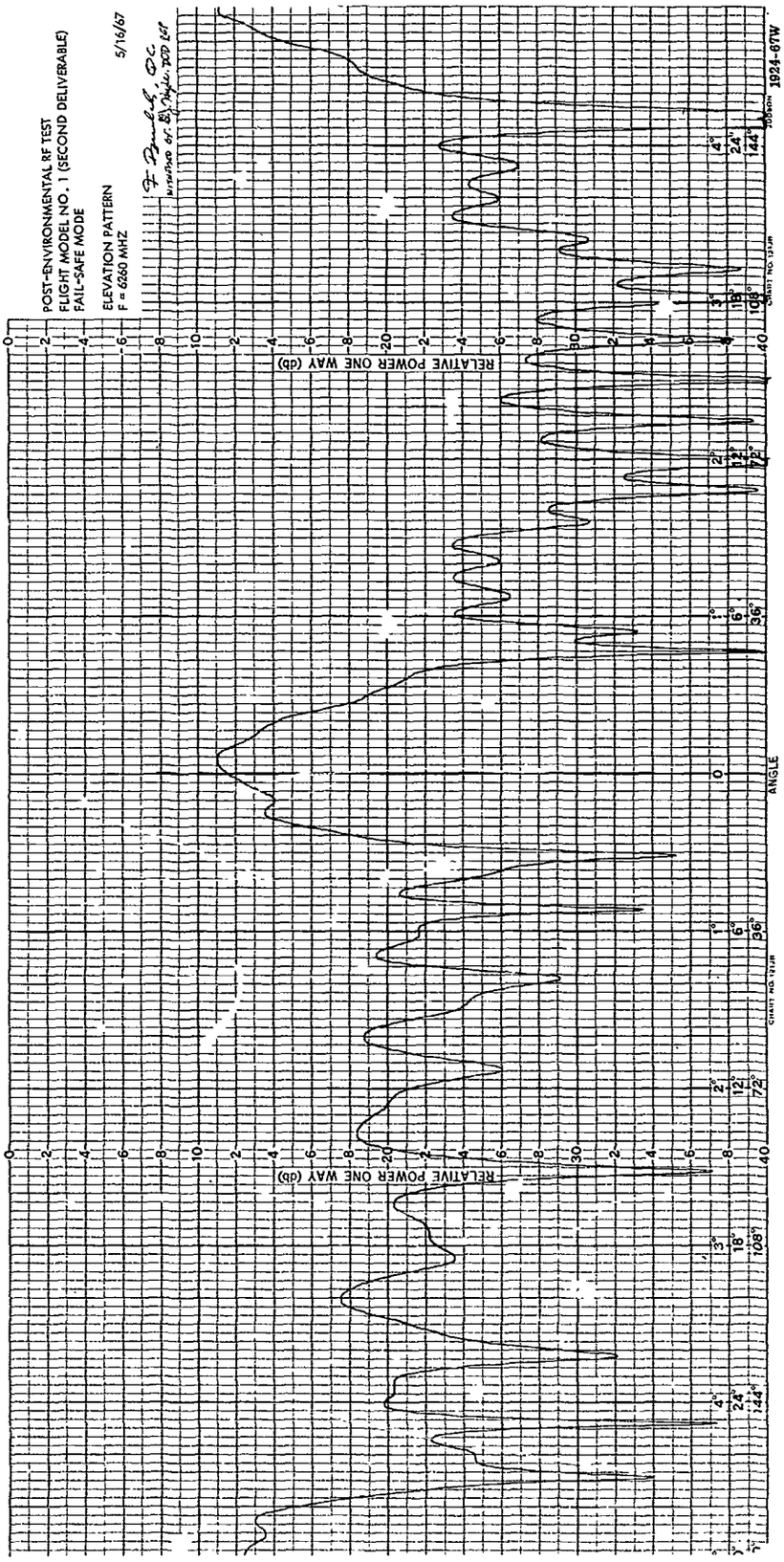

POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 8.4°
5/16/67
RELATIVE POWER ONE WAY (db)
ANGLE
1919-67W


POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
NORMAL MODE
ELEVATION PATTERN
F = 6260 MHZ
CUT ANGLE = 14°
RELATIVE POWER ONE WAY (db)
ANGLE
1920-67W


POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
FAIL-SAFE MODE
ELEVATION PATTERN
F = 4150 MHZ
5/16/67
RELATIVE POWER ONE WAY (db)
RELATIVE POWER ONE WAY (db)
AZ. GLE
1921-67W


POST-ENVIRONMENTAL
FLIGHT MODEL NO. 1
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 4150 MHZ
5/15/67
RELATIVE POWER ONE WAY (db)
ANGLE
0°
4°
24°
144°
3°
18°
108°
2°
12°
72°
1°
6°
36°
0
1°
6°
36°
2°
12°
72°
3°
18°
108°
4°
24°
144°
1922-67W


POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
FAIL-SAFE MODE
AZIMUTH PATTERN
F = 6260 MHZ
5/16/67
RELATIVE POWER ONE WAY (db)
ANGLE
1923-67W


POST-ENVIRONMENTAL RF TEST
FLIGHT MODEL NO. 1 (SECOND DELIVERABLE)
FAIL-SAFE MODE
ELEVATION PATTERN
F = 6260 MHZ
5/16/67
RELATIVE POWER ONE WAY (db)
ANGLE
1924-67W

APPENDIX B

RF IMPEDANCE TEST DATA

The following data provides performance characteristics of the qualification and two flight model units conducted in accordance with the Qualification and Flight Acceptance Test Plan latest revision.

Pre-environmental and post-environmental data permit an observation of the effects, if any, of environmental testing.

VSWR TEST DATA - TRANSMIT BAND
PRE-ENVIRONMENTAL
QUALIFICATION MODEL DATA

Frequency	VSWR	Frequency	VSWR
3950 MHz	2.70	4170 MHz	1.16
4000 MHz	2.40	4175 MHz	1.16
4050 MHz	1.95	4180 MHz	1.16
4090 MHz	1.45	4185 MHz	1.17
4095 MHz	1.40	4190 MHz	1.16
4100 MHz	1.35	4195 MHz	1.18
4105 MHz	1.32	4200 MHz	1.16
4110 MHz	1.29	4205 MHz	1.18
4115 MHz	1.26	4210 MHz	1.17
4120 MHz	1.24	4215 MHz	1.18
4125 MHz	1.21	4220 MHz	1.18
4130 MHz	1.19	4225 MHz	1.17
4135 MHz	1.18	4230 MHz	1.18
4140 MHz	1.17	4250 MHz	1.20
4145 MHz	1.17	4300 MHz	1.20
4150 MHz	1.16	4350 MHz	1.04
4155 MHz	1.16	4400 MHz	1.09
4160 MHz	1.16	4450 MHz	1.10
4165 MHz	1.16	4500 MHz	1.12

Specification Limits: Maximum VSWR = 1.[illegible] between 4090 MHz and 4230 MHz

VSWR DATA - RECEIVE BAND
PRE-ENVIRONMENTAL
QUALIFICATION MODEL DATA

Frequency	VSWR	Frequency	VSWR
5950 MHz	2.00	6260 MHz	1.34
6000 MHz	1.43	6265 MHz	1.34
6050 MHz	1.09	6270 MHz	1.35
6100 MHz	1.16	6275 MHz	1.36
6150 MHz	1.28	6280 MHz	1.36
6180 MHz	1.32	6285 MHz	1.35
6185 MHz	1.33	6290 MHz	1.36
6190 MHz	1.34	6295 MHz	1.36
6195 MHz	1.34	6300 MHz	1.36
6200 MHz	1.34	6305 MHz	1.38
6205 MHz	1.34	6210 MHz	1.38
6210 MHz	1.34	6315 MHz	1.39
6215 MHz	1.35	6320 MHz	1.39
6220 MHz	1.35	6325 MHz	1.40
6225 MHz	1.33	6330 MHz	1.42
6230 MHz	1.32	6350 MHz	1.44
6235 MHz	1.33	6400 MHz	1.48
6240 MHz	1.32	6450 MHz	1.50
6245 MHz	1.32	6500 MHz	1.42
6250 MHz	1.33	6550 MHz	1.27
6255 MHz	1.34		

Specification Limits: Maximum VSWR = 1.45 between 6180 MHz and 6330 MHz

VSWR TEST DATA - TRANSMIT BAND
POST ENVIRONMENTAL
QUALIFICATION MODEL DATA

Frequency	VSWR	Frequency	VSWR
3950 MHz	2.70	4170 MHz	1.20
4000 MHz	2.50	4175 MHz	1.20
4050 MHz	2.00	4180 MHz	1.20
4090 MHz	1.46	4185 MHz	1.19
4095 MHz	1.40	4190 MHz	1.19
4100 MHz	1.36	4195 MHz	1.18
4105 MHz	1.32	4200 MHz	1.19
4110 MHz	1.30	4205 MHz	1.19
4115 MHz	1.27	4210 MHz	1.19
4120 MHz	1.24	4215 MHz	1.20
4125 MHz	1.22	4220 MHz	1.20
4130 MHz	1.22	4225 MHz	1.21
4135 MHz	1.21	4230 MHz	1.20
4140 MHz	1.21	4250 MHz	1.22
4145 MHz	1.20	4300 MHz	1.22
4150 MHz	1.19	4350 MHz	1.06
4155 MHz	1.19	4400 MHz	1.10
4160 MHz	1.19	4450 MHz	1.10
4165 MHz	1.20	4500 MHz	1.13

Specification Limits: Maximum VSWR = 1.35 between 4090 MHz and 4230 MHz

VSWR DATA - RECEIVE BAND

FINAL QUALIFICATION MODEL DATA

Frequency	VSWR	Frequency	VSWR
5950 MHz	2.1	6260 MHz	1.35
6000 MHz	1.45	6265 MHz	1.35
6050 MHz	1.06	6270 MHz	1.36
6100 MHz	1.18	6275 MHz	1.36
6150 MHz	1.32	6280 MHz	1.37
6180 MHz	1.33	6285 MHz	1.37
6185 MHz	1.35	6290 MHz	1.37
6190 MHz	1.35	6295 MHz	1.38
6195 MHz	1.35	6300 MHz	1.39
6200 MHz	1.36	6305 MHz	1.38
6205 MHz	1.35	6310 MHz	1.38
6210 MHz	1.35	6315 MHz	1.39
6215 MHz	1.36	6320 MHz	1.40
6220 MHz	1.35	6325 MHz	1.40
6225 MHz	1.36	6330 MHz	1.40
6230 MHz	1.35	6350 MHz	1.42
6235 MHz	1.35	6400 MHz	1.43
6240 MHz	1.35	6450 MHz	1.42
6245 MHz	1.35	6500 MHz	1.31
6250 MHz	1.35	6550 MHz	1.19
6255 MHz	1.36		

Specification Limits: Maximum VSWR = 1.45 between 6180 MHz and 6330 MHz

VSWR DATA-TRANSMIT BAND

PRE-ENVIRONMENT TEST

FLIGHT MODEL NO. 1

Frequency	VSWR	Frequency	VSWR
3950 MHz	2.4	4170 MHz	1.20
4000 MHz	1.95	4175 MHz	1.19
4050 MHz	1.65	4180 MHz	1.19
4090 MHz	1.34	4185 MHz	1.19
4095 MHz	1.32	4190 MHz	1.19
4100 MHz	1.29	4195 MHz	1.19
4105 MHz	1.27	4200 MHz	1.19
4110 MHz	1.27	4205 MHz	1.18
4115 MHz	1.24	4210 MHz	1.16
4120 MHz	1.22	4215 MHz	1.16
4125 MHz	1.22	4220 MHz	1.16
4130 MHz	1.22	4225 MHz	1.15
4135 MHz	1.21	4230 MHz	1.14
4140 MHz	1.21	4250 MHz	1.13
4145 MHz	1.19	4300 MHz	1.18
4150 MHz	1.21	4350 MHz	1.20
4155 MHz	1.22	4400 MHz	1.19
4160 MHz	1.21	4450 MHz	1.16
4165 MHz	1.21	4500 MHz	1.21

Specification Limits

Transmit Band: Maximum VSWR = 1.35 between 4090 MHz and 4230 MHz

VSWR DATA - RECEIVE BAND
PRE-ENVIRONMENTAL TEST
FLIGHT MODEL NO. 1

Frequency	VSWR	Frequency	VSWR
5950 MHz	2.1	6250 MHz	1.19
6000 MHz	1.6	6255 MHz	1.18
6050 MHz	1.19	6260 MHz	1.18
6100 MHz	1.10	6265 MHz	1.18
6150 MHz	1.23	6270 MHz	1.18
6180 MHz	1.26	6275 MHz	1.17
6185 MHz	1.25	6280 MHz	1.17
6190 MHz	1.25	6285 MHz	1.17
6195 MHz	1.26	6290 MHz	1.18
6200 MHz	1.24	6295 MHz	1.18
6205 MHz	1.24	6300 MHz	1.19
6210 MHz	1.24	6305 MHz	1.20
6215 MHz	1.24	6310 MHz	1.20
6220 MHz	1.23	6315 MHz	1.21
6225 MHz	1.21	6320 MHz	1.22
6230 MHz	1.20	6325 MHz	1.23
6235 MHz	1.21	6330 MHz	1.24
6240 MHz	1.20	6350 MHz	1.29
6245 MHz	1.19	6400 MHz	1.39
		6450 MHz	1.42
		6500 MHz	1.34
		6550 MHz	1.17

Receiving Band: Maximum VSWR = 1.45 between 6180 MHz and 6330 MHz

VSWR DATA - TRANSMIT BAND

POST VIBRATION

FLIGHT MODEL NO. 1

Frequency	VSWR	Frequency	VSWR
3950 MHz	2.30	4170 MHz	1.28
4000 MHz	[illegible]	4175 MHz	1.30
4050 MHz	1.70	4180 MHz	1.29
4090 MHz	1.28	4185 MHz	1.28
4095 MHz	1.24	4190 MHz	1.26
4100 MHz	1.20	4195 MHz	1.25
4105 MHz	1.19	4200 MHz	1.24
4110 MHz	1.18	4205 MHz	1.21
4115 MHz	1.18	4210 MHz	1.17
4120 MHz	1.18	4215 MHz	1.17
4125 MHz	1.20	4220 MHz	1.13
4130 MHz	1.20	4225 MHz	1.11
4135 MHz	1.21	4230 MHz	1.10
4140 MHz	1.24	4250 MHz	1.08
4145 MHz	1.26	4300 MHz	1.28
4150 MHz	1.28	4350 MHz	1.28
4155 MHz	1.28	4400 MHz	1.16
4160 MHz	1.28	4450 MHz	1.09
4165 MHz	1.29	4500 MHz	1.27

Specification Limits

Transmit Band: Maximum VSWR = 1.35 between 4090 MHz and 4230 MHz

VSWR DATA - RECEIVE BAND

POST VIBRATION

FLIGHT MODEL NO. 1

Frequency	VSWR	Frequency	VSWR
5950 MHz	2.30	6250 MHz	1.19
6000 MHz	1.72	6255 MHz	1.19
6050 MHz	1.32	6260 MHz	1.18
6100 MHz	1.04	6265 MHz	1.18
6150 MHz	1.14	6270 MHz	1.17
6180 MHz	1.19	6275 MHz	1.17
6185 MHz	1.20	6280 MHz	1.16
6190 MHz	1.20	6285 MHz	1.16
6195 MHz	1.20	6290 MHz	1.16
6200 MHz	1.21	6295 MHz	1.18
6205 MHz	1.20	6300 MHz	1.17
6210 MHz	1.20	6305 MHz	1.18
6215 MHz	1.20	6310 MHz	1.18
6220 MHz	1.20	6315 MHz	1.19
6225 MHz	1.20	6320 MHz	1.20
6230 MHz	1.21	6325 MHz	1.20
6235 MHz	1.20	6330 MHz	1.20
6240 MHz	1.20	6350 MHz	1.25
6245 MHz	1.20	6400 MHz	1.36
		6450 MHz	1.45
		6500 MHz	1.50
		6550 MHz	1.40

Receiving Band: Maximum VSWR = 1.45 between 6180 MHz and 6330 MHz

VSWR DATA - TRANSMIT BAND

POST ENVIRONMENTAL

FLIGHT MODEL NO. 1

Frequency	VSWR	Frequency	VSWR
3950 MHz	2.4	4170 MHz	1.[illegible]
4000 MHz	2.05	4175 MHz	1.20
4050 MHz	1.65	4180 Mhz	1.21
4090 MHz	1.35	4185 MHz	1.20
4095 MHz	1.33	4190 MHz	1.19
4100 MHz	1.31	4195 MHz	1.19
4105 MHz	1.28	4200 MHz	1.16
4110 MHz	1.26	4205 MHz	1.16
4115 MHz	1.25	4210 MHz	1.17
4120 MHz	1.24	4215 MHz	1.15
4125 MHz	1.23	4220 MHz	1.14
4130 MHz	1.22	4225 MHz	1.14
4135 MHz	1.21	4230 MHz	1.13
4140 MHz	1.22	4250 MHz	1.14
4145 MHz	1.22	4300 MHz	1.21
4150 MHz	1.23	4350 MHz	1.22
4155 MHz	1.22	4400 MHz	1.18
4160 MHz	1.20	4450 MHz	1.15
4165 MHz	1.19	4500 MHz	1.23

Specification Limits

Transmit Band: Maximum VSWT = 1.35 between 4090 MHz and 4230 MHz

VSWR DATA - RECEIVE BAND
POST-ENVIRONMENTAL TEST
FLIGHT MODEL NO. 1

Frequency	VSWR	Frequency	VSWR
5950 MHz	2.05	6250 MHz	1.22
6000 MHz	1.58	6255 MHz	1.22
6050 MHz	1.18	6260 MHz	1.21
6100 MHz	1.10	6265 MHz	1.21
6150 MHz	1.23	6270 MHz	1.21
6180 MHz	1.27	6275 MHz	1.19
6185 MHz	1.26	6280 MHz	1.20
6190 MHz	1.26	6285 MHz	1.21
6195 MHz	1.28	6290 MHz	1.21
6200 MHz	1.28	6295 MHz	1.21
6205 MHz	1.26	6300 MHz	1.22
6210 MHz	1.26	6305 MHz	1.23
6215 MHz	1.25	6310 MHz	1.24
6220 MHz	1.25	6315 MHz	1.25
6225 MHz	1.24	6320 MHz	1.25
6230 MHz	1.24	6325 MHz	1.27
6235 MHz	1.23	6330 MHz	1.28
6240 MHz	1.23	6350 MHz	1.33
6245 MHz	1.22	6400 MHz	1.43
		6450 MHz	1.47
		6500 MHz	1.37
		6550 MHz	1.16

Receiving Band: Maximum VSWR = 1.45 between 6180 MHz and 6330 MHz

POST-ENVIRONMENTAL RF PERFORMANCE SUMMARY

FLIGHT MODEL NO. 1

	Transmit	Receive	Specification
Frequency (MHz)	4150	6260	-
Peak Gain (db)	17.4	17.1	17.0 Nominal
3 db Beamwidth (degrees)	20° x 21.5°	19.5° x 20.5°	20° ± 2°
VSWR (Max.)	1.35	1.28	1.35 max. Transmit 1.45 max. Receive
Cross Polarization (db)	47	37	20 min.
Beam Squint (db)	0	0.2	0.4 max.
Beam Ripple (db)	±0.1	±0.1	±0.5

VSWR DATA - TRANSMIT BAND

PRE-ENVIRONMENTAL TEST

Frequency	VSWR	Frequency	VSWR
3950 MHz	2.10	4170 MHz	1.26
4000 MHz	1.95	4175 MHz	1.23
4050 MHz	1.48	4180 MHz	1.21
4090 MHz	1.23	4185 MHz	1.19
4095 MHz	1.22	4190 MHz	1.17
4100 MHz	1.24	4195 MHz	1.14
4105 MHz	1.28	4200 MHz	1.10
4110 MHz	1.28	4205 MHz	1.08
4115 MHz	1.28	4210 MHz	1.06
4120 MHz	1.29	4215 MHz	1.06
4125 MHz	1.32	4220 MHz	1.08
4130 MHz	1.35	4225 MHz	1.08
4135 MHz	1.35	4230 MHz	1.10
4140 MHz	1.34	4250 MHz	1.22
4145 MHz	1.34	4300 MHz	1.35
4150 MHz	1.33	4350 MHz	1.24
4155 MHz	1.34	4400 MHz	1.17
4160 MHz	1.34	4450 MHz	1.30
4165 MHz	1.29	4500 MHz	1.42

Specification Limits: Maximum VSWR = 1.35 between 4090 MHz and 4230 MHz

VSWR DATA-TRANSMIT BAND

PRE-ENVIRONMENTAL TEST

Frequency	VSWR	Frequency	VSWR
3950 MHz	2.10	4170 MHz	1.26
4000 MHz	1.95	4175 MHz	1.23
4050 MHz	1.48	4180 MHz	1.21
4090 MHz	1.23	4185 MHz	1.19
4095 MHz	1.22	4190 MHz	1.17
4100 MHz	1.24	4195 MHz	1.14
4105 MHz	1.28	4200 MHz	1.10
4110 MHz	1.28	4205 MHz	1.08
4115 MHz	1.28	4210 MHz	1.06
4120 MHz	1.29	4215 MHz	1.06
4125 MHz	1.32	4220 MHz	1.08
4130 MHz	1.35	4225 MHz	1.08
4135 MHz	1.35	4230 MHz	1.10
4140 MHz	1.34	4250 MHz	1.22
4145 MHz	1.34	4300 MHz	1.35
4150 MHz	1.33	4350 MHz	1.24
4155 MHz	1.34	4400 MHz	1.17
4160 MHz	1.34	4450 MHz	1.30
4165 MHz	1.29	4500 MHz	1.42

Specification Limits: Maximum VSWR = 1.35 between 4090 MHz and 4230 MHz

VSWR DATA - RECEIVE BAND

FLIGHT MODEL NO. 2

PRE-ENVIRONMENTAL TEST

Frequency	VSWR	Frequency	VSWR
5950 MHz	1.68	6250 MHz	1.16
6000 MHz	1.22	6255 MHz	1.15
6050 MHz	1.10	6260 MHz	1.14
6100 MHz	1.29	6265 MHz	1.14
6150 MHz	1.34	6270 MHz	1.15
6180 MHz	1.28	6275 MHz	1.15
6185 MHz	1.27	6280 MHz	1.16
6190 MHz	1.26	6285 MHz	1.16
6195 MHz	1.25	6290 MHz	1.18
6200 MHz	1.24	6295 MHz	1.18
6205 MHz	1.23	6300 MHz	1.20
6210 MHz	1.22	6305 MHz	1.20
6215 MHz	1.20	6310 MHz	1.23
6220 MHz	1.19	6315 MHz	1.24
6225 MHz	1.20	6320 MHz	1.24
6230 MHz	1.19	6325 MHz	1.26
6235 MHz	1.18	6330 MHz	1.26
6240 MHz	1.17	6350 MHz	1.27
6245 MHz	1.16	6400 MHz	1.33
		6450 MHz	1.30
		6500 MHz	1.23
		6550 MHz	1.12

Specification Limits: Maximum VSWR = 1.45 between 6180 MHz and 6330 MHz

VSWR DATA - TRANSMIT BAND

POST VIBRATION

FLIGHT MODEL NO. 2

Frequency	VSWR	Frequency	VSWR
3950 MHz	2.20	4170 MHz	1.23
4000 MHz	1.90	4175 MHz	1.22
4050 MHz	1.47	4180 MHz	1.20
4090 MHz	1.24	4185 MHz	1.18
4095 MHz	1.26	4190 MHz	1.17
4100 MHz	1.26	4195 MHz	1.15
4105 MHz	1.26	4200 MHz	1.14
4110 MHz	1.26	4205 MHz	1.13
4115 MHz	1.26	4210 MHz	1.12
4120 MHz	1.26	4215 MHz	1.12
4125 MHz	1.26	4220 MHz	1.12
4130 MHz	1.26	4225 MHz	1.12
4135 MHz	1.26	4230 MHz	1.14
4140 MHz	1.26	4250 MHz	1.17
4145 MHz	1.26	4300 MHz	1.28
4150 MHz	1.26	4350 MHz	1.26
4155 MHz	1.26	4400 MHz	1.20
4160 MHz	1.26	4450 MHz	1.25
4165 MHz	1.25	4500 MHz	1.31

Specification Limits

Transmit Band: Maximum VSWR = 1.35 between 4090 MHz and 4230 MHz

VSWR DATA - RECEIVE BAND

POST VIBRATION

FLIGHT MODEL NO. 2

Frequency	VSWR	Frequency	VSWR
5950 MHz	1.65	6250 MHz	1.13
6000 MHz	1.23	6255 MHz	1.12
6050 MHz	1.07	6260 MHz	1.13
6100 MHz	1.23	6265 MHz	1.12
6150 MHz	1.30	6270 MHz	1.12
6180 MHz	1.25	6275 MHz	1.12
6185 MHz	1.24	6280 MHz	1.13
6190 MHz	1.24	6285 MHz	1.13
6195 MHz	1.22	6290 MHz	1.14
6200 MHz	1.20	6295 MHz	1.14
6205 MHz	1.19	6300 MHz	1.14
6210 MHz	1.18	6305 MHz	1.15
6215 MHz	1.18	6310 MHz	1.16
6220 MHz	1.16	6315 MHz	1.16
6225 MHz	1.14	6320 MHz	1.18
6230 MHz	1.14	6325 MHz	1.19
6235 MHz	1.15	6330 MHz	1.20
6240 MHz	1.14	6350 MHz	1.26
6245 MHz	1.14	6400 MHz	1.32
		6450 MHz	1.29
		6500 MHz	1.25
		6550 MHz	1.17

Receiving Band: Maximum VSWR = 1.45 between 6180 MHz and 6330 MHz

VSWR DATA - TRANSMIT BAND
POST-ENVIRONMENT TEST
FLIGHT MODEL NO. 2

Frequency	VSWR	Frequency	VSWR
3950 MHz	2.20	4170 MHz	1.22
4000 MHz	1.95	4175 MHz	1.20
4050 MHz	1.41	4180 MHz	1.16
4090 MHz	1.30	4185 MHz	1.13
4095 MHz	1.30	4190 MHz	1.10
4100 MHz	1.31	4195 MHz	1.09
4105 MHz	1.33	4200 MHz	1.07
4110 MHz	1.34	4205 MHz	1.07
4115 MHz	1.35	4210 MHz	1.08
4120 MHz	1.35	4215 MHz	1.10
4125 MHz	1.34	4220 MHz	1.13
4130 MHz	1.34	4225 MHz	1.14
4135 MHz	1.34	4230 MHz	1.18
4140 MHz	1.32	4250 MHz	1.26
4145 MHz	1.30	4300 MHz	1.32
4150 MHz	1.28	4350 MHz	1.18
4155 MHz	1.27	4400 MHz	1.22
4160 MHz	1.24	4450 MHz	1.34
4165 MHz	1.22	4500 MHz	1.34

Specification Limits

Transmit Band: Maximum VSWR = 1.35 between 4090 MHz and 4230 MHz

VSWR DATA - RECEIVE BAND

POST-ENVIRONMENTAL TEST

FLIGHT MODEL NO. 2

Frequency	VSWR	Frequency	VSWR
5950 MHz	1.56	6250 MHz	1.10
6000 MHz	1.22	6255 MHz	1.10
6050 MHz	1.14	6260 MHz	1.08
6100 MHz	1.22	6265 MHz	1.08
6150 MHz	1.24	6270 MHz	1.08
6180 MHz	1.19	6275 MHz	1.10
6185 MHz	1.19	6280 MHz	1.11
6190 MHz	1.19	6285 MHz	1.11
6195 MHz	1.19	6290 MHz	1.12
6200 MHz	1.18	6295 MHz	1.13
6205 MHz	1.16	6300 MHz	1.15
6210 MHz	1.15	6305 MHz	1.15
6215 MHz	1.14	6310 MHz	1.17
6220 MHz	1.13	6315 MHz	1.16
6225 MHz	1.13	6320 MHz	1.17
6230 MHz	1.12	6325 MHz	1.20
6235 MHz	1.10	6330 MHz	1.21
6240 MHz	1.10	6350 MHz	1.23
6245 MHz	1.10	6400 MHz	1.28
		6450 MHz	1.28
		6500 MHz	1.23
		6550 MHz	1.16

Receiving Band: Maximum VSWR = 1.45 between 6180 MHz and 6330 MHz

POST-ENVIRONMENTAL RF PERFORMANCE SUMMARY

FLIGHT MODEL NO. 2

	Transmit	Receive	Specification
Frequency (MHz)	4150	6260	-
Peak Gain (db)	17.4	17.7	17.0 Nominal
3 db Beamwidth (degrees)	20° x 19.5°	21° x 21°	20° ± 2°
VSWR (Max.)	1.35	1.21	1.35 max. Transmit 1.45 max. Receive
Cross Polarization (db)	48	41.6	20 min.
Beam Squint (db)	0	0.1	0.4 max.
Beam Ripple (db)	±0.1	±0.1	±0.5

APPENDIX C

CONTROL ELECTRONICS DATA - SYSTEM POWER DRAIN

Due to component tolerances the power drain for each system is different. To estimate the power drain for a particular system at a certain temperature, the reader is referred to the following graphs, Figures C-1 through C-9. The graphs were derived from the test results at 50, 100 and 150 RPM at various temperatures. Any value between these three speeds is interpolated and should not be taken with too high an accuracy especially in the speed range between 50 and 100 RPM.

Each graph for the Qualification Unit represents performance data under atmospheric and vacuum conditions at the qualification level temperature extremes. Figures C-1 through C-3 represent the mean and limiting voltages.

The graphs for the flight units, Figures C-4 through C-9, differ only in the temperature limits.

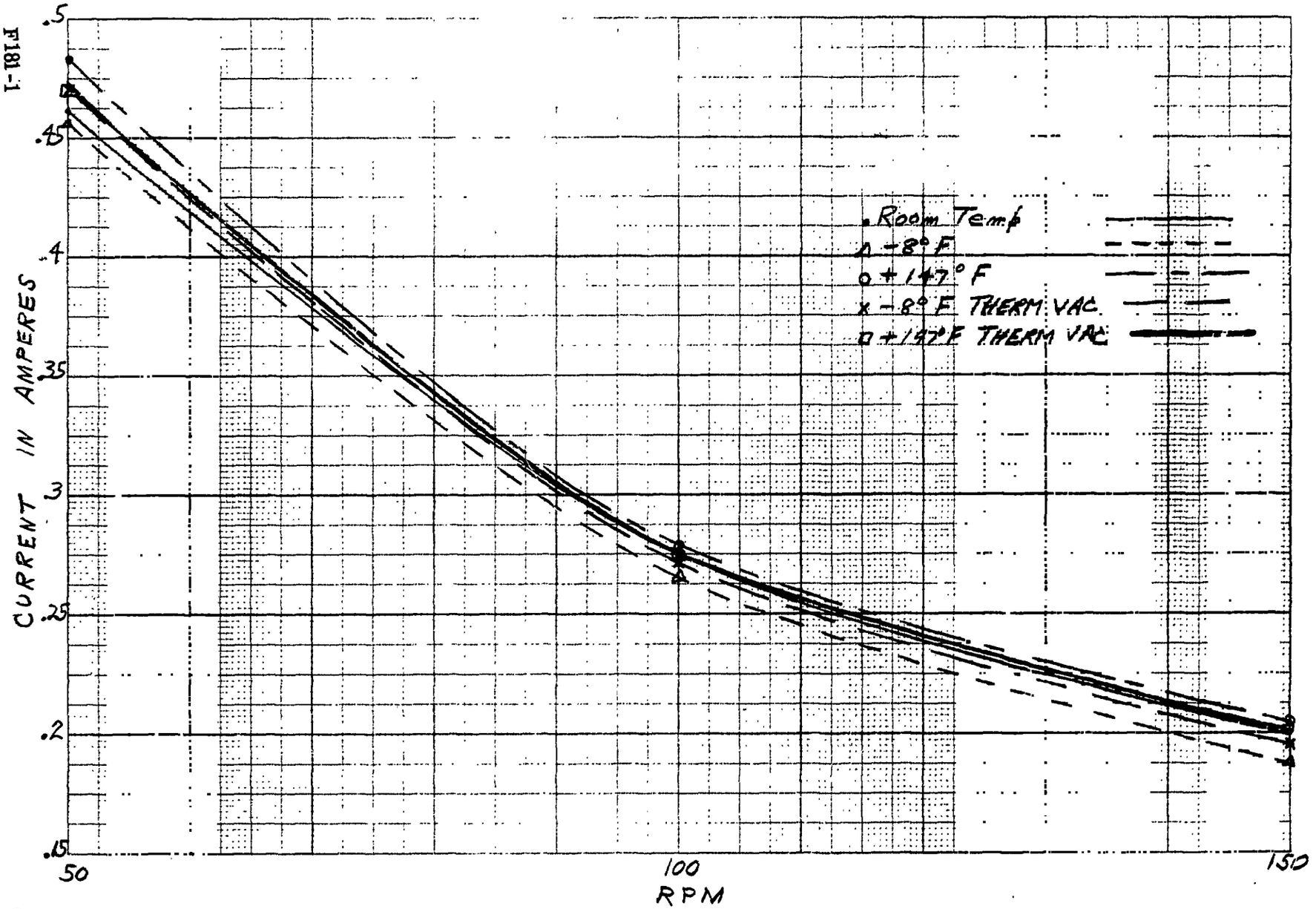


Figure C-1. Qual Model MDA System Current Vs. RPM 23.04 Volts

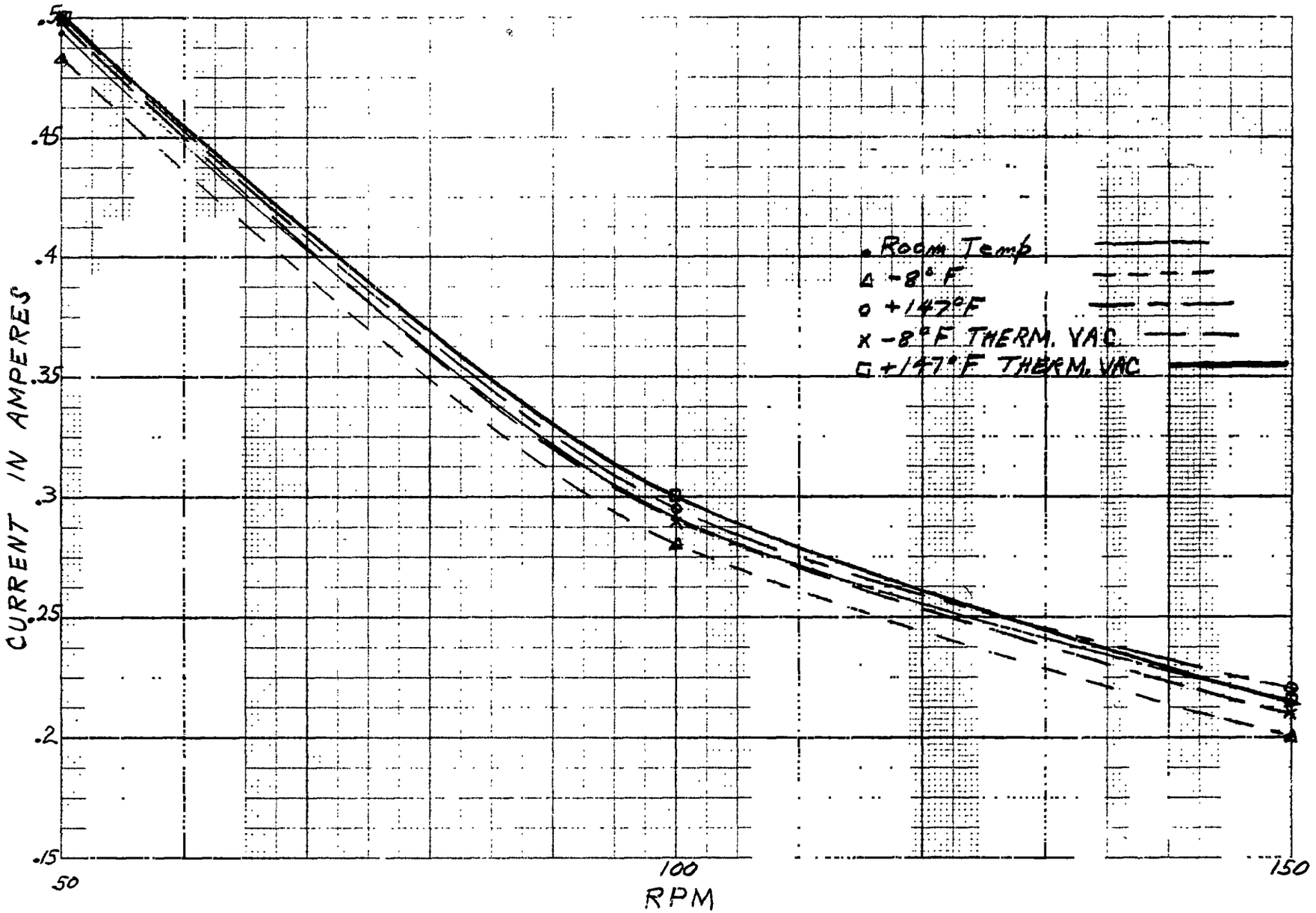


Figure C-2. Qual Model MDA System Current Vs. RPM 24 Volts

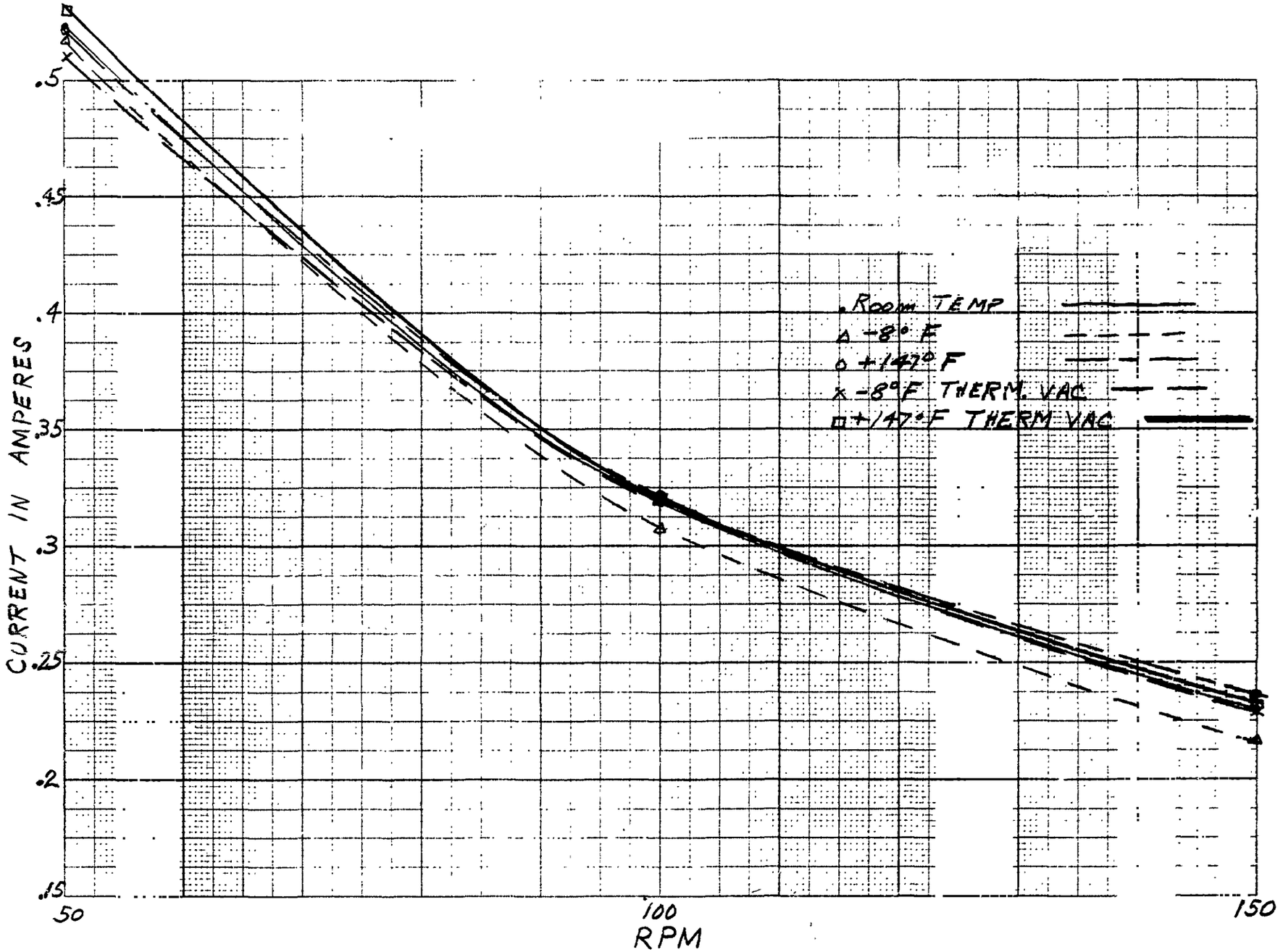


Figure C-3. Qual Model MDA System Current Vs. RPM 24.96 Volts

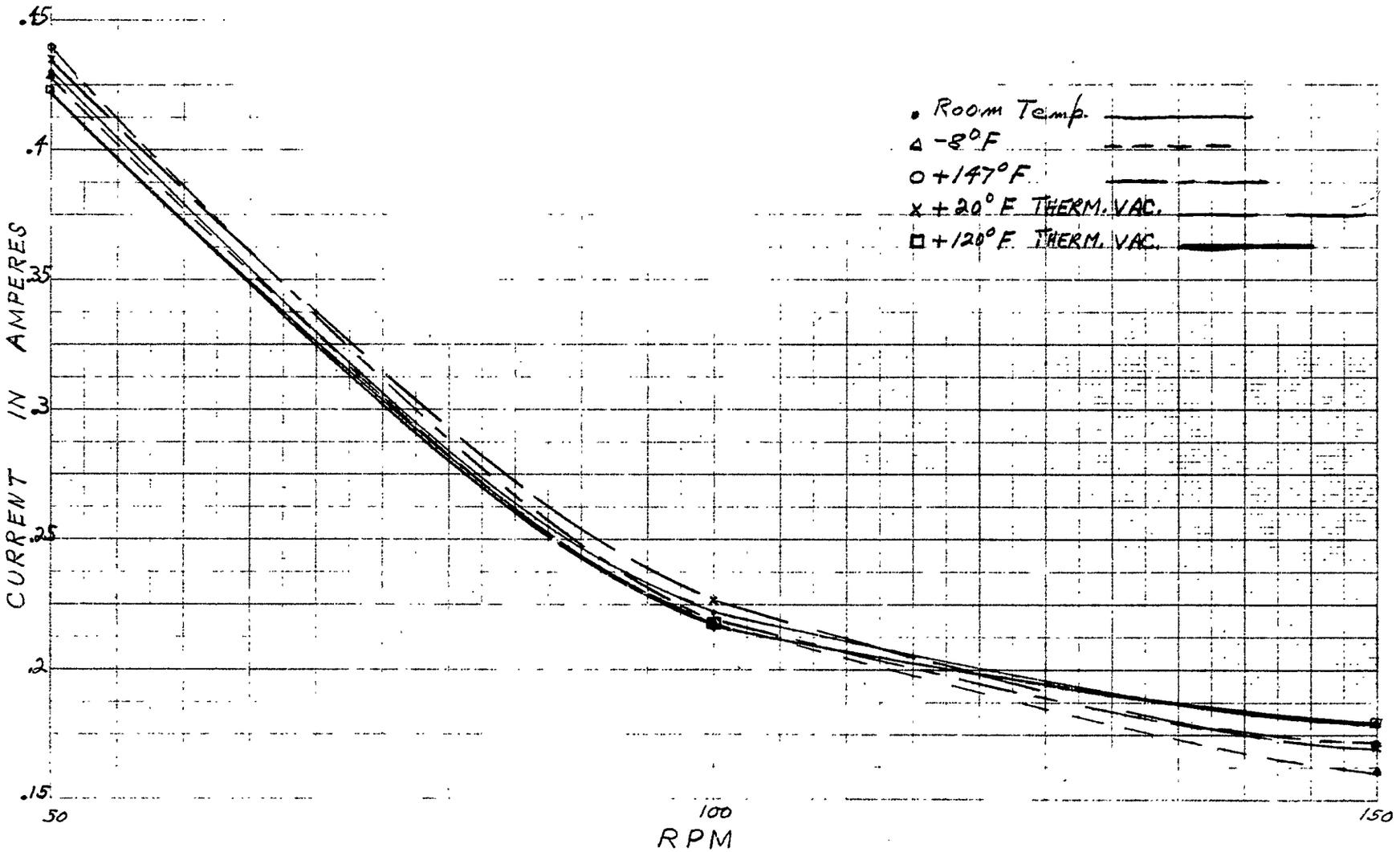


Figure C-4. Flight 1 MDA System Current Vs. RPM 23.04 Volts

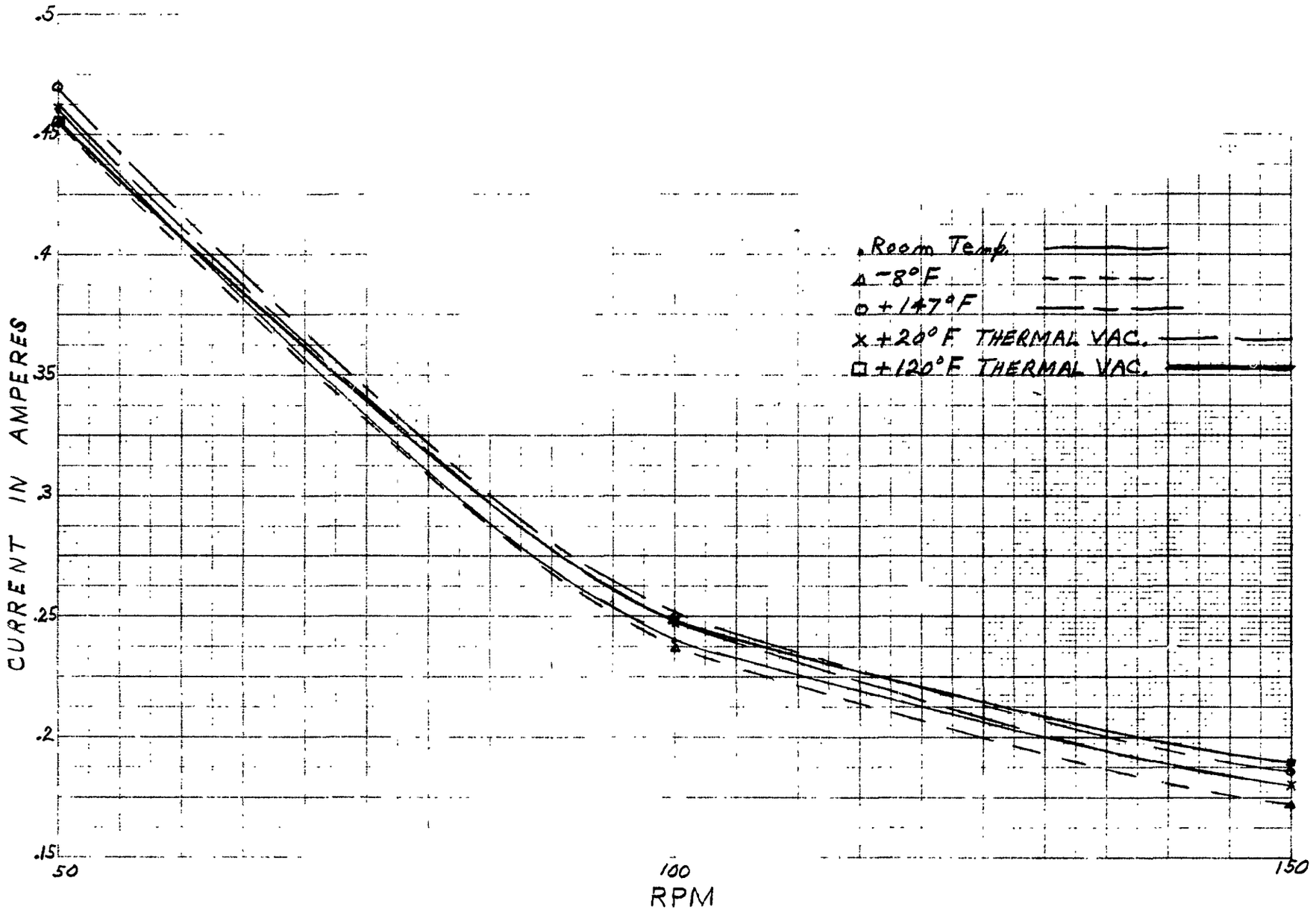


Figure C-5. Flight 1 MDA System Current Vs. RPM 24 Volts

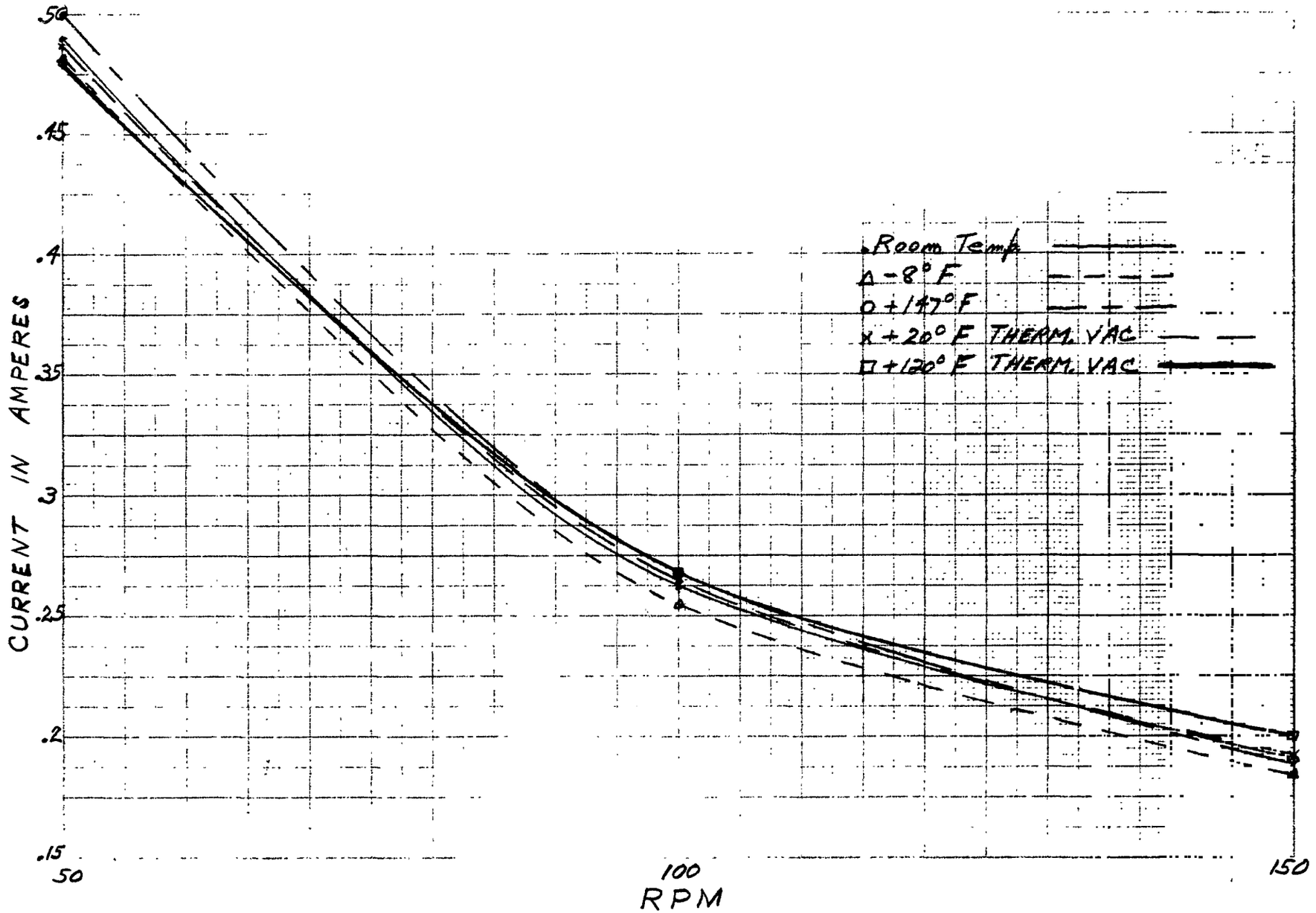


Figure C-6. Flight 1 MDA System Current Vs. RPM 24.96 Volts

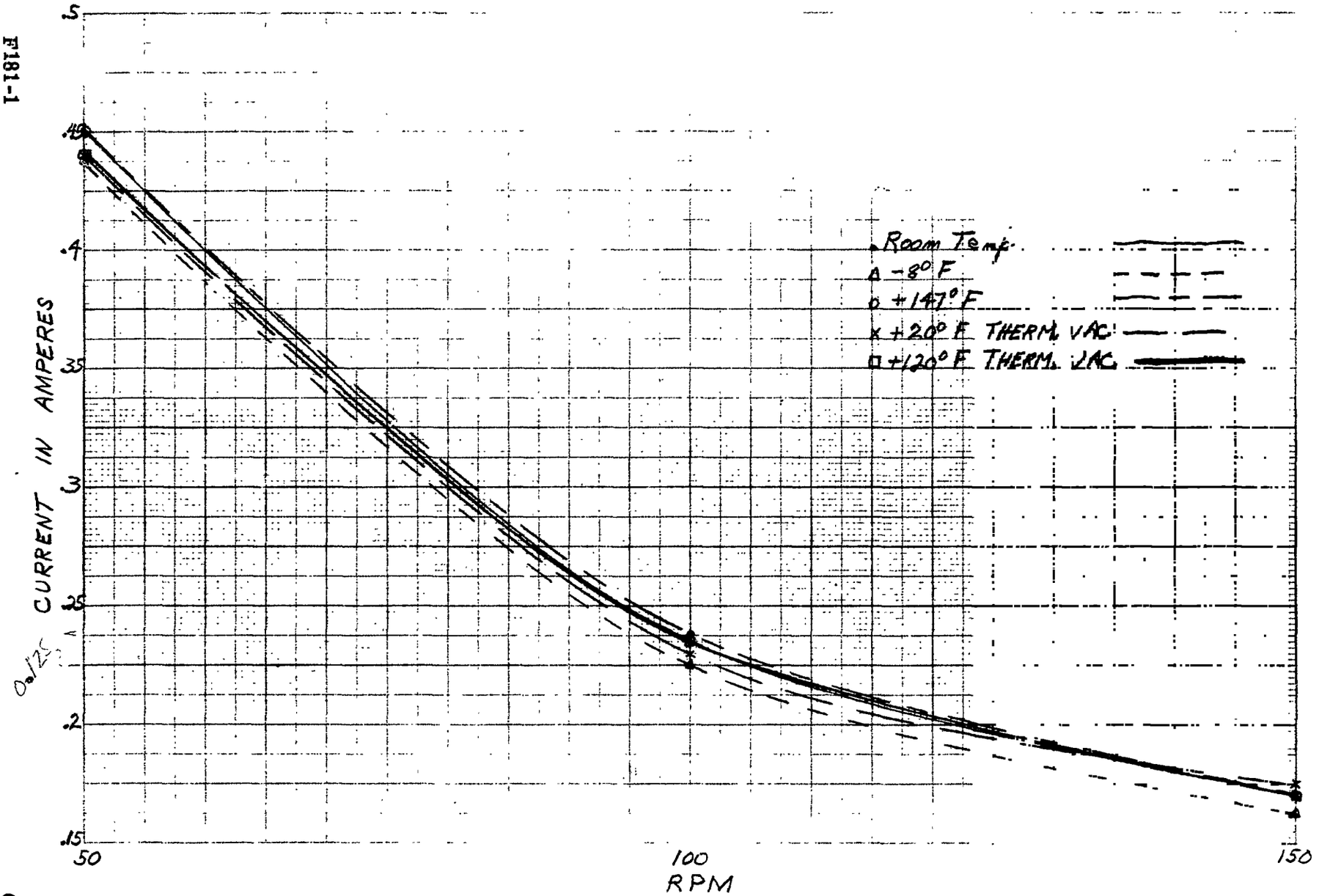


Figure C-7. Flight 2 MDA System Current Vs. RPM 23.04 Volts

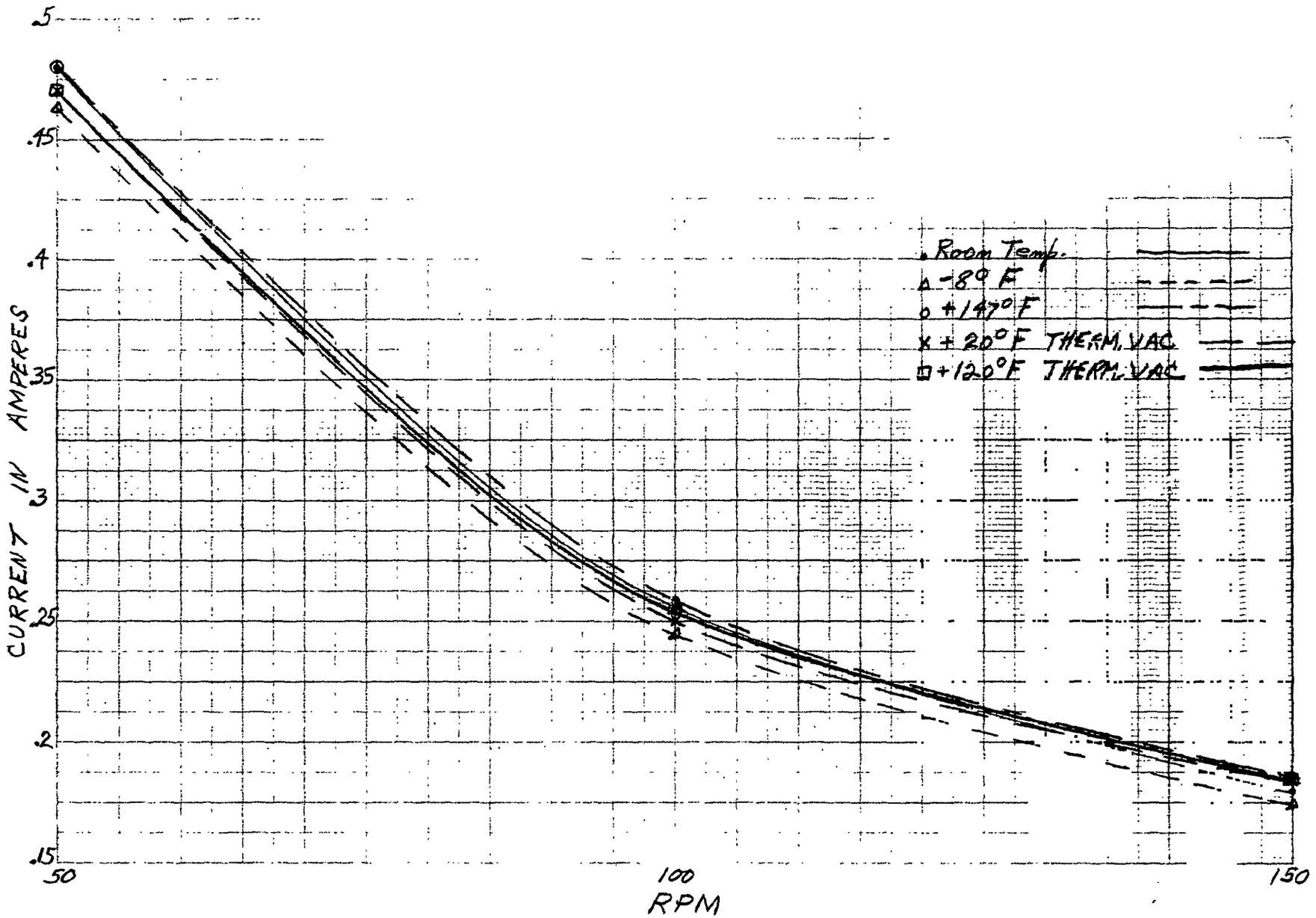


Figure C-8. Flight 2 MDA System Current Vs. RPM 24 Volts

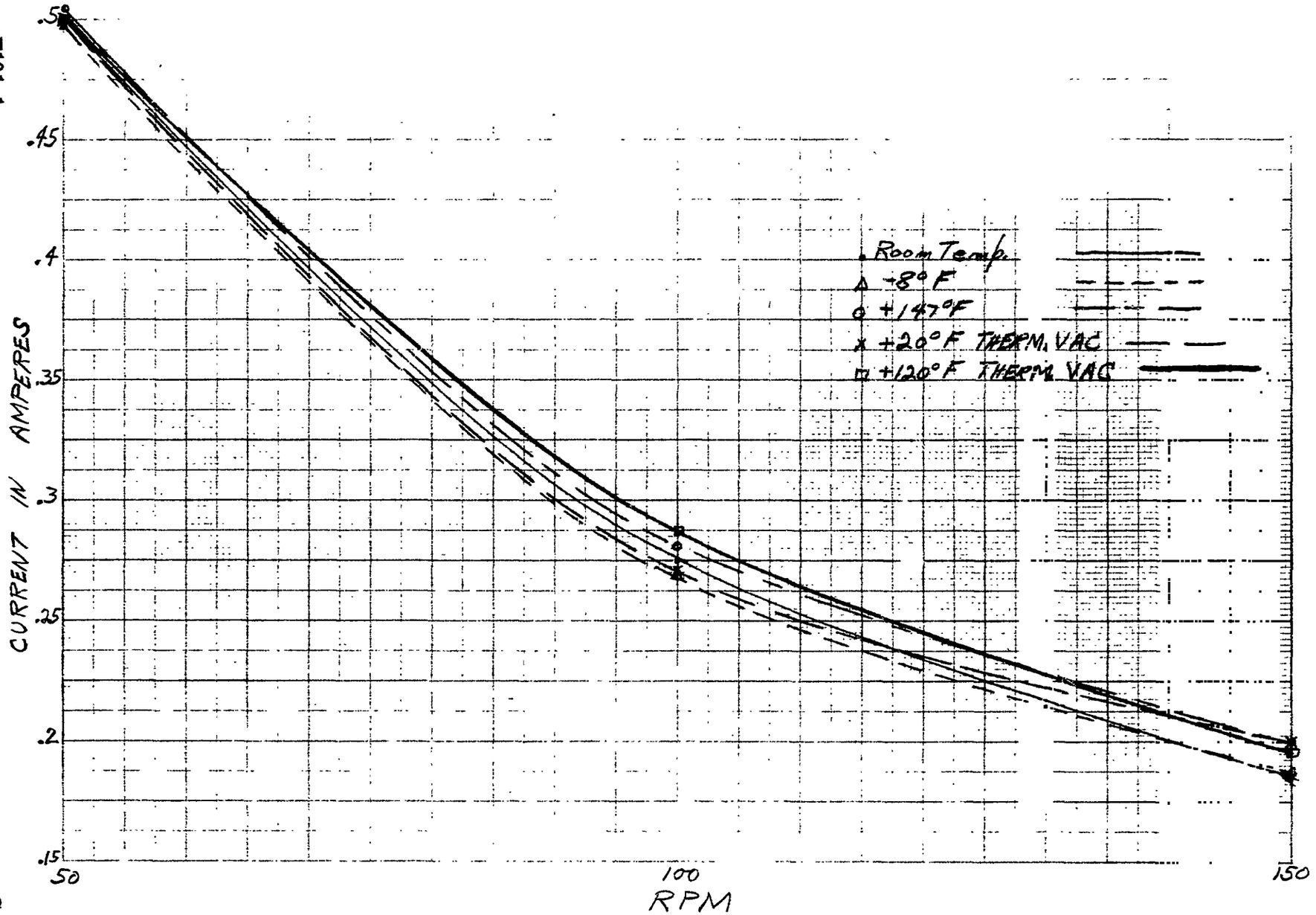


Figure C-9. Flight 2 MDA System Current Vs. RPM 24.96 Volts

APPENDIX D

VIBRATION TEST REPORTS

The following vibration test reports are for the qualification and flight acceptance testing of the Mechanical Drive Assembly and the Control System. These two basic components were vibrated independently. The Mechanical Drive was non-operating, whereas the Control System was operational during the testing.

Qualification Model

Test Report No. 5197

No. of Pages 5
Plus graphs

Report of Test on

ATS MECHANICAL DESPUN ANTENNA
for
SYLVANIA ELECTRONIC SYSTEMS
under
PURCHASE ORDER NO. 06811

ACTON ENVIRONMENTAL TESTING CORPORATION

Date February 7, 1967

	Prepared	Checked	Approved
By	R.Gilfoy	A.Giroux	M.L.Tolf
Signed	R. Gilfoy	A. Giroux	M. L. Tolf
Date	10 Feb 67	2-10-67	2/10/67

Government Inspector George Malta
George Malta

MLT:RG/hmf

Administrative Data

1.0 Purpose of Test: Qualification sine and random vibration to determine the ability of the antenna and associated electronics to withstand these dynamic environments.

2.0 Manufacturer: Sylvania Electronic Systems
100 First Avenue, Waltham, Massachusetts

3.0 Manufacturer's Type or Model No: ATS Mechanical Despun Antenna

4.0 Drawing, Specification or Exhibit: Qualification and Acceptance Test Plan Z181-3

5.0 Quantity of Items Tested: One (1)

6.0 Security Classification of Items: None. Government Inspection Required. Contract No. NAS 5-9521

7.0 Date Test Completed: January 20, 1967

8.0 Test Conducted By: A. Giroux

9.0 Disposition of Specimens: Returned to Sylvania Electronic Systems

10.0 Abstract: The electronics passed the vibration testing with no apparent problems. The antenna passed the sine and random vibration after two modifications were made to more securely retain the central vertical member.

Report No. 5197 Page 1

ACTON ENVIRONMENTAL TESTING CORPORATION

1.0 REQUIREMENTS

The Sylvania Electronic Systems, ATS Mechanical Despun Antenna, including the Control Electronics must meet the storage launch and space environment, defined in the NASA Goddard Space Flight Center Environmental Specification S2-0102.

2.0 PROCEDURES

2.1 SINUSOIDAL VIBRATION TESTS

The sinusoidal vibration test specified in paragraph 5.3.4 of Sylvania Electronics Systems Specification Z181-3 was performed on the control electronics and the ATS Despun Antenna. It should be noted that the test procedure had to be modified to take into account the operation of the Ling, A-300 System, on which the tests were performed. The vibration levels and sweep rate were not modified, only the procedure by which they were attained.

2.2 RANDOM VIBRATION TESTS

The random vibration tests specified in paragraph 5.3.5 of Sylvania Electornics Systems Specification

2.2 RANDOM VIBRATION TESTS (cont'd)

Z181-3 was performed on the control electronics and the ATS Mechanical Despun Antenna. The test procedure had to be modified as explained in paragraph 2.1 above.

3.0 RESULTS

3.1 SINUSOIDAL VIBRATION - CONTROL ELECTRONICS

On January 12, 1967, the control electronics passed the sinusoidal vibration tests specified in paragraph 2.1 above. No mechanical defects were noted on any of the control electronics modules in any of the three axes of vibration. The oscillographic recording data was retained by Sylvania personnel.

3.2 RANDOM VIBRATION - CONTROL ELECTRONICS

On January 12, 1967, the control electronics passed the sinusoidal vibration tests specified in paragraph 2.2 above. No mechanical defects were noted in any of the control electronics modules in any of the three (3) axes of vibration. The oscillographic recording data was retained by Sylvania personnel.

3.3 SINUSOIDAL VIBRATION - DESPUN ANTENNA

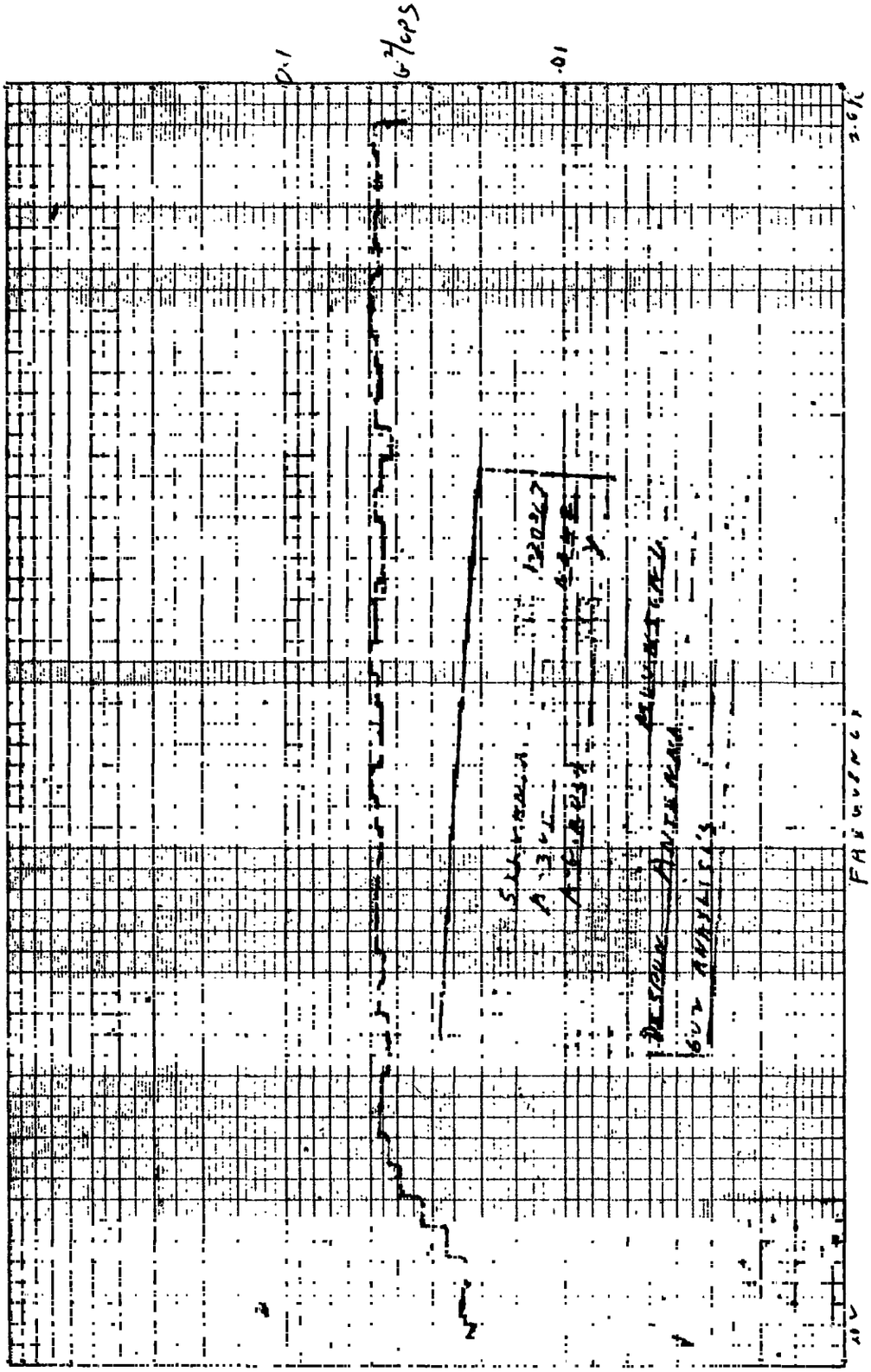
3.3.1 On January 9, 1967, the Despun Antenna passed the sinusoidal vibration test in the Z axis with no apparent defects. In the X axis, when the vibration input reached a frequency of 33 cps, the main vertical rod came out of the antenna ground plane structure. The unit was reassembled and the sweep restarted from 10 cps. This time the rod came out at 26 cps. The unit was removed and returned to Sylvania.

3.3.2 On January 14, 1967, the reworked antenna passed the sinusoidal vibration test in the Z axis with no apparent defects. In the X axis, the teflon shear pins added to retain the rod in the ground plane, showed signs of working out. During vibration in the Y axis the main vertical antenna rod came out of the ground plane at 50 cps. The antenna was returned to Sylvania for additional rework.

3.3.3 On January 20, 1967, the reworked Despun Antenna passed the sinusoidal vibration test specified in paragraph 2.1 above with no visible mechanical defects. X-Y recordings were made of the input vibration level in all three (3) axes of vibration and are included in this report. The oscillographic recording data taken during the course of the tests were retained by Sylvania personnel.

3.4 RANDOM VIBRATION - DESPUN ANTENNA

On January 20, 1967, the reworked Despun Antenna passed the random vibration test specified in paragraph 2.2 above, with no visible mechanical defects. The specified random vibration levels were automatically equalized and analyzed on a Ling Model ASDE-40 System. Plots of acceleration spectral density versus frequency were made during each axis of random vibration and are included in this report. The oscillographic recording data taken during the course of the random vibration tests was retained by Sylvania personnel.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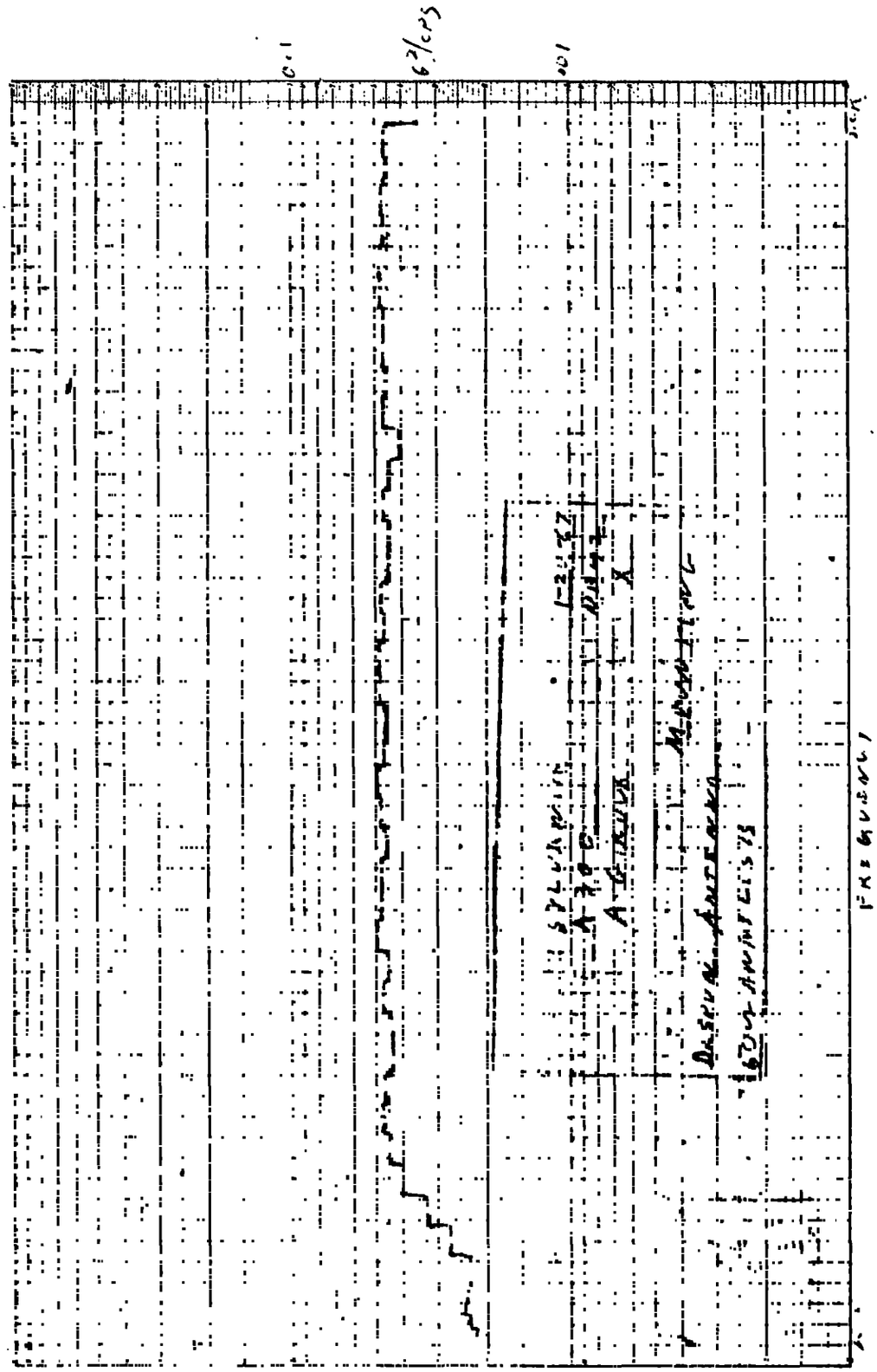

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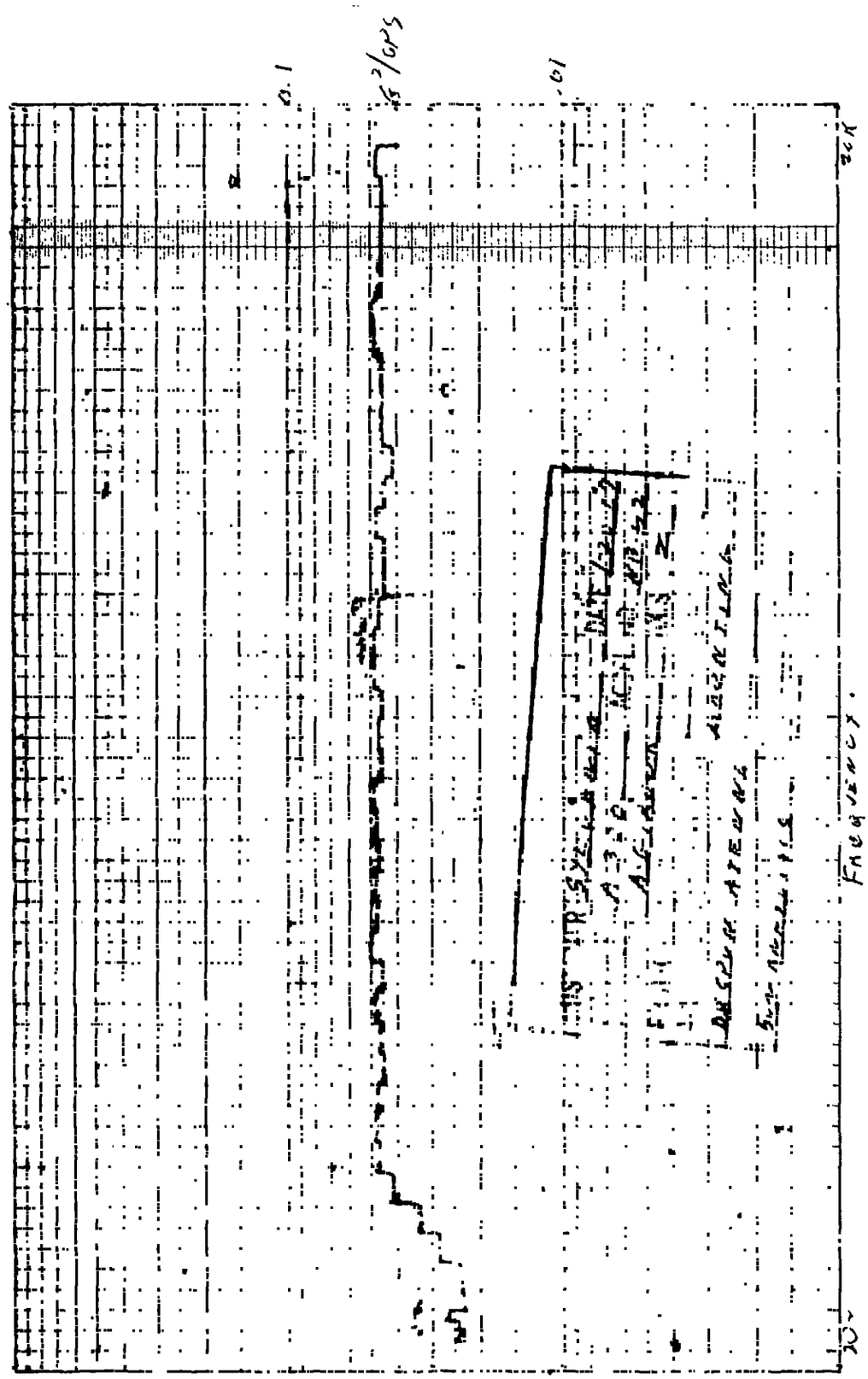
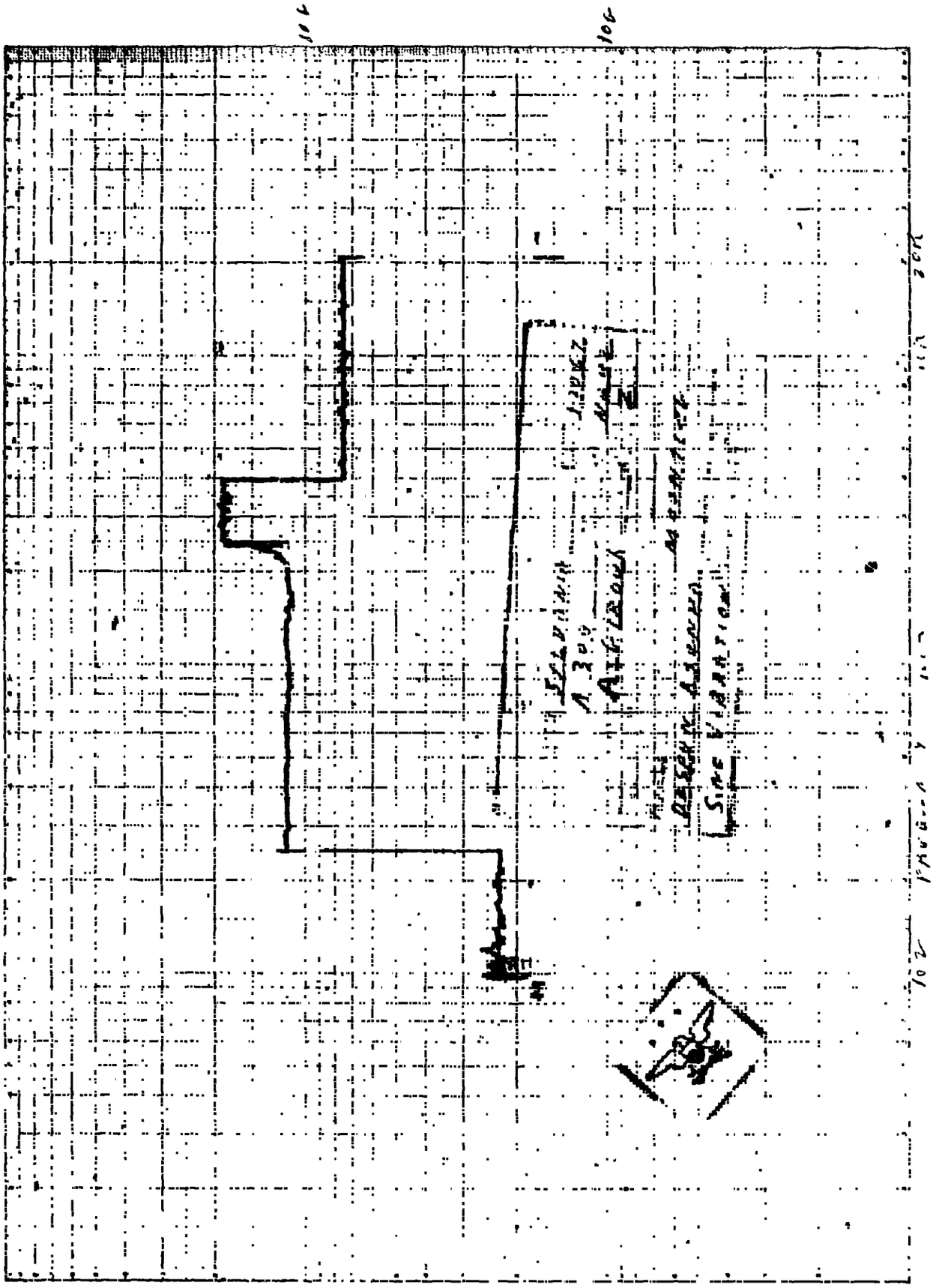
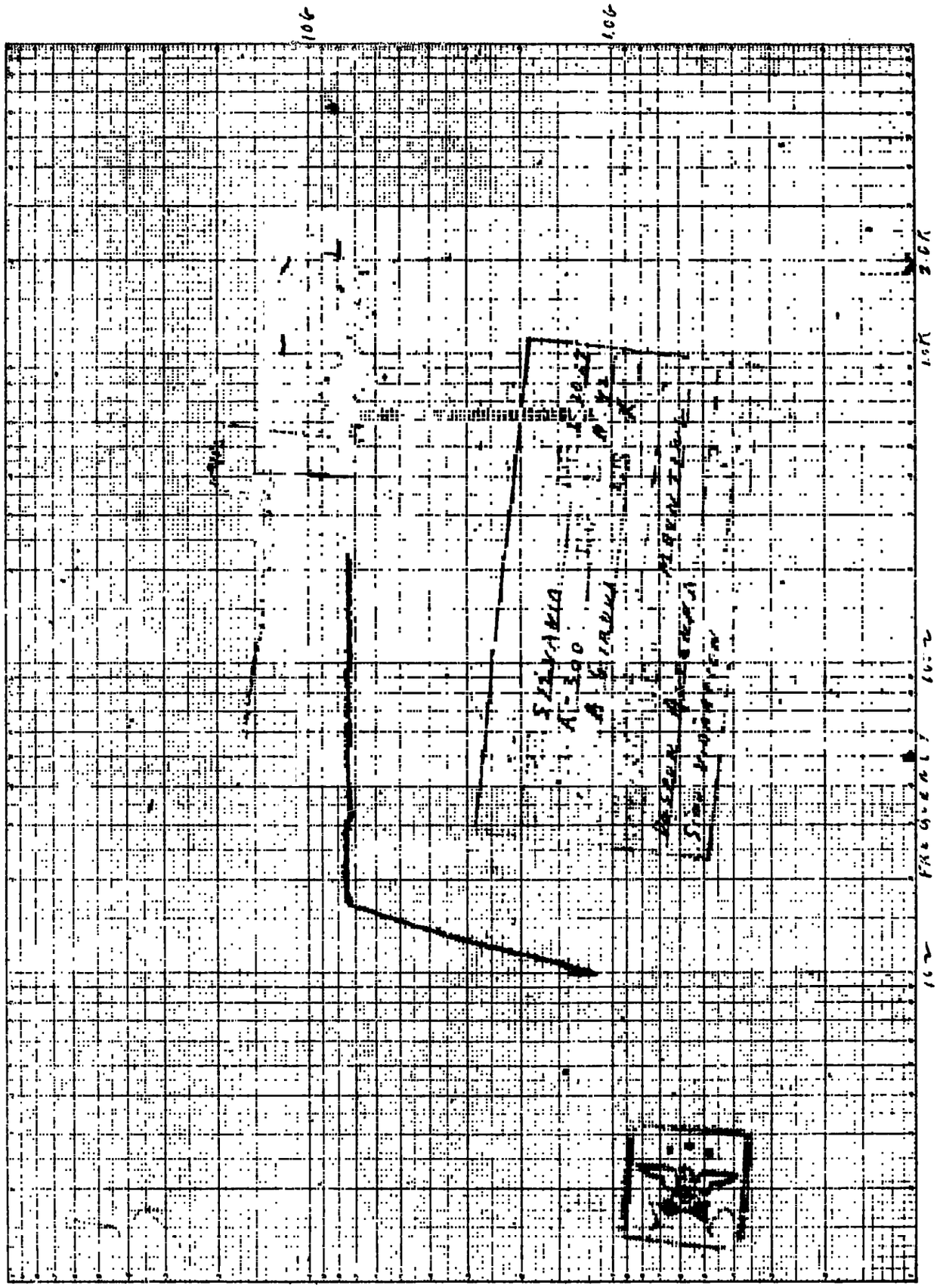
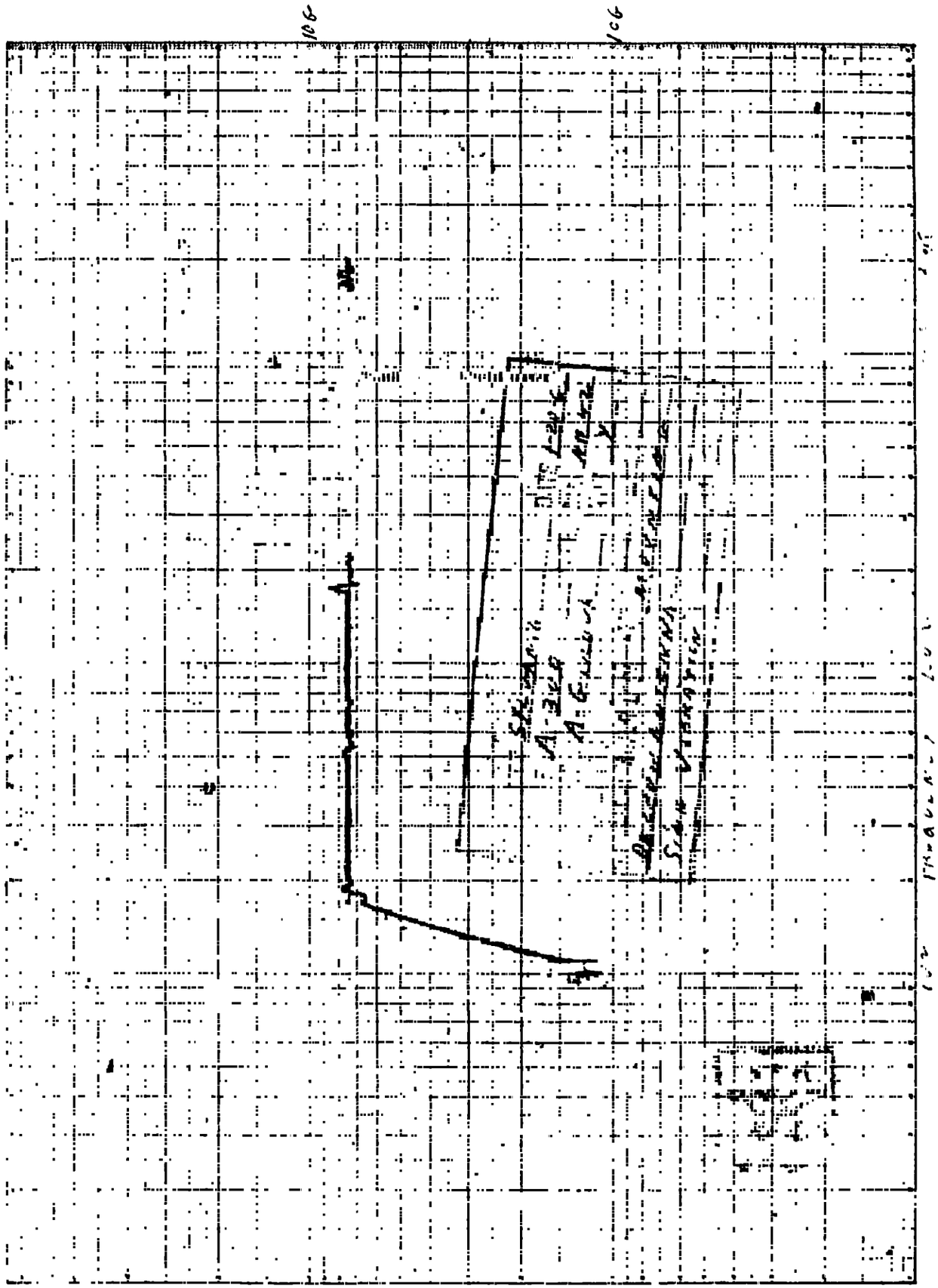








Flight Model (Unit #2)

Test Report No. 5338 No. of Pages 3

Report of Test on

A.T.S. MECHANICAL DESPUN ANTENNA
for
SYLVANIA ELECTRONIC SYSTEMS
Under
PURCHASE ORDER NO. C1622

ACTON ENVIRONMENTAL TESTING CORPORATION

Date April 12, 1967

	Prepared	Checked	Approved
By	R.Gilfoy	A. Giroux	M.L.Tolf
Signed	R. Gilfoy	A. Giroux	M.L. Tolf (for)
Date	12 APR 67	4-12-67	4-13-67

Government Inspector: George Malta
George Malta

Administrative Data

1.0 Purpose of Test: Acceptance sine and random vibration to determine the ability of the antenna and associated electronics to withstand these dynamic environments.

2.0 Manufacturer: Sylvania Electronic Systems
100 First Avenue, Waltham, Massachusetts

3.0 Manufacturer's Type or Model No: ATS Mechanical Despun Antenna Flight Model No. 2

4.0 Drawing, Specification or Exhibit: Qualification and Acceptance Test Plan 2181-3

5.0 Quantity of Items Tested: One (1) Each

6.0 Security Classification of Items: None. Government Inspection Required, Contract No. NAS-5-9521

7.0 Date Test Completed: March 22, 1967

8.0 Test Conducted By: A. Giroux

9.0 Disposition of Specimens: Returned to Sylvania Electronic Systems

10.0 Abstract: The antenna and electronics passed the acceptance vibration testing with no apparent problems.

Report No. 5338 Page 1

ACTON ENVIRONMENTAL TESTING CORPORATION

1.0 REQUIREMENTS

The Sylvania Electronic Systems, A.T.S. Mechanical Despun Antenna, including the Control Electronics must meet the storage launch and space environment defined in the NASA Goddard Space Flight Center Environmental Specification S2-0102.

2.0 PROCEDURES

2.1 SINUSOIDAL VIBRATION TESTS

The sinusoidal vibration test specified in paragraph 6.3.1 of Sylvania Electronic Systems Specification Z181-3 was performed in a clean room on the control electronics and the A.T.S. Despun Antenna. It should be noted that the test procedure had to be modified to take into account the operation of the Ling A-300 System, on which the tests were performed. The vibration levels and sweep rate were not modified, only the procedure by which they were attained.

2.2 RANDOM VIBRATION TESTS

The random vibration test specified in paragraph 6.3.2 of Sylvania Electronic Systems Specification Z181-3 was performed in a clean room on the control electronics and the A.T.S. Despun Antenna. The test procedure had to be modified as explained in paragraph 2.1 above.

3.0 RESULTS

3.1 SINUSOIDAL VIBRATION - CONTROL ELECTRONICS

On March 22, 1967 the control electronics passed the sinusoidal vibration tests specified in paragraph 2.1 above. No mechanical defects were noted on any of the control electronics modules in any of the three (3) axes of vibration. The oscillographic recording data was retained by Sylvania personnel.

3.0 RESULTS (Cont'd)

3.2 RANDOM VIBRATION - CONTROL ELECTRONICS

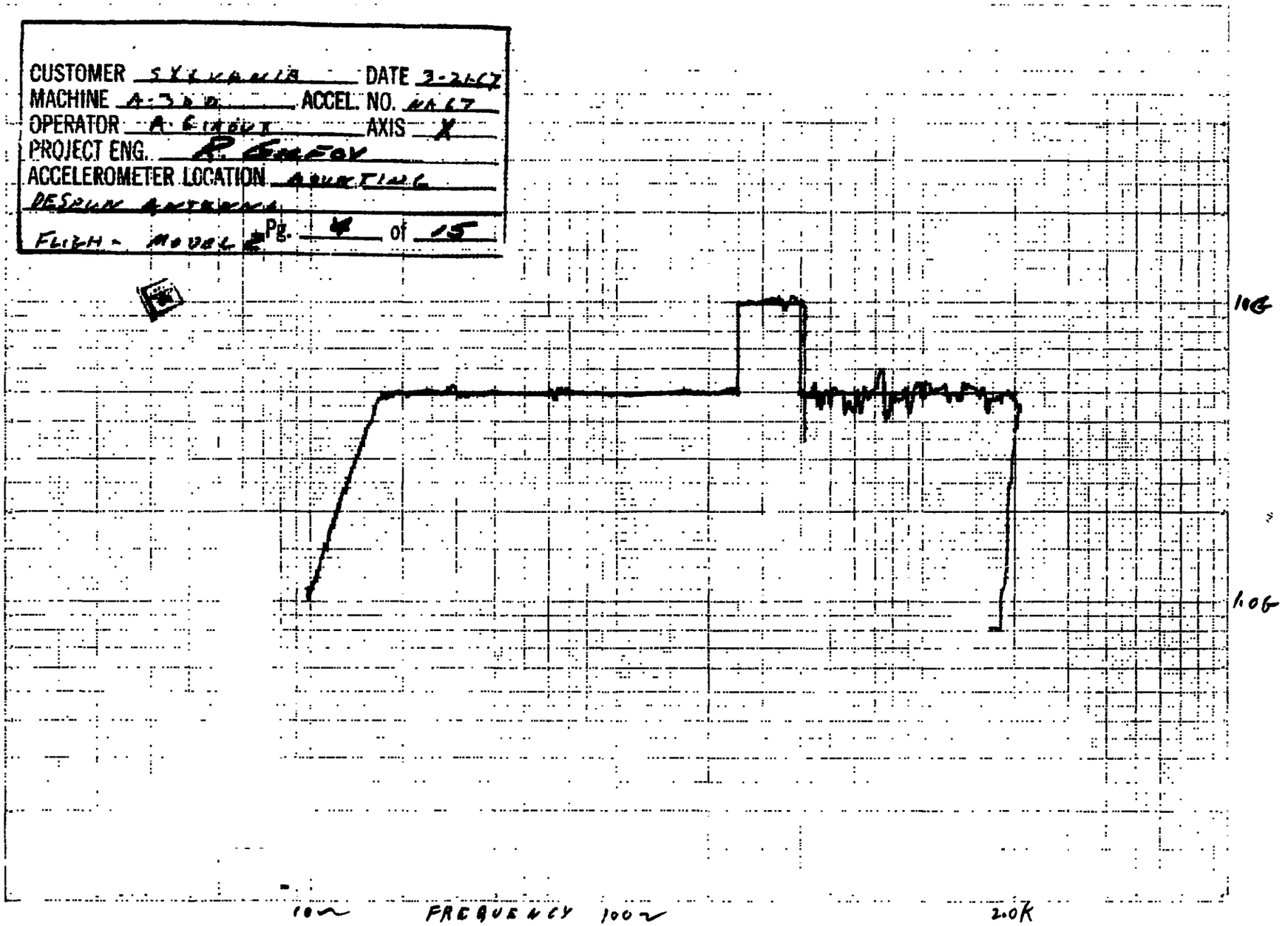
On March 22, 1967 the control electronics passed the random vibration tests specified in paragraph 2.2 above. No mechanical defects were noted in any of the control electronics modules in any of the three (3) axes of vibration. The oscillographic recording data was retained by Sylvania personnel.

3.3 SINUSOIDAL VIBRATION - A.T.S. MECHANICAL DESPUN ANTENNA

On March 21, 1967 the A.T.S. Mechanical Despun Antenna passed the sinusoidal vibration tests specified in paragraph 2.1 above. No mechanical defects were noted on the Despun Antenna in any of the three (3) axes of vibration. The oscillographic recording data was retained by Sylvania personnel.

3.4 RANDOM VIBRATION - A.T.S. MECHANICAL DESPUN ANTENNA

On March 21, 1967 the A.T.S. Mechanical Despun Antenna passed the random vibration tests specified in paragraph 2.2 above. No mechanical defects were noted on the Despun Antenna in any of the three (3) axes of vibration. The oscillographic recording data was retained by Sylvania personnel.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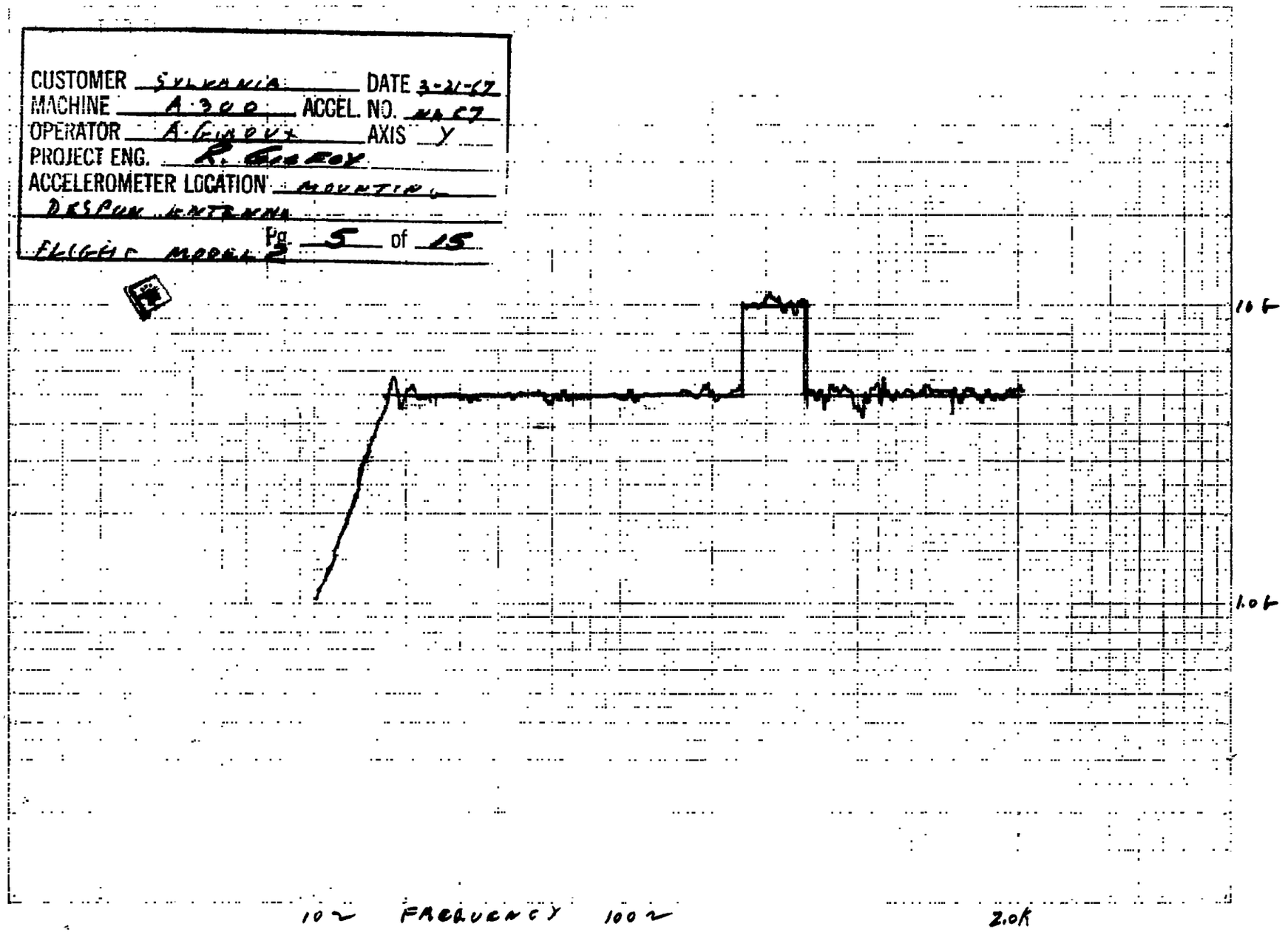
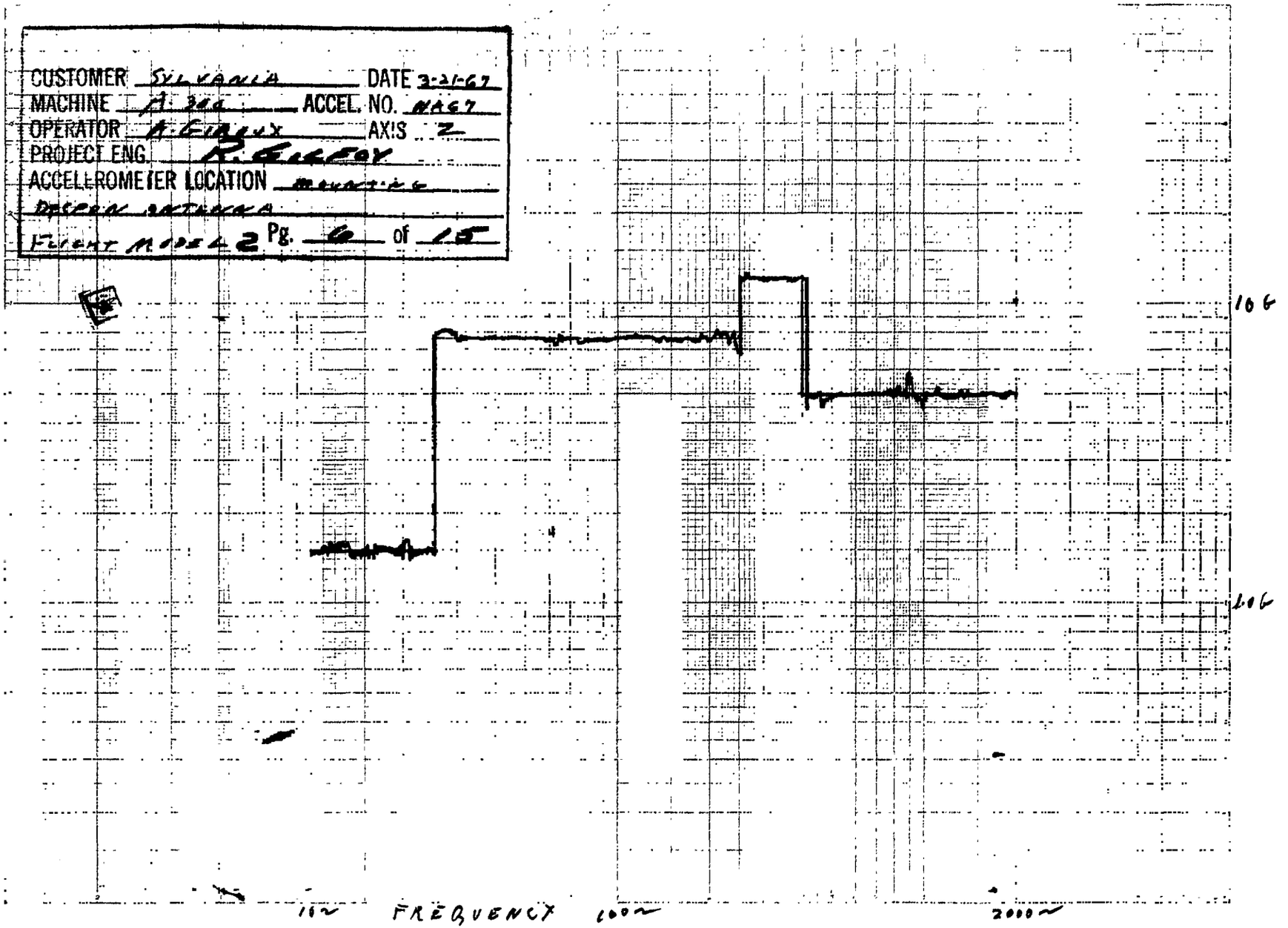
MACHINE A-300 ACCEL. NO. NA 67
OPERATOR A. GIROUX AXIS X
PROJECT ENG. R. GRAFOV
ACCELEROMETER LOCATION MOUNTING
DESPUN ANTENNA
FLIGHT MODEL 2 Pg. 4 of 15
10G
1.0G
10~
FREQUENCY 100~
2.0K

CUSTOMER SYLVANIA DATE 3-21-67
MACHINE A-300 ACCEL. NO. [illegible]
OPERATOR A. [illegible] AXIS Y
PROJECT ENG. R. [illegible]
ACCELEROMETER LOCATION MOUNTING
DESPUN ANTENNA
FLIGHT MODEL 2 Pg. 5 of 15

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MACHINE A 300 ACCEL. NO. NA67
OPERATOR A. GIROUX AXIS Z
PROJECT ENG. R. GILFOY
ACCELEROMETER LOCATION MOUNTING
DESPUN ANTENNA
FLIGHT MODEL 2 Pg. 6 of 15
10G
1.0G
10~
FREQUENCY
100~
2000~

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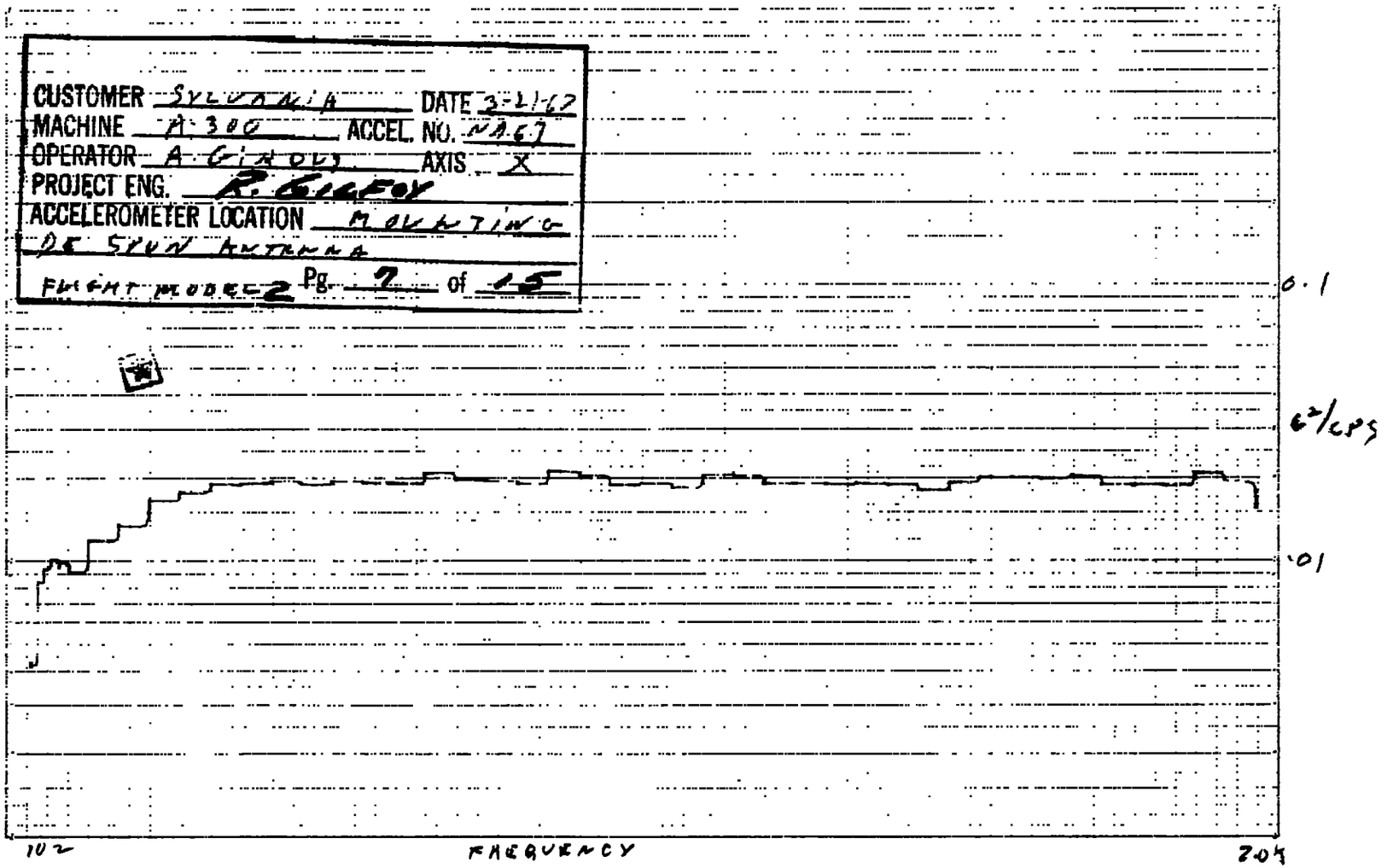

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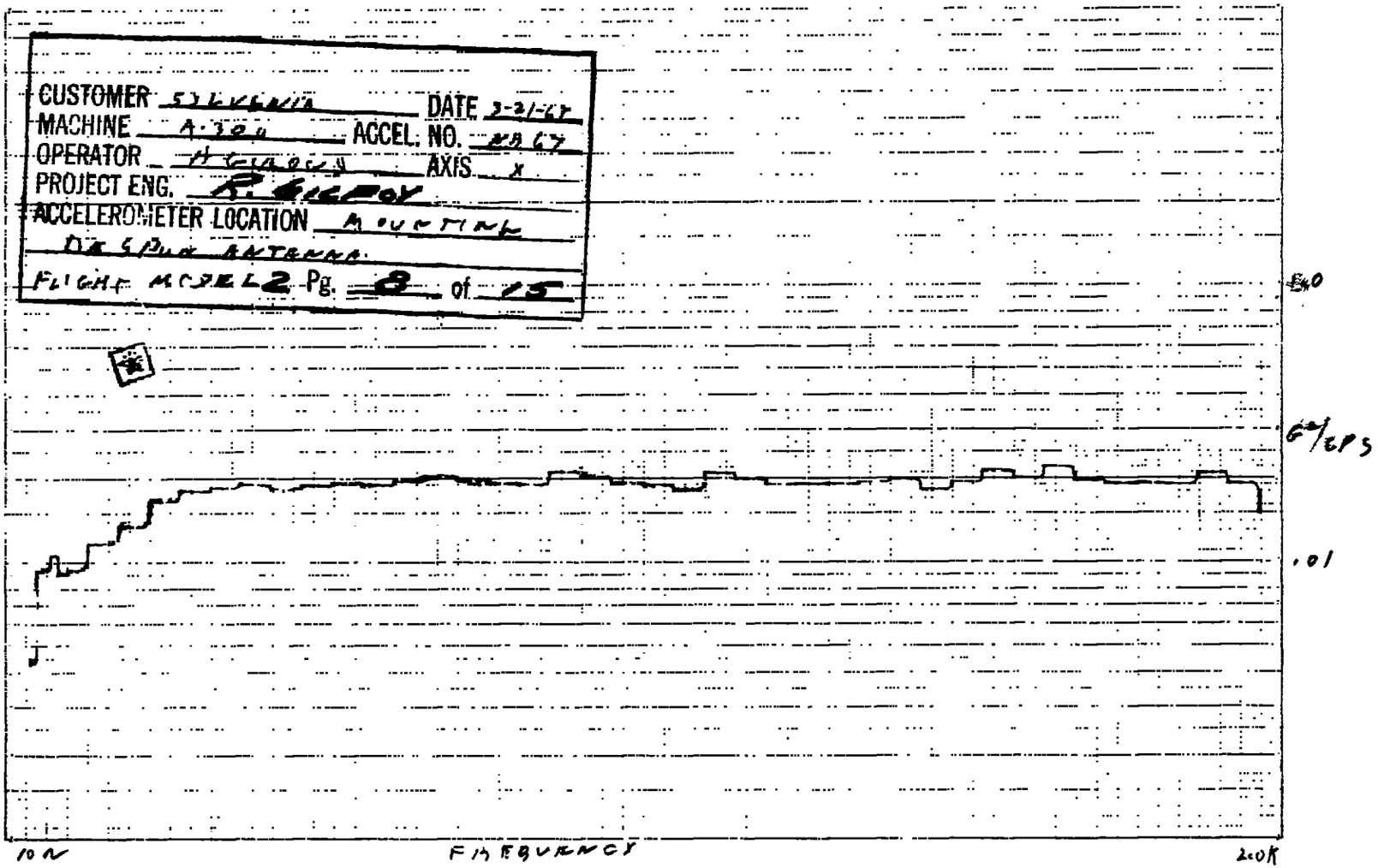

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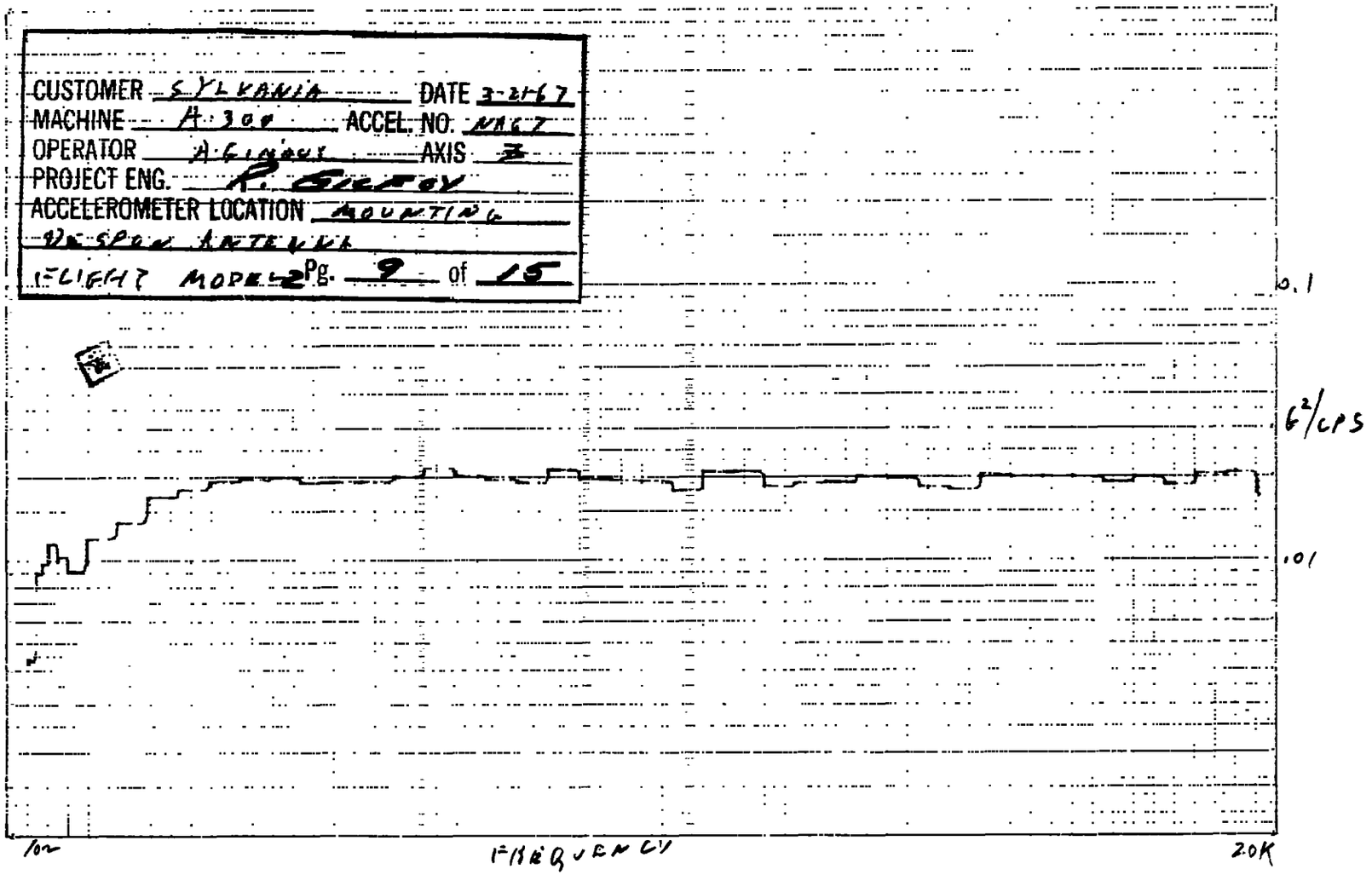

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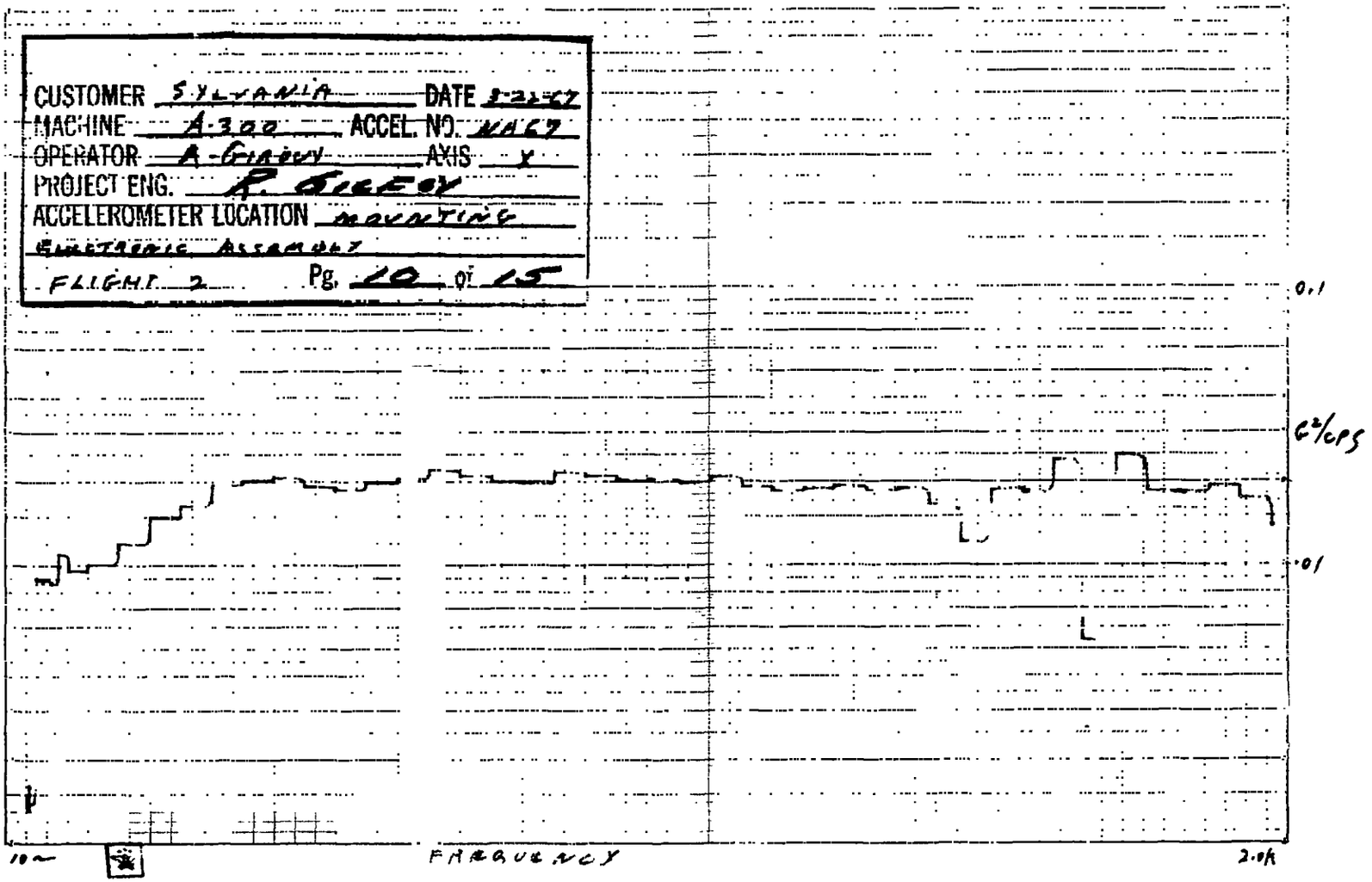

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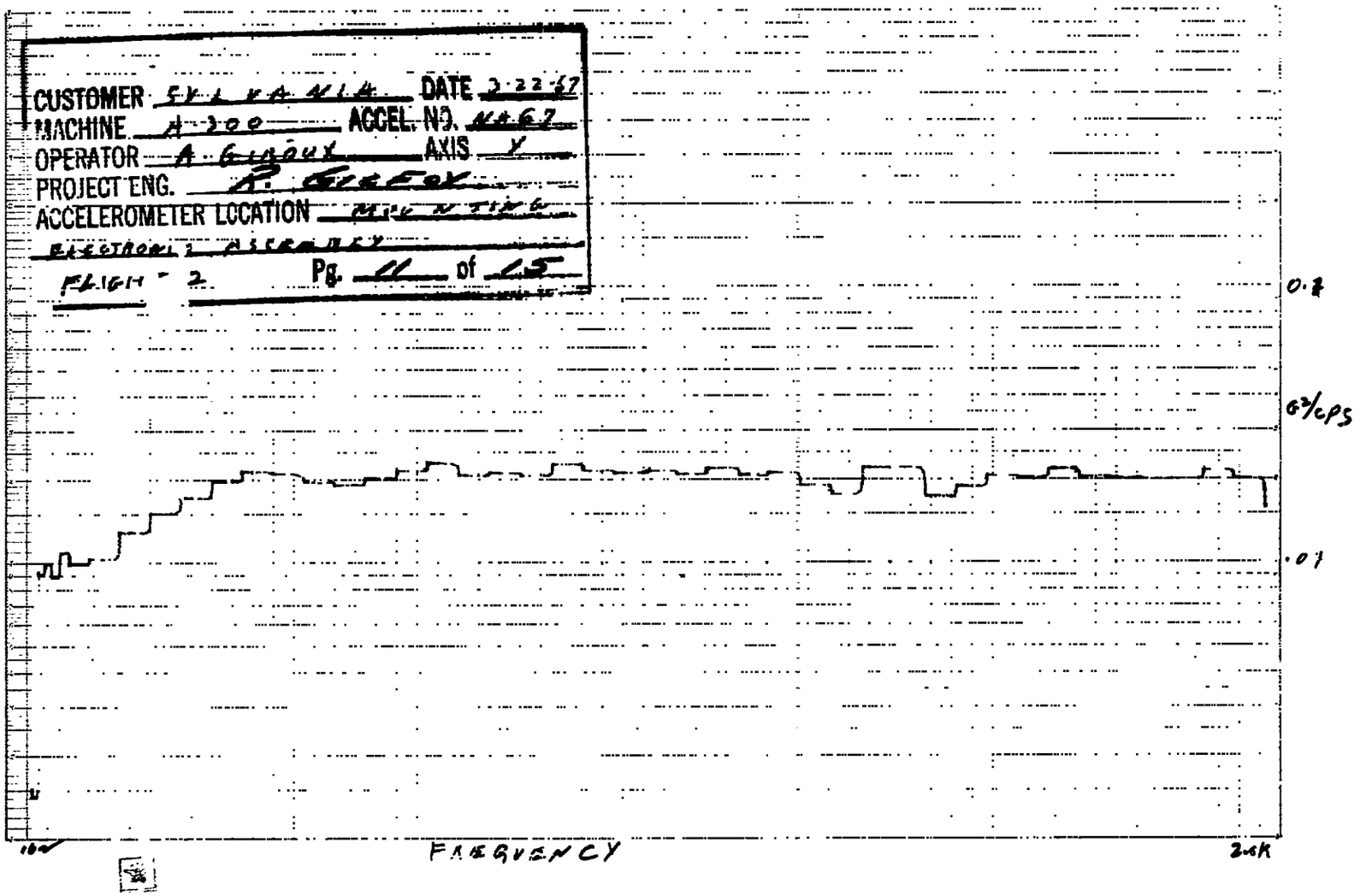

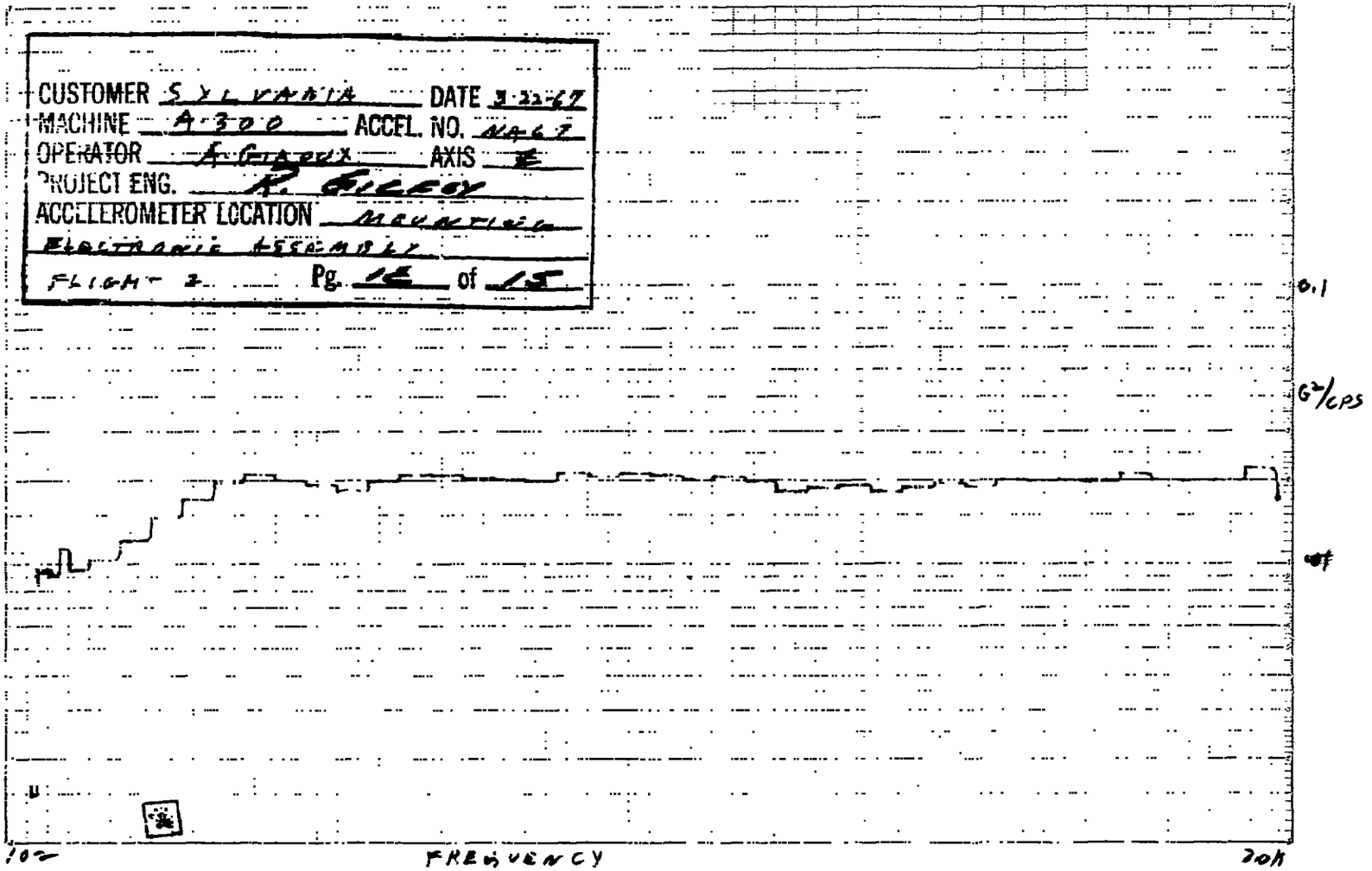
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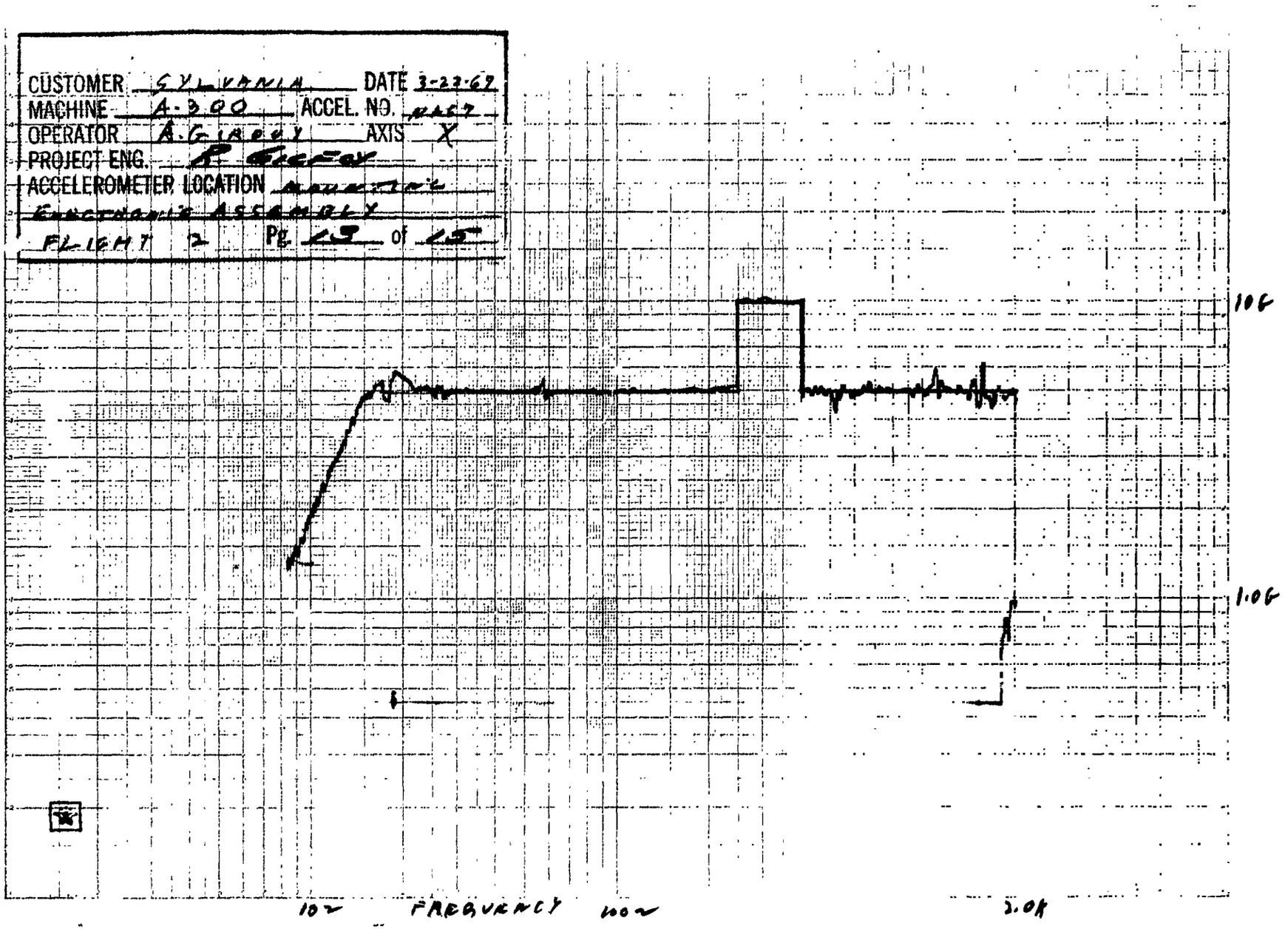
ELECTRONIC ASSEMBLY
FLIGHT 2 Pg. 12 of 15
0.1
G²/CPS
10
FREQUENCY
20K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Pg. 15 of 15
10G
1.0G
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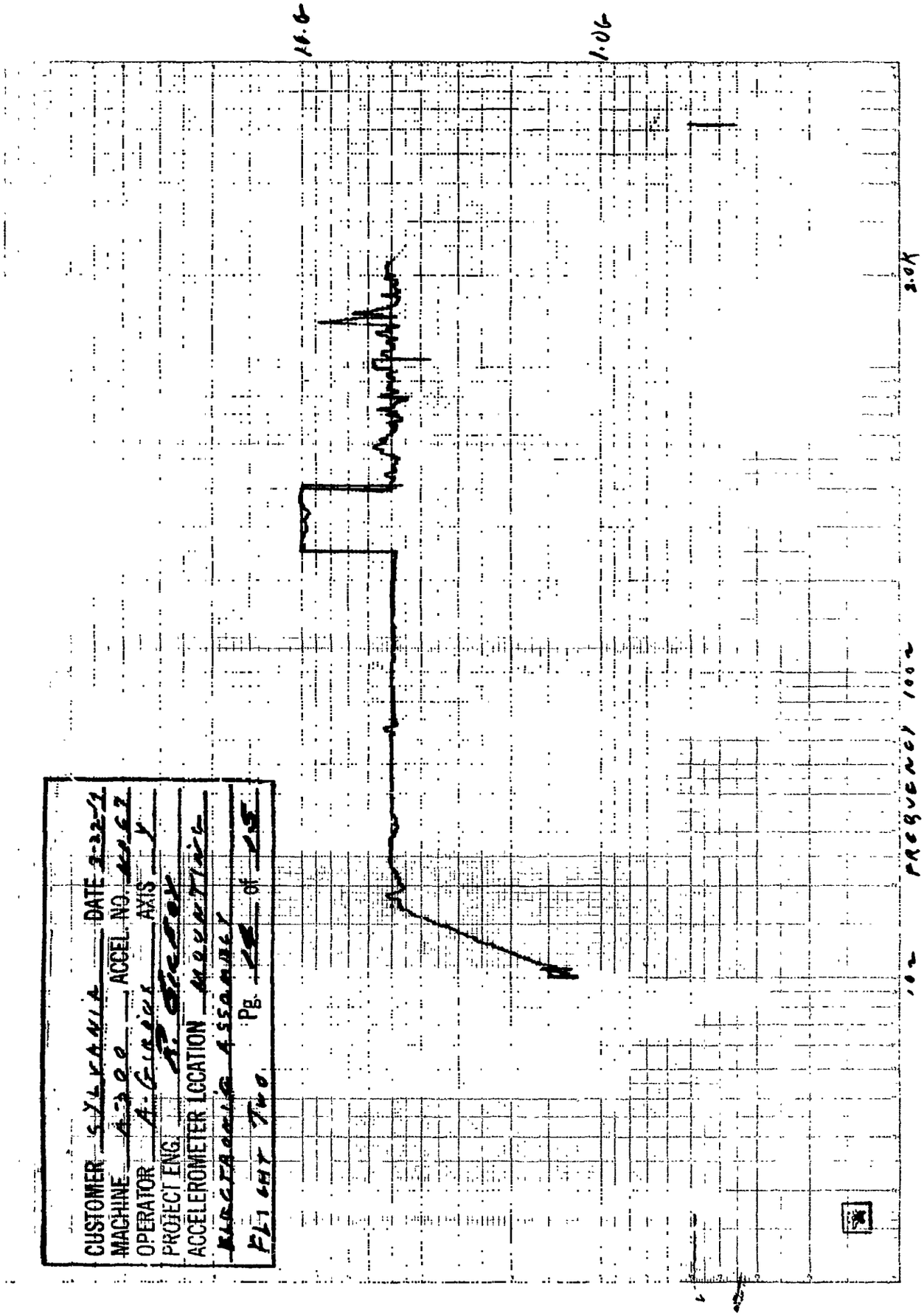
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Pg. of
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1.0
2.0K
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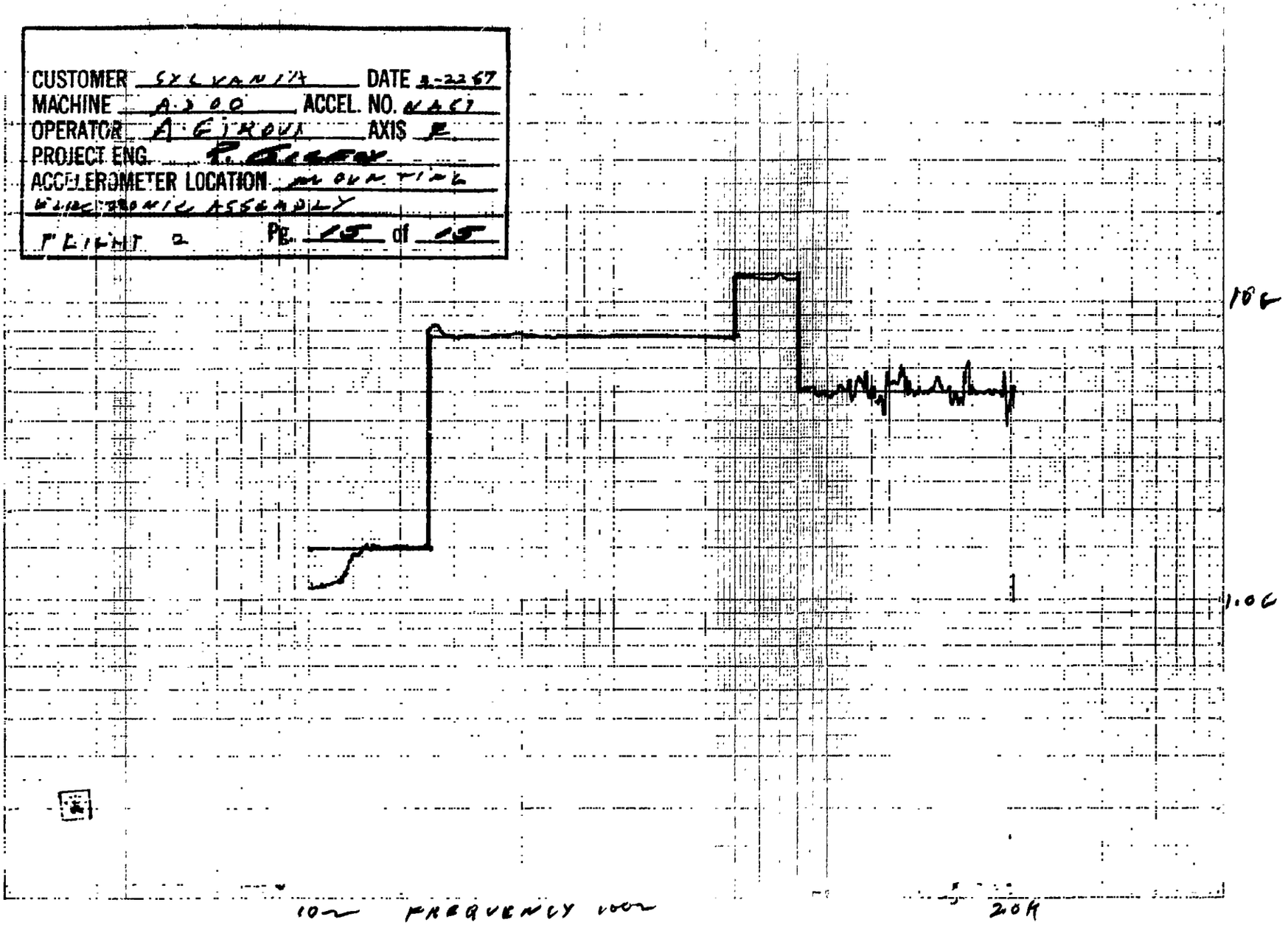
FREQUENCY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ELECTRONIC ASSEMBLY
FLIGHT 2 Pg. 15 of 15
10G
1.0G
10~ FREQUENCY 100~
20K

Flight Back Up Model (Unit #1)

Test Report No. 5338 No. of Pages 22

Report of Test on

A.T.S. MECHANICAL DESPUN ANTENNA
For
SYLVANIA ELECTRONIC SYSTEMS
Under
PURCHASE ORDER NO. C 1622

ACTON ENVIRONMENTAL TESTING CORPORATION

Date April 29, 1967

	Prepared	Checked	Approved
By	R. Gilfoy	A. Giroux	M.L.Tolf
Signed	R. Gilfoy	A. Giroux	M. L. Tolf
Date	3 May 67	5/3/67	3/3/67

Government Inspector _____
George Malta

Administrative Data

1.0 Purpose of Test: Qualification sine and random vibration to determine the ability of the antenna and associated electronics to withstand these dynamic environments.

2.0 Manufacturer: Sylvania Electronic Systems
100 First Street, Waltham, Mass.

3.0 Manufacturer's Type or Model No: A.T.S. Mechanical Despun Antenna, Flight Model #1

4.0 Drawing, Specification or Exhibit: Qualification and Acceptance Test Plan Z181-3.

5.0 Quantity of Items Tested: One (1) each

6.0 Security Classification of Items: None. Government Source Inspection required. Contract No. NAS5-9521.

7.0 Date Test Completed: April 28, 1967

8.0 Test Conducted By: A. Giroux

9.0 Disposition of Specimens: Returned to Sylvania Electronic Systems.

10.0 Abstract: The antenna and electronics passed the Acceptance Vibration Testing with no apparent mechanical problems. When the antenna was returned to SES-E, out-of-tolerance electrical measurements were noted. These problems were corrected and the antenna was resubmitted for vibration testing. The antenna subsequently passed the vibration tests specified herein with no apparent mechanical problems.

Report No. 5338 Page 1

ENVIRONMENTAL TESTING CORPORATION ACTON

1.0 REQUIREMENTS

The Sylvania Electronic Systems A.T.S. Mechanical Despun Antenna, including the control Electronics, must meet the storage launch and space environment defined in the NASA Goddard Space Flight Center Environmental Specification S2-0102.

2.0 PROCEDURES

2.1 SINUSOIDAL VIBRATION TESTS

The sinusoidal vibration test specified in paragraph 6.3.1 of Sylvania Electronic Systems Specification Z181-3 was performed in a clean room on the control electronics and the A.T.S. Despun Antenna. It should be noted that the test procedure had to be modified to take into account the operation of the Ling A-300 System, on which the tests were performed. The vibration levels and sweep rate were not modified, only the procedure by which they were attained. It should also be noted that the vibration of the Despun Antenna was videotaped.

2.2 RANDOM VIBRATION TESTS

The random vibration tests specified in paragraph 6.3.2 of Sylvania Electronic Systems Specification Z181-3 was performed in a clean room on the control electronics and the A.T.S. Mechanical Despun Antenna. The test procedure had to be modified as explained in paragraph 2.1 above.

3.0 RESULTS

3.1 SINUSOIDAL VIBRATION - CONTROL ELECTRONICS

On April 28, 1967 the control electronics passed the sinusoidal vibration test specified in paragraph 2.1 above. No mechanical defects were noted on any of the control electronic modules in any of the three (3) axes of vibration. The oscillographic recording data will be included with this test report.

3.2 RANDOM VIBRATION - CONTROL ELECTRONICS

On April 28, 1967 the control electronics passed the random vibration tests specified in paragraph 2.2 above. No mechanical defects were noted in any of the control electronic modules in any of the three (3) axes of vibration. The oscillographic recording data will be included in this test report.

3.3 SINUSOIDAL VIBRATION - A.T.S. MECHANICAL DESPUN ANTENNA

On April 27, 1967 the A.T.S. Mechanical Despun Antenna passed the sinusoidal vibration tests specified in paragraph 2.1 above. No mechanical defects were noted on the Despun Antenna in any of the three (3) axes of vibration. The oscillographic recording data will be included in this test report.

3.4 RANDOM VIBRATION - A.T.S. MECHANICAL DESPUN ANTENNA

On April 27, 1967 the A.T.S. Mechanical Despun Antenna passed the random vibration tests specified in paragraph 2.2 above. No mechanical defects were noted on the Despun Antenna in any of the three (3) axes of vibration. The oscillographic recording data will be included in this report.

3.0 RESULTS (Cont'd)

3.5 ELECTRICAL TESTS

After the A.T.S. Mechanical Despun Antenna was returned to Sylvania, electrical tests were performed on it. During these tests it was noted that the VSWR readings were out-of-tolerance. The antenna was disassembled and the internal difficulties corrected.

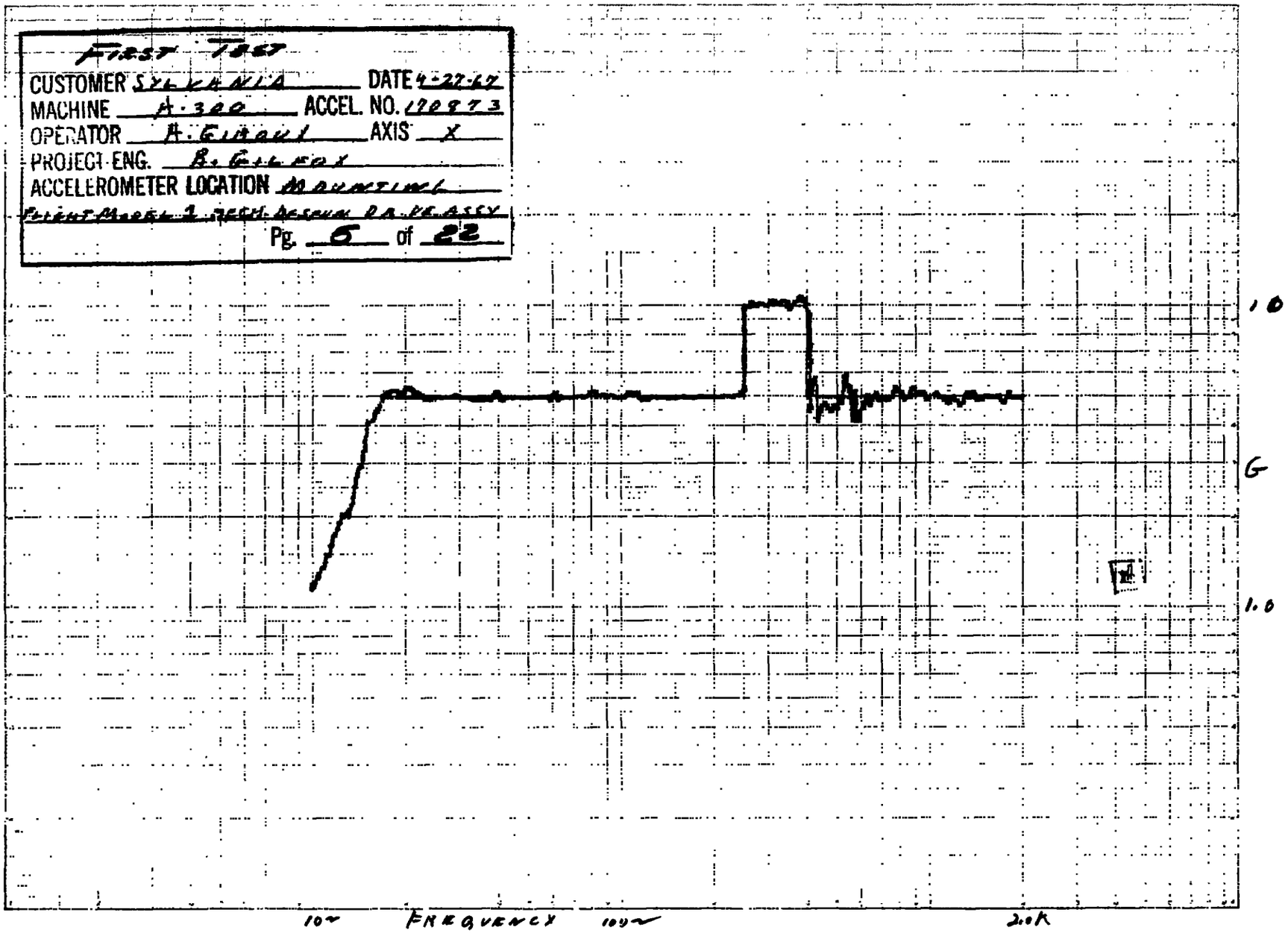
4.0 RE-TEST

4.1 PROCEDURE

The vibration tests specified in paragraph 2.0 above were repeated on the A.T.S. Mechanical Despun Antenna, Flight Model #1 on May 3, 1967.

4.2 RESULTS

The A.T.S. Mechanical Despun Antenna passed the sine and random vibration tests specified in paragraph 2.0 with no apparent mechanical difficulties. X-Y Plots of control accelerometer acceleration vs. frequency for sine vibration and power spectral density vs. frequency for random vibration are included with this report. Oscillographic data from the specified tri-axial accelerometers are also included.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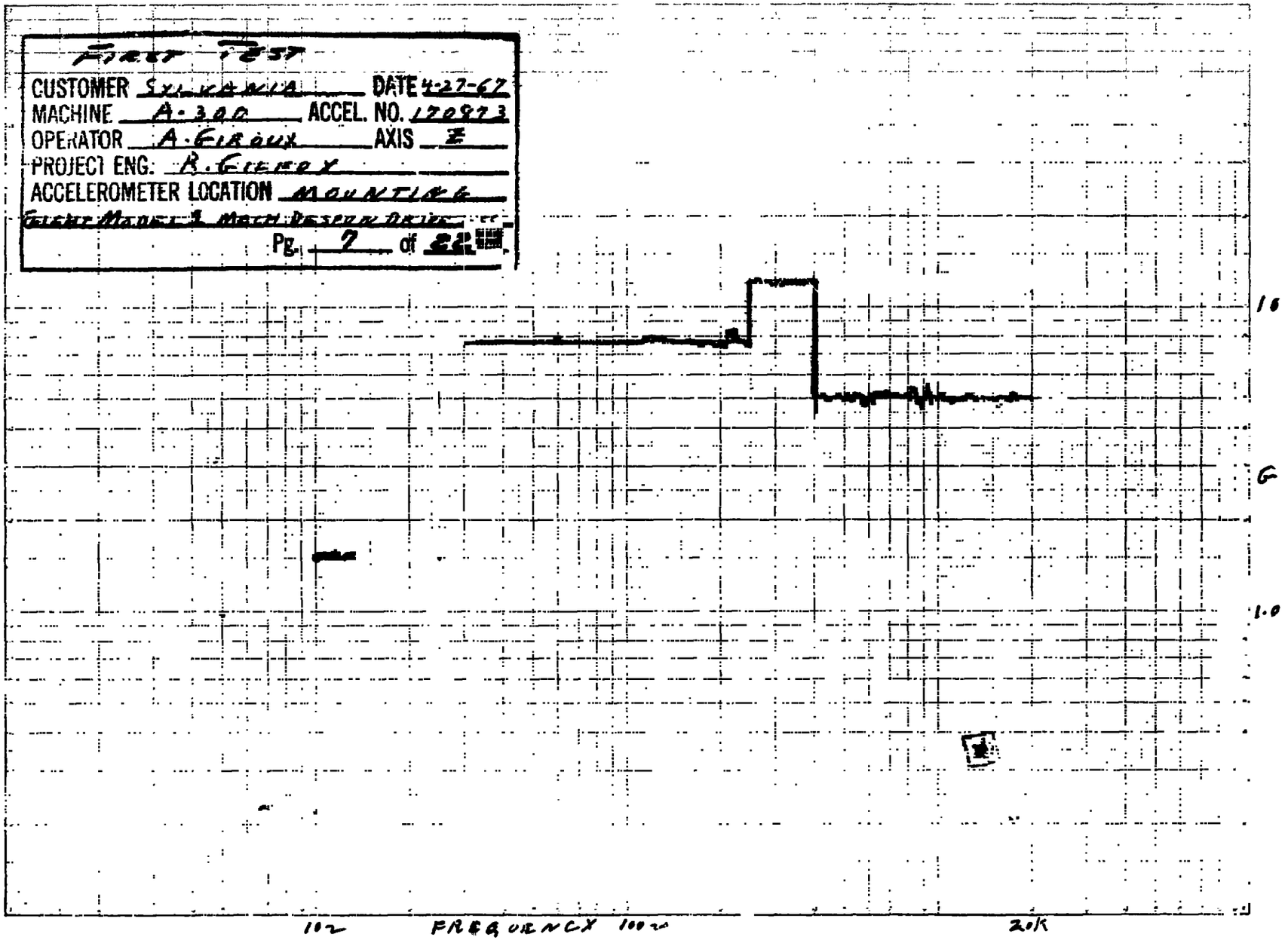
DATE 4-27-67
MACHINE A-300
ACCEL. NO. 170973
OPERATOR A. GIROUX
AXIS X
PROJECT ENG. B. GILFOX
ACCELEROMETER LOCATION MOUNTING
FLIGHT MODEL 1 MECH. DESPUN DR. VE. ASSY
Pg. 6 of 22
10
G
1.0
10~
FREQUENCY
100~
2.0K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OPERATOR A. GIROUX AXIS Z
PROJECT ENG. R. GILFOY
ACCELEROMETER LOCATION MOUNTING
FLIGHT MODEL 1 MACH DESPUN DRIVE
Pg. 7 of 22
10
G
1.0
10~
FREQUENCY 100~
20K

FIRST TEST

CUSTOMER SYLVANIA DATE 4-2-67
MACHINE A-300 ACCEL. NO. 170973
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PROJECT ENG. A. GILMOR
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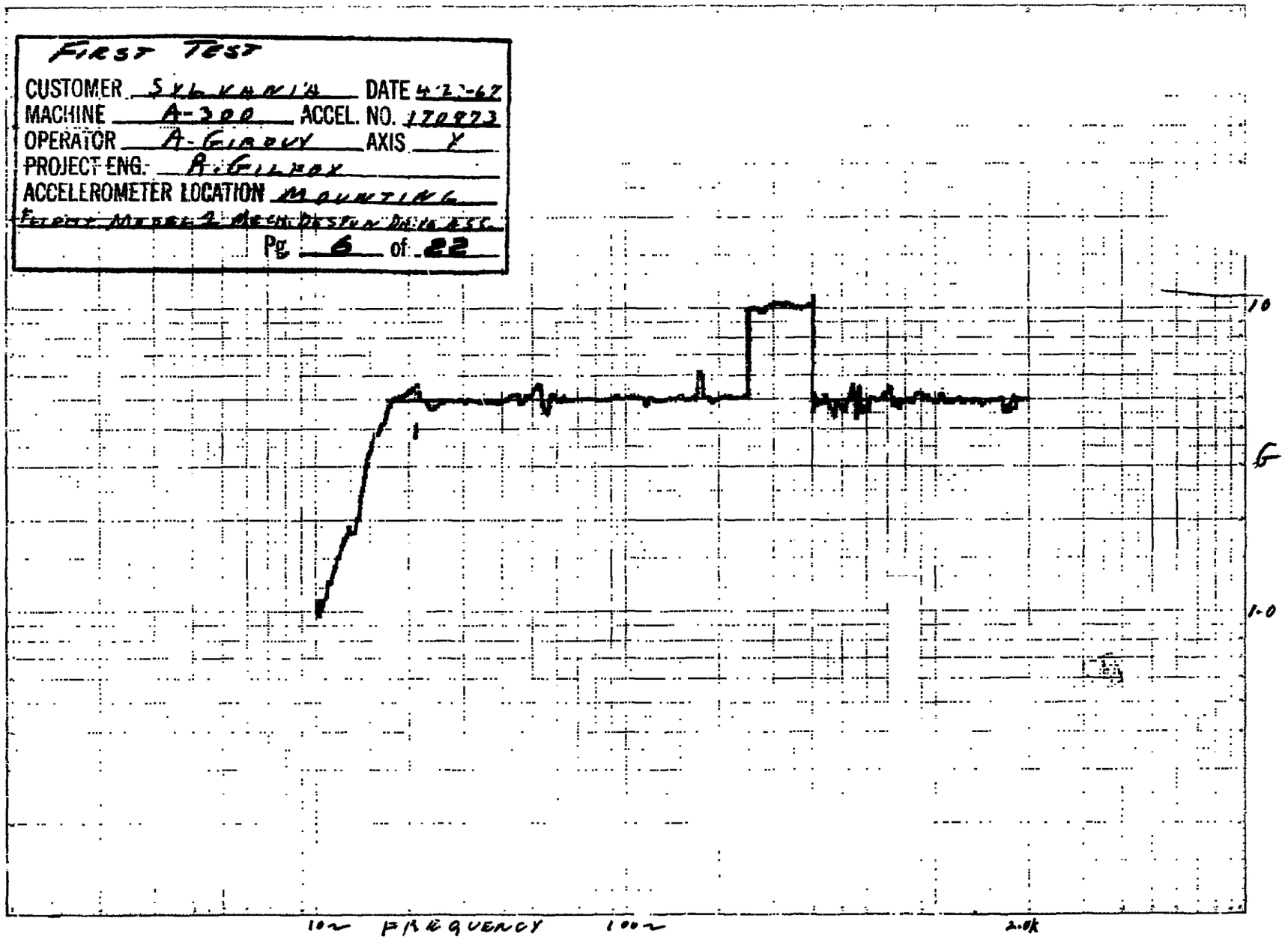
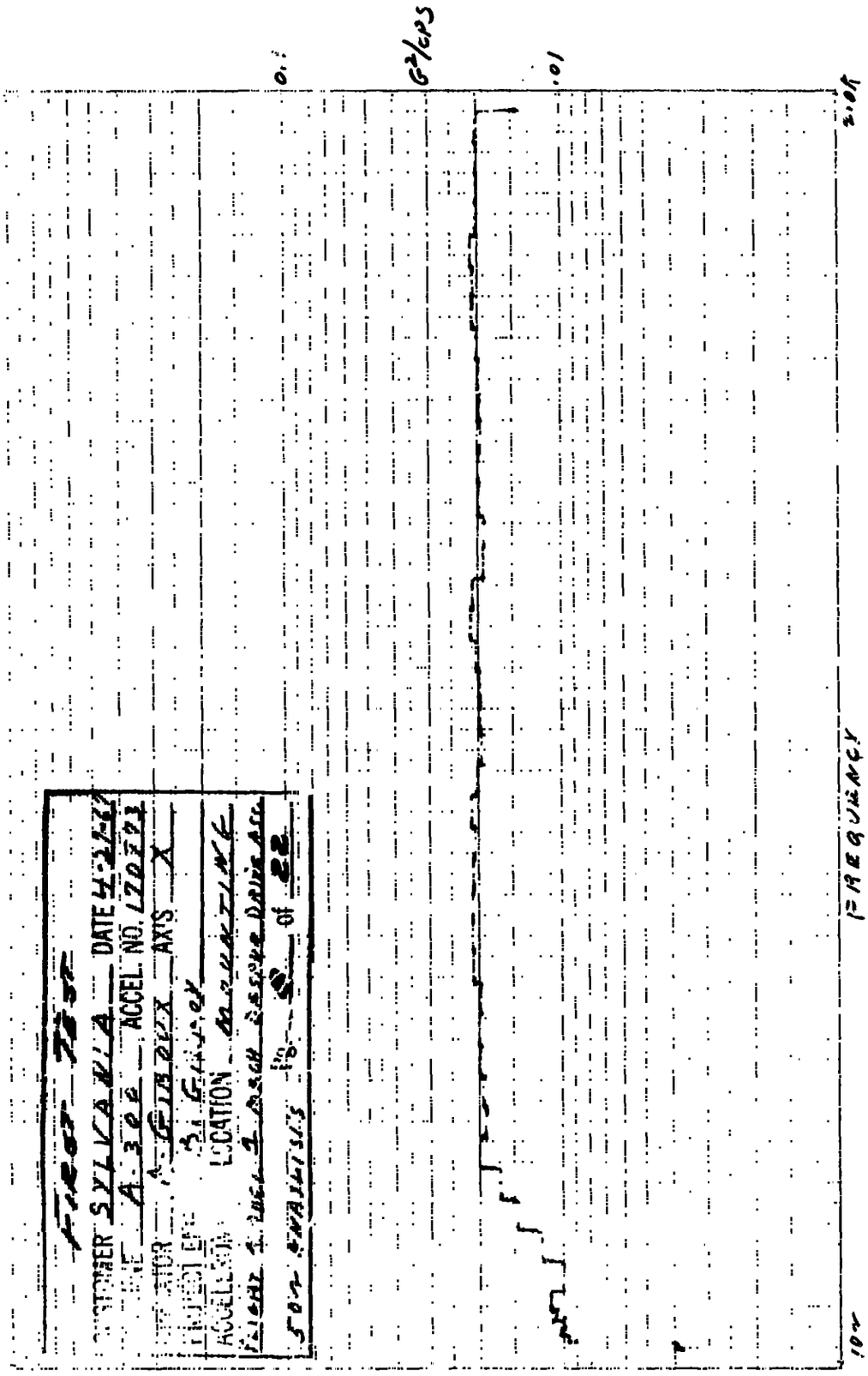
FLIGHT MODEL 2 MECH. DESIGN DATA ESC.
Pg. 6 of 22

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SYLVANIA
DATE
ACCEL. NO.
AXIS X
LOCATION
of 22
G²/CPS
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FREQUENCY

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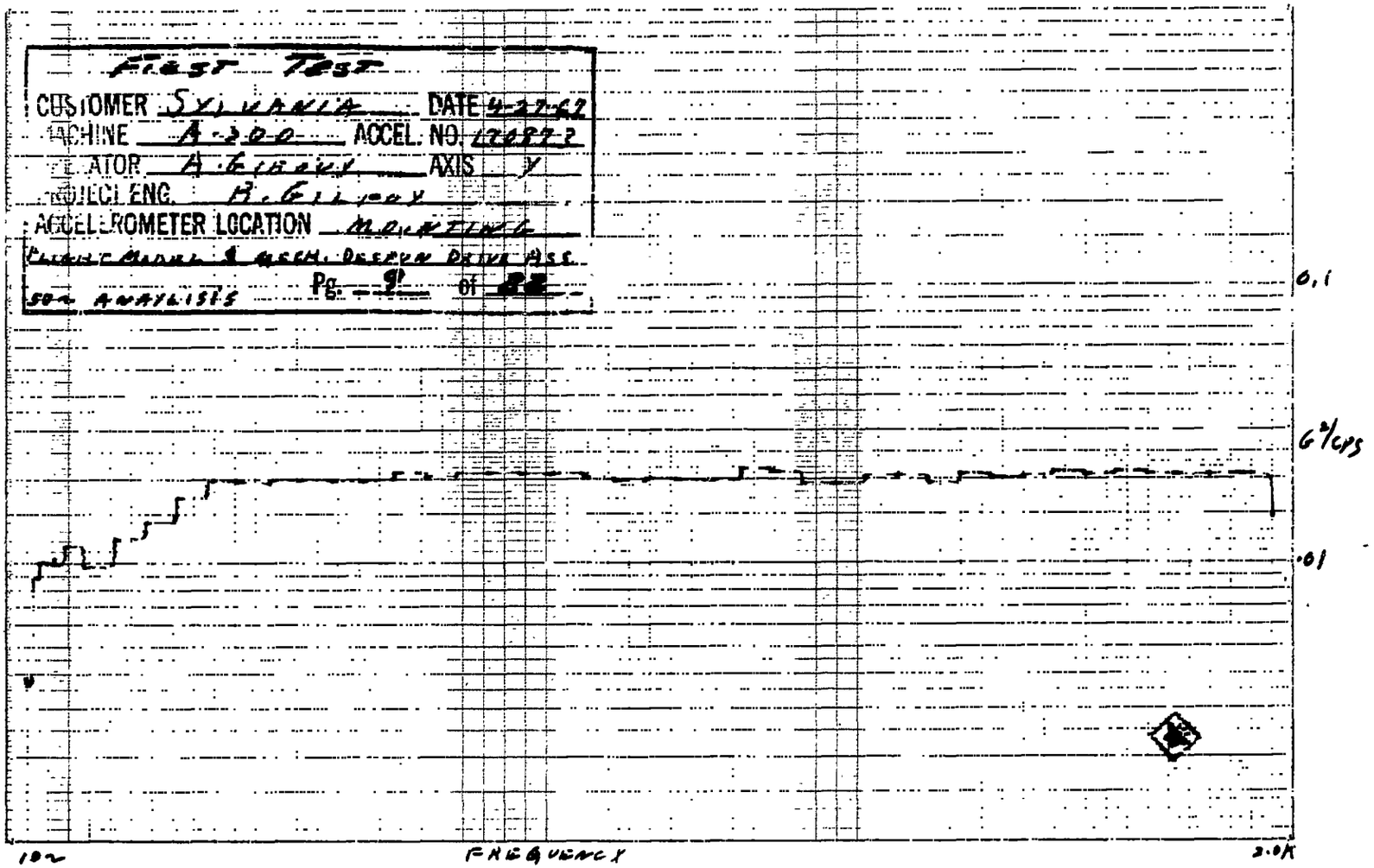

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PRINTED IN U.S.A.

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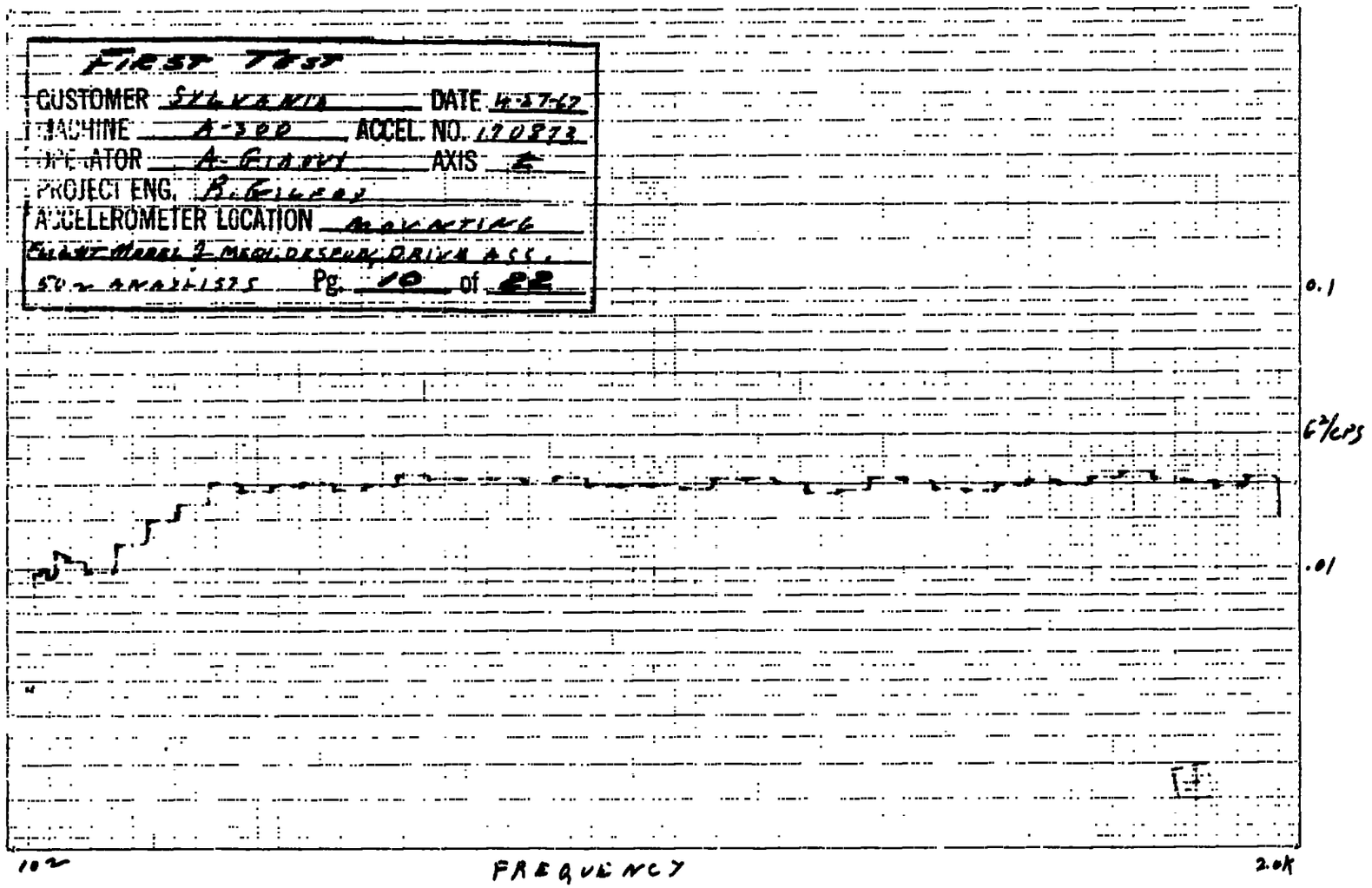

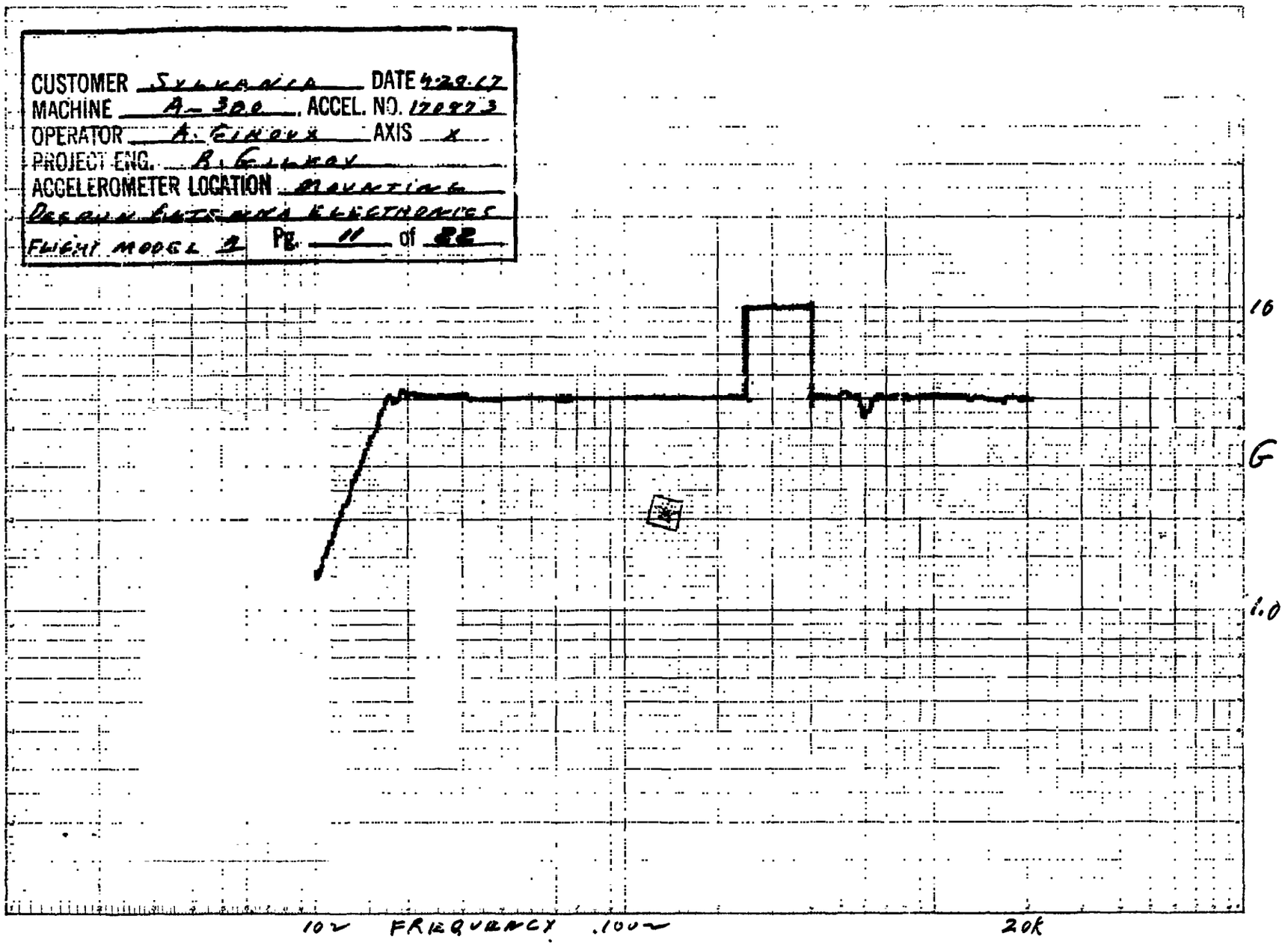
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PROJECT ENG. R. GILKOY
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DESPUN ANTENNA ELECTRONICS
FLIGHT MODEL 2 Pg. 11 of 22
10
G
1.0
10~ FREQUENCY .100~
20k

CUSTOMER SYLVANIA DATE 4-28-67
MACHINE A-300 ACCEL. NO. 170873
OPERATOR A. GIROUX AXIS Y
PROJECT ENG. R. GILFOY
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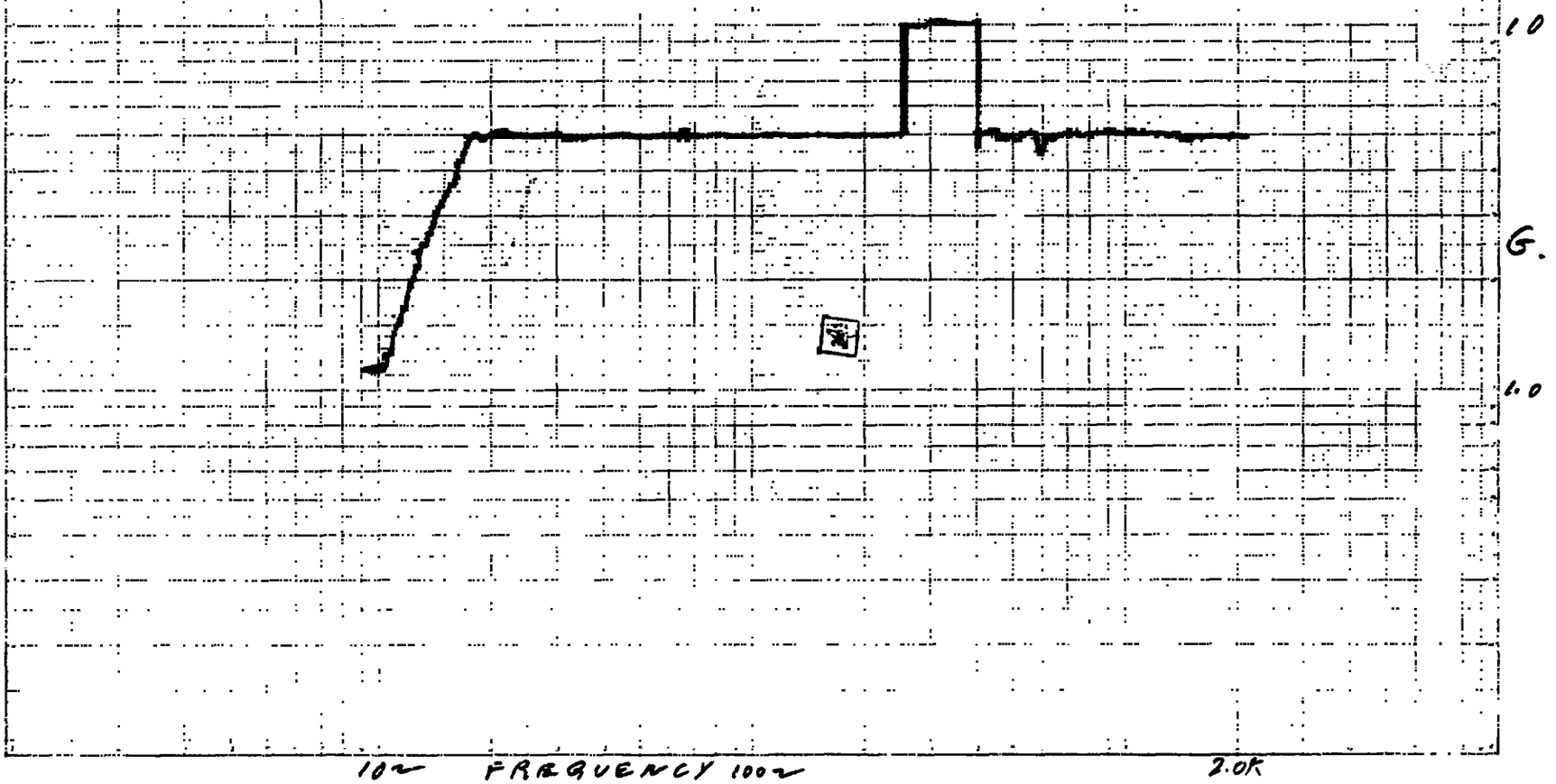
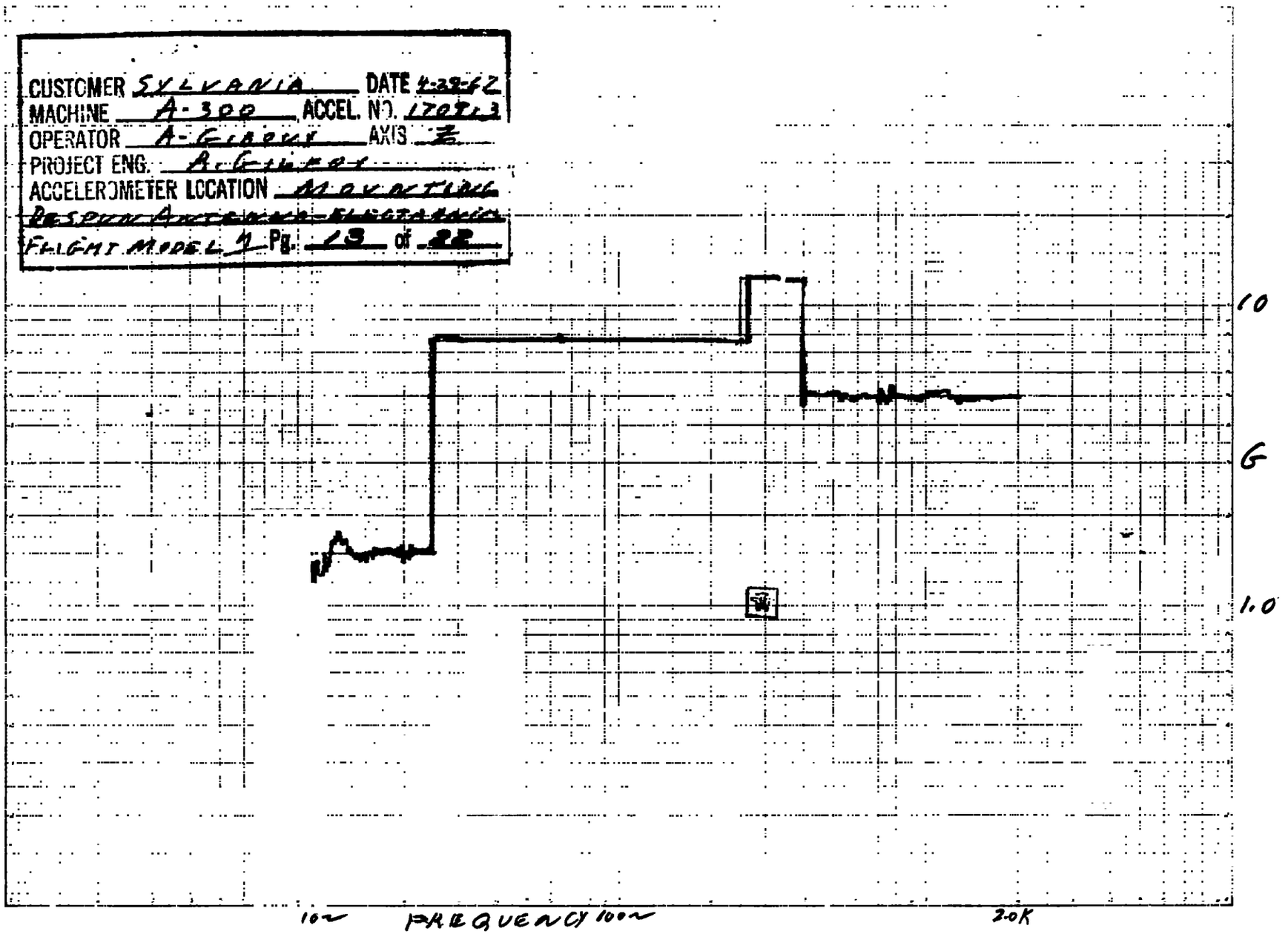
FLIGHT MODEL 1 Pg. 12 of 22

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PROJECT ENG. A. GILFOY
ACCELEROMETER LOCATION MOUNTING
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FLIGHT MODEL 4 Pg. 13 of 22
10
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1.0
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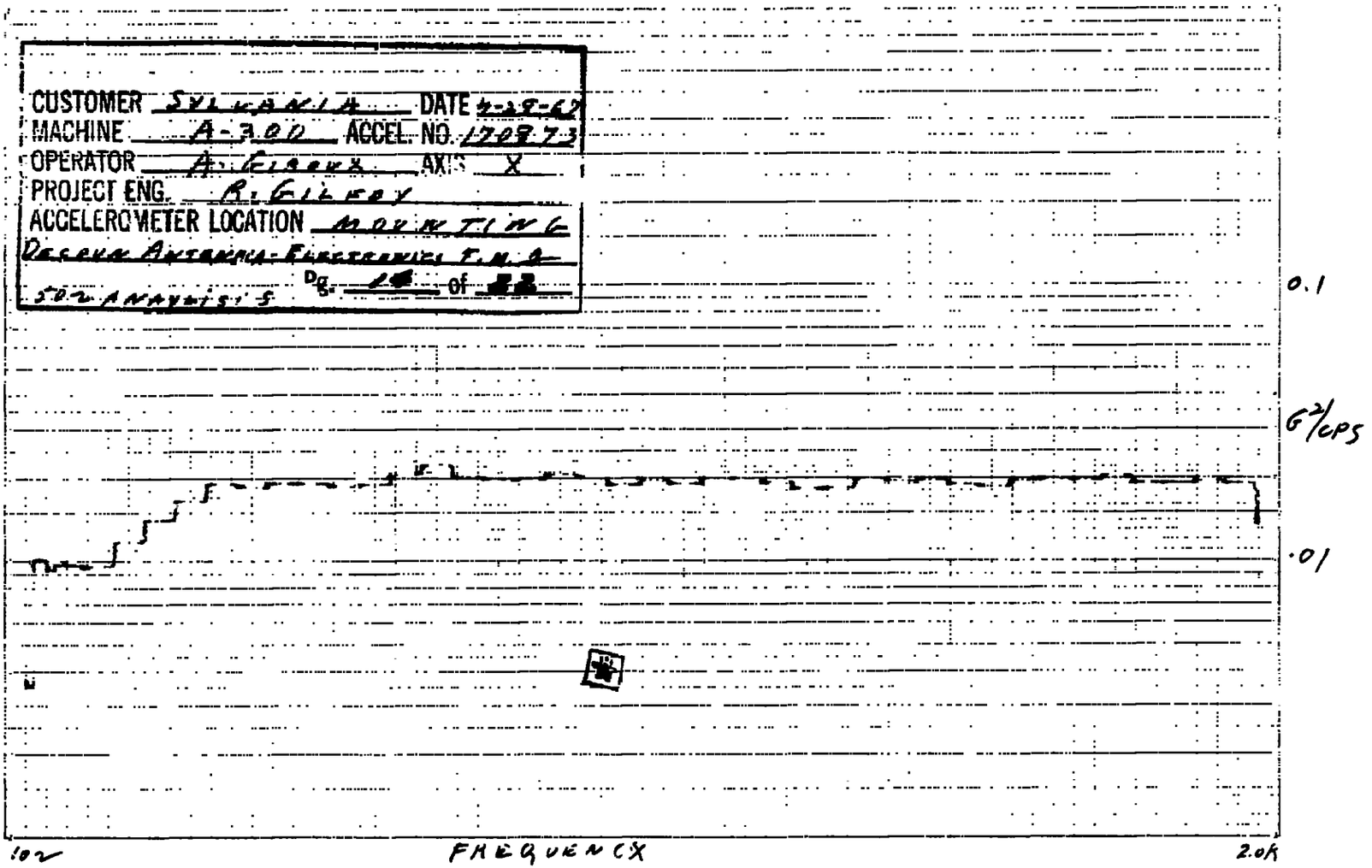
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PROJECT ENG. R. GILFOY
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DESOUN ANTENNA-ELECTRONICS T.M.A.
50~ ANALYSIS
Pg. 14 of 22
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FREQUENCY
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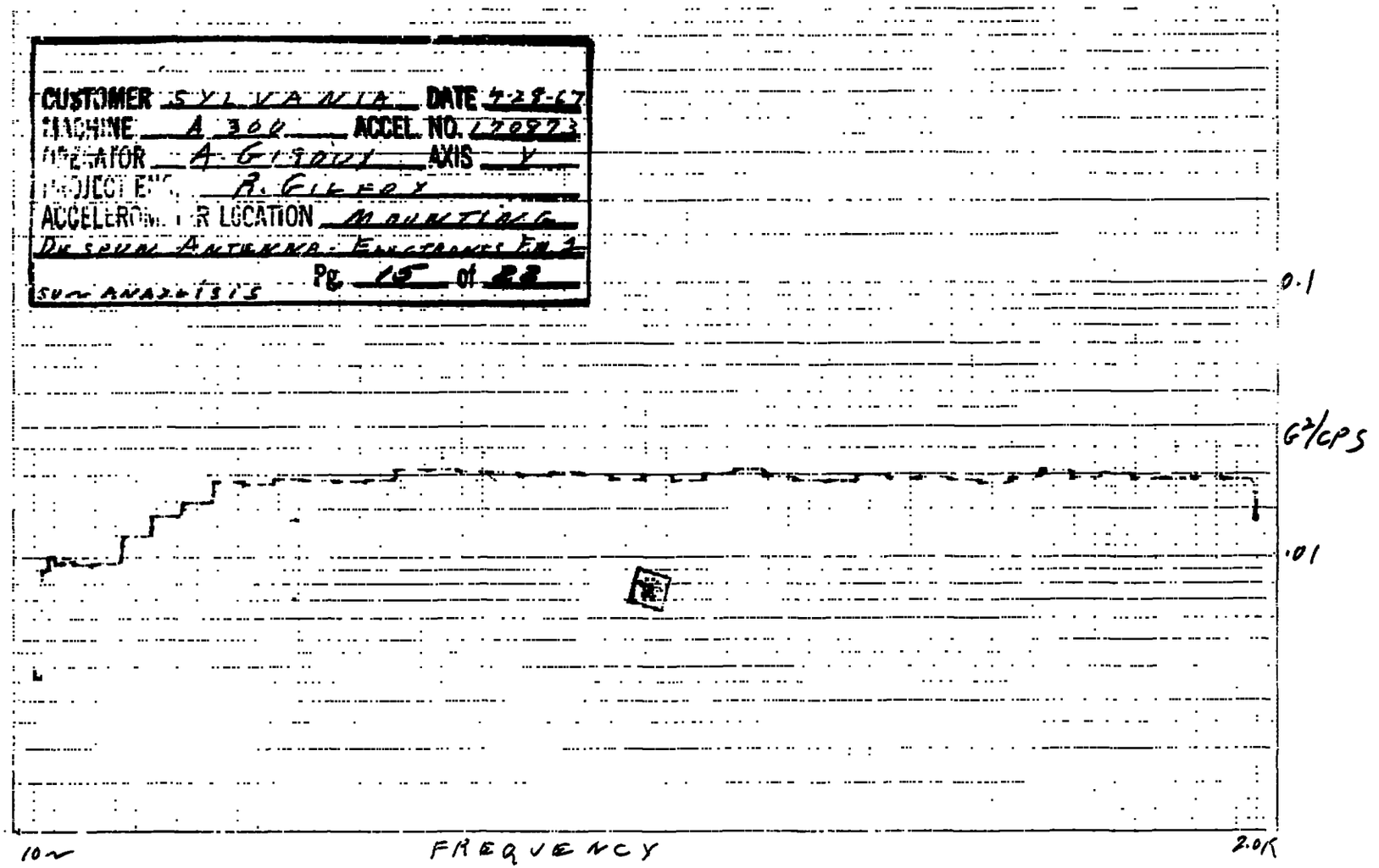
CODEX BOOK COMPANY, INC. NORWOOD MASSACHUSETTS



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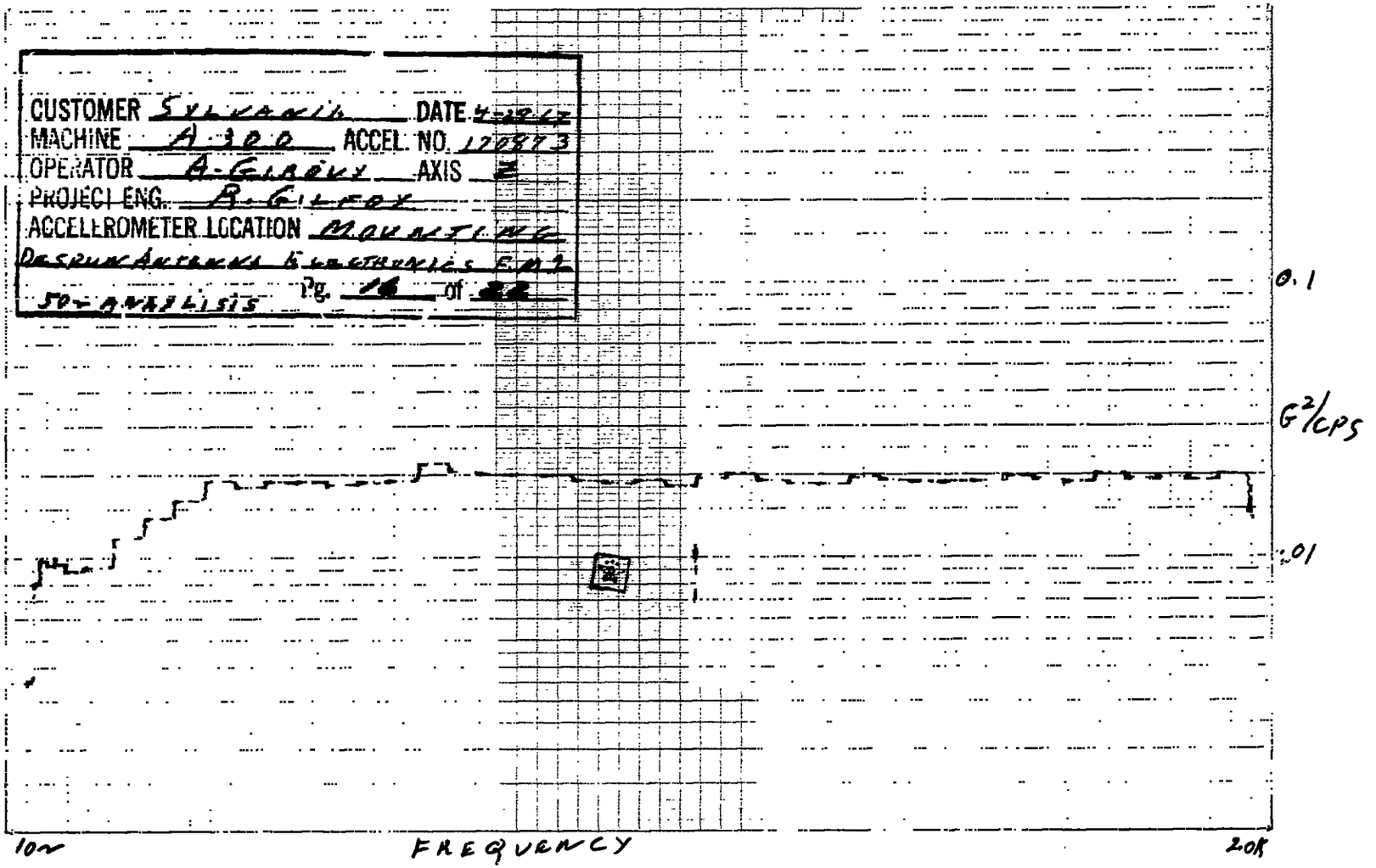

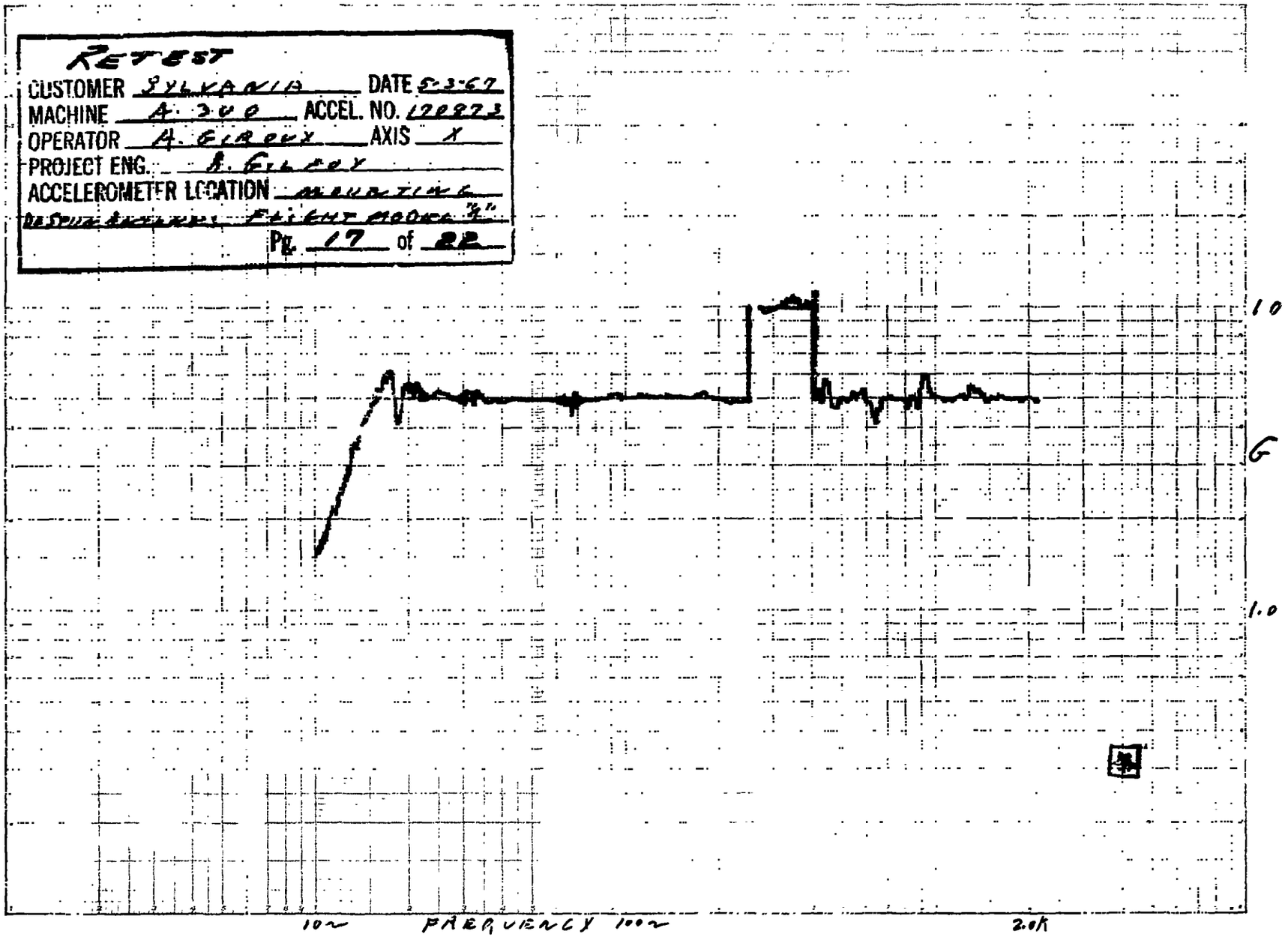
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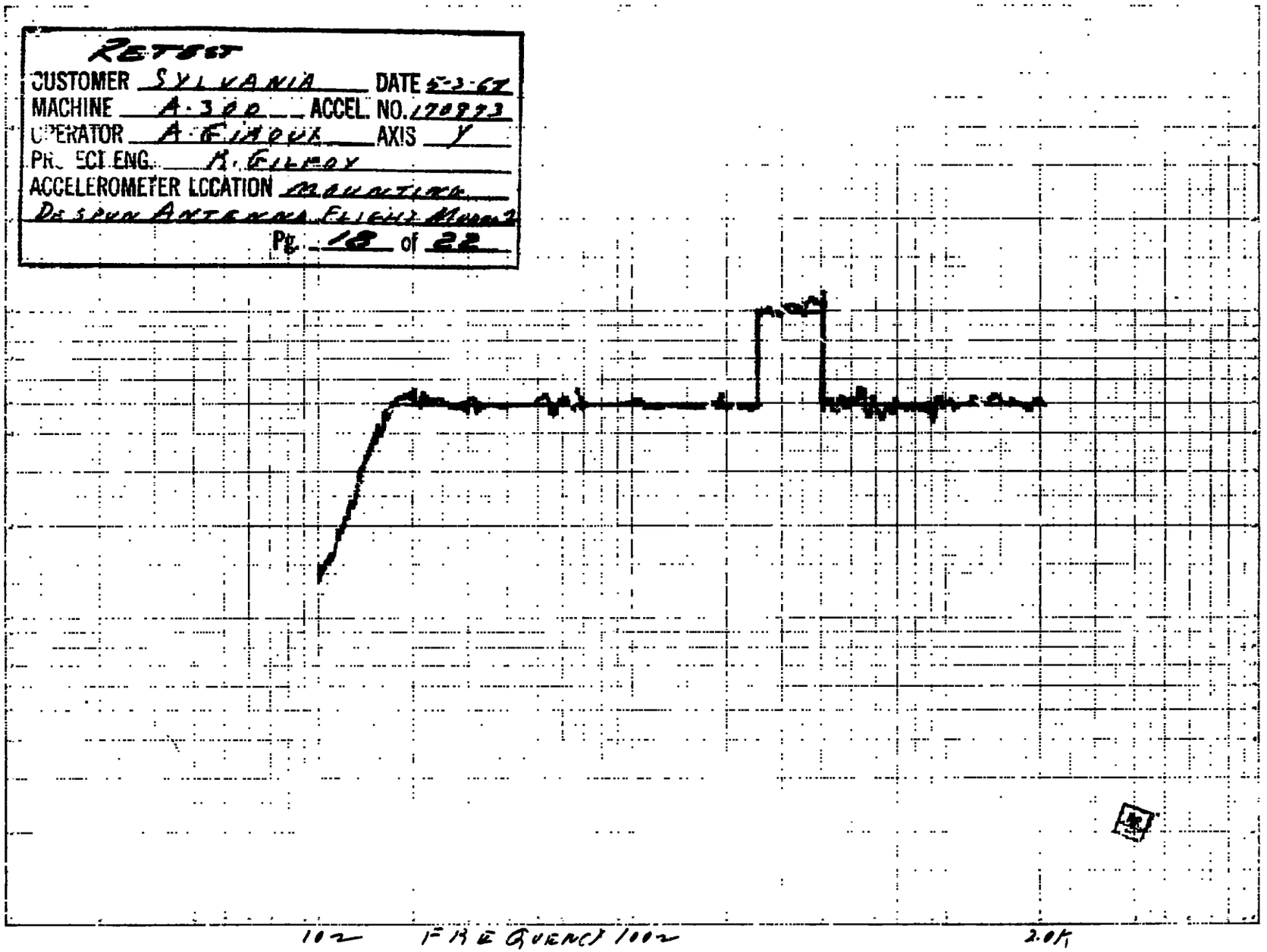
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PROJECT ENG. R. GILROY
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Pg. 18 of 22
10~
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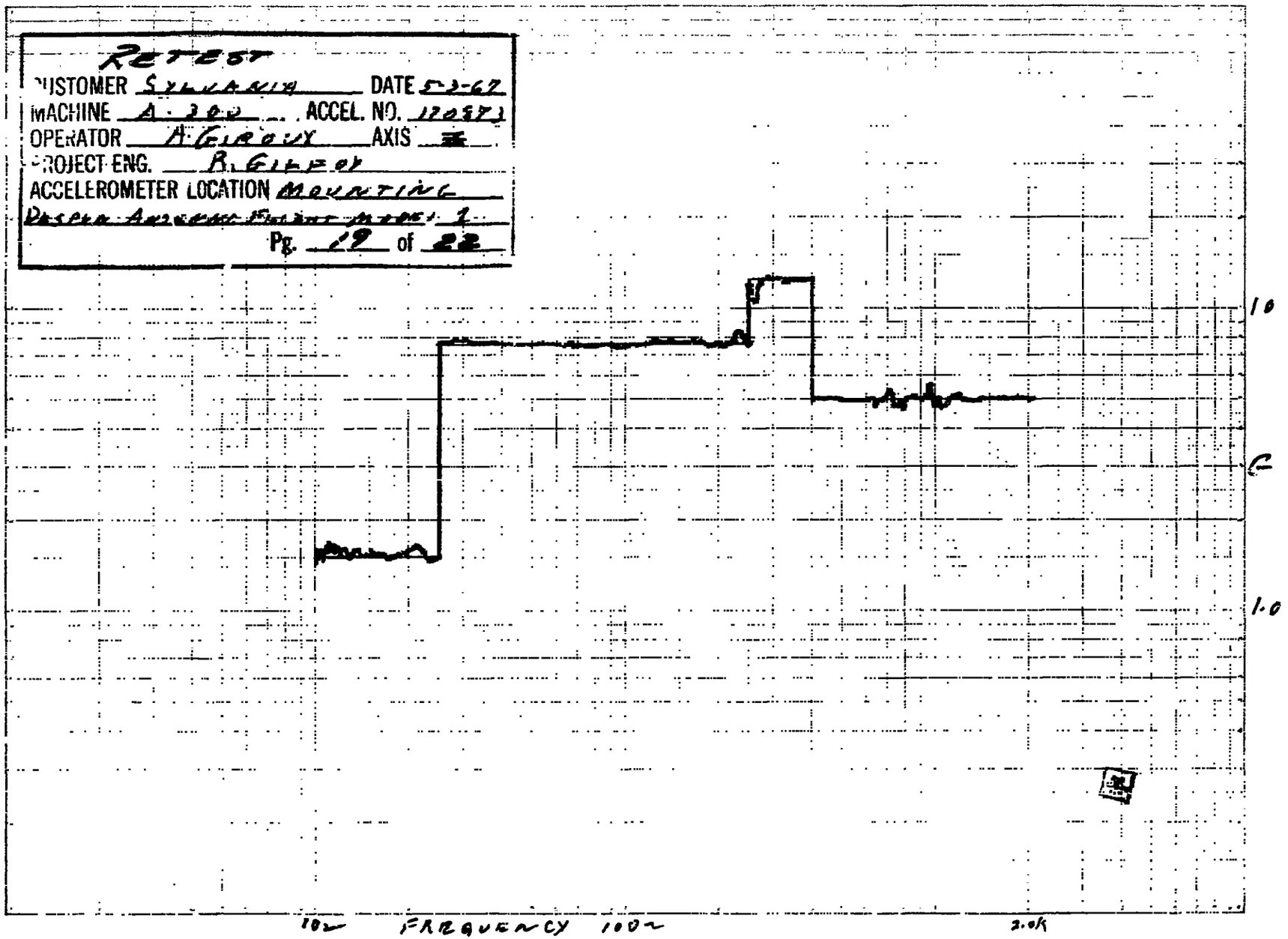
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ACCELEROMETER LOCATION MOUNTING
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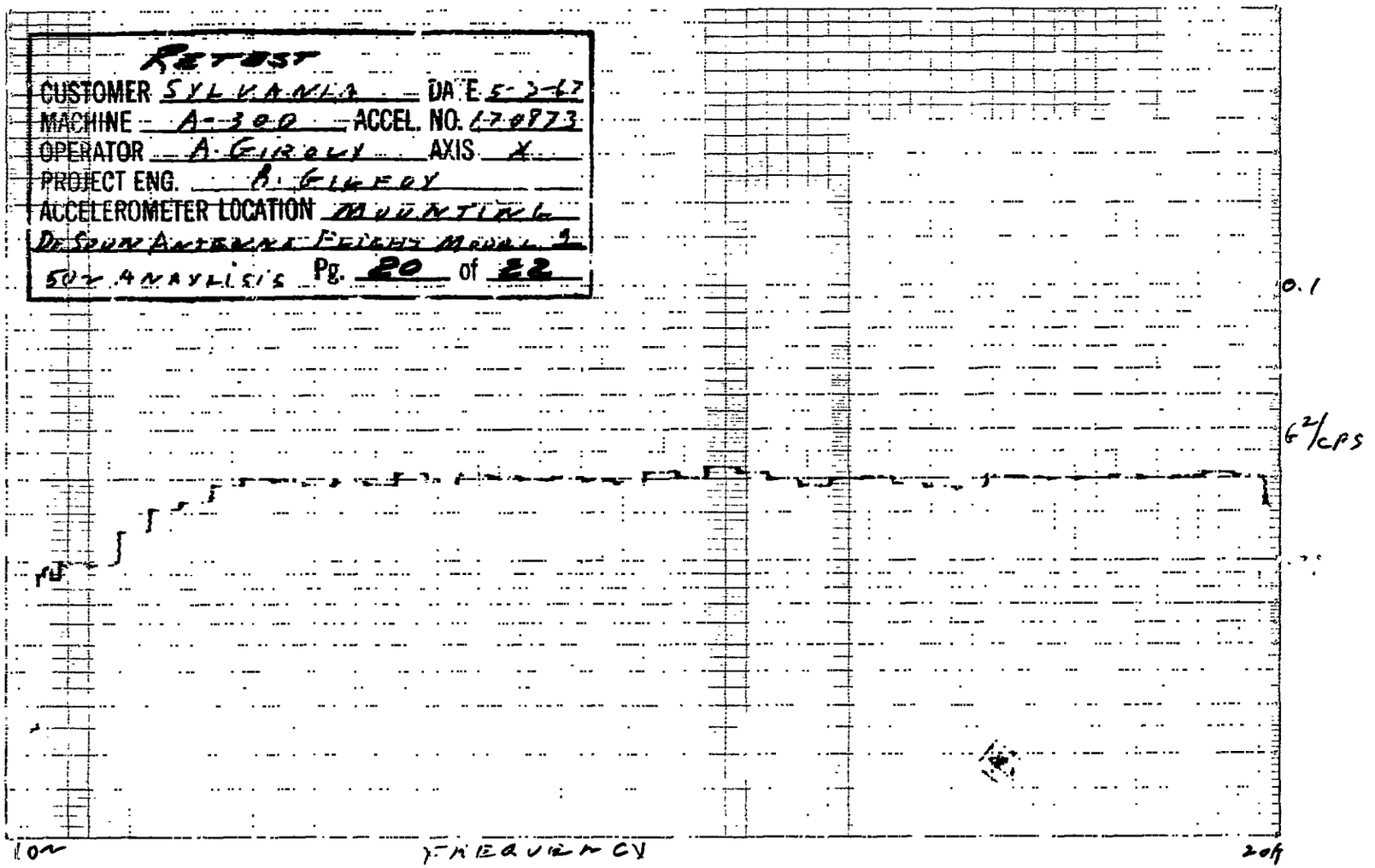
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G²/CPS
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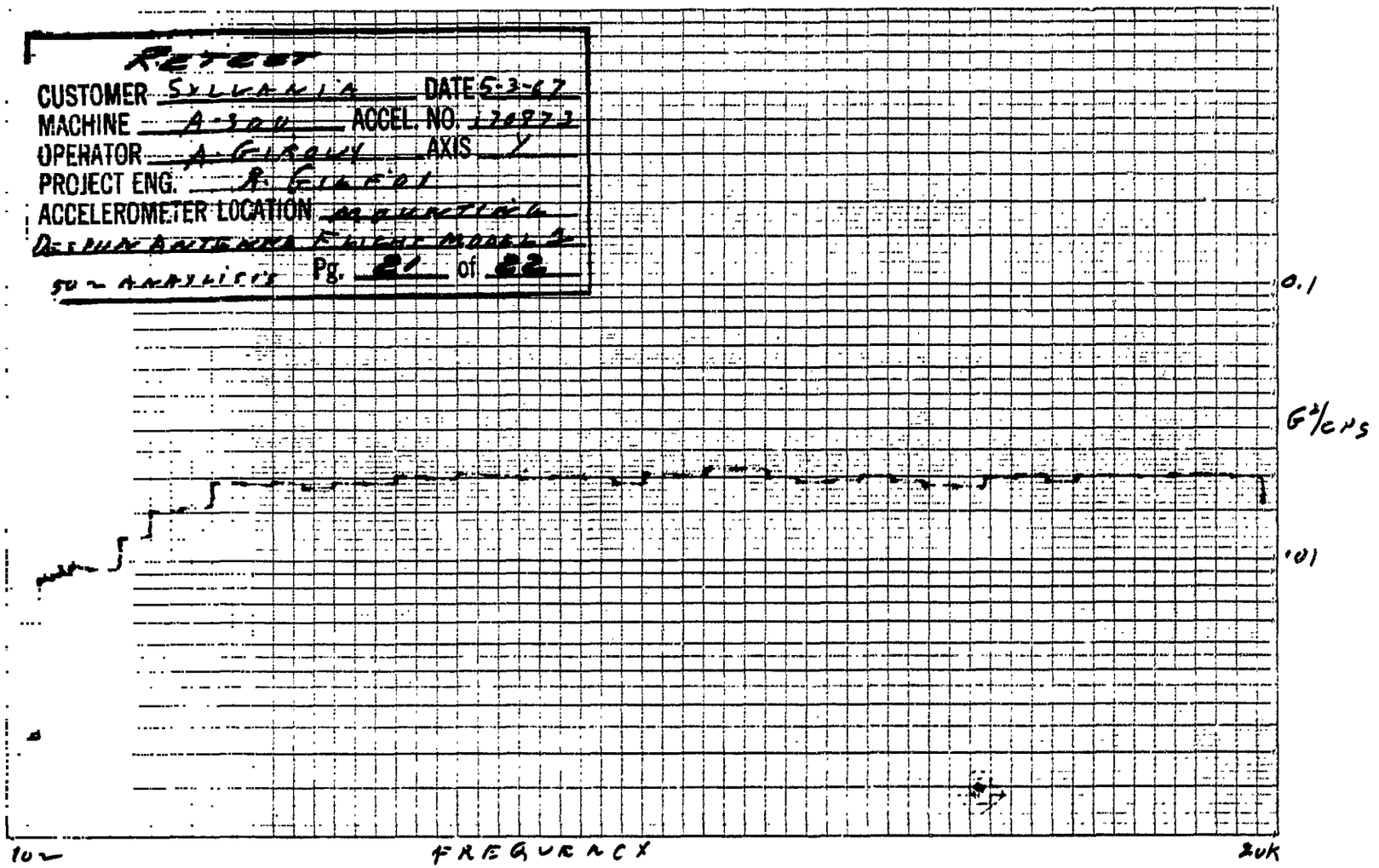

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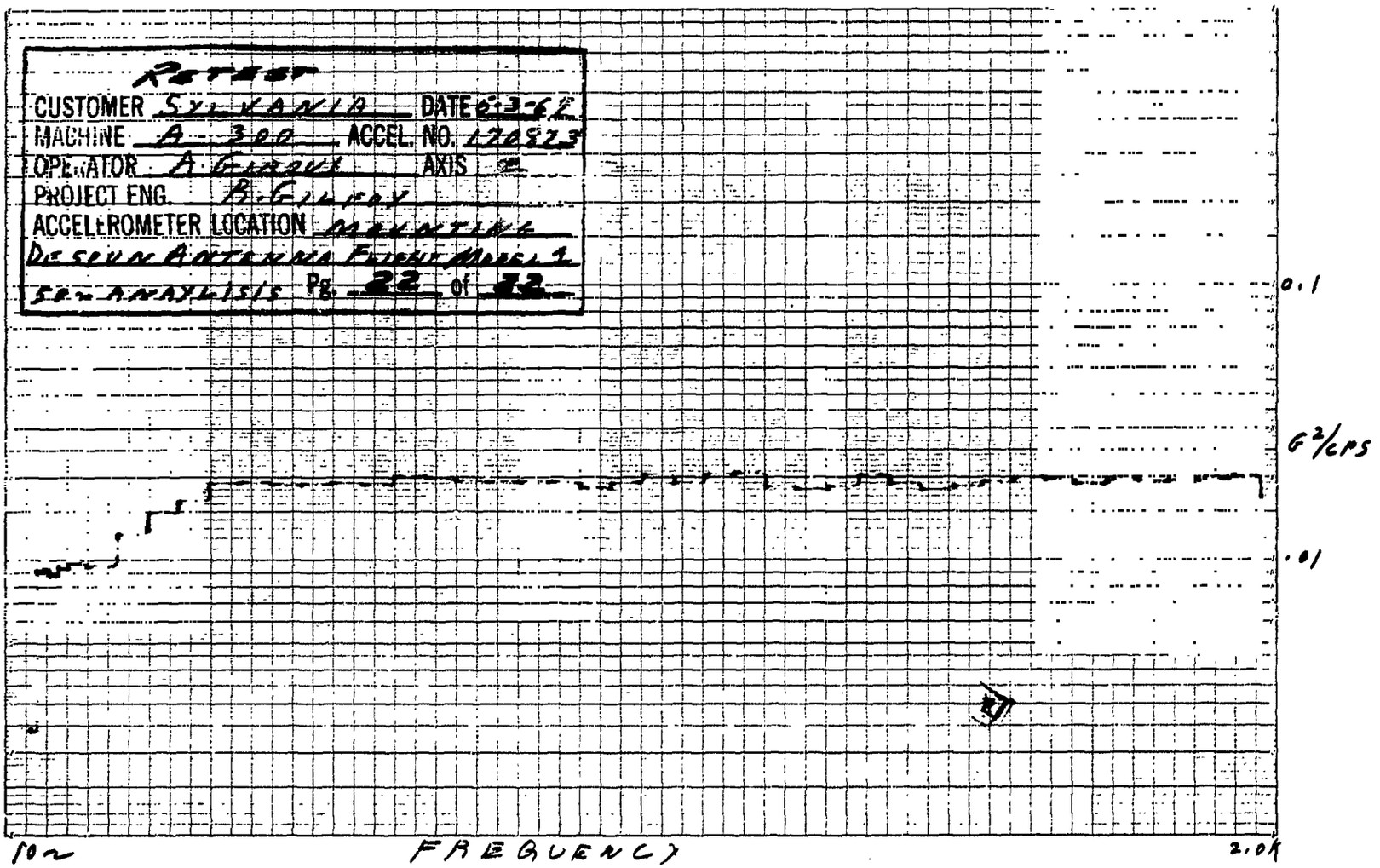

APPENDIX E

ATS-MDA: SPACECRAFT VIBRATION TEST

The ATS qualification model MDA successfully passed vibration test on 16 February 1967 at Hughes on a fully simulated Hughes spacecraft. The writer witnessed at the sine and random vibration tests in the horizontal plane (x-y and y-y axes). The unit was then vibrated in the vertical (z-z axis) plane.

Three of the triaxial accelerometers were mounted on the cruciform structure. These accelerometers recorded loads directly affecting the antenna mount. They were observed with particular interest because the principal frequency of the spacecraft and antenna were very close to each other. High forcing loads from the antenna mount at the spacecraft principal frequency might have resulted in an extremely unfavorable condition for the antenna feed and reflector. This problem did not materialize, because the forcing loads were much less than expected.

In addition to a principal frequency at around 22-29 cps, the spacecraft experienced modes at approximately 200 cps and 1600 cps. At 1600 cps, one of the accelerometers on the cruciform structure recorded forcing loads of about 15-16 g's. However, it was noted that the accelerometer was mounted in a position that was not representative of the stiffness at the antenna mount.

The antenna was inside of the interstage structure and could not be readily observed during the testing. However, after each plane of vibration, the entire spacecraft was lifted off the vibration table so that the antenna could be inspected. Because of a malfunction during component qualification testing, the ball-lock sleeve position was carefully observed after each plane of vibration. There was no indication that the part had moved. Other components such as the feed and reflector were also closely inspected for signs of distress or damage and the ground plane was checked for looseness. There was no apparent damage to the mechanical drive assembly.

Even though the antenna appeared to resonate at its principal frequency, the amplitudes appeared to be no more than when the mechanical drive assembly was vibrated by itself. It was theorized that the interconnecting fiberglass structure had particularly good damping characteristics at the dominant frequency, thus preventing a large magnification of the forcing load.

APPENDIX F

ATS DESPUN ANTENNA (MARK II)

REPORT NUMBER

460

DATE

22 February 1967

ELECTROMAGNETIC INTERFERENCE
CONTROL SECTION

SYLVANIA ELECTRONIC SYSTEMS--EAST
WALTHAM, MASS.

ABSTRACT

The ATS Despun Antenna, Flight Model Number 1, was tested for radiated and power line conducted interference in accordance with the methods and procedures of MSFC-SPEC-279. Radiated interference measurements were performed over the frequency range from 15 kHz to 1 GHz. Power line conducted interference measurements were performed on each power line over the frequency range from 150 kHz to 25 MHz.

The requirements of MSFC-SPEC-279 were not imposed upon the ATS Mechanical Despun Antenna Contract. Therefore, the equipment was not designed to meet these requirements. These tests were performed on the Mark II control system only for information purposes.

TEST EQUIPMENT

TYPE	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DATE	FREQUENCY RANGE USED
NFI Meter	Empire	NF-105	2060	5/28/67	15 KHz - 1 GHz
Tuning Unit	Empire	TX-105	2389	4/13/67	15 KHz - 150 KHz
Tuning Unit	Empire	TA-105	2060	8/26/67	150 KHz - 30 MHz
Tuning Unit	Empire	T1-105	904	10/14/67	30 MHz - 200 MHz
Tuning Unit	Empire	T2-105	2308	12/16/67	200 MHz - 400MHz
Tuning Unit	Empire	T3-105	1829	12/10/67	400 MHz - 1 GHz
Function Gen.	Exact Electronics	303	JG009	12/20/67	1 KHz
Power Supply	Harrison Labs	808A	1280	9/21/67	-24 VDC
Power Supply	Power Designs Inc.	2050	F306072	8/9/67	-7.5 VDC

DETAILED MEASURING PROCEDURES

1.0 Mark II System

1.1 System Description

The Mark II system as tested consisted of the following five subunits:

1) Chassis No. 1
2) Chassis No. 2
3) Chassis No. 3
4) Chassis No. 4
5) Motor, Encoder, and Antenna

1.2 System Operation

1.2.1 Synchronous Operation

This Mark II system mode of operation was defined as operation after the motor had reached the rotational speed determined by, and was under control of, the constant input drive signal (signal name 2^9FLL). The input drive signal PRF was adjusted so as to have the motor rotate as a synchronous motor. Figure 1 shows the waveform of this input drive signal.

1.2.2 Stepping Operation

This mode of operation was defined as operation during the short interval of time during which the motor was being stepped up to its steady state (synchronous) rotational speed under control of the VCO. This was accomplished by continuously interrupting prime power to the Mark II system before the motor was up to its steady state rotational speed.

2.0 Physical Configuration

2.1 Test Chamber

The Mark II system was set up in a double-wall, copper-screen shielded enclosure of the following dimensions:

Length: 20 feet
Width: 10 feet
Height: 7.5 feet

DETAILED MEASURING PROCEDURES

2.2 System Configuration

This section describes the Mark II system configuration used during all tests (see Figure 2).

2.2.1 System Grounding

The Mark II was grounded to a 3' x 6' copper clad bench in a manner similar to the actual sattelite grounding configuration. This copper clad bench was in turn bonded to the wall of the shielded enclosure by means of bonding straps spaced two feet apart.

2.2.2 System Inputs

2.2.2.1 System Power

Since Chassis No. 2 and Chassis No. 4 are identical and in parallel (a redundant system), prime power (-24 VDC) was applied to the input of Chassis No. 4 during all tests. With Line Impedance Stabilization Networks (LISN's) inserted in series with the power lines excessive power line ripple was generated affecting systems operation. To provide a more compatible power source a breadboard model of the Hughes Payload Regulator Circuit was used to drive the Mark II system during all tests. Two LISN's were used on the standby power lines to Chassis No. 2 to provide a known impedance.

In addition, -7.5 VDC was supplied as a bias voltage for the telemetry simulation loads described in Section 2.2.4.

All power for the Mark II system was derived from power supplies located external to the shielded enclosure. System prime power (-24 VDC) entered the shielded enclosure through two Cornell Dubilier Type NFR 110-9 filters bulkhead mounted to the shielded enclosure access panel. The bias voltage for the telemetry loads entered the shielded enclosure through two Filtron Type SP-236 filters bulkhead mounted to the shielded enclosure access panel.

2.2.2.2 Drive Signal

The drive signal for the Mark II was derived from an Exact Electronics Type 303 Function Generator located external to the shielded enclosure. The drive signal entered the shielded enclosure through a coaxial BNC connector bulkhead mounted to the shielded enclosure access panel.

DETAILED MEASURING PROCEDURES

2.2.3 System Cabling

The cable harness used to completely interconnect the component parts of the Mark II system and to connect the Mark II system to its power source and loads was configured in a similar manner to the cable harness to be used in the sattelite.

2.2.4 System Terminations

To simulate as close as possible the actual Mark II system operating configuration, the following output lines were terminated as shown in Table I:

Table I

Mark II Coutput Terminations

Connector	Pin	Function	Load
101	3	Telemetry Output	See Figure 3
101	5	Telemetry Output	See Figure 3
101	10	Telemetry Output	See Figure 3
101	15	Telemetry Output	See Figure 3
101	21	Telemetry Output	See Figure 3
101	24	Telemetry Output	See Figure 3
101	6	Motor Current Monitor	Ammeter

3.0 Ambient Measurements

Radiated and power line conducted ambient measurements were performed prior to the start of operational tests. The system configuration for each test was identical to that described in Section 2.2.

During ambient measurements the system prime power source located external to the shielded enclosure was de-energized. The drive signal (2^9FLL) generated by the function generator was present during all ambient measurements.

4.0 System Interference Measurements

4.1 Radiated Measurements

Radiated interference measurements were performed over the frequency range 15 KHz to 1 GHz with the applicable antenna located at a distance of one foot in front of the test specimen.

DETAILED MEASURING PROCEDURES

Table II

Antenna Useage--Radiated Interference Measurements

Frequency Range (MHz)	Antenna Description	Model Number
0.015 - 0.15	41" Vertical Rod	VX-105
.15 - 25	41" Vertical Rod	VA-105
25 - 35	Dipole tuned to 35 MHz	DM-105-T1
35 - 200	Tuned Dipole	DM-105-T1
200 - 400	Tuned Dipole	DM-105-T2
400 - 1000	Tuned Dipole	DM-105-T3

4.2 Power Line Conducted Measurements

Power line conducted interference measurements were performed on each of the four power leads to the Mark II system using a Stoddart 91550-1 RF Current Probe. Measurements were performed over the frequency range from 150 KHz to 25 MHz.

5.0 Detection System Calibration

All measurements were performed using substitution techniques. After a signal was detected a calibrated signal source (impulse generator) was substituted for the signal being measured and the output was adjusted so as to obtain the same reading on the Field Intensity Meter. The impulse generator output level was then recorded and by addition or subtraction of the appropriate pickup device factor, the amplitude of the unknown signal was determined. The following sample calculations show the methods employed to determine the unknown signals amplitude:

Radiated Interference

Frequency (150 KHz)	
Impulse Generator Output Level	53 dbmc
Antenna Factor	39 db
Unknown Signal Amplitude	92 dbmc/AI

Conducted Interference

Frequency (3 MHz) Chassis #4 +24 VDC Line	
Impulse Generator Output Level	84 dbmc
Current Probe Transfer Impedance	-(+15) db
Unknown Signal Amplitude	69 dbμA/Mc

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SUMMARY OF RESULTS

1.0 Radiated Interference

1.1 Ambient Measurements

Figure 4 shows the radiated ambient noise level existing within the shielded enclosure. By turning off the Function Generator which generated the input drive signal, the radiated ambient level within the shielded enclosure was reduced to the noise level of the test instrumentation, thus proving that the ambient level as plotted in Figure 4 was the input drive signal radiated from its unshielded input line.

1.2 Synchronous Operation

Figure 4 also shows the radiated noise levels emanating from the Mark II system during synchronous operation. Only broadband noise was detected emanating from the Mark II system. Radiated interference voltages were a maximum of 14 db above the limit of MSFC-SPEC-279. This condition occurred at a frequency of 150 KHz. Radiated interference voltages were generally above the applicable specification limit over the frequency range from 15 KHz to 90 MHz. In this frequency range the interference voltage level was below the limit a maximum of 5 db occurring at a frequency of 25 MHz.

1.3 Stepping Operation

No differences in radiated voltage levels were detected during the time the motor was stepping up to its steady staterotational speed.

2.0 Conducted Interference

2.1 Ambient Measurements

Figures 5 through 8 show the ambient noise levels existing on each of the four prime power lines to the Mark II system. Since the drive signal (29FLL) was present during these measurements and the driver signal input line and power lines were unshielded (simulating the actual flight configuration) the ambient levels measured on each of these four lines were due to cross-coupling within the cable harness. Differences in ambient levels between the individual lines can be attributed to their location within the cable bundle in relation to the drive signal input line and to differences in terminal impedances thus affecting the magnitude of noise currents existing on each line.

SUMMARY OF RESULTS

2.2 Synchronous Operation

Figures 5 through 8 show the conducted noise levels existing on each of the four prime power lines during synchronous operation. Conducted noise currents were a maximum of 27 db above the limit of MSFC-SPEC-279. This condition occurred on the +24 volt input line to Chassis No. 4 at a frequency of 3 MHz. Conducted noise current amplitudes exceeded the applicable specification limit on each of the four lines. Noise currents below 5 MHz were due to the DC-DC converter located in Chassis No. 4. Although the noise currents due to the DC-DC converter were generally above the specification limit no degradation in performance of the Mark II system was observed during operation in the test configuration. Above 5 MHz the major contributor to the noise level was cross-coupling from the drive signal input line. No narrowband signals were detected on any of the four power lines.

2.3 Stepping Operation

No differences in noise current levels were observed on any power line during the time the motor was stepping up to its steady state rotational speed.

CONCLUSIONS AND RECOMMENDATIONS

The ATS Despun Antenna (Mark II) does not meet all the radiated and power line conducted interference requirements of MSFC-SPEC-279.

If compatibility problems occur during integration checkout that can be traced to the Despun Antenna system, it is strongly recommended that the input signal line be shielded over the entire length of its run.

Measurements Witnessed By:

NA
Name

Title

Date

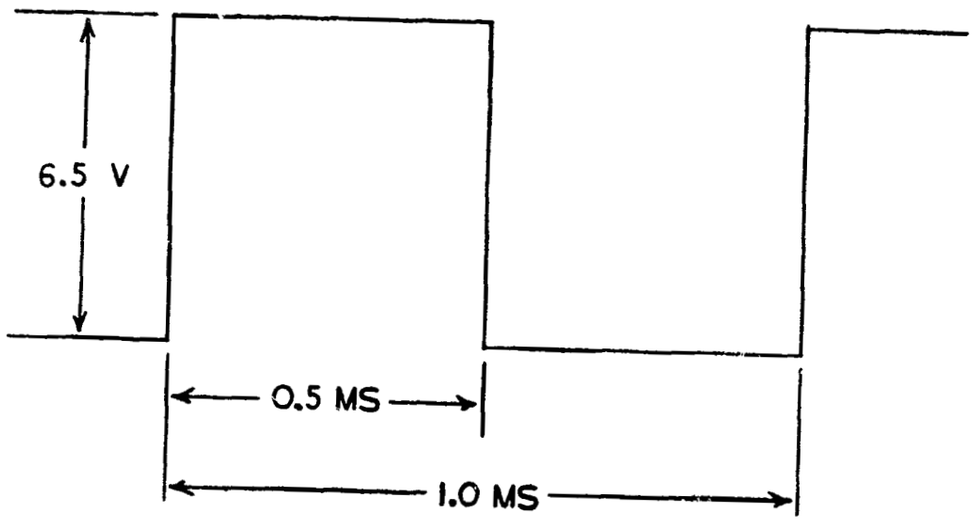
Test Conducted By L. Libbeck

Task Engineer M. J. Freeman

Title Senior Engineer

Approved by D. Loouche

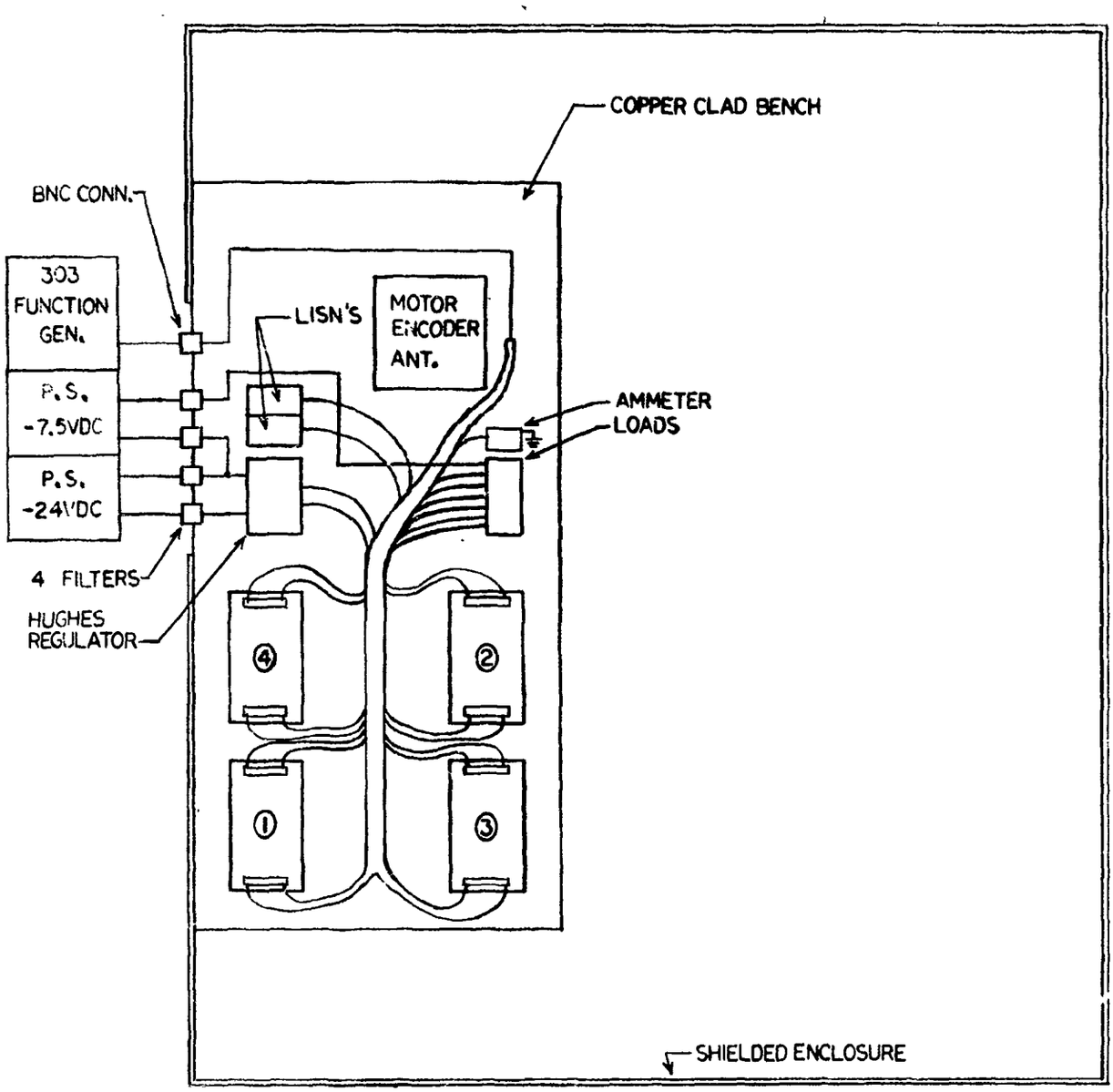
Title Section Head



INPUT DRIVE PULSE – 2^9FLL

FIGURE 1

SKETCH OF MEASURING SETUP



TEST CONFIGURATION

FIGURE 2

REPORT NO. _____

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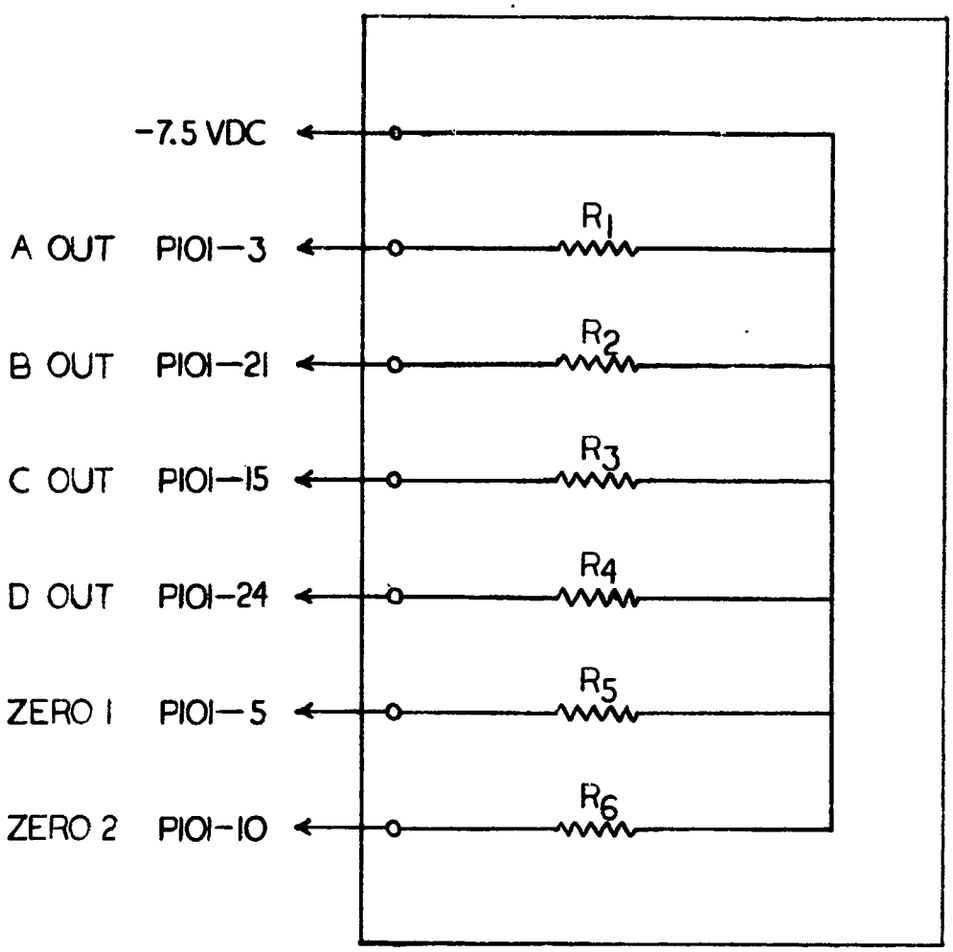

NOTE: ALL RESISTORS ARE 27KΩ 1/2W

TELEMETRY SIMULATION LOADS

FIGURE 3

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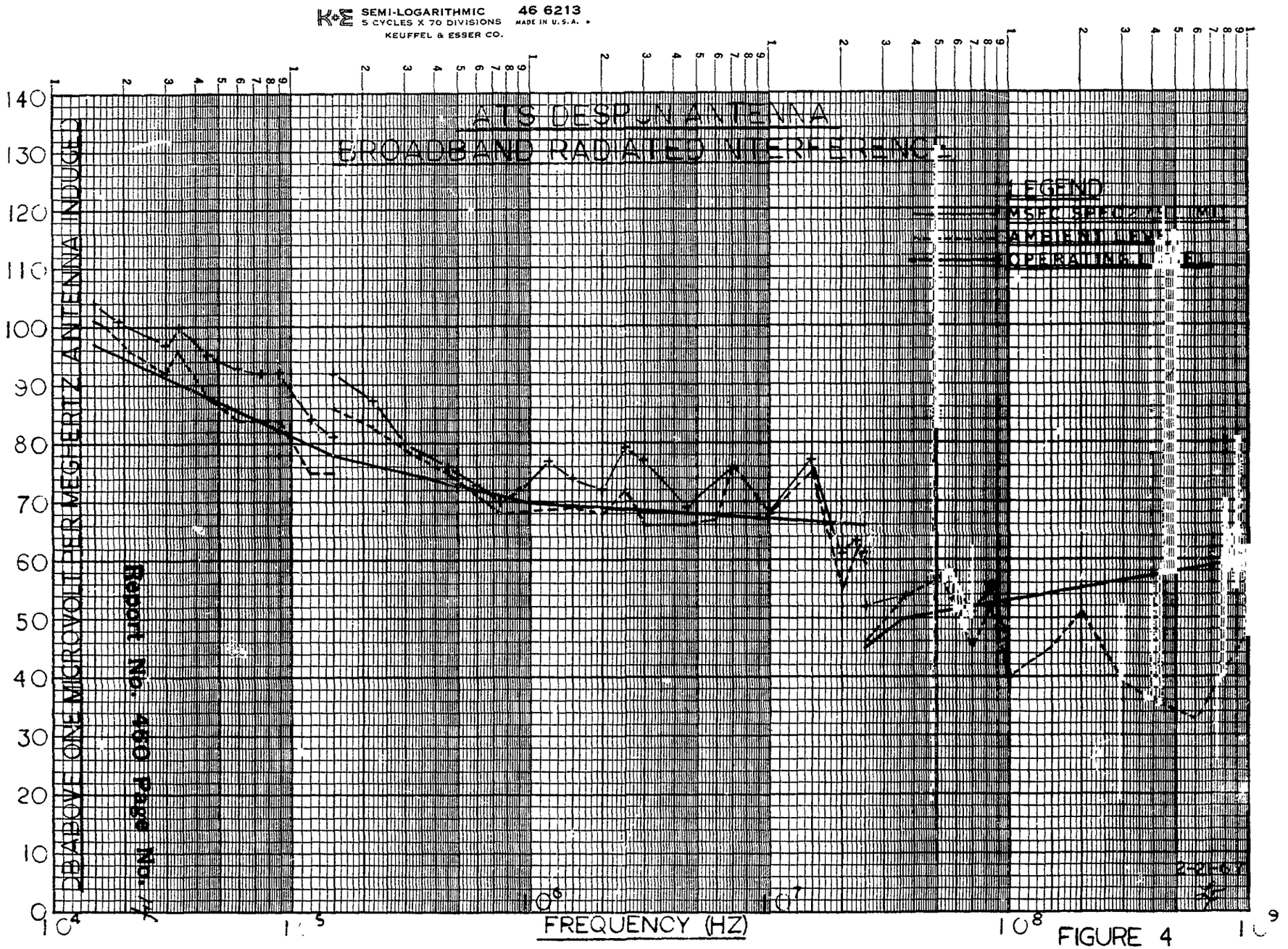
SEMI-LOGARITHMIC 46 6213
5 CYCLES X 70 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.
ATS DESPUN ANTENNA
BROADBAND RADIATED INTERFERENCE
LEGEND
MSFC SPEC
AMBIENT
OPERATING
DB ABOVE ONE MICROVOLT PER MEGAHERTZ ANTENNA INDUCED
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
10^4
10^5
10^6
10^7
10^8
10^9
FREQUENCY (HZ)

FIGURE 4

NO. 340R-L310 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.

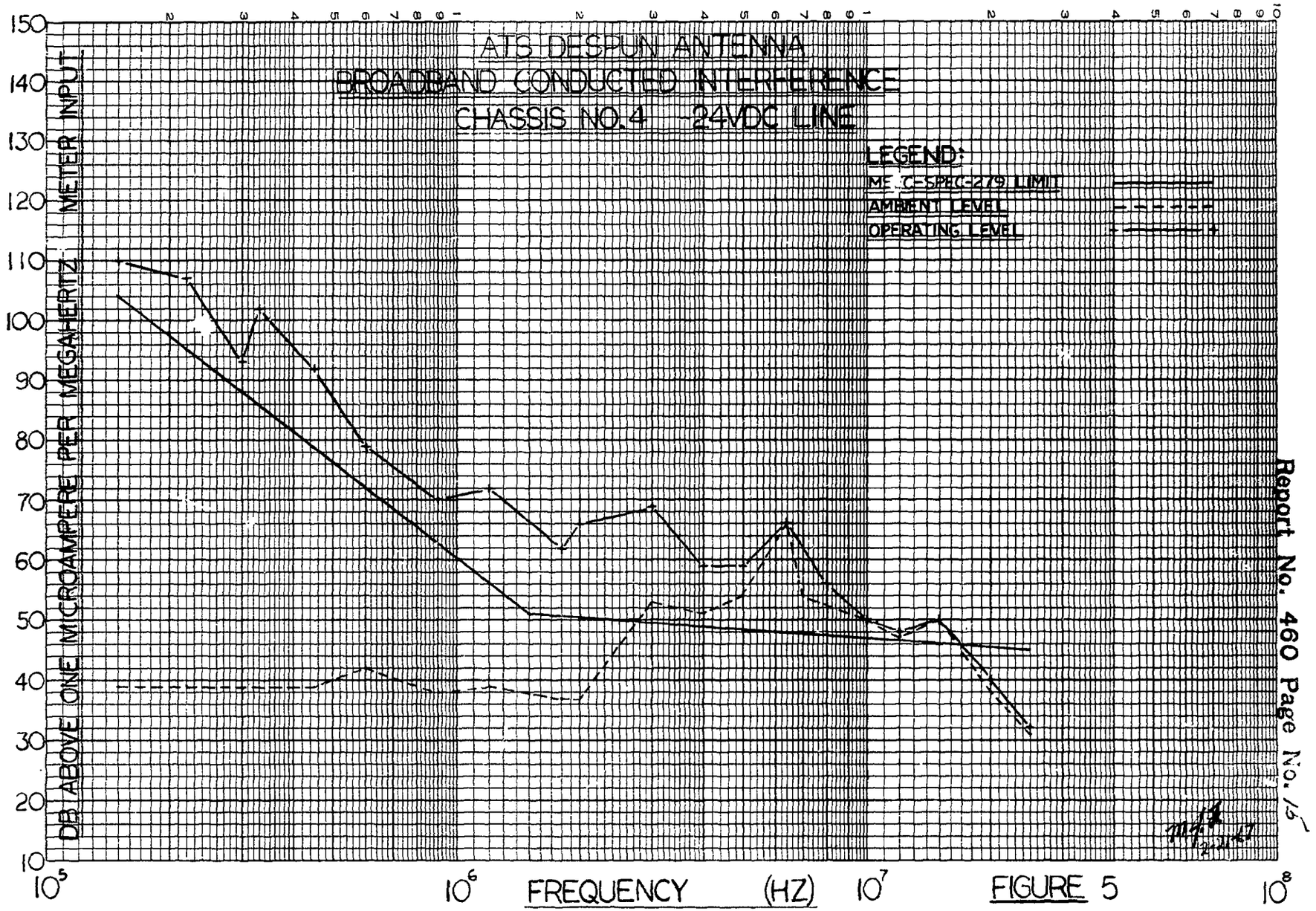

FIGURE 5

NO. 340R-L310 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.

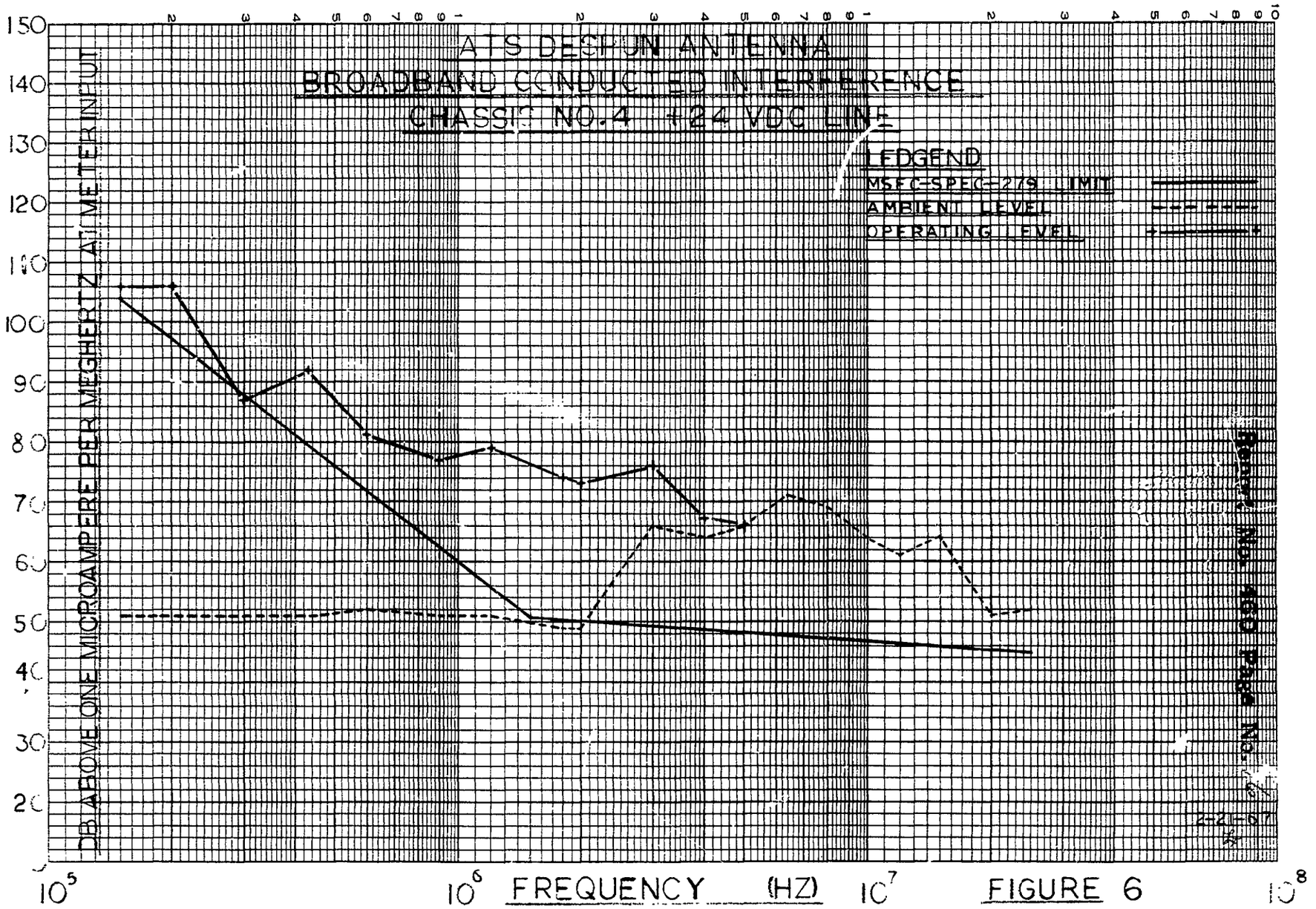

FIGURE 6

NO. 340R-L310 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.

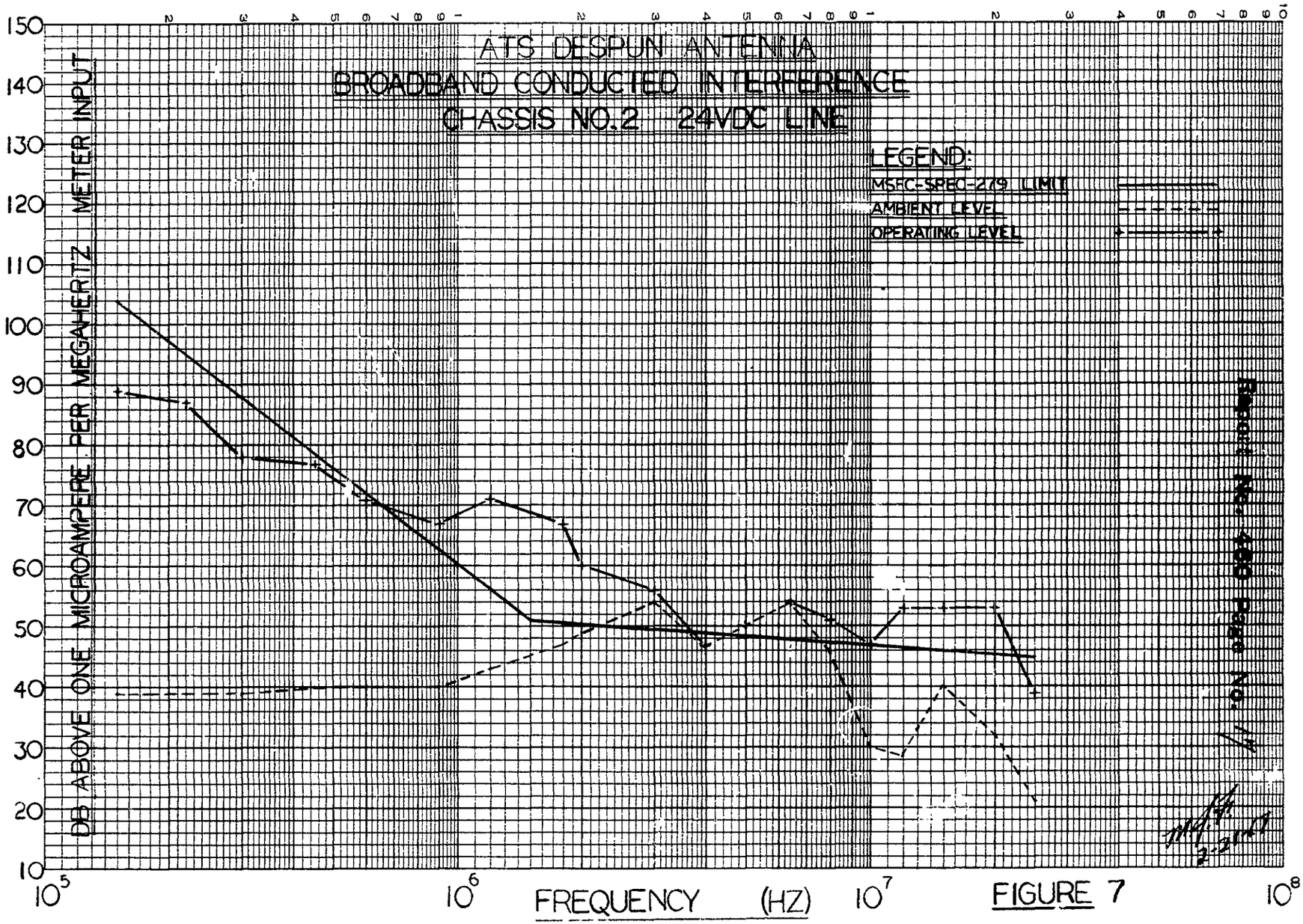

FIGURE 7

NO. 340R-L310 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.

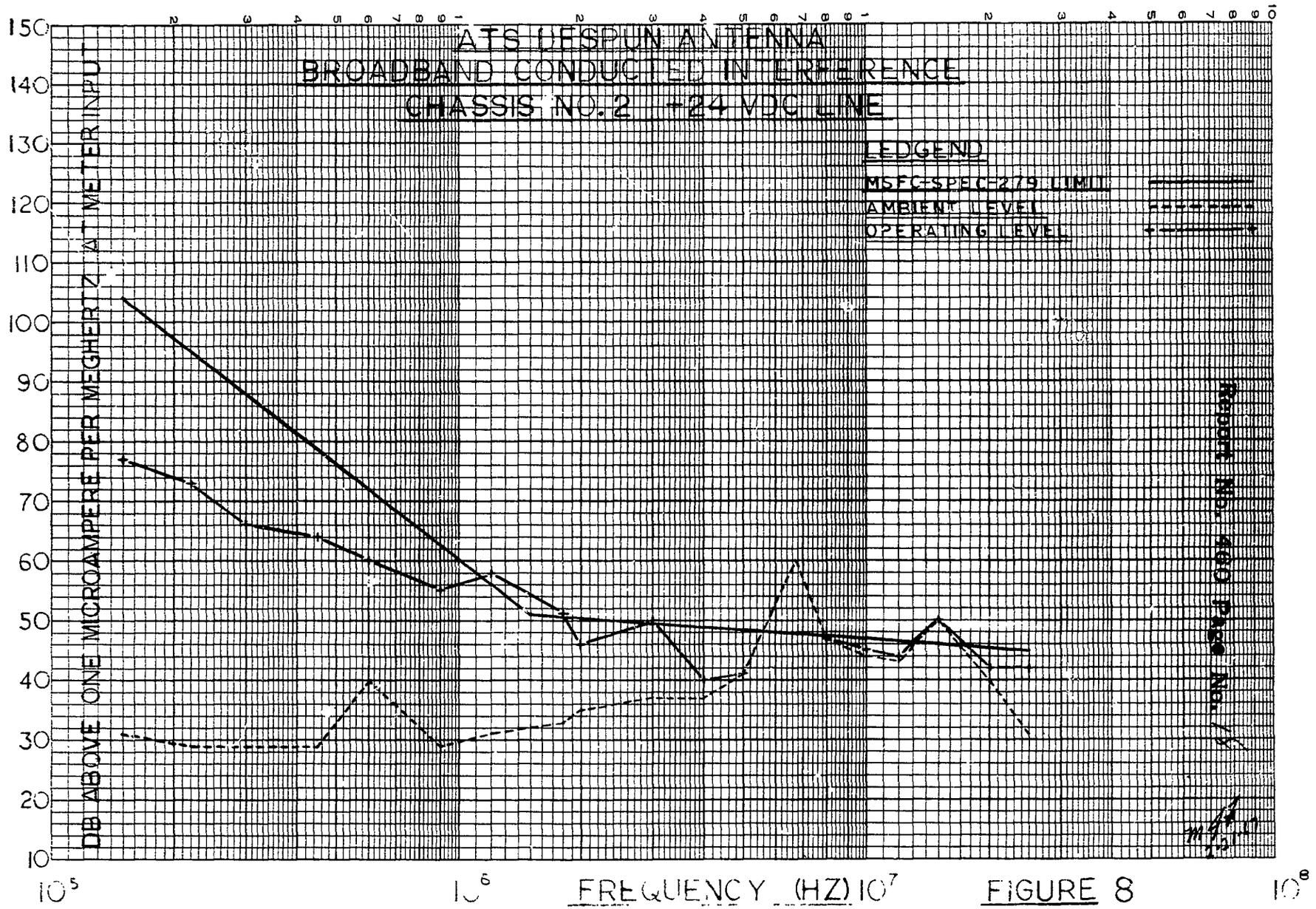

FIGURE 8

SYLVANIA Electronic Systems
EASTERN OPERATION

INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND RADIATED INTERFERENCE FREQUENCY RANGE 0.015 MHz - 1 GHz

TEST CONDITION RADIATED AMBIENT

MEASUREMENT METHOD SUB. GRAPH ON PAGE NO. FIG. 4 SUMMARY ON LINE NO. _____

1	2	3	4	5	6	7	8
TEST FREQ	DIRECT READING	ANTENNA FACTOR			TOTAL	SPEC LIMIT	REMARKS
MHz	DBMC	DB			DBMC/AI	DBMC/AI	
.015	55	46			101	97	
.017	55	45			100	95	
.021	53	43			96	94	
.030	49	43			92	91	
.034	54	42			96	90	
.045	52	36			88	88	
.060	52	32			84	85	
.075	45	39			84	83	
.090	48	36			84	82	
.12	46	29			75	79	
.15	48	27			75	78	
.15	47	39			86	78	
.22	45	38			83	76	
.30	41	38			79	75	
.45	43	32			75	73	
.60	38	33			71	72	
.75	34	34			68	71	
.90	39	32			71	70	
1.5	38	31			69	69	
2.0	36	32			68	69	

DATE 2-14-67 MEASUREMENTS PERFORMED BY [signature]

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SYLVANIA Electronic Systems
EASTERN OPERATION

INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND RADIATED INTERFERENCE FREQUENCY RANGE 0.015 MHz - 1 GHz

TEST CONDITION RADIATED AMBIENT

MEASUREMENT METHOD SUB. GRAPH ON PAGE NO. FIG. 4 SUMMARY ON LINE NO. _____

(1) TEST FREQ	(2) DIRECT READING	(3) ANTENNA FACTOR	(4)	(5)	(6) TOTAL	(7) SPEC LIMIT	(8) REMARKS
MHz	DBMC	DB			DBMC/AI	DBMC/AI	
2.5	45	27			72	69	
3.0	42	24			66	68.5	
4.5	40	26			66	68	
6.0	45	22			67	68	
7.0	55	21			76	67.5	
10.0	48	20			68	67	
15.0	56	19			75	66.5	
20.0	38	17			55	66	
23.0	46	16			62	66	
25.0	43	16			59	66	
25.0	38	8			46	45	
37.0	46	8			54	50	
52.0	49	8			57	51	
70.0	36	9			45	52	
84.0	43	9			52	52.5	
100	31	9			40	53	
150	36	9			45	54.5	
200	42	9			51	55	
300	29	10			39	56.5	
400	26	10			36	57	

DATE 2-14-67 MEASUREMENTS PERFORMED BY Lt Mitt

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INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND RADIATED INTERFERENCE FREQUENCY RANGE 0.015 MHz - 1GHz

TEST CONDITION RADIATED AMBIENT

MEASUREMENT METHOD SUB. GRAPH ON PAGE NO. FIG. 4 SUMMARY ON LINE NO. _____

1	2	3	4	5	6	7	8
TEST FREQ	DIRECT READING	ANTENNA FACTOR			TOTAL	SPEC LIMIT	REMARKS
MHz	DBMC	DB			DBMC/AI	DBMC/AI	
600	22	11			33	58.5	
800	29	12			41	59	
1000	36	12			48	60	

DATE 2-14-67 MEASUREMENTS PERFORMED BY [signature]

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INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND RADIATED INTERFERENCE FREQUENCY RANGE 0.015 MHz - 1GHz

TEST CONDITION SYNCHRONOUS OPERATION CHASSIS #4 ENERGIZED

MEASUREMENT METHOD SUB GRAPH ON PAGE NO. FIG 4 SUMMARY ON LINE NO. _____

(1) TEST FREQ	(2) DIRECT READING	(3) ANTENNA FACTOR	(4)	(5)	(6) TOTAL	(7) SPEC LIMIT	(8) REMARKS
MHz	DBMC	DB			DBMC/AI	DBMC/AI	
.015	58	46			104	97	
.019	57	44			101	95	
.021	57	43			100	94	
.030	54	43			97	91	
.034	58	42			100	90	
.045	59	36			95	88	
.060	61	32			93	85	
.075	53	39			92	83	
.090	56	36			92	82	
.12	55	29			84	79	
.15	54	27			81	78	
.15	53	39			92	78	
.22	49	38			87	76	
.30	42	38			80	75	
.45	44	32			76	73	
.60	40	33			73	72	
.75	36	34			70	71	
.90	40	32			72	70	
1.2	48	29			77	70	
1.5	43	31			74	69	

DATE 2-14-67 MEASUREMENTS PERFORMED BY [illegible]

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SYLVANIA Electronic Systems
EASTERN OPERATION

INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND RADIATED INTERFERENCE FREQUENCY RANGE 0.015 MHz - 1 GHz

TEST CONDITION SYNCHRONOUS OPERATION - CHASSIS #4 ENERGIZED

MEASUREMENT METHOD SUB. GRAPH ON PAGE NO. FIG. 4 SUMMARY ON LINE NO. _____

(1) TEST FREQ	(2) DIRECT READING	(3) ANTENNA FACTOR	(4)	(5)	(6) TOTAL	(7) SPEC LIMIT	(8) REMARKS
MHz	DBMC	DB			DBMC/AI	DBMC/AI	
2.0	40	32			72	69	
2.5	52	27			79	69	
3.0	53	24			77	68.5	
4.5	43	26			69	68	
6.0	50	22			72	68	
7.0	55	21			76	67.5	
10.0	48	20			68	67	
15.0	58	19			77	66.5	
20.0	44	17			61	66	
23.0	47	16			63	66	
25.0	45	16			61	66	
25.0	44	8			52	45	
37.0	46	8			54	50	
52.0	49	8			57	51	
56.0	50	8			58	51	
70.0	42	9			51	52	
84.0	46	9			55	52.5	
95.0	39	9			48	53	
100.0	31	9			40	53	
150	36	9			45	54.5	

DATE 2-14-67 MEASUREMENTS PERFORMED BY [illegible]

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SYLVANIA Electronic Systems
EASTERN OPERATION

INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND RADIATED INTERFERENCE FREQUENCY RANGE 0.015 MHz - 1 GHz

TEST CONDITION SYNCHRONOUS OPERATION - CHASSIS #4 ENERGIZED

MEASUREMENT METHOD SUB GRAPH ON PAGE NO. FIG. 4 SUMMARY ON LINE NO. _____

(1) TEST FREQ	(2) DIRECT READING	(3) ANTENNA FACTOR	(4)	(5)	(6) TOTAL	(7) SPEC LIMIT	(8) REMARKS
MHz	DBMC	DB			DBMC/AI	DBMC/AI	
200	42	9			51	55	
300	29	10			39	56.5	
400	26	10			36	57	
600	22	11			33	58.5	
800	29	12			41	59	
1000	36	12			48	60	

DATE 2-15-67 MEASUREMENTS PERFORMED BY [illegible]

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SYLVANIA Electronic Systems
EASTERN OPERATION

INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND CONDUCTED INTERFERENCE FREQUENCY RANGE 0.15 MHz - 25 MHz

TEST CONDITION CONDUCTED AMBIENT - CHASSIS NO. 4 - 24VDC LINE

MEASUREMENT METHOD SUB GRAPH ON PAGE NO. FIG. 5 SUMMARY ON LINE NO. _____

(1) TEST FREQ	(2) DIRECT READING	(3) CURRENT PROBE TRANSFER IMPEDANCE	(4)	(5)	(6) TOTAL	(7) SPEC LIMIT	(8) REMARKS
MHz	DBMC	DB			DB>1MA/MC	DB>1MA/MC	
.15	45	+6			39	104	
.22	47	+8			39	95	
.30	49	+10			39	88	
.45	51	+12			39	78.5	
.60	55	+13			42	72	
.90	52	+14			38	62.5	
1.2	53	+14			39	56	
1.8	52	+15			37	50.5	
2.0	52	+15			37	50	
3.0	68	+15			53	49	
4.0	67	+16			51	48.5	
5.0	70	+16			54	48	
6.4	82	+16			66	47.5	
8.0	70	+16			54	47	
10.0	66	+16			50	47	
12.0	63	+16			47	46.5	
15.0	66	+16			50	46	
20.0	54	+16			38	45.5	
25.0	47	+16			31	45.0	

DATE 2-15-67 MEASUREMENTS PERFORMED BY [illegible]

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EASTERN OPERATION

INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND CONDUCTED INTERFERENCE FREQUENCY RANGE 0.15 MHz - 25 MHz

TEST CONDITION SYNCHRONOUS OPERATION - CHASSIS #4 ENERGIZED - CHASSIS #4 - 24VDC LINE

MEASUREMENT METHOD SUD GRAPH ON PAGE NO. FIG. 5 SUMMARY ON LINE NO. _____

(1) TEST FREQ	(2) DIRECT READING	(3) CURRENT PROBE TRANSFER IMPEDANCE	(4)	(5)	(6) TOTAL	(7) SPEC LIMIT	(8) REMARKS
MHz	DBMC	DB			DB>1MA/MC	DB>1MA/MC	
.15	116	+6			110	104	
.22	115	+8			107	95	
.30	103	+10			93	88	
.33	112	+10			102	86	
.45	104	+12			92	78.5	
.60	92	+13			79	72	
.90	84	+14			70	62.5	
1.2	86	+14			72	56	
1.8	77	+15			62	56.5	
2.0	81	+15			66	50	
3.0	84	+15			69	50	
4.0	75	+16			59	48.5	
5.0	75	+16			59	48	
6.7	82	+16			66	47.5	
8.0	72	+16			56	47	
10.0	66	+16			50	47	
12.0	64	+16			48	46.5	
15.0	66	+16			50	46	
20.0	56	+16			40	45.5	
25.0	48	+16			32	45	

DATE 2-15-67 MEASUREMENTS PERFORMED BY [illegible]

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SYLVANIA Electronic Systems
EASTERN OPERATION

INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND CONDUCTED INTERFERENCE FREQUENCY RANGE 0.15 MHz - 25 MHz

TEST CONDITION CONDUCTED AMBIENT CHASSIS #4 +24VDC LINE

MEASUREMENT METHOD SUB GRAPH ON PAGE NO. FIG. 6 SUMMARY ON LINE NO. _____

(1) TEST FREQ	(2) DIRECT READING	(3) CURRENT PROBE TRANSFER IMPEDANCE	(4)	(5)	(6) TOTAL	(7) SPEC LIMIT	(8) REMARKS
MHz	DBMC	DB			DB>1MA/MC	DB>1MA/MC	
.15	57	+6			51	104	
.22	59	+8			51	95	
.30	61	+10			51	88	
.45	63	+12			51	78.5	
.60	65	+13			52	72	
.90	65	+14			51	62.5	
1.2	65	+14			51	56	
1.8	64	+15			49	50.5	
2.0	64	+15			49	50	
3.0	81	+15			66	49	
4.0	80	+16			64	48.5	
5.0	82	+16			66	48	
6.7	87	+16			71	47.5	
8.0	85	+16			69	47	
10.0	80	+16			64	47	
12.0	77	+16			61	46.5	
15.0	80	+16			64	46	
20.0	67	+16			51	45.5	
25.0	68	+16			52	45.0	

DATE 2-15-67 MEASUREMENTS PERFORMED BY [illegible]

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SYLVANIA Electronic Systems
EASTERN OPERATION

INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND CONDUCTED INTERFERENCE FREQUENCY RANGE 0.15 MHz - 25 MHz

TEST CONDITION SYNCHRONOUS OPERATION - CHASSIS #4 ENERGIZED CHASSIS No. 4 +24VDC LINE

MEASUREMENT METHOD SUB. GRAPH ON PAGE NO. FIG. 6 SUMMARY ON LINE NO. _____

(1) TEST FREQ	(2) DIRECT READING	(3) CURRENT PROBE TRANSFER IMPEDANCE	(4)	(5)	(6) TOTAL	(7) SPEC LIMIT	(8) REMARKS
MHz	DBMC	DB			DB>1MA/MC	DB>1MA/MC	
.15	112	+6			106	104	
.22	114	+8			106	95	
.30	97	+10			87	88	
.43	104	+12			92	75.5	
.60	94	+13			81	72	
.90	91	+14			77	62.5	
1.2	93	+14			79	56	
1.8	89	+15			74	50.5	
2.0	88	+15			73	50	
3.0	91	+15			76	49	
4.0	83	+16			67	48.5	
5.0	82	+16			66	48	
6.4	87	+16			71	47.5	
8.0	85	+16			69	47	
10.0	80	+16			64	47	
12.0	77	+16			61	46.5	
15.0	80	+16			64	46	
20.0	67	+16			51	45.5	
25.0	68	+16			52	45	

DATE 2-15-67 MEASUREMENTS PERFORMED BY [illegible]

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SESE 1578 (965)

SYLVANIA Electronic Systems
EASTERN OPERATION

INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND CONDUCTED INTERFERENCE FREQUENCY RANGE 0.15 MHz - 25 MHz

TEST CONDITION CONDUCTED AMBIENT CHASSIS NO. 2 -24VDC LINE

MEASUREMENT METHOD SUB. GRAPH ON PAGE NO. FIG. 7 SUMMARY ON LINE NO. _____

(1) TEST FREQ	(2) DIRECT READING	(3) CURRENT PROBE TRANSFER IMPEDANCE	(4)	(5)	(6) TOTAL	(7) SPEC LIMIT	(8) REMARKS
MHz	DBMC	DB			DB>1MA/MC	DB>1MA/MC	
.15	45	+6			39	104	
.22	47	+8			39	95	
.30	49	+10			39	88	
.45	52	+12			40	78.5	
.60	53	+13			40	72	
.90	54	+14			40	62.5	
1.2	57	+14			43	56	
1.8	62	+15			47	50.5	
2.0	64	+15			49	50	
3.0	69	+15			54	49	
4.0	63	+16			47	48.5	
5.0	66	+16			50	48	
6.4	70	+16			54	47.5	
8.0	62	+16			46	47	
10.0	46	+16			30	47	
12.0	45	+16			29	46.5	
15.0	56	+16			40	46	
20.0	48	+16			32	45.5	
25.0	37	+16			21	45.0	

DATE 2-16-67 MEASUREMENTS PERFORMED BY [illegible]

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Report No. 460 Page No. 29

SESE 1578 (965)

SYLVANIA Electronic Systems
EASTERN OPERATION

INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND CONDUCTED INTERFERENCE FREQUENCY RANGE 0.15 MHz – 2.5 MHz

TEST CONDITION SYNCHRONOUS OPERATION - CHASSIS #4 ENERGIZED - CHASSIS NO. 2 -24VDC LINE

MEASUREMENT METHOD SUB. GRAPH ON PAGE NO. FIG. 7 SUMMARY ON LINE NO. _____

(1) TEST FREQ	(2) DIRECT READING	(3) CURRENT PROBE TRANSFER IMPEDANCE	(4)	(5)	(6) TOTAL	(7) SPEC LIMIT	(8) REMARKS
MHz	DBMC	DB			DB>1MA/MC	DB>1MA/MC	
.15	95	+6			89	104	
.22	95	+8			87	95	
.30	88	+10			78	88	
.45	89	+12			77	78.5	
.60	84	+13			71	72	
.90	81	+14			67	62.5	
1.2	85	+14			71	56	
1.8	82	+15			67	50.5	
2.0	75	+15			60	50	
3.0	81	+15			66	49	
4.0	73	+16			57	48.5	
5.0	66	+16			50	48	
6.7	70	+16			54	47.5	
8.0	67	+16			51	47	
10.0	63	+16			47	47	
12.0	69	+16			53	46.5	
15.0	69	+16			53	46	
20.0	69	+16			53	45.5	
25.0	55	+16			39	45.0	

DATE 2-16-67 MEASUREMENTS PERFORMED BY [signature]

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SESE 1578 (965)

SYLVANIA Electronic Systems
EASTERN OPERATION

INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II) SERIAL NO. FLT. MOD. #1

TEST BROADBAND CONDUCTED INTERFERENCE FREQUENCY RANGE 0.15 MHz - 25 MHz

TEST CONDITION CONDUCTED AMBIENT CHASSIS #2 +24 VDC LINE

MEASUREMENT METHOD SUB. GRAPH ON PAGE NO. FIG. 8 SUMMARY ON LINE NO. _____

(1) TEST FREQ	(2) DIRECT READING	(3) CURRENT PROBE TRANSFER IMPEDANCE	(4)	(5)	(6) TOTAL	(7) SPEC LIMIT	(8) REMARKS
MHz	DBMC	DB			DB>1MA/MC	DB>1MA/MC	
.15	37	+6			31	104	
.22	37	+8			29	95	
.30	39	+10			29	88	
.45	41	+12			29	78.5	
.60	53	+13			40	72	
.90	43	+14			29	62.5	
1.2	45	+14			31	56	
1.8	48	+15			33	50.5	
2.0	50	+15			35	50	
3.0	52	+15			37	49	
4.0	53	+16			37	48.5	
5.0	57	+16			41	48	
6.7	76	+16			60	47.5	
8.0	63	+16			47	47	
10.0	60	+16			44	47	
12.0	59	+16			43	46.5	
15.0	66	+16			50	46	
20.0	56	+16			40	45.5	
25.0	47	+16			31	45.0	

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SESE 1578 (965)

SYLVANIA Electronic Systems
EASTERN OPERATION

INTERFERENCE DATA SHEET

TEST SAMPLE ATS DESPUN ANTENNA (MARK II SERIAL NO. FLT. MOD. #1

TEST BROADBAND CONDUCTED INTERFERENCE FREQUENCY RANGE 0.15 MHz - 25 MHz

TEST CONDITION SYNCHRONOUS OPERATION - CHASSIS #4 ENERGIZED CHASSIS #3, +24VDC LINE

MEASUREMENT METHOD SUB GRAPH ON PAGE NO. FIG. 8 SUMMARY ON LINE NO. _____

(1) TEST FREQ	(2) DIRECT READING	(3) CURRENT PROBE TRANSFER IMPEDANCE	(4)	(5)	(6) TOTAL	(7) SPEC LIMIT	(8) REMARKS
MHz	DBMC	DB			DB>1MA/MC	DB>1MA/MC	
.15	83	+6			77	104	
.22	81	+8			73	95	
.30	76	+10			66	88	
.45	76	+12			64	78.5	
.60	73	+13			60	72	
.90	69	+14			55	62.5	
1.2	72	+14			58	56	
1.8	66	+15			51	50.5	
2.0	61	+15			46	50	
3.0	65	+15			50	49	
4.0	56	+16			40	48.5	
5.0	57	+16			41	48	
6.7	76	+16			60	47.5	
8.0	63	+16			47	47	
10.0	61	+16			45	47	
12.0	60	+16			44	46.5	
15.0	66	+16			50	46	
20.0	58	+16			42	45.5	
25.0	58	+16			42	45.0	

DATE 2-16-67 MEASUREMENTS PERFORMED BY [illegible]

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APPENDIX G

ANALYSIS OF THERMAL ENERGY EXCHANGE BETWEEN THE MECHANICALLY DESPUN ANTENNA AND THE SPACECRAFT

Prepared for NASA/GSFC

Contract No. NAS-5-9521

by

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Sylvania Electronic Systems
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March 15, 1967

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Letter	Antenna Temperatures (°R) at:
A	A/0 and A/24
AA	A/0 and A/24 (Satellite at 70°F)
B	A/23.4
C	A/23.4 Satellite at 70°F)
D	A/6 and A/18
E	A/12
F	B/0 and B/24
G	B/6 and B/18
H	B/6 and B/18 (Satellite at 70°F)
I	B/12
J.	C/0 and C/24
K	C/0 and C/24 (Satellite at 70°F)
L	C/12
M	C/6 and C/18

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REFERENCES

(a) Modification No. 24 to Contract No. NAS-5-9521

(b) "Temperature Gradients Developed Along the Despun Antenna Reflector and Feed in a Synchronous Orbit," dated 2 March 1966

ABSTRACT

The purpose of this investigation was to determine the thermal energy exchange between the ATS Mechanically Despun Antenna and the satellite for the three conditions outlined in Reference (a). The three conditions represent three synchronous orbits of the satellite in a years travel around the earth in which the satellite spin axis is (A) normal to the ecliptic plane or an earth-sun line, (B) inclined 65° from an earth-sun line and (C) inclined 115° from an earth-sun line. The heat exchange between the antenna and satellite is determined by computing the temperature history of the antenna at selected times in each of the three orbits.

A 58-zone mathematical model is used to describe the thermal behavior of the Mechanically Despun Antenna. The equations are solved using an IBM 360 Computer.

The heat exchange data for the three orbital conditions are presented in graphical form for two satellite temperatures at the antenna mounting points. Temperature data from some of the computer runs is superimposed upon sketches of the antenna and presented as an appendix to this report.

INTRODUCTION

This analysis is concerned only with those parts of the Mechanically Despun Antenna which project above the blanket of superinsulation on the separation plane of the satellite; the reflector, feed, and motor housing. The reflector consists of upper and lower parabolic faces to the back of which stiffening struts and ribs are brazed to carry a perforated outer skin. The reflector is attached to a ground plane and despun in opposition to the spin-stabilized satellite so that its parabolic face always views the earth. The feed is attached to the motor housing and spins with the satellite. The motor housing is bolted to the satellite with sufficient bearing area to create a low-resistance thermal interface, thereby providing a favorable thermal environment for the motor.

The reflector face is sandblasted with #80 grit to avoid concentrating solar heat upon the feed. The surface treatments of the reflector and feed have been selected to prevent feed temperatures from becoming excessively hot when the reflector faces the sun and to minimize thermal gradients developed in the feed and reflector when part or all of the antenna is in shadow. The ground plane surface (bright, bare, aluminum) was selected to minimize thermal shock of the reflector when the antenna enters the earth's umbra. Its low emittance also tends to reduce satellite heat loss. The results of the analysis described herein show the effect of these surface treatments upon the heat exchange between the antenna and satellite.

CONDITIONS OF ANALYSIS

1. Thermal Control Surfaces

The solar absorptances (α) and IR emittances (ϵ) of the MDA surfaces were obtained from a search of the literature.

a) Reflector (6061 aluminum)

Face: Sandblasted, clear-anodized. $\alpha_R = .50$ $\epsilon_R = .80$

Back: Clean and bright as practicable. $\alpha_B = .40$ $\epsilon_B = .20$

Skin: Exterior surface polished. $\alpha_S = .40$ $\epsilon_S = .10$

b) Feed (6061 aluminum)

Polished exterior surface. .5 to .6 of feed circumference clear anodized. Thickness of anodic coat, .075 mil $\pm$ .025 mil. $\alpha_F = .32$ $\epsilon_F = .45$

c) Ground Plane

Bare aluminum, unpolished. $\alpha_G = .40$ $\epsilon_G = .10$

d) Motor Housing $\alpha_M = .03$ $\epsilon_M = .02$

Assumed to be covered with at least two layers of aluminized mylar.

2. Antenna/Satellite Interface Resistance

The thermal resistance of the interface between the antenna and satellite is assumed to be .025°C/watt (.013°F hr/BTU) which is about one-eighth the resistance between a stud-mounted power transistor and a smooth aluminum surface. Although this is a low thermal resistance, it is realistic and represents a "worst-case" condition insofar as heat transfer between the satellite and antenna is concerned. A finite, non-zero resistance was chosen since it provides a simple check for the amount of heat exchange between the satellite and antenna.

3. Resistance Between Reflector, Feed and Motor Housing

The thermal resistance of the complex heat flow paths between the motor housing and reflector and feed bases through the motor and bearings was estimated from the results of a thermal-vacuum test (see Reference b) as 4 and 6°F hr/BTU respectively.

4. Satellite Temperature

The satellite is considered to be an infinite heat reservoir at 1) 55°F, the nominal temperature of the temperature range at the antenna mounting points specified in Section 3.3 of S2-0404, and 2) 70°F, the temperature specified in Reference (a).

5. Equilibrium

The thermal energy withdrawn from the satellite by the antenna when the satellite is in the earth's umbra in Condition A (see Figure 1) is not determined in this analysis since Reference (a) is concerned with only insolated (sunlit) conditions. (Due to the synchronous orbit, the satellite time in the sun is about 96% for Condition A and 100% for conditions B and C.) The time constant of the lightweight antenna is relatively small compared to the 24 hour orbit time (see Reference b); therefore, it is assumed that the antenna will achieve essentially equilibrium orbital temperatures.

6. Shadowing of Antenna by the Satellite

The antenna is shadowed by the satellite in Condition B when the satellite spin axis is inclined 65° to an earth-sun line. The shadowed area of the reflector and feed was determined graphically using a satellite diameter of 59 inches.

7. Radiation Heat Exchange between Antenna and Satellite

The radiation resistance between the antenna and satellite is very high due to the superinsulation blanket on the satellite. The antenna is considered to be only conductively connected to the satellite; radiative heat transfer between the two is neglected.

SUMMARY OF ANALYSIS RESULTS

The total heat exchange between the MDA and the satellite for each of the three orbit conditions is shown in Figure 5 and 6. In Figure 5, the satellite temperature at the antenna mounting points is 55°F (515°R); in Figure 6, the satellite temperature is 70°F (530°R). It is seen that the heat supplied to the satellite by the antenna is greatest for Condition C, 6.89 watts for a satellite temperature of 55°F and 5.95 watts for a 70°F satellite temperature. Although, in Condition C, the reflector and feed are inclined at 115° to the ecliptic plane and do not receive as much solar heat input as in Condition A, the top surface of the ground plane is also inclined into the sun and receives much more solar heat than it did in Condition A (compare the heat inputs to Zone 57 in computer runs e and a in Table 3).

Figures 5 and 6 indicate that the amount of heat withdrawn from the satellite by the antenna is greatest, as would be expected, in Condition B when the lower half of the antenna is shadowed by the satellite. The analysis results indicate that when only the edge of the reflector is insolated (orbit time, 6 and 18 hours in Figures 5 and 6) 6.97 and 7.60 watts of heat are witndrawn from the satellite in Condition B at satellite temperatures of 55°F and 70°F respectively.

ANALYTICAL METHOD

A. Mathematical Model

The Mechanically Despun Antenna was divided into the 58 zones listed below:

- Lower parabolic reflector, 9 zones, each 2.10 x 2.92 inches
- Lower reflector flanges, 6 zones, each 1.66 x 2.92 inches
- Lower skin, 12 zones, each 2.00 x 2.92 inches
- Upper parabolic reflector, 15 zones, each 2.10 x 3.55 inches
- Upper skin, 8 zones, each 2.00 x 3.55 inches
- Feed, 6 zones of equal length
- Ground plane, 1 zone
- Motor housing, 1 zone

The ground plane and motor housing have high thermal conductances and were not divided into zones. The reflector, feed, and skin zone locations are shown in Figure 3.

1. Conductance Between Zones

The thickness of the parabolic reflector, flanges and skin is .016 inch. The struts and ribs are .025 inch thick. The thermal conductivity of the 6061 aluminum is 97 BTU/hr ft. °F. The total thermal resistance along the length of the feed was calculated to be 51°F hr/BTU (see Reference b). For the purpose of this analysis, the feed is considered to be a cylinder with an average diameter of .61 inches and whose thermal resistance varies linearly along its length. Since the feed is divided into 6 zones, the conductance between feed zones is (6-1)/51 or .098 BTU/hr°F.

The conductive conductances between antenna zones are listed in Table 1 below.

TABLE 1

Conductive Conductances Between MDA Zones

Conductive Coefficient	Zone/Zone	Conductance, BTU/hr°F
C_1	Lwr. Refl. Lateral	.1800
C_2	Lwr. Refl. Axial	.0925
C_3	Flange/Refl.	.1370
C_4	Refl./Skin, Lwr.	.0452
C_5	Refl./Grd. Plane	.1850
C_6	Refl./Skin, Lwr.	.2410
C_7	Refl./Skin, Lwr.	.0685

Conductive Coefficient	Zone/Zone	Conductance, BTU/hr°F
C_8	Refl./Skin, Lwr.	.2020
C_9	Lwr. Refl./Upper Refl.	.0781
C_{10}	Refl./Skin, Lwr.	.0775
C_{11}	Refl./Skin, Lwr.	.2100
C_{12}	Upper Refl., Lateral	.2180
C_{13}	Upper Refl., Axial	.0763
C_{14}	Flange/Upper Refl.	.0417
C_{15}	Refl./Skin, Upper	.2730
C_{16}	Refl./Skin, Upper	.1030
C_{17}	Refl./Skin, Upper	.3000
C_{18}	Refl./Skin, Upper	.1020
C_{19}	Flange/Flange	.0403
C_{20}	Flange/Grd. Plane	.0806
C_{21}	Flange/Skin	.1000
C_{22}	Feed/Feed	.0980
C_{23}	Feed/Mtr. Housing	.1670
C_{24}	Lwr. Skin, Axial	.0555
C_{25}	Lwr. Skin, Lateral	.0900
C_{26}	Skin/Grd. Plane	.1110
C_{27}	Lwr. Skin/Upper Skin	.0490
C_{28}	Upper Skin, Lateral	.1260
C_{29}	Upper Skin, Axial	.0438
C_{30}	Grd. Plane/Mtr. Housing	.2500
C_{31}	Mtr. Housing/Satellite	76.9000

2. Radiative Coefficients

The 58 antenna zones radiate heat to each other as well as [illegible]ce. However, to simplify the view factor calculations, we shall assume h[illegible] interchange only between the reflector and feed zones. A particular zone on the parabolic reflector, for example, would radiate heat to space from its face and back (through the holes in the skin) and to those zones that it views on the feed. Radiation between zones on the parabolic reflector is neglected. (Radiation heat-transfer between zones on the parabolic reflector, flanges, and skin is negligible compared to the conducted heat.) Thus the radiated heat from a reflector zone, q_{r_n}, can be expressed as

$$(a) \quad q_{R_n}(\text{radiated}) = \sigma A_{R_n}\left(1-\sum_{i=31}^{36}\beta_{R_n,F_i}\right)\epsilon_R T_n^4 + \sigma A_{B_n}\epsilon_B T_n^4 + \sigma A_{R_n}\left[\sum_{i=31}^{36}\beta_{R_n,F_i}\left(T_n^4 - T_{F_i}^4\right)\right]\epsilon_R\,\epsilon_F$$

where σ = Stefan-Boltzmann constant = $.173 \times 10^{-8}$ BTU/hr. ft.^{2} $^\circ R^4$

A_{r_n} = Surface area of reflector face zone, ft.^{2}

β_{n,F_i} = View factor between reflector zone, n, and feed zone, i, dimensionless.

A_{b_n} = Surface area of back of reflector zone viewing space, ft.^{2}

T_n = Temperature of reflector zone, $^\circ R$

T_{f_i} = Temperature of feed zone viewed by reflector zone, n, $^\circ R$

Combining the T_n^4 terms in Equation (a) into a single coefficient for T_n^4 we have

$$(b) \quad B_k = \sigma\left[A_{R_n}\left(1-\sum_{i=31}^{36}\beta_{R_n,F_i}\right)\epsilon_R + A_{B_n}\epsilon_B + A_{R_n}\left(\sum_{i=31}^{36}\beta_{R_n,F_i}\right)\epsilon_R\,\epsilon_F\right]$$

Equation (b) was used to compute the radiative coefficients of the reflector zone temperatures in the heat balance equations for the 24 reflector zones.

The radiative coefficients of the feed zone temperatures ($T_{f_i}^4$) viewed by a particular reflector zone are from Equation (a),

$$(c) \quad B_k = \left(\sigma A_{R_n}\beta_{R_n,F_i}\right)\epsilon_R\,\epsilon_F \qquad n = 1\text{-}24$$

(Equation (c) was used to compute the radiative coefficients of the feed zone temperatures which appear in the heat balance equations for the 24 reflector zones.)

The reflector flanges (zones 25-30 in Figure 3) are considered to radiate heat only to space and to have the same emittance as the exterior surface of the skin. Thus the heat radiated from a flange zone is simply $\sigma \epsilon_s A_{f_n} T_n^4$ and the radiative coefficients of the flange zone temperatures and

$$(d) \qquad B_k = \sigma A_{f_n} \epsilon_s \qquad n = 25-30$$

The heat radiated from a particular feed zone (zones 31 - 36 in Figure 3) is

$$(e) \qquad q_{F_n}(\text{radiated}) = \sigma \epsilon_F A_{F_n} \left(1 - \sum_{j=1}^{24} \beta_{F_n, R_j}\right) T_n^4 + \sigma \epsilon_R \epsilon_F A_{F_n} \sum_{j=1}^{24} \beta_{F_n, R_j} \left(T_n^4 - T_{R_j}^4\right)$$

where A_{f_n} = surface area of feed zone, ft.^{2}

β_{f_n, R_j} = View factor between feed zone, n, and reflector zone, j, dimensionless.

T_n = Temperature of feed zone, ^oR

T_{r_j} = Temperature of reflector zone viewed by feed zone, n, ^oR

Combining the T_n^4 terms in Equation (e), we obtain the radiative coefficients of the feed zone temperatures in the heat balance equations for the 6 feed zones,

$$(f) \qquad B_k = \sigma A_{F_n} \left[\left(1 - \sum_{j=1}^{24} \beta_{F_n, R_j}\right) \epsilon_F + \left(\sum_{j=1}^{24} \beta_{F_n, R_j}\right) \epsilon_R \epsilon_F \right]$$

The radiative coefficients for the reflector zone temperatures appearing in the feed zone heat balance equations are, from Equation (e),

$$(g) \qquad B_k = \left(\sigma A_{F_n} \beta_{F_n, R_j}\right) \epsilon_R \epsilon_F \qquad n = 31-36$$

Since

$$A_{F_n} \beta_{F_n, R_j} = A_{R_n} \beta_{R_n, F_i}$$

The coefficients obtained from Equation (g) are the same as those from Equation (c). Thus the radiative coefficients derived from Equation (c) for the reflector zone equations will also appear in the feed zone equations.

TABLE 2

VIEW FACTORS, β, BETWEEN REFLECTOR AND FEED ZONES

REFLECTOR/FEED β_{R_n, F_i} — FEED/REFLECTOR β_{F_n, R_j}

REFL. ZONE \ FEED ZONE	31	32	33	34	35	36
1	.125 / .115	.5 / .014	.003 / .003	.001 / .001	0 / 0	0 / 0
2	.204 / .187	.024 / .022	.004 / .004	.001 / .002	0 / 0	0 / 0
3	.125 / .115	.015 / .014	.003 / .003	.001 / .001	0 / 0	0 / 0
4	.013 / .012	.095 / .087	.013 / .012	.002 / .002	0 / 0	0 / 0
5	.026 / .024	.153 / .140	.021 / .019	.004 / .004	0 / 0	0 / 0
6	.013 / .012	.095 / .087	.013 / .012	.002 / .002	0 / 0	0 / 0
7	.004 / .004	.035 / .032	.087 / .080	.011 / .010	.004 / .004	.002 / .002
8	.008 / .007	.061 / .052	.142 / .130	.014 / .013	.008 / .007	.003 / .003
9	.004 / .004	.035 / .035	.087 / .080	.011 / .010	.004 / .004	.002 / .002
10	0 / 0	.002 / .002	.016 / .018	.028 / .031	.009 / .010	.003 / .003
11	0 / 0	.002 / .002	.015 / .017	.050 / .056	.011 / .012	.003 / .003
12	0 / 0	.004 / .004	.023 / .026	.076 / .085	.016 / .018	.004 / .004
13	0 / 0	.002 / .002	.015 / .017	.050 / .056	.011 / .012	.003 / .003
14	0 / 0	.002 / .002	.016 / .018	.028 / .031	.009 / .010	.003 / .003
15	0 / 0	.001 / .001	.006 / .007	.020 / .022	.031 / .034	.012 / .013
16	0 / 0	.002 / .002	.006 / .007	.026 / .029	.048 / .054	.013 / .015
17	0 / 0	.002 / .002	.008 / .009	.039 / .044	.073 / .080	.020 / .022
18	0 / 0	.002 / .002	.006 / .007	.026 / .029	.048 / .054	.013 / .015
19	0 / 0	.001 / .001	.006 / .007	.020 / .022	.031 / .034	.012 / .013
20	0 / 0	0 / 0	.002 / .002	.005 / .006	.016 / .018	.031 / .035
21	0 / 0	0 / 0	.002 / .002	.005 / .006	.022 / .024	.050 / .056
22	0 / 0	0 / 0	.002 / .002	.006 / .007	.033 / .037	.070 / .078
23	0 / 0	0 / 0	.002 / .002	.005 / .006	.022 / .024	.050 / .056
24	0 / 0	0 / 0	.002 / .002	.005 / .006	.016 / .018	.031 / .035

The radiative coefficients for the skin, ground plane, and motor housing zones are

(h) $B_k = \sigma A_{S_n} \epsilon_S$ $n = 37-56$

(i) $B_k = \sigma A_G (1 - \beta_{G,R}) \epsilon_G$ $n = 57$

(j) $B_k = \sigma A_M \epsilon_M$ $n = 58$

3. View Factor Computation

The view factors, β, between feed and reflector zones were computed graphically by a method described on page 157 of ASD Technical Report 61-119 Part 1, December 1961. This method calculates the configuration or view factor from a differential area to an infinitely long surface generated by an infinitely long line moving parallel to itself and to the plane containing the differential area, dA_1. However, as stated in the report, the method produces good results for finite surfaces if the length of the A_2 surface is greater than twice the distance between A_1 to A_2 and the view factors of several points are taken along the A_1 surface and then averaged. View factors between each of the feed zones and the reflector zones were computed in this manner in both the transverse and axial directions and the actual view factor taken as the product of the view factors in the two directions. The feed/reflector zone view factors are listed in Table 2.

4. Example

In order to demonstrate how the mathematical model of the MDA was formulated, a heat balance equation will be written for a single thermal zone. As a typical zone we can choose Zone 7 which is conductively connected to Zones 4, 8, 11 and 29 (see Figure 3) through C_2, C_1, C_9 and C_3 respectively and to Zone 45 on the skin by C_{10} (see Table 1). Table 2 indicates that significant view factors exist between Reflector Zone 7 and Feed Zones 32, 33 and 34 of .035, .087 and .011 respectively. The surface area of Zone 7 facing space and the feed (A_{r_7}) is .0426 sq. ft. and the area viewing space through the holes in the skin (A_{b_7}) is .018 sq. ft. The radiative coefficient for T_7^4 which we shall call B_5 is, from Equation 2(b)

$$B_5 = (6.32\epsilon_R + 3.12\epsilon_B + .983\epsilon_R\epsilon_F)10^{-11}$$

The radiative coefficients for T_{32}^4, T_{33}^4, and T_{34}^4 which we shall call B_{25}, B_{26} and B_{27} respectively are, from Equation 2(c)

$$B_{25} = .258(10^{-11})\epsilon_R\epsilon_E \; ; \quad B_{26} = .645(10^{-11})\epsilon_R\epsilon_F \; ; \quad B_{27} = .080(10^{-11})\epsilon_R\epsilon_F$$

Thus the heat balance equation for Zone 7 is

$$q_7 = -C_2 T_4 + B_5 T_7^4 + (C_1 + C_2 + C_3 + C_9 + C_{10}) T_7 - C_1 T_8 - C_9 T_{11} - C_3 T_{29} - B_{25} T_{32}^4 - B_{26} T_{33}^4 - B_{27} T_{34}^4 - C_{10} T_{45}$$

B. Determination of Input Powers

The prime source of power input to the MDA zones is, of course, the sun. Solar heat inputs to each of the antenna zones were computed as the product of the solar absorptance, α., of the zones, their projected areas upon a plane normal to the earth-sun line, and a solar constant, G_s, of 443 BTU/hr. ft.^{2}. Secondary heat input sources are earthshine (earth's emitted IR radiation) and the earth's albedo.

The power incident upon a unit area of the reflector face, q/A, from earthshine can be expressed by (a) $P_e = q/A = \sigma T_e^4 \cos\lambda / H^2$

where H = Altitude of reflector above earth's center in terms of the earth's radius.

λ = Angle between principal axis of the parabolic reflector and a line between the earth's center and the reflector focus.

Since the earth's average temperature is about 450°R and the reflector always faces earth (λ=0),

$$P_e = .173(4.50)^4/(22,750/3437)^2 = 1.61 \text{ BTU/hr ft}^2$$

If we assume that the reflector receives heat from the portion of the earth's albedo directly beneath it, the albedo radiation then fluctuates like a rectified cosine function as the reflector circles the sunlit portion of the earth starting from the terminator and,

(b) $$P_a = A_e G_s \cos\theta \cos\lambda / H^2 = 3.63 \cos\theta \text{ BTU/hr ft}^2$$

where A_e = Average value of the earth's albedo = .36
θ = Angle between the principal axis of the parabolic reflector and the earth-sun line

Computed power inputs to the 58 antenna zones from the sun, earthshine, and the earth's albedo for 14 computer runs are listed in Table 3. The computer runs, a through n, represent various orientations of the antenna to the sun at different times in the three orbits as listed below. The orbit times are defined in Figure 4.

RUN	DESCRIPTION
a	Prior to entering, and just after leaving the earth's umbra. Reflector facing sun.
b	In earth's umbra.

RUN	DESCRIPTION
c	Solar heat on edge of reflector.
d	Reflecter back fully insolated.
e	Reflector face fully insolated.
f	Solar heat on edge of reflector.
g	Reflector back fully insolated.
h	Reflector face facing sun but only upper portion of reflector insolated.
i	Reflector edge facing sun but only upper portion insolated.
j	Reflector back facing sun but only upper portion insolated.
k	Portion of reflector face insolated.
l	Portion of reflector back insolated.
m	Same as k except lower portion of antenna shadowed by satellite.
n	Same as l except lower portion of antenna in shadow.

C. Computer Program

The computer program used to solve the 58 non-linear equations of the mathematical model is written especially for the ATS/MDA. The temperature coefficients are computed and stored separately from the mathematical model so that structural or mechanical changes to the antenna which involve thermal conductances can easily be accommodated. If, for example, it is desired to see what effect a lower conductance (higher thermal resistance) between the antenna and the satellite will have upon the computer output data, a new value of C_{31} (see Table 1) is simply plugged into the program.

The absorbed powers of each zone, the emittances E_r, E_b, E_s, E_f, E_g and E_m and the satellite temperature are all program inputs. If output data is desired for antenna/sun orientations, surface emittances and/or satellite temperatures other than those used in this analysis, the new inputs are simply punched on cards.

TABLE 3

HEAT INPUTS (BTU/HR) TO ATS/MDA ZONES

	COMPUTER RUNS													
ZONE	a	b	c	d	e	f	g	h	i	j	k	l	m	n
1	7.60	.055	.055	.831	6.90	.055	.764	.055	.055	.055	2.018	.055	.080	.055
2	9.00		.310	1.880	8.17	.280	1.716				.635	1.360		
3	7.60		1.310	.831	6.90	1.190	.764				.080	7.495		
4	7.60		.055	.831	6.90	.055	.764				2.018	.055		
5	9.00		.310	1.880	8.17	.280	1.716				.635	1.360		
6	7.60		1.310	.831	6.90	1.190	.764				.080	7.495		
7	7.60		.055	.831	6.90	.055	.764				2.018	.055		
8	9.00		.310	1.880	8.17	.280	1.716				.635	1.360		
9	7.60		1.310	.831	6.90	1.190	.764				.080	7.495		
10	8.55	.067	.067	6.740	7.76	.067	6.125	1.550	.067	1.950	8.377	3.467	5.347	2.377
11	10.30			2.420	9.34		2.210	.721		.980	1.997	.492	1.130	.298
12	11.20				10.18			.067		1.390	1.357	.067	.668	.067
13	10.30		1.040		9.34	.943		.721	.632	.980	.097	6.737	.097	1.897
14	8.55		6.12	6.740	7.76	5.550	6.125	1.550	4.440	1.950	.097	10.467	.097	.543
15	8.55		.067	6.740	7.76	.067	6.125	7.760	.067	6.125	8.377	3.467	7.597	3.145
16	10.30			2.240	9.34		2.210	9.340		2.210	1.997	.492	1.817	.453
17	11.20			2.240	10.18		2.210	10.180		2.210	1.357	.067	1.239	.067
18	10.30		1.040	2.240	9.34	.943	2.210	9.340	.943	2.210	.097	6.737	.097	6.117
19	8.55		6.120	6.740	7.76	5.550	6.125	7.760	5.550	6.125	.097	10.467	.097	9.507
20	8.55		.067	7.160	7.76	.067	6.490	7.760	.067	6.490	8.377	3.467	7.597	3.145
21	10.30		.067	8.460	9.34		7.680	9.340		7.680	6.057	.492	5.597	.453
22	11.20		.570	9.330	10.18	.517	8.320	10.180	.517	8.320	3.507	.067	3.277	.067
23	10.30		3.850	8.460	9.34	3.490	7.680	9.340	3.490	7.680	.097	6.737	.097	6.917
24	8.55		6.120	7.160	7.76	5.550	6.490	7.760	5.550	6.490	.097	10.467	.097	9.507
25	2.75	0	0	0	2.50	0	0	0	0	0	2.020	4.110	0	0
26		0	3.270	0		2.960	0	0	0	0	0	0	0	0
27		0	0	0		0	0	0	0	0	2.020	4.110	0	0

TABLE 3 (CONTINUED)

COMPUTER RUN

ZONE	a	b	c	d	e	f	g	h	i	j	k	l	m	n
28	2.75	0	3.270	0	2.500	2.960	0	0	0	0	0	0	0	0
29	↓	0	0	0	↓	0	0	0	0	0	2.020	4.110	0	0
30	↓	0	3.270	0	↓	2.960	0	0	0	0	0	0	0	0
31	3.050	.011	.011	.028	2.760	.011	.025	.017	.011	.025	.025	3.050	.025	.025
32	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
33	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
34	↓	↓	↓	↓	↓	↓	↓	1.400	↓	↓	↓	↓	↓	1.400
35	↓	↓	↓	↓	↓	↓	↓	2.760	↓	↓	↓	↓	↓	2.760
36	↓	↓	↓	↓	↓	↓	↓	2.760	↓	↓	↓	↓	↓	2.760
37	.550	0	0	4.970	.500	0	4.510	0	0	0	3.460	0	0	0
38	0	0	0	↓	0	0	↓	0	0	0	3.460	0	0	0
39	0	0	1.820	↓	0	1.650	↓	0	0	0	0	0	0	0
40	.550	0	1.820	↓	.500	1.650	↓	0	0	0	0	0	0	0
41	.550	0	0	↓	.500	0	↓	0	0	0	3.460	0	0	0
42	0	0	0	↓	0	0	↓	0	0	0	3.460	0	0	0
43	0	0	1.820	↓	0	1.650	↓	0	0	0	0	0	0	0
44	.550	0	1.820	↓	.500	1.650	↓	0	0	0	0	0	0	0
45	.550	0	0	↓	.500	0	↓	0	0	0	3.460	0	0	0
46	0	0	0	↓	0	0	↓	0	0	0	3.460	0	0	0
47	0	0	1.820	↓	0	1.650	↓	0	0	0	0	0	0	0
48	.550	0	1.820	↓	.500	1.650	↓	0	0	0	0	0	0	0
49	0	0	0	5.920	0	0	5.370	0	0	2.145	4.120	0	2.240	0
50	0	0	0	↓	0	0	↓	0	0	3.220	4.120	0	1.978	0
51	0	0	2.270	↓	0	2.060	↓	0	1.030	3.220	0	0	0	0
52	0	0	2.270	↓	0	2.060	↓	0	1.380	2.145	0	0	0	0
53	0	0	0	↓	0	0	↓	0	0	5.370	4.120	0	3.735	0
54	0	0	0	↓	0	0	↓	0	0	↓	4.120	0	3.735	0
55	0	0	2.270	↓	0	2.060	↓	0	2.060	↓	0	0	0	0
56	0	0	2.270	↓	0	2.060	↓	0	2.060	↓	0	0	0	0
57	2.660	0	2.150	0	14.700	9.880	0	0	0	0	2.000	2.000	0	0
58	1.250	0	1.250	1.250	2.560	2.560	2.560	0	0	0	1.250	1.250	0	0

The computer output data consists of the 58 zone temperatures and the satellite temperature input, T_{59}. The thermal energy exchange between the satellite and the antenna, q_{MS}, can be easily computed by the temperature difference across C_{31} (see Figure 2),

$$(a) \qquad q_{MS} = C_{31}\left(T_{58} - T_{59}\right)$$

The thermal energy exchange between the satellite and antenna due to the reflector, feed and heat input to the motor housing can be computed by rearranging the last equation (Zone 58) of the mathematical model

$$(b) \qquad q_{MS} = q_{58} + C_{23}\left(T_{31} - T_{58}\right) + C_{30}\left(T_{57} - T_{58}\right) - B_{55}\, T_{58}^{4}$$

Table 5 lists the heat transfer between the reflector (and ground plane), the feed and the satellite as well as the heat input to and loss from the motor housing for all 28 computer runs. The algebraic sum of these quantities is equal to the total exchange of thermal energy between the antenna and satellite.

TABLE 4

THERMAL ENERGY EXCHANGE BETWEEN ANTENNA AND SATELLITE

RUN	COND.	TIME HRS	q_M	FEED TO MTR. HSG.	GRD PLANE TO MTR HSG	MTR HSG TO SPACE	ANTENNA/SATELLITE BTU/HR	ANTENNA/SATELLITE WATTS
a	A	0.6	1.25	4.76 BTU/HR	13.81 BTU/HR	-.62 BTU/HR	19.20	5.26
b	A	0,24	0	-5.08	-23.02		-28.72	-8.41
c	A	6,18	1.25	-4.17	-8.00		-11.53	-3.39
d	A	12	1.25	-2.24	8.06		6.45	1.89
e	C	0,24	2.56	4.16	17.43		23.52	6.89
f	C	6,18	2.56	-4.17	-5.26		-7.49	-2.20
g	C	12	2.56	-2.50	6.11		5.55	1.63
h	B	0,24	0	-2.38	-13.32		-16.32	-4.79
i	B	6,18	0	-4.73	-18.42		-23.77	-6.97
j	B	12	0	-3.88	-12.49		-16.99	-4.98
k	A	7.4, 16.6	1.25	-3.69	-3.60		-6.66	-1.95
l	A	4.6, 19.4	1.25	3.28	-1.97		1.93	0.57
m	B	7.4, 16.6	0	-4.44	-16.24		-21.30	-6.25
n	B	4.6, 19.4	0	-2.78	-16.71		-20.11	-5.89
SATELLITE AT 70° F								
a'	A	SAME AS OVE	1.25	4.16	11.78	-.70 BTU/HR	16.49	4.83
b'	A		0	-5.52	-24.46		-30.80	-9.03
c'	A		1.25	-4.65	-9.97		-14.07	-4.12
d'	A		1.25	-2.74	6.04		3.85	1.13
e'	C		2.56	3.56	14.84		20.26	5.95
f'	C		2.56	-4.62	-7.04		-9.80	-2.87
g'	C		2.56	-2.98	4.11		2.99	0.88
h'	B		0	-2.90	-15.05		-18.65	-5.47
i'	B		0	-5.16	-20.02		-25.88	-7.60
j'	B		0	-4.35	-14.24		-19.29	-5.65
k'	A		1.25	-4.15	-5.44		-9.04	-2.65
l'	A		1.25	2.70	-3.84		-0.59	-0.17
m'	B		0	-4.89	-17.90		-23.49	-6.89
n'	B		0	-3.29	-18.36		-22.35	-6.55

DISCUSSION OF RESULTS

The curves of Figures 5 and 6, based upon the data in the last column of Table 4, represent the thermal energy exchange between the MDA and satellite for complete orbits in Conditions A, B, and C except for the time that the satellite is in the earth's umbra in Condition A. As expected, the thermal energy exchange is greatest for Condition B when only the edge of the reflector is insolated (sunlit) and most of the antenna is in shadow. In fact, the results of the analysis indicate that the satellite heat loss to the antenna will be greater for Condition B than when the antenna is in the earth's umbra in Condition A. Comparing Runs b and b^1 (see Table 4) with Runs i and i^1 indicates that the steady-state heat loss of the satellite to the antenna in the earth's umbra is no more than 1.5 watts greater than maximum loss in Condition B when only the top edge of the antenna reflector is insolated. Before the antenna enters the earth's umbra, however, its temperature is relatively hot and it is supplying heat to the satellite as shown in Runs a and a^1. Reference to Figures A and B in the temperature data attached to this report shows that the average temperature of the reflector must drop over 200°F during the time it is in the earth's umbra to achieve the steady-state heat withdrawal listed for Run b^1. The time constant of the antenna will prevent its temperature drop from approaching 200°F and the satellite heat withdrawn by the antenna should not exceed that withdrawn in Condition B.

In Condition B, the motor housing, ground plane, and the entire lower reflector are always in the shadow of the satellite. Portions of reflector Zones 10 through 14 and skin Zones 49 through 52 are also shadowed by the satellite. The size of the shadowed area of these zones is dependent upon the antenna's orientation to the sun. The effect of the satellite shadow upon the antenna temperature can be seen by comparing the temperature distributions shown in Figures F through I for Condition B with those of Condition C (Figures J through M) where the solar angle is the same but the antenna is not shadowed by the satellite.

The values of solar absorptances and IR emittances used for the antenna surfaces in this analysis were increased slightly over those found for similar surfaces in the literature to provide a "worst-case" condition with respect to thermal energy exchange between the antenna and satellite. In other words, the values of α and ϵ were increased to allow for some handling contamination of the surfaces and to account for uncertainties in anodic coating thicknesses, surface finishes, etc.

The results of tests to determine the absorptance and emittance of samples of the antenna surfaces were not received in time to use in this analysis. However, if the test values of α and/or ϵ are significantly different from those used in this analysis, it would be a simple matter to repeat Runs a, e, and i with the new values plugged into the computer program.

The antenna temperature data in Figures A through M at the end of this report represent only part of the total computer output used in preparing the curves shown in Figure 5 and 6. The temperature data shown includes the antenna temperatures at the times of maximum thermal energy exchange between the antenna and

satellite for satellite temperatures of 70° F as well as 55° F.

A copy of the computer program and the computer output used in this analysis is being forwarded to NASA/GSFC as required in Modification No. 24 of Contract No. NAS-5-9521.

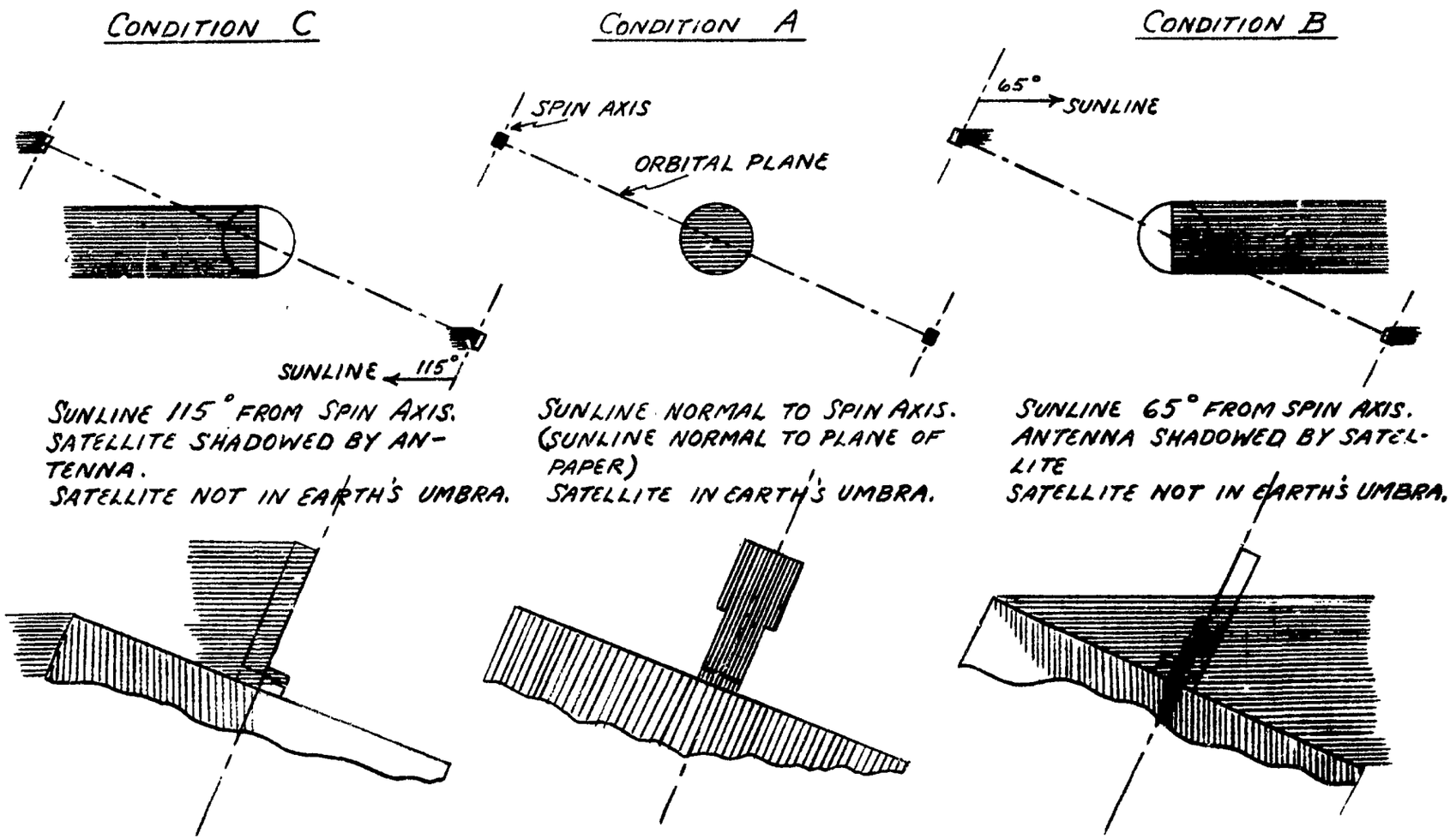


FIGURE 1: RANGE OF SUNLINE/SATELLITE SPIN AXIS ANGLES DURING A YEAR IN ORBIT

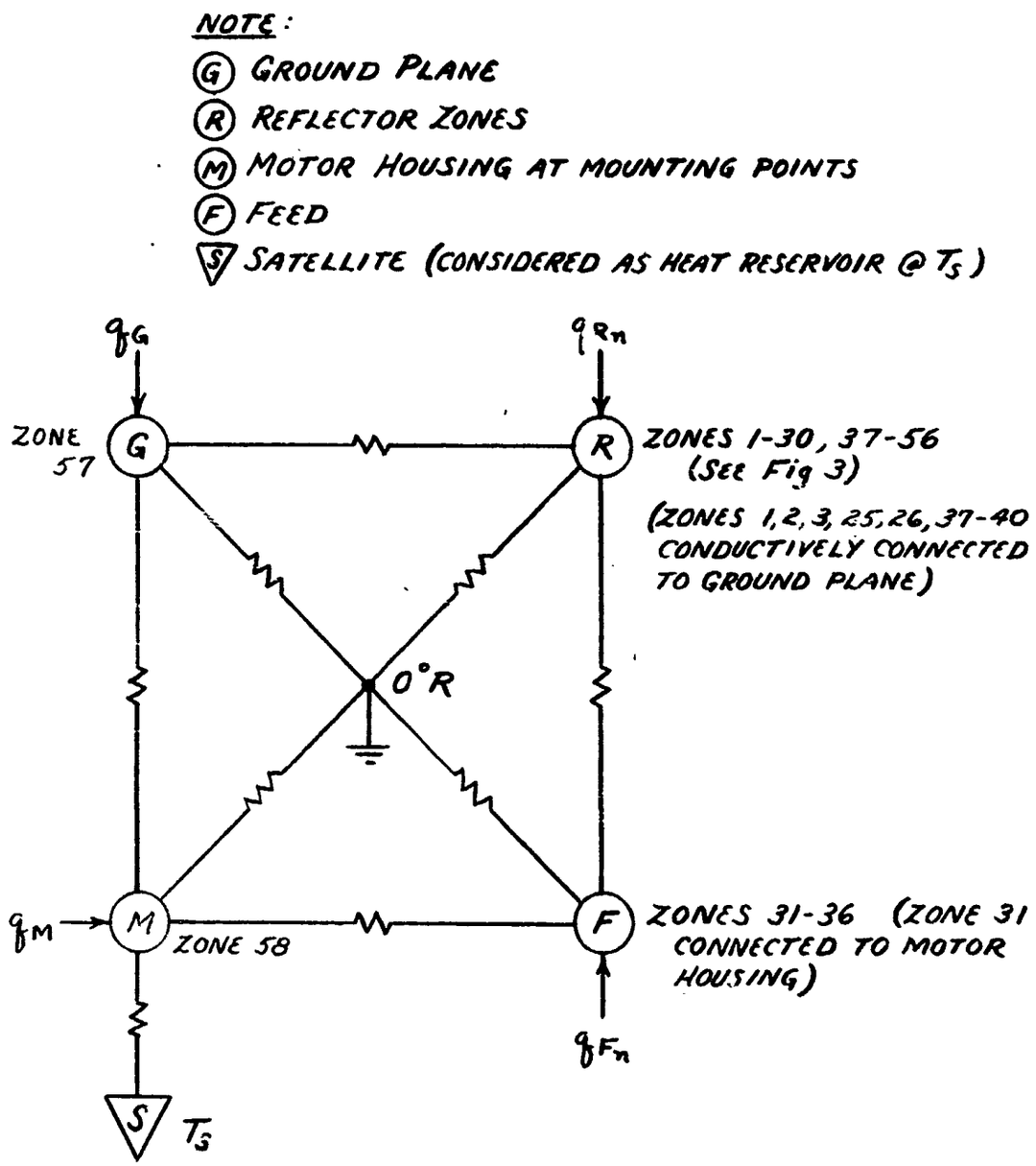


FIGURE 2: ELECTRICAL ANALOG OF ATS/MDA

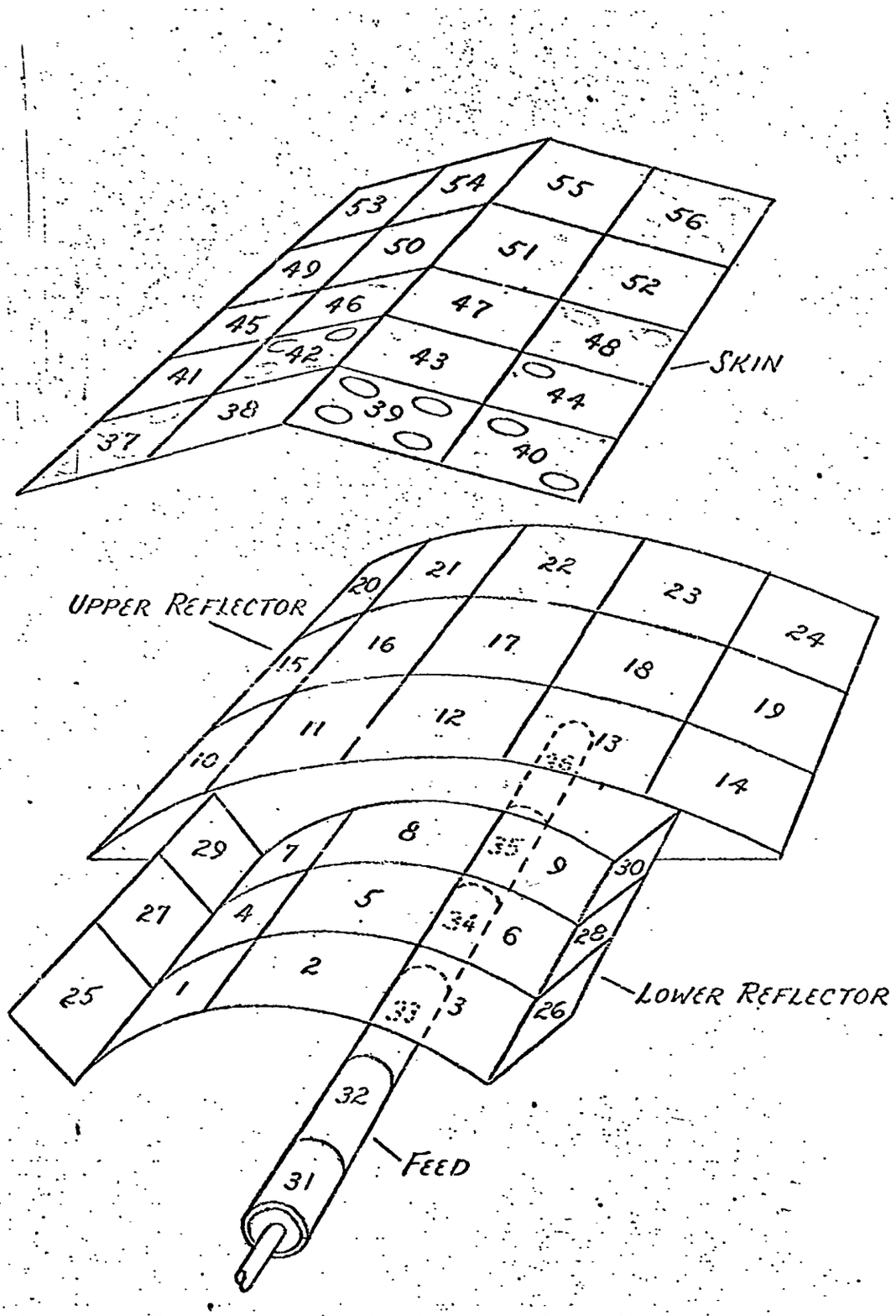
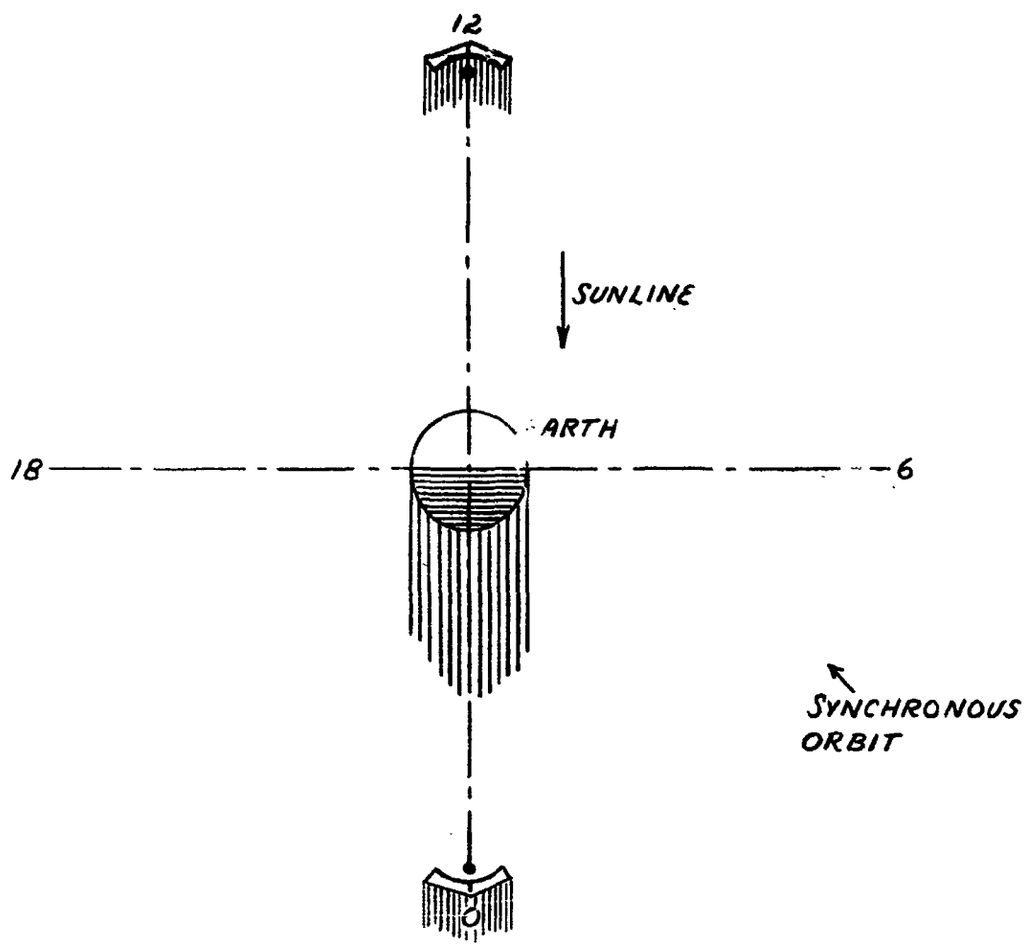


FIGURE 3 : ATS/MDA ZONE BAEDEKER



TIME :

0 HRS - REFLECTOR FACE LOOKS DIRECTLY INTO SUN EXCEPT IN CONDITION (ORBIT) A WHEN SATELLITE IS IN EARTH'S UMBRA.

6, 18 HRS - REFLECTOR EDGE INSOLATED. FACE AND FEED IN SHADOW.

12 HRS - REFLECTOR BACK LOOKS DIRECTLY INTO SUN.

FIG. 4: ORBIT TIME

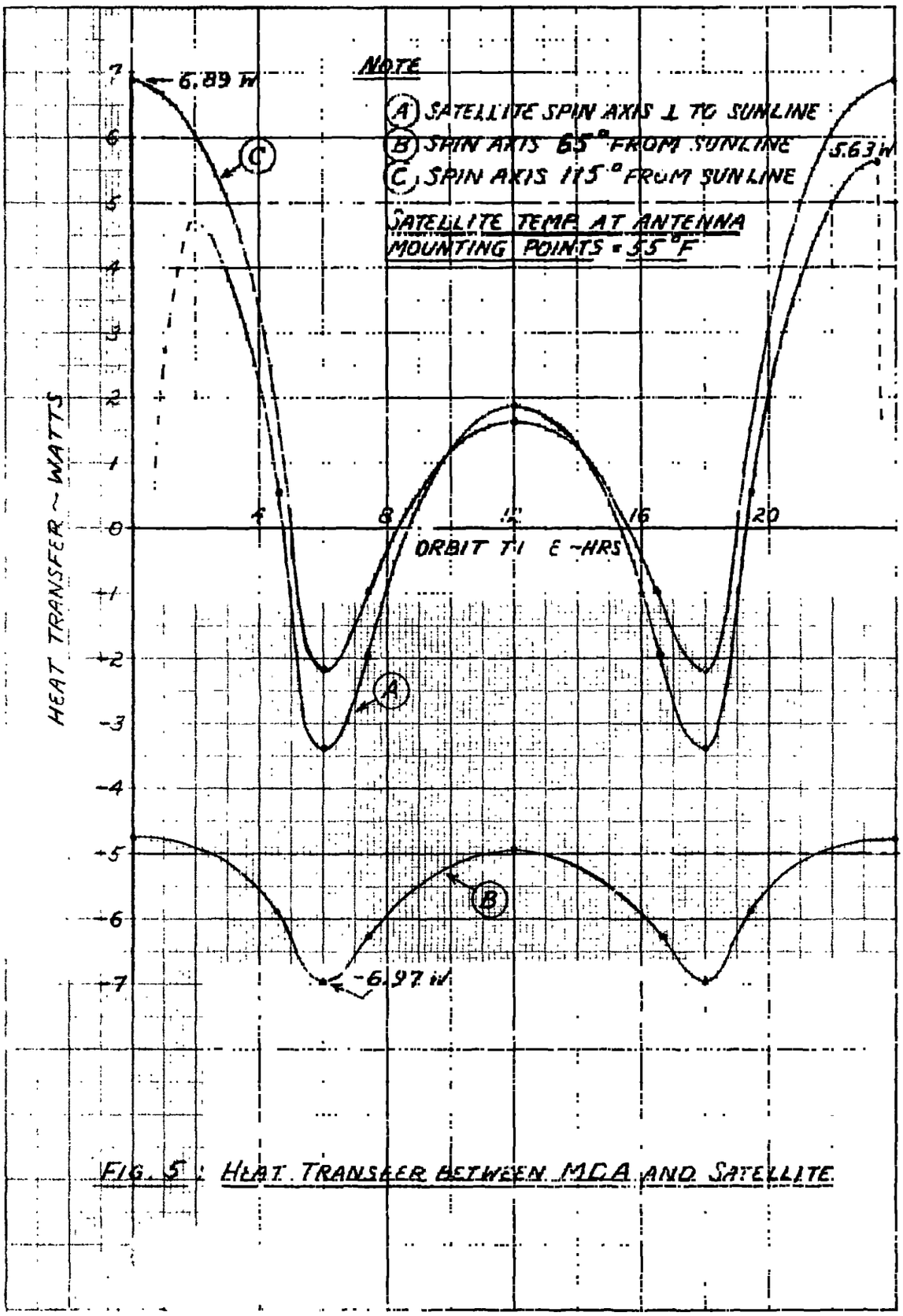


FIG. 5: HEAT TRANSFER BETWEEN MCA AND SATELLITE

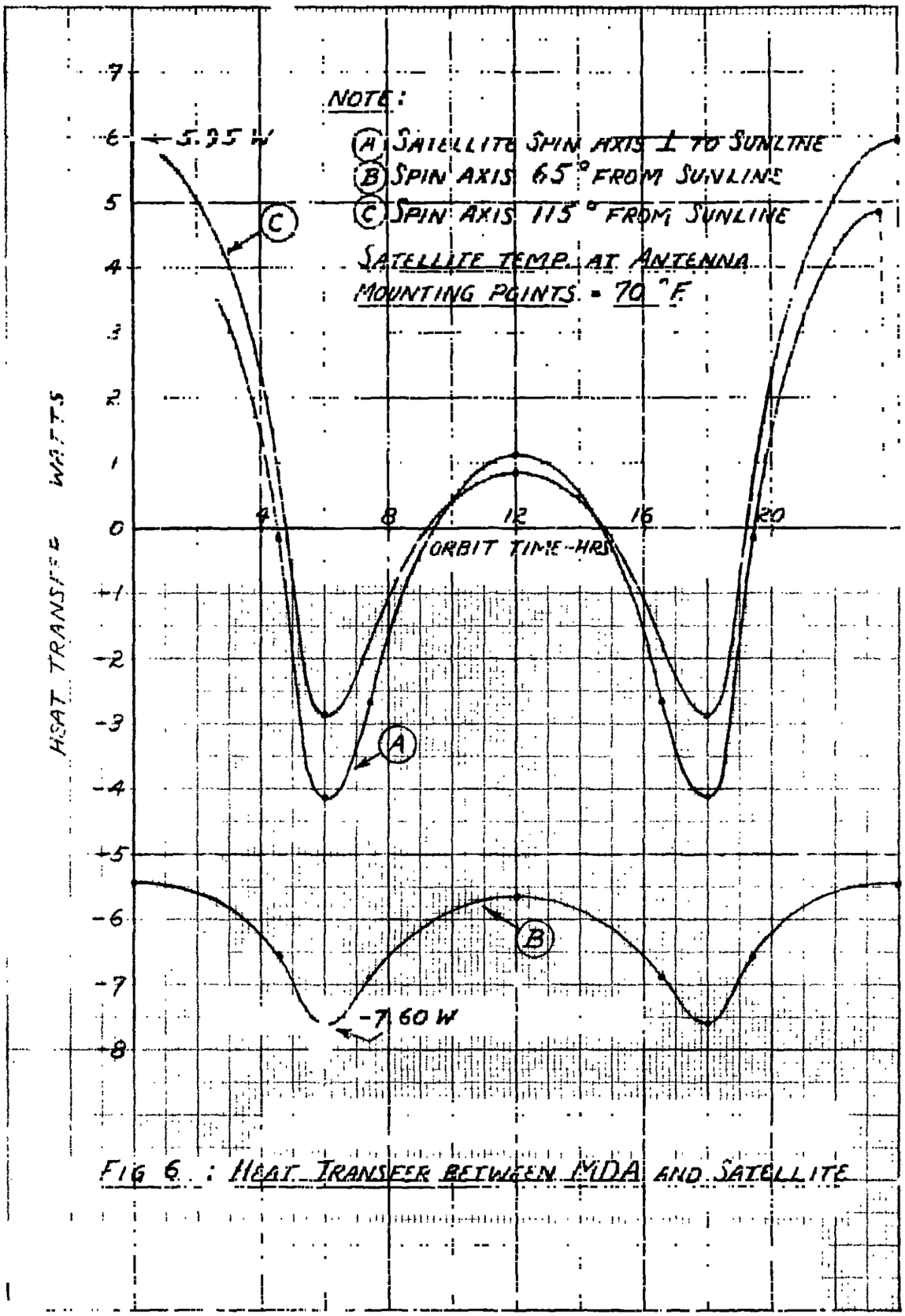


FIG 6 : HEAT TRANSFER BETWEEN MDA AND SATELLITE

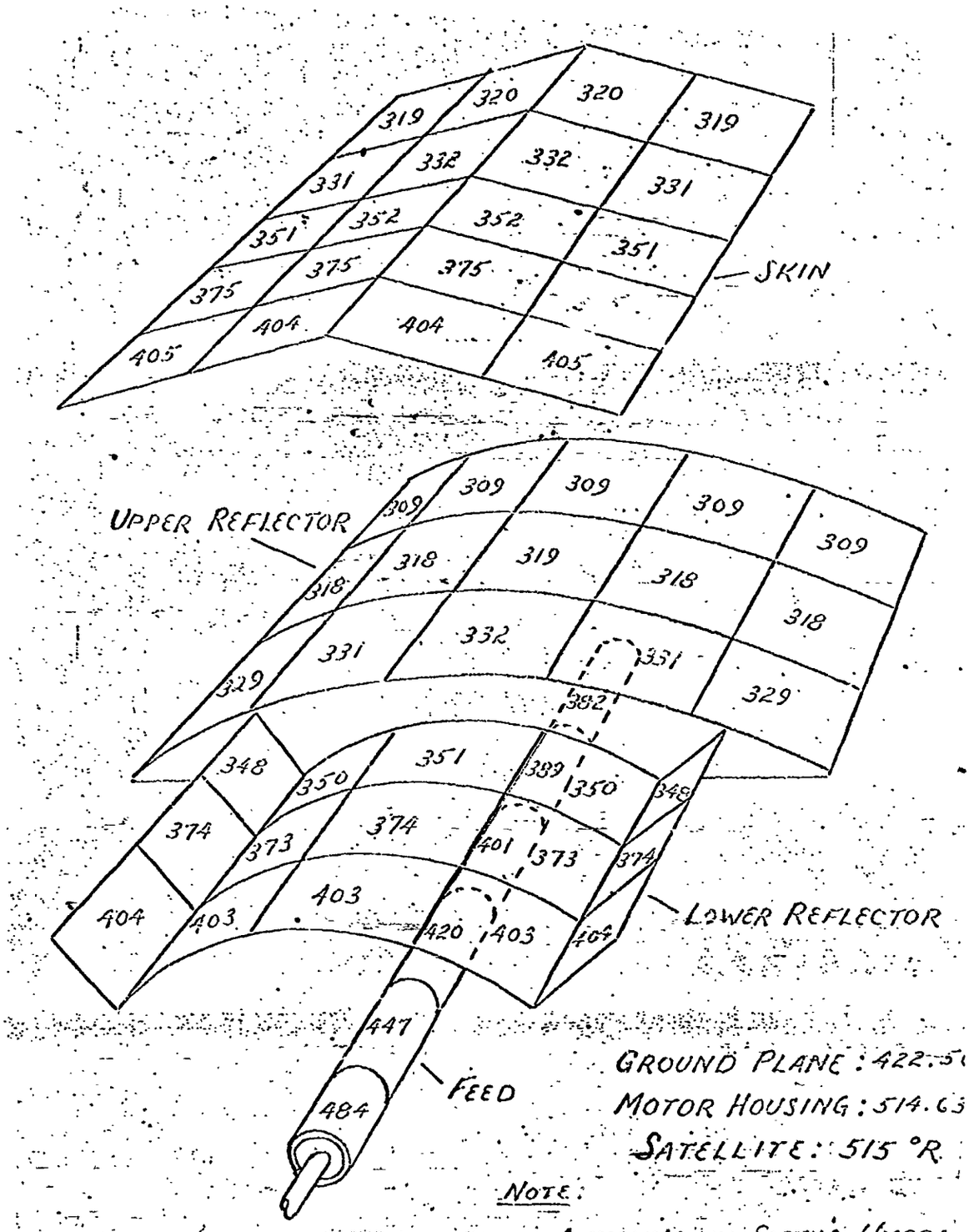


FIG. A : ANTENNA TEMPERATURES (°R) AT A/O + A/24

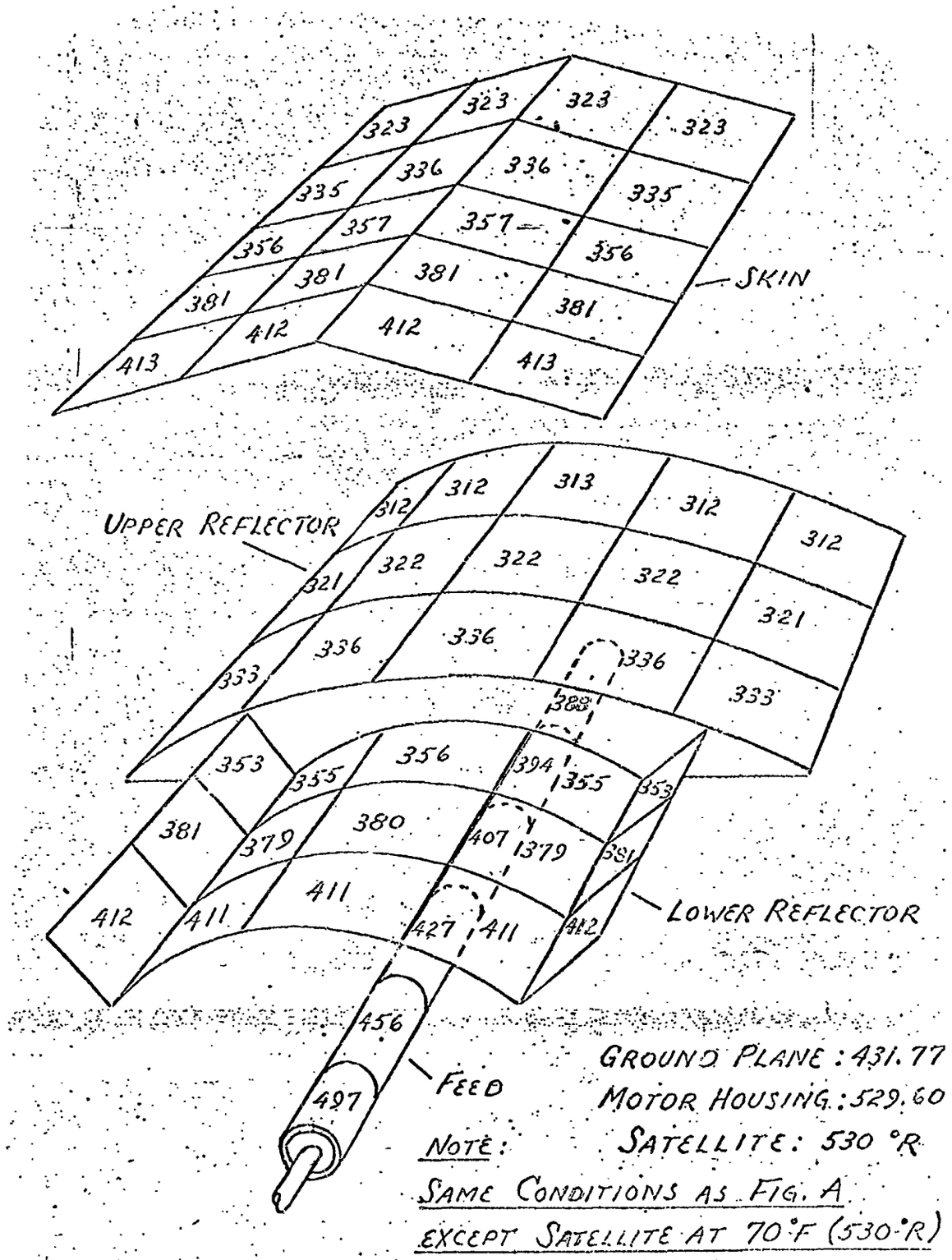


FIG. AA : ANTENNA TEMPERATURES (°R) AT A/0 & A/2

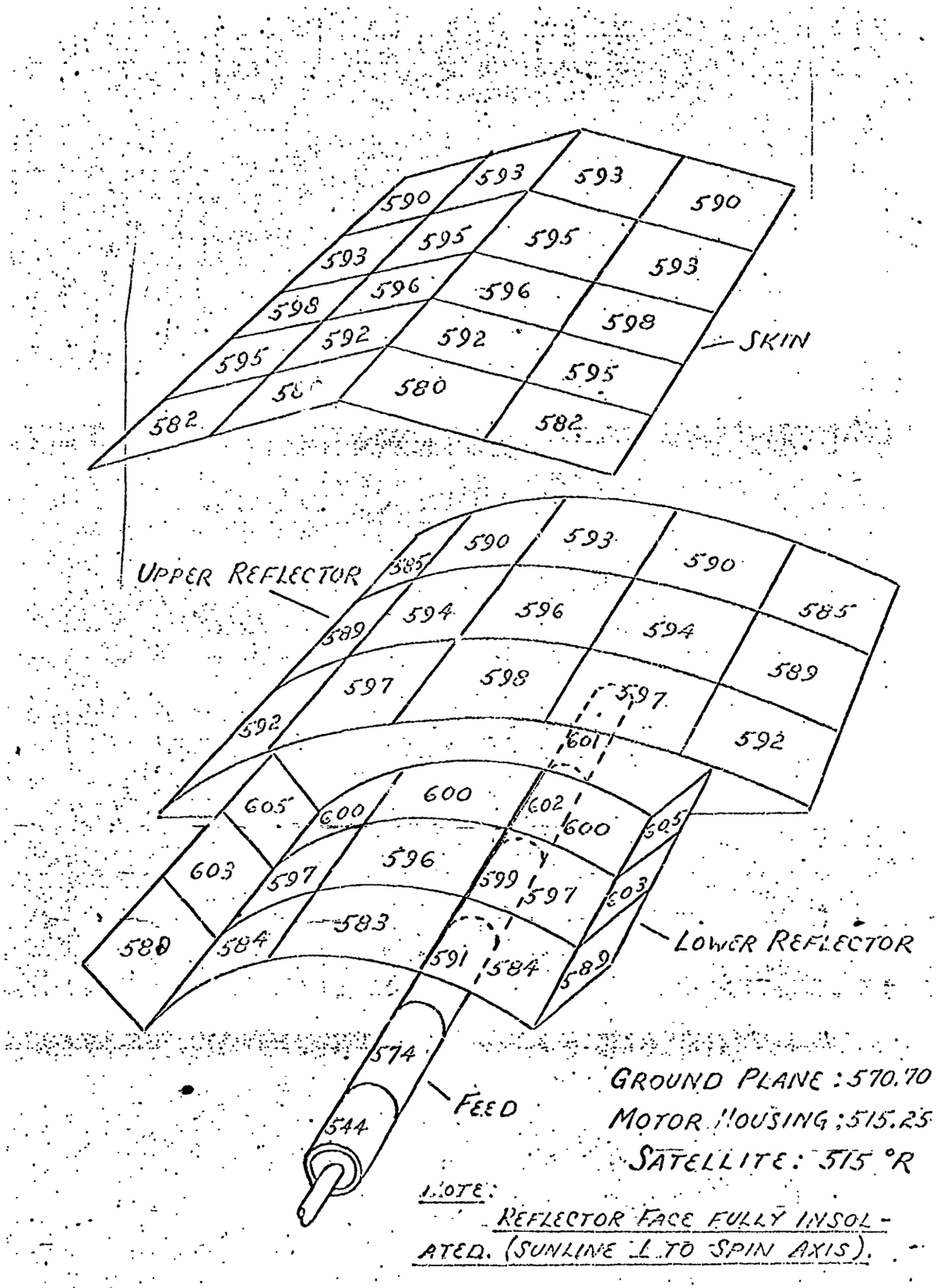


FIG. B : ANTENNA TEMPERATURES (°R) AT TIME A/23.4

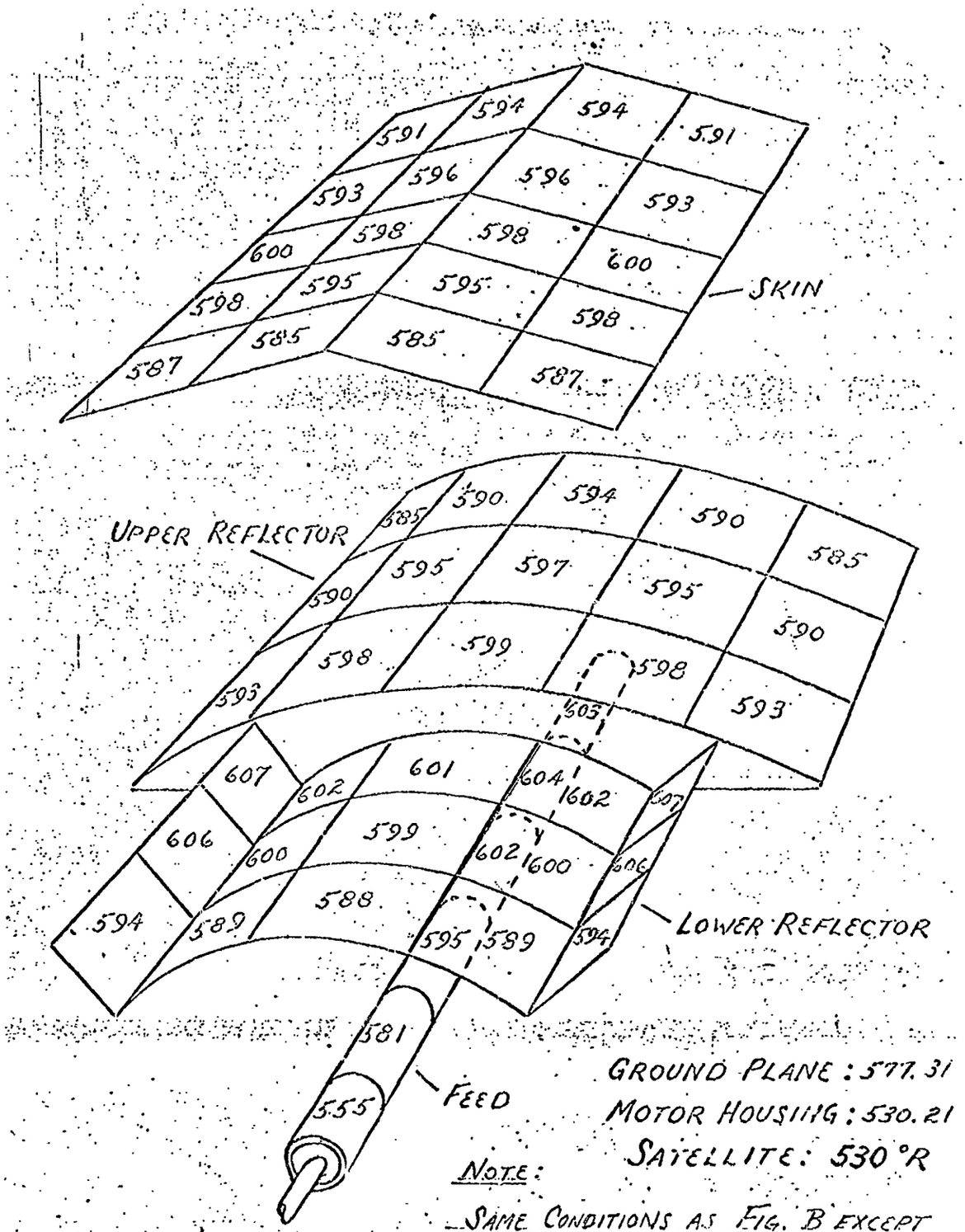


FIG. C : ANTENNA TEMPERATURES (°R) AT A/23.4

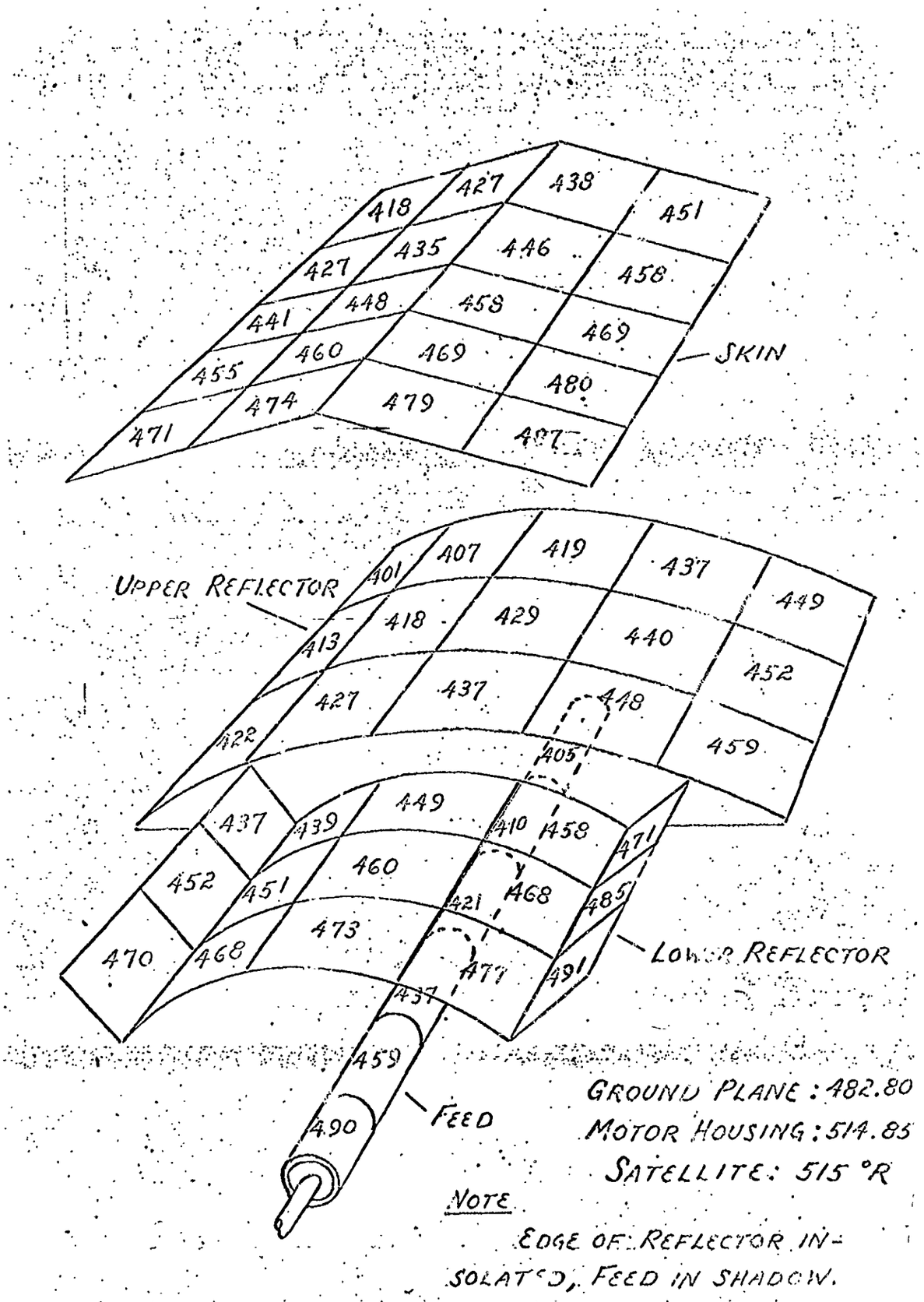


FIG. D : ANTENNA TEMPERATURES (°R) AT A/6.0 & A/18.0

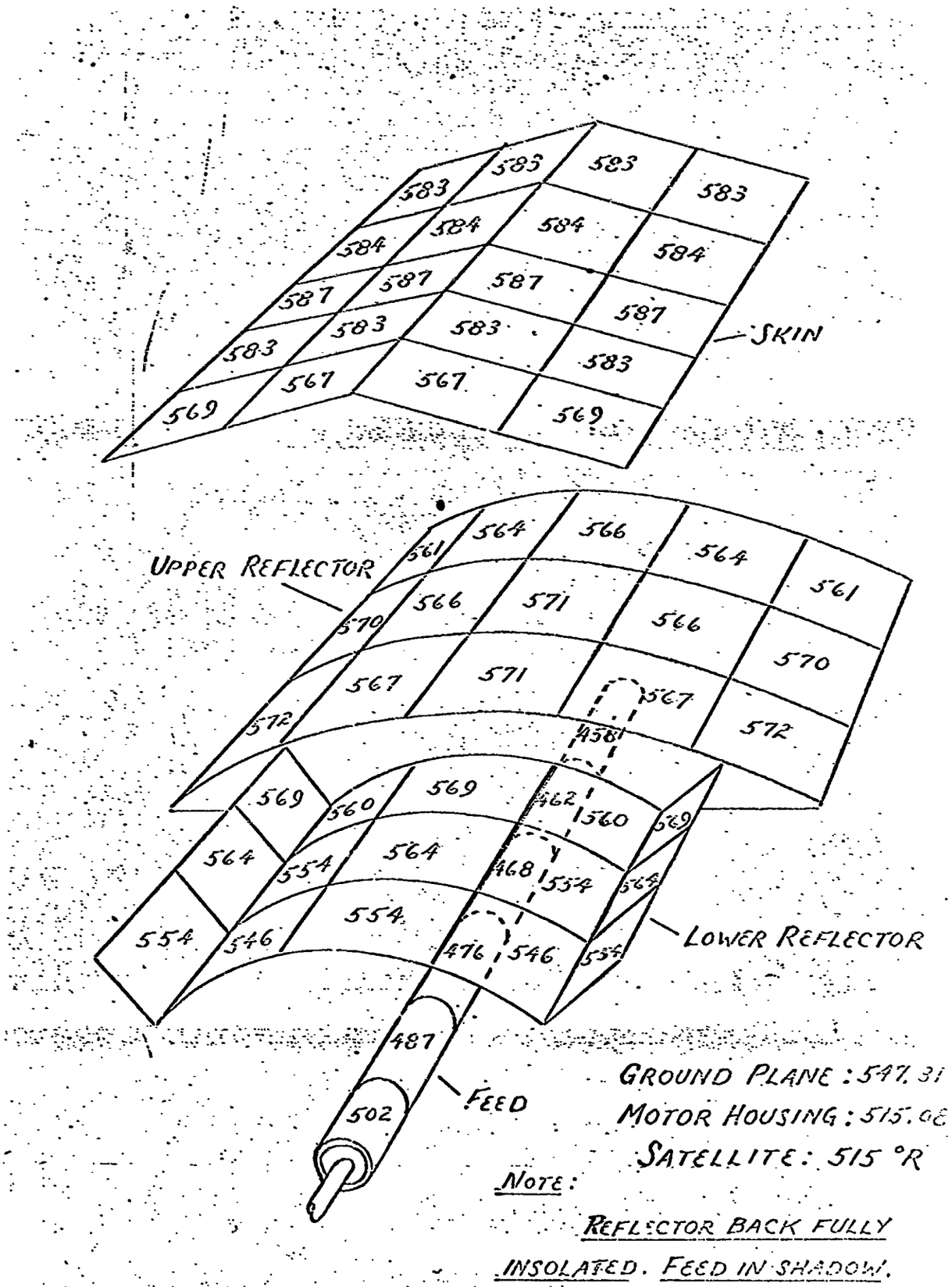


FIG E : ANTENNA TEMPERATURES (°R) AT A/12

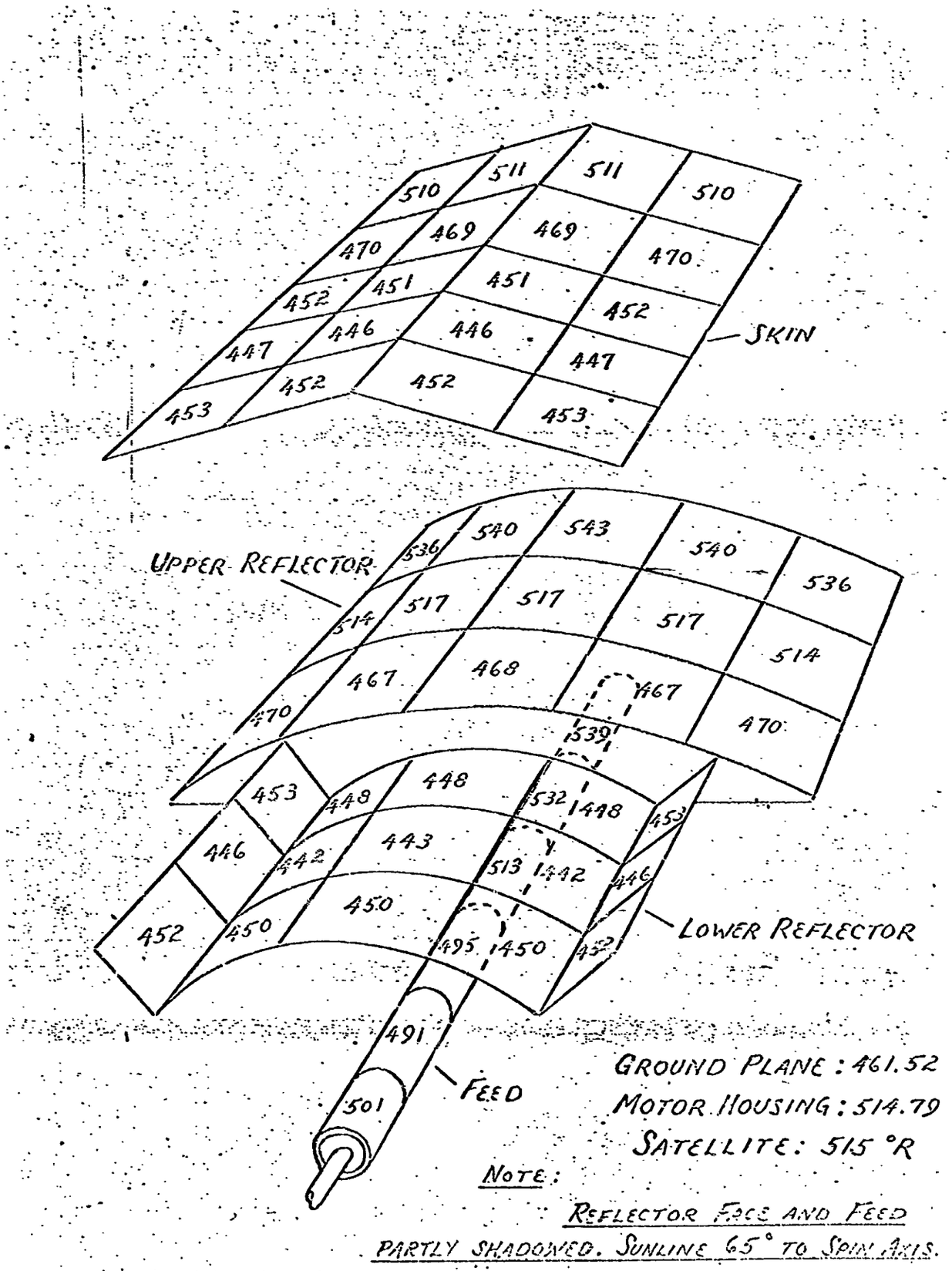


FIG. F : ANTENNA TEMPERATURES (°R) AT B/0 & B/24

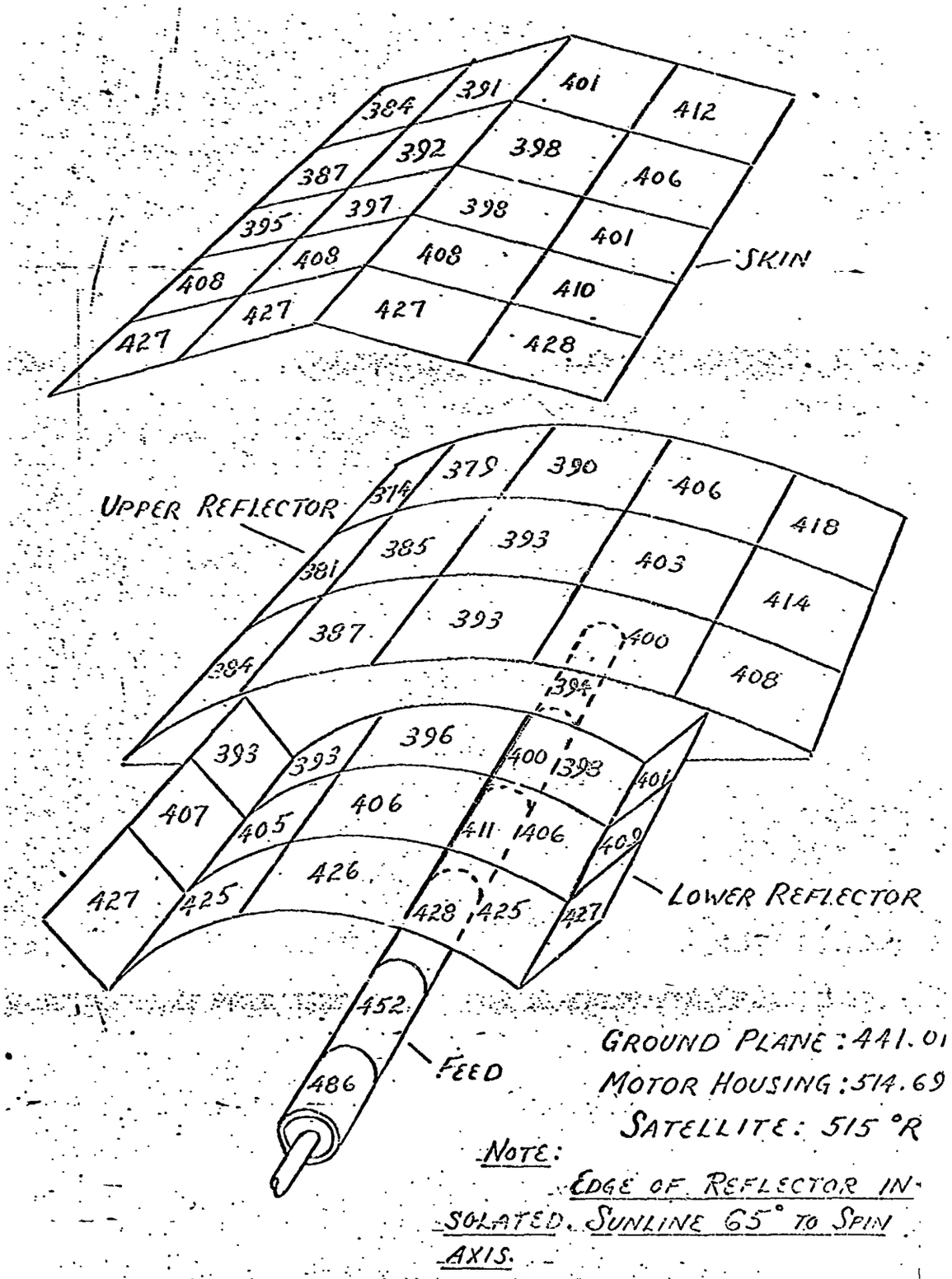
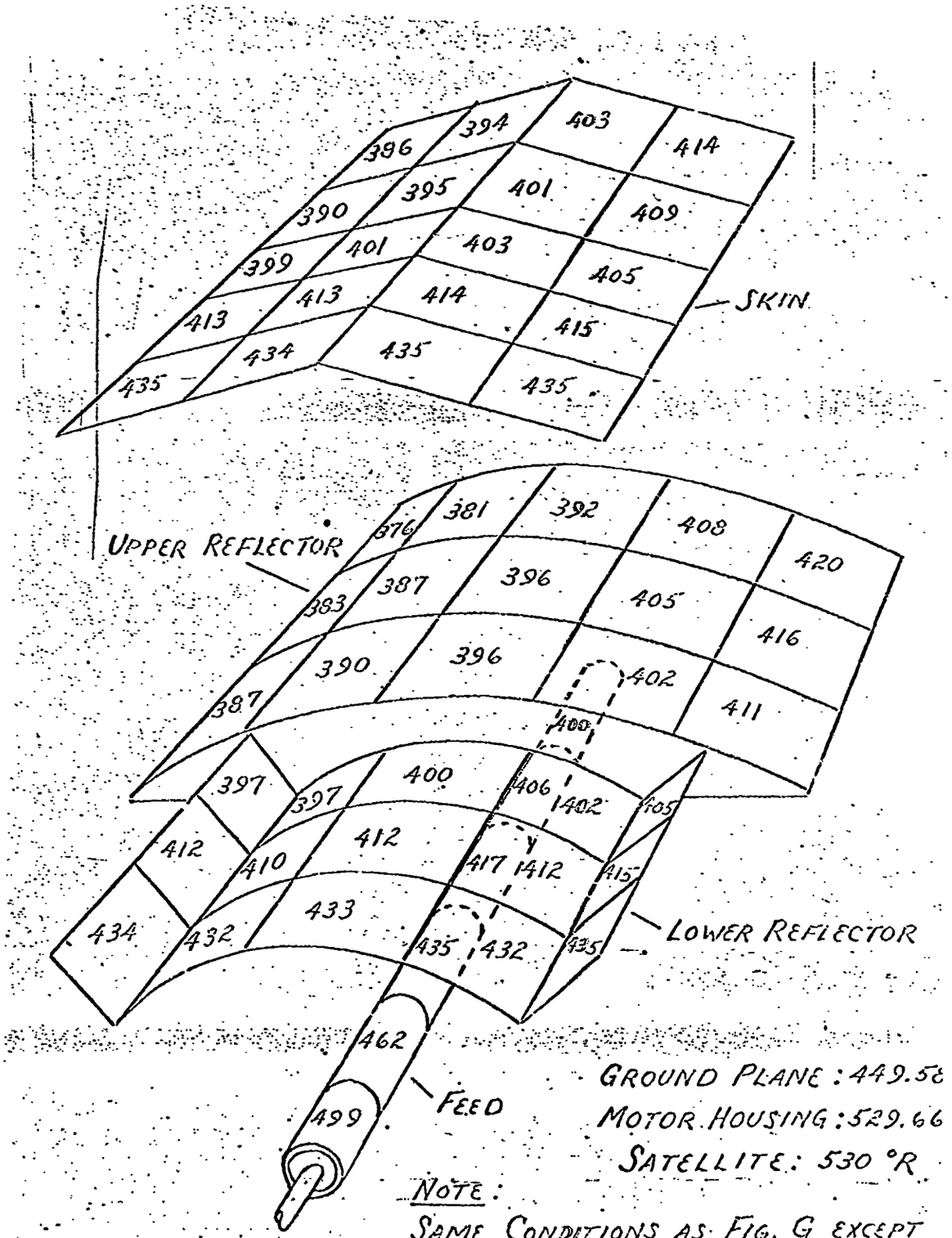
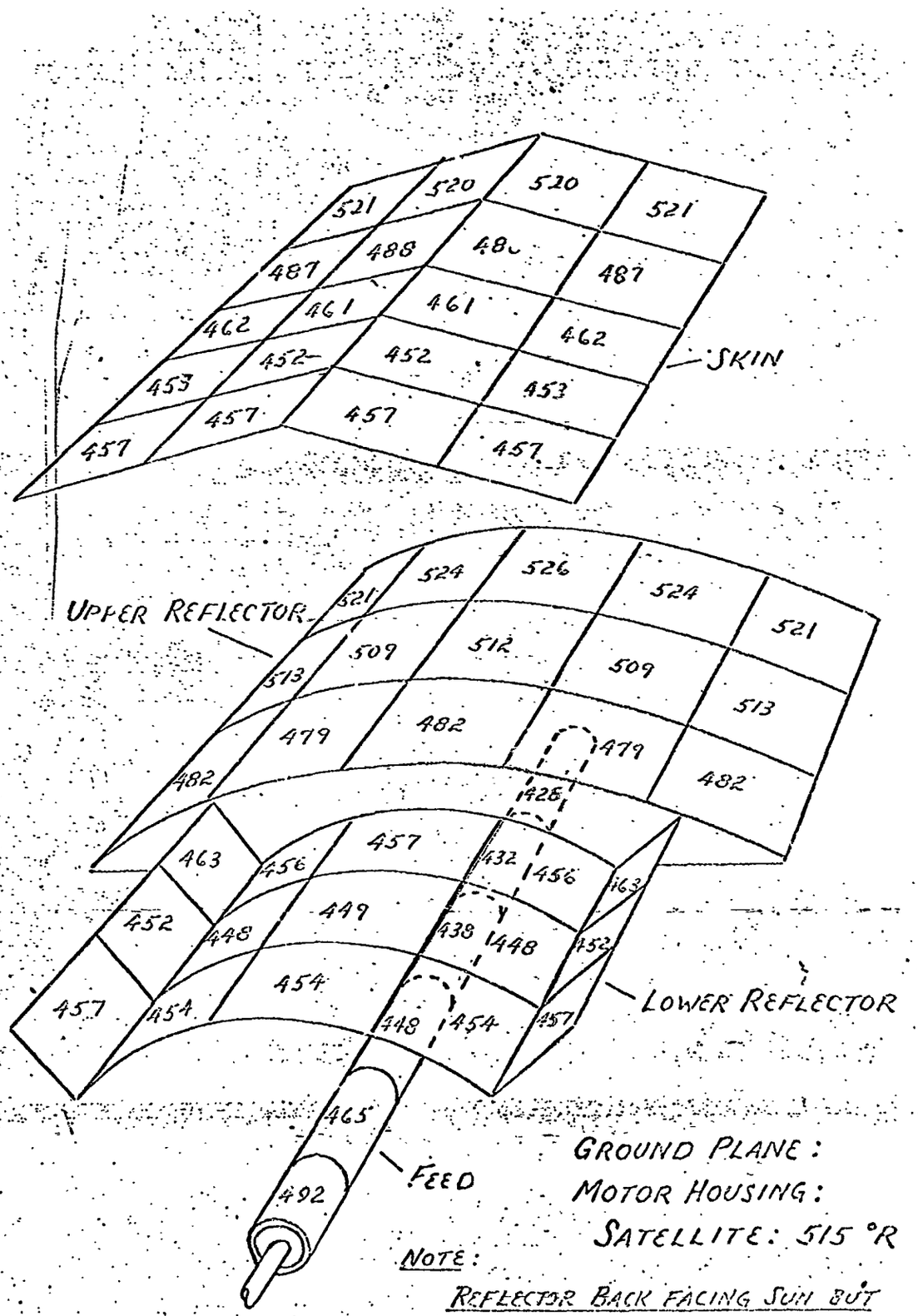


FIG. G : ANTENNA TEMPERATURES (°R) AT B/6 & B/18



NOTE:
SAME CONDITIONS AS FIG. G EXCEPT SATELLITE AT 70°F (530°R)

FIG. H : ANTENNA TEMPERATURES (°R) AT B/6 & B/18



NOTE:

REFLECTOR BACK FACING SUN BUT PARTIALLY SHADOWED. SUNLINE 65° TO SPIN AXIS.

FIG I : ANTENNA TEMPERATURES (°R) AT B/12

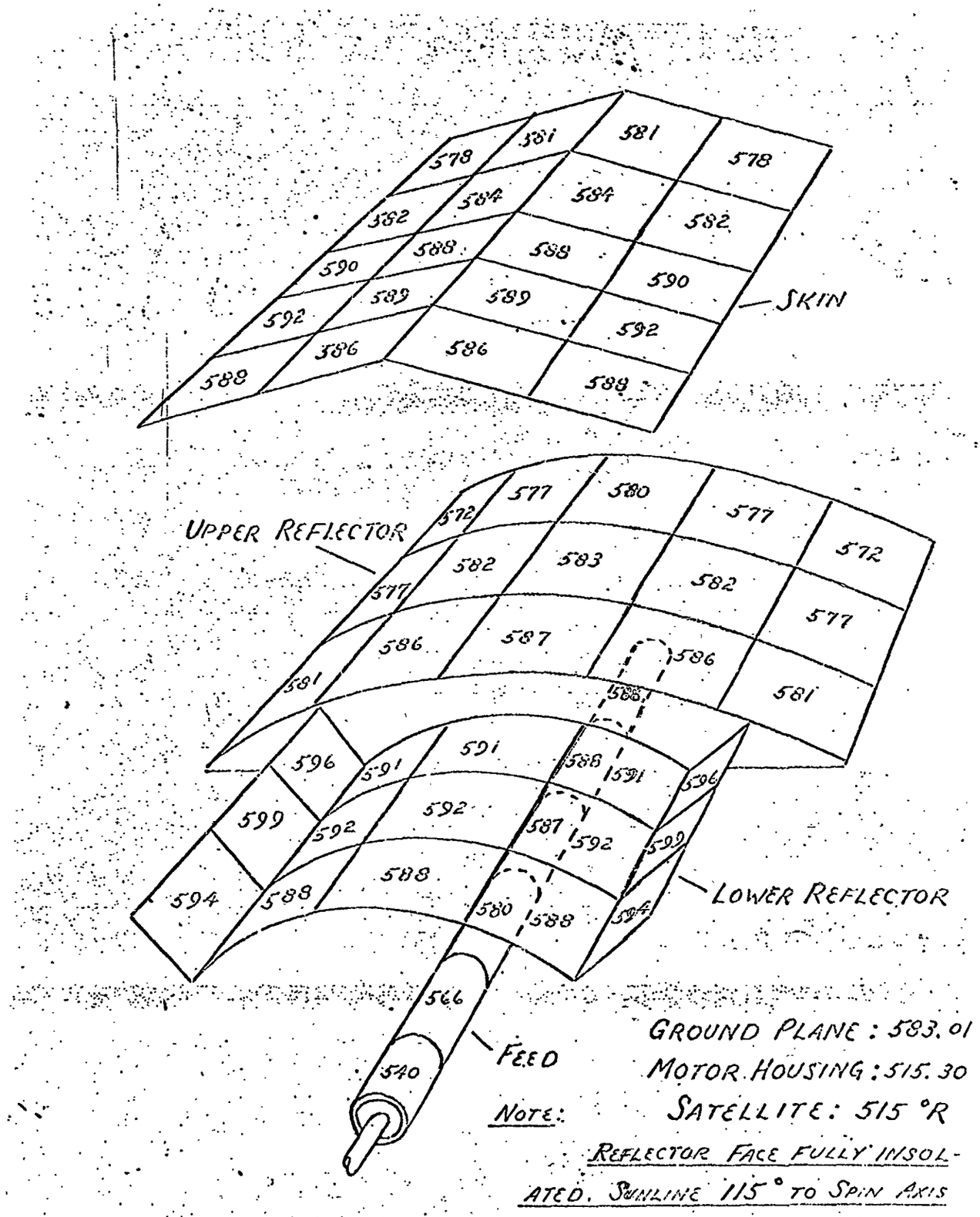


FIG. J : ANTENNA TEMPERATURES (°R) AT C/O & C/24

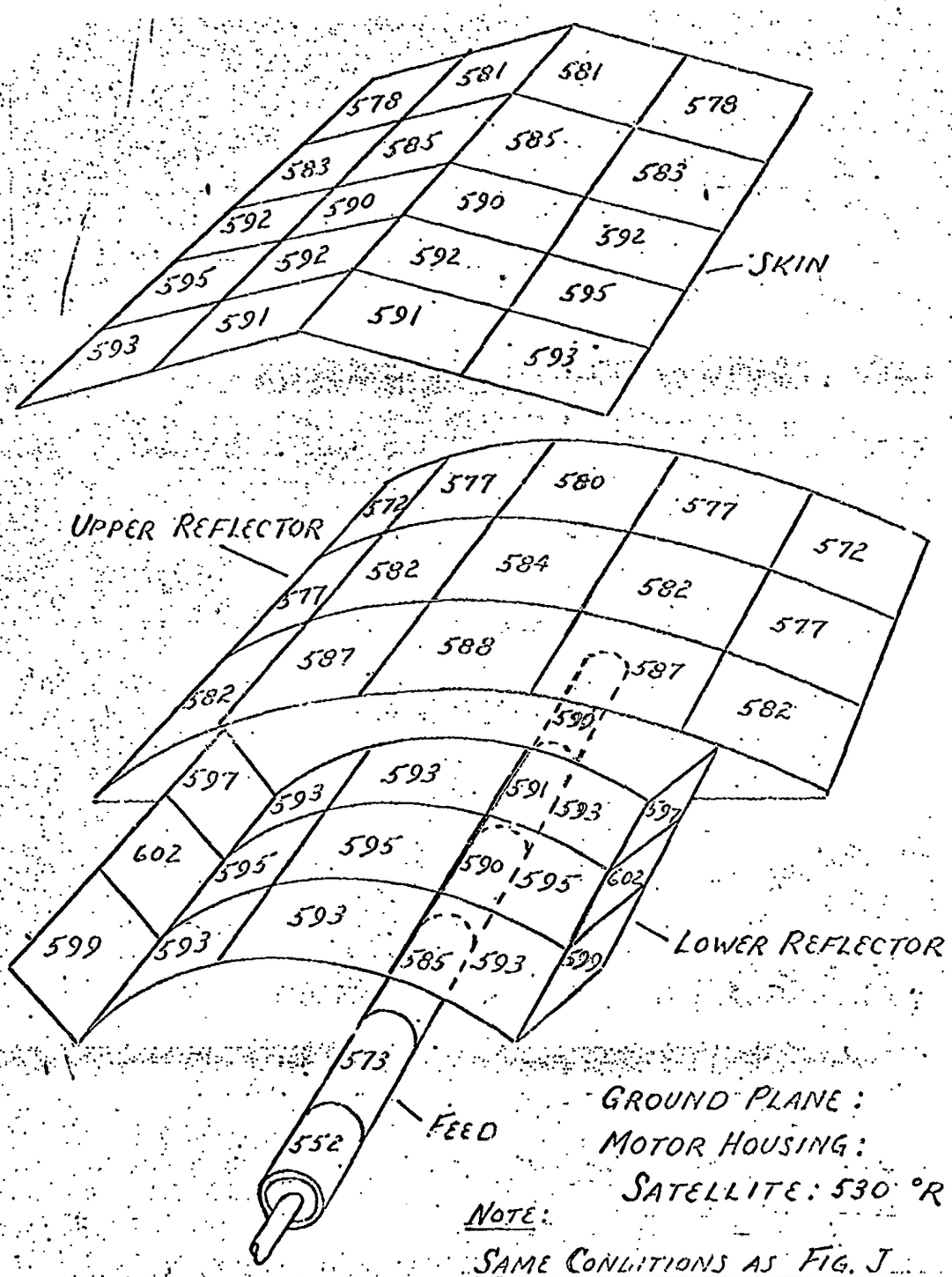
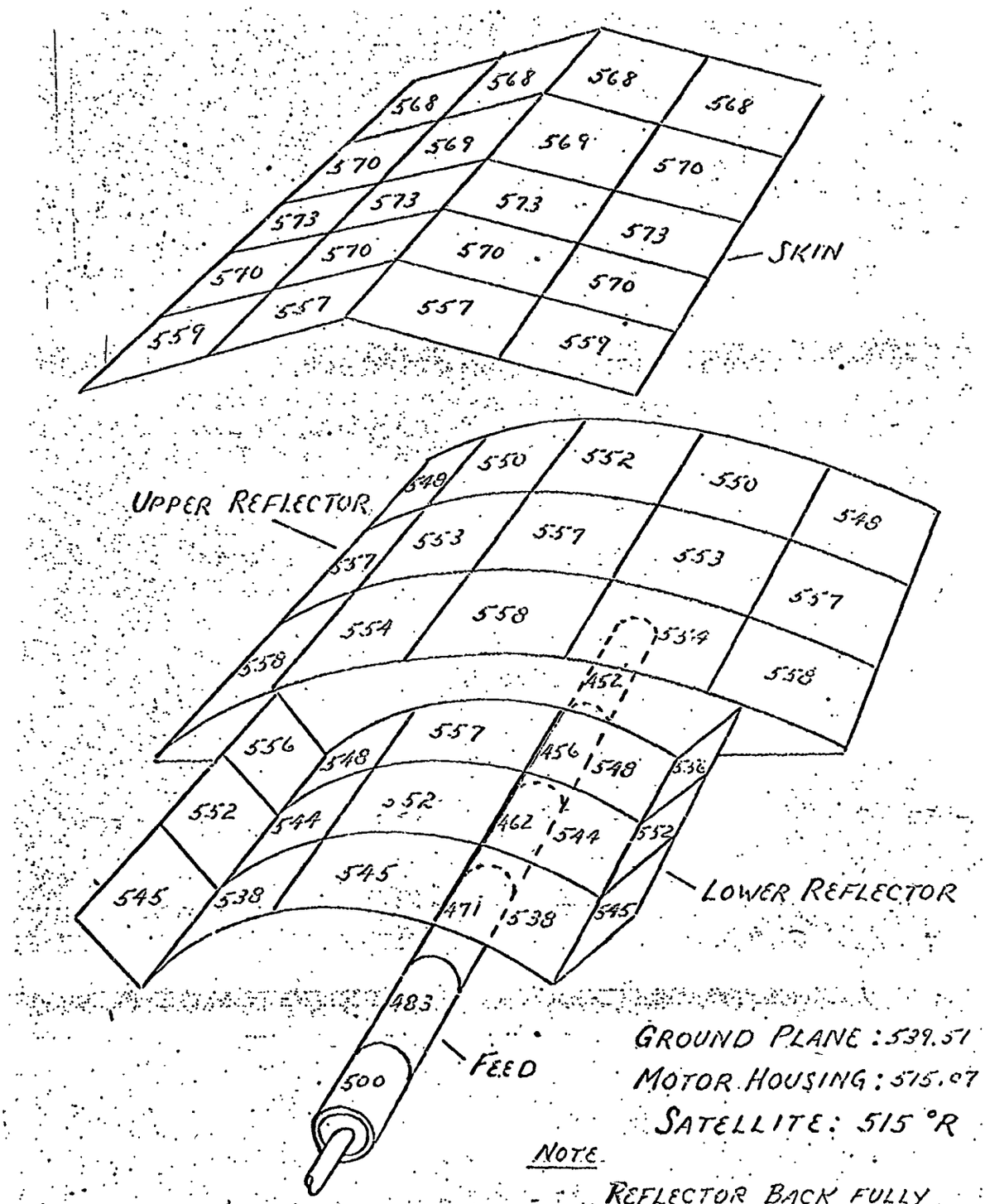


FIG. K : ANTENNA TEMPERATURES (°R) AT C/O & C/24



GROUND PLANE : 539.51
MOTOR HOUSING : 575.07
SATELLITE : 515 °R

NOTE

REFLECTOR BACK FULLY INSOLATED. SUNLINE 115° TO SPIN AXIS.

FIG. L : ANTENNA TEMPERATURES (°R) AT C/12

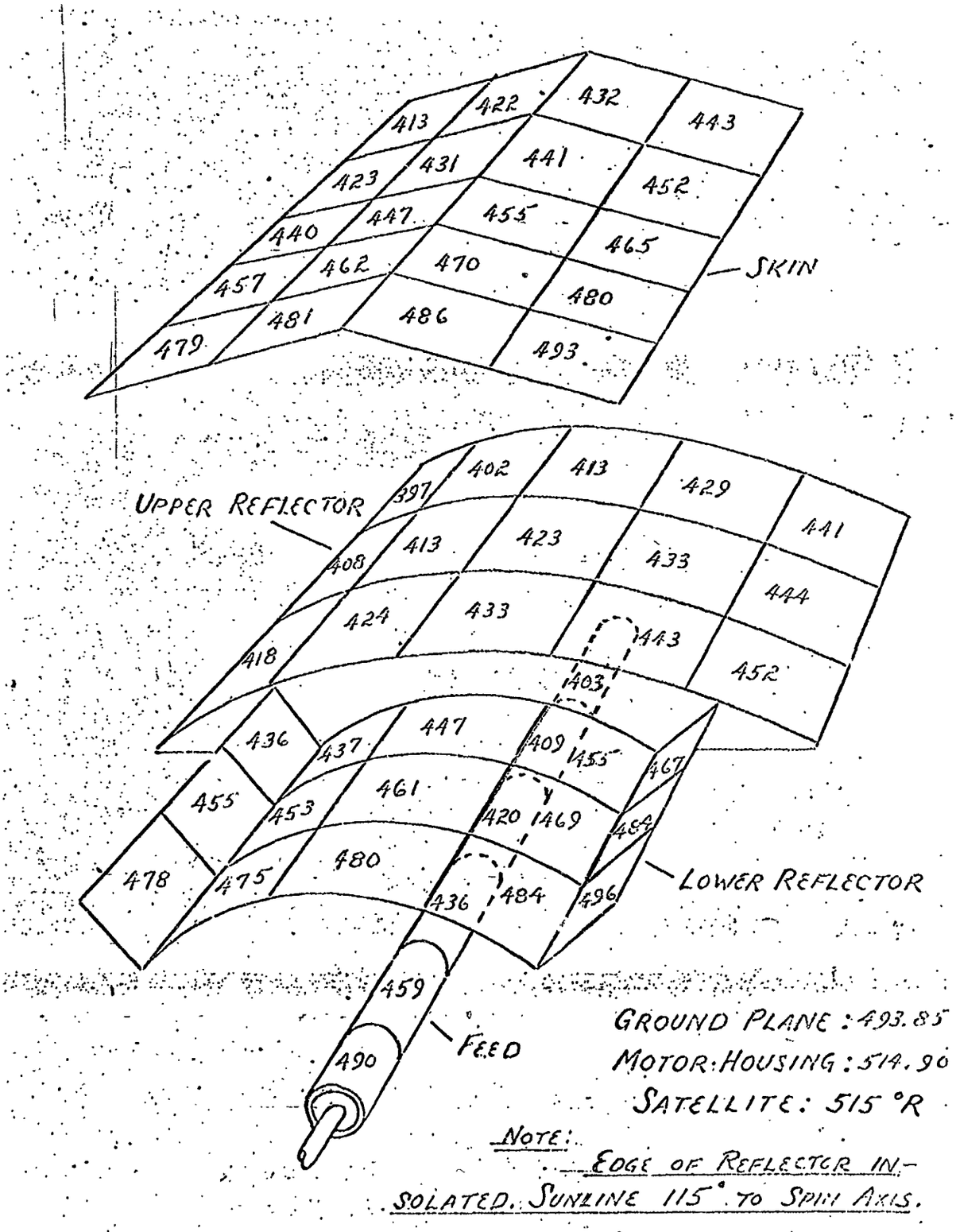


FIG. M : ANTENNA TEMPERATURES (°R) AT C/6 & C/18