[redacted]

UNCLASSIFIED

1621

SANDIA SYSTEMATIC DECLASSIFICATION REVIEW
DOWNGRADING OR DECLASSIFICATION STAMP
CLASSIFICATION DOWNGRADED TO: U AUTHORITY: R.B. Cramer
Emilda Selph 10/15/98
PERSON CHANGING MARKING & DATE RECORD ID: 99SN0074
WC Layne 10/19/98
PERSON VERIFYING MARKING & DATE DATED: 10/12/98

| PROGRAM | | |

Table of Contents

		Page
Introduction		3
Summary		3-4
Procedure and Results		4-6
Discussion of Results		7
Table I	Typical Test Field Strengths	8
Table II	Horizontal Response Variations with Height	9
Figure 1	Basic Sections of Polaris Missile	10
Figure 2	Polaris Model Wiring Diagram	11
Figures 3-6	Photographs of Test Setups	12-15
Figures 7-16	Test Data	16-25

T-90266

EMR EVALUATION OF A SCALE MODEL POLARIS MISSILE

Introduction

The purpose of this test was to determine the maximum RF transfer characteristics between a radiated field and the guidance bay and the nozzle control section of a Polaris missile. Only the metallic portions of the Polaris airframe were used in making the one-half scale model. Wiring was added to simulate the mode of coupling between the airframe and internal components which exists in an actual missile.

A second purpose of the test was to provide information on ground effects to aid in planning future tests.

A third purpose was to investigate to a limited degree the source feeding the particular locations. In other words, was the source primarily a voltage or a current source.

This test was performed by Organization 7331-3 at a remote test site in Area III, during the period from June 24, 1964 to July 27, 1964. Special authorization was granted by the FCC, through the AEC Area Office, for 7331-3 to radiate assigned frequencies using a 100-watt transmitter during the time required to run the test. Daily transmissions were coordinated with the Albuquerque Frequency Monitoring Station on Sandia Base.

This test was requested verbally by Division 1531. The consultant for the test was D. E. Merewether, 1531. C. W. Cook, 7331-3, was the Test Project Engineer.

Summary

A one-half scale model of the metallic portions of a Polaris airframe was tested in an RF environment to determine induced currents in certain critical locations. The model was evaluated through a test spectrum of 12 to 52 megacycles. To evaluate possible ground effects, the model was run in a horizontal position and in the vertical position. It was felt that, if there were no ground effects, the responses would be independent of polarization. Two channels showed variations which might be attributed to ground effects. The largest effect occurred on the channel which was fed by wires which extended into the tail of the model.

Further checks indicated that changing the instrumentation termination resistances from 4.5 ohms to 16 ohms had little effect on the response of the model.

It was also learned that small changes in the model wiring could significantly change the response characteristic of the points being monitored.

Procedure

Test Item

The test unit was a 1/2 scale model of the metallic portions of the Polaris missile airframe. Coupling into the guidance bay and the nozzle control section was simulated by adding wiring which fed into these sections. Figure 1 in the Appendix shows a sketch of the Polaris missile.

Dimensions for the model were supplied by D. E. Merewether of 1531. The metal fabrication was done in the Sandia Corporation sheet-metal shop. The model assembly, wiring installation, and instrumentation installation were done by 7331-3.

The model was instrumented at four locations as specified by the consultant. The output of the instrumentation was recorded on two Model 561 Midwestern recorders. Figure 2 in the Appendix details the recorder locations, coupling wires, and instrumentation wiring.

For the first phase of the test two types of instrumentation were used to instrument the model. DRI-developed thermopiles with 16-ohm bridgewires were used to instrument channels 1 and 4, see Figure 2 in the Appendix. DRI thermocouples with 4.5 ohm bridgewires were used to instrument channels 2 and 3. The bridgewires were tied in series with the coupling wire near the ground points.

For a later phase of the test the instrumentation on channels 1 and 4 was interchanged with the instrumentation on channels 2 and 3. Throughout this report the channel number will designate a particular location in the model.

Test Environment

The test was performed at a remote test site in the southwest corner of Area III. Two 50-foot poles were erected at the site to support the test model above ground. The overall test site is shown in Figure 3 of

the Appendix. A trailer, assigned to 7331-3, was positioned at the site and contained the r-f transmitter, field monitoring equipment, and record-processing equipment.

The test environment was a radiated r-f field covering the frequencies between 12 and 52 megacycles. Above 20 megacycles a halfwave dipole was used as the radiating antenna. Below 20 megacycles a 25-foot tuned dipole was used. The transmitting antenna was oriented horizontally or vertically, depending upon the polarization desired. It was located 25 feet from the test model and is visible in Figure 3 of the Appendix.

A remote monitoring antenna was used to set up the test field strengths at each frequency. The monitoring antenna is visible in the center of Figure 3 of the Appendix. In initially setting up the test environment, the field strengths were measured with a dipole antenna, identical to the transmitting antenna, tied to the supporting ropes at the height at which the center of the model would be during the test. As the initial field measurements were made, a reference reading was made on the monitoring antenna. An Empire Devices Field Intensity Meter, Model NF-205, was used to make the field strength measurements and the monitor reference readings. Numerous cross checks were performed to verify that reference readings from the monitoring antenna represented a given field strength and that a change in the monitor reading represented a corresponding change in field strength.

Typical field strengths and the corresponding frequencies are listed in Table I of the Appendix.

The transmitter consisted of an ITA Model WBA-200A, 100-watt amplifier with a Hewlett Packard Model 606A signal generator used as a driver. The ITA amplifier was borrowed from Division 1432. The transmitter in operation is shown in Figure 4.

Test Procedure and Results

Actual testing of the model began on June 24, 1964. The first phase of the test was run with the model held horizontally 12 feet above the ground. Figure 5 of the Appendix shows the model in the horizontal test configuration.

The second phase of the test was run with the model held vertically with the tail 5 feet above the ground. This configuration is shown in Figure 6 of the Appendix. To obtain more information on ground effects, recordings were made while the model was raised and lowered in the vertically polarized field. The tail of the model moved between a height of 5 feet and 1 foot above ground. These recordings indicated negligible changes in the response levels with variation of the tail height above ground.

The horizontal and vertical configurations were run throughout the entire test spectrum. In both cases, the transmitting antenna was oriented parallel to the length of the model. A comparison of the horizontal and vertical results is shown in Figures 7, 8, 9, and 10 of the Appendix.

There is no simple explanation for the variation in the responses of channel 4 shown in Figure 10. Since all responses are related to the test environment, it was decided to cross check our environment definition. Division 1424 hypothesized that possibly the cable attached to our field strength antenna could be affecting our readings. To eliminate the cable, a probe, built and calibrated by 1424 and identified as the Parker Probe, was used as an independent check on the NF-205 reading. The results of these checks are given in Figure 11. As the results show, no significant variations were found. A rerun of the vertical configuration indicated that the vertical responses obtained previously on channel 4 were repeatable. These results are shown in Figure 12 of the Appendix. Since no environment or repeatability problems were found, it was decided to continue with the test plan.

For the third phase of the test the instrumentation on channels 1 and 2 and 3 and 4 was interchanged. This change gave a limited check on the effect which the termination resistance had on the response. This phase was run with the model held horizontally 12 feet above the ground. The results of this phase are shown in Figures 13, 14 and 15 of the Appendix. Not enough data was obtained on channel 3 to give an across-the-spectrum comparison.

The final phase of the test was a horizontal up-and-down run. Continuous recordings were made while the model was moved between 12 feet and 2 feet above the ground. The response variations obtained during this phase are listed in Table II of the Appendix.

The final phase gave some unexpected results due to faulty instrumentation. The line attached to the high side of the bridgewire in channel 2 was open during this portion of the test. This necessarily meant that no responses were obtained on channel 2. However the unexpected result was the radical change in the response of channel 3, see Figure 16 of the Appendix. Since the open line on channel 2 was the only variation from the configuration of the first phase of the test, it was decided to rerun the open condition on channel 2. As Figure 16 shows, the results were repeatable.

Discussion of Results

All of the responses which have been plotted in this report are normalized to a 10 volt/meter field. The ordinates are in db above 10 ma. The db presentation was used so that all responses would have the same relative weight. On a linear scale, high response variations tend to be emphasized and low response variations tend to be de-emphasized.

The RF transfer characteristics show that the model had a fundamental resonance between 22 and 24 megacycles. The peak normalized response on the system for either horizontal or vertical polarization was 30.6 db above 10 ma at 24 megacycles on channel 4. This response occurred with vertical polarization and can be seen on Figure 10 of the Appendix.

All of the channels except channel 1 indicated that the responses in general fell off above 42 megacycles. Channel 1 was still gradually increasing at 52 megacycles. The reading on channel 1 was approximately the same at both 22 and 52 megacycles. Channel 1 response curve is given in Figure 7.

There were some effects which might be called ground effects that resulted from this test. If there were no ground effects, it was felt that the model should have the same response curve regardless of polarization. Two portions of the model showed a variation with polarization. Above 40 megacycles the vertical response on channel 1 was roughly 10 db higher than the horizontal response. The response on channel 4 was considerably different for horizontal and vertical polarizations. It was not possible to attribute this variation to test procedure as described in the previous section.

A repeatability check indicated that the data was repeatable, see Figure 12 of the Appendix. It should be noted that channel 4 in the vertical configuration was attached to wires which extended to near the ground.

Whether a 4.5 ohm or a 16 ohm termination was used seemed to have little effect on a channel's response, see Figures 13, 14, and 15 of the Appendix.

The large changes seen on channel 3, Figure 16, due to a minor model change indicate that for meaningful model studies very accurate simulation must be achieved.

UNCLASSIFIED

T-90266

TABLE I

Typical Test Field Strengths

Frequency	Horizontal Polarization	Vertical Polarization
12.05 mc	.40 volt/meter	---
14.05	.91	---
15.05	2.4	---
16.05	2.0	---
18.05	4.4	---
20.30	4.5	1.8 volt/meter
22.05	3.7	2.6
24.05	4.4	2.4
26.0	4.4	3.7
28.05	4.4	2.6
30.05	5.5	3.2
32.05	6.0	2.7
34.15	6.8	2.6
36.05	6.1	4.4
38.05	4.9	3.6
40.06	5.0	4.0
42.10	6.7	3.6
44.04	8.0	5.1
46.15	9.5	5.1
48.14	9.6	4.6
50.50	10.7	4.6
52.00	8.8	4.7

TABLE II

Variations From 2 Ft. to 12 Ft. Horizontal Height

	Environment			Response			
				Top Recorder		Bottom Recorder	
Frequency	Empire Dipole	Empire Loop	Parker Probe	Channel 2	Channel 1	Channel** 3	Channel 4
20.3 mc	6 db	8 db	5.8 db	Open Circuit	4.4 db	3.5* db	5.2 db
22.05	6.0		6.4		3.0	8.9*	11.2
24.5	6.5		7.7		4.7	5.3	6.7*
26.0	6.0		7.4		---	9.1	8.0*
28.05	6.0		7.2		4.7	7.9	11.5
30.05	6.5		9.0		2.9	4.8	5.5
32.05	7.0		7.5		0.0	0.0	---
34.15	6.5		8.3		4.8	4.0	---
36.05	6.5		8.7		3.2*	6.7	---
38.05	7.0		8.0		2.3*	3.7*	---
40.06	6.5		8.4		7.0	---	
46.15	6.5		7.2		2.9	---	---
52.0	6.5		7.2		2.1	---	---

* Minimum Current Greater Than 9 ma.

** Responses for These Variations Were Very High (880 ma peak @ 20.3 mc).

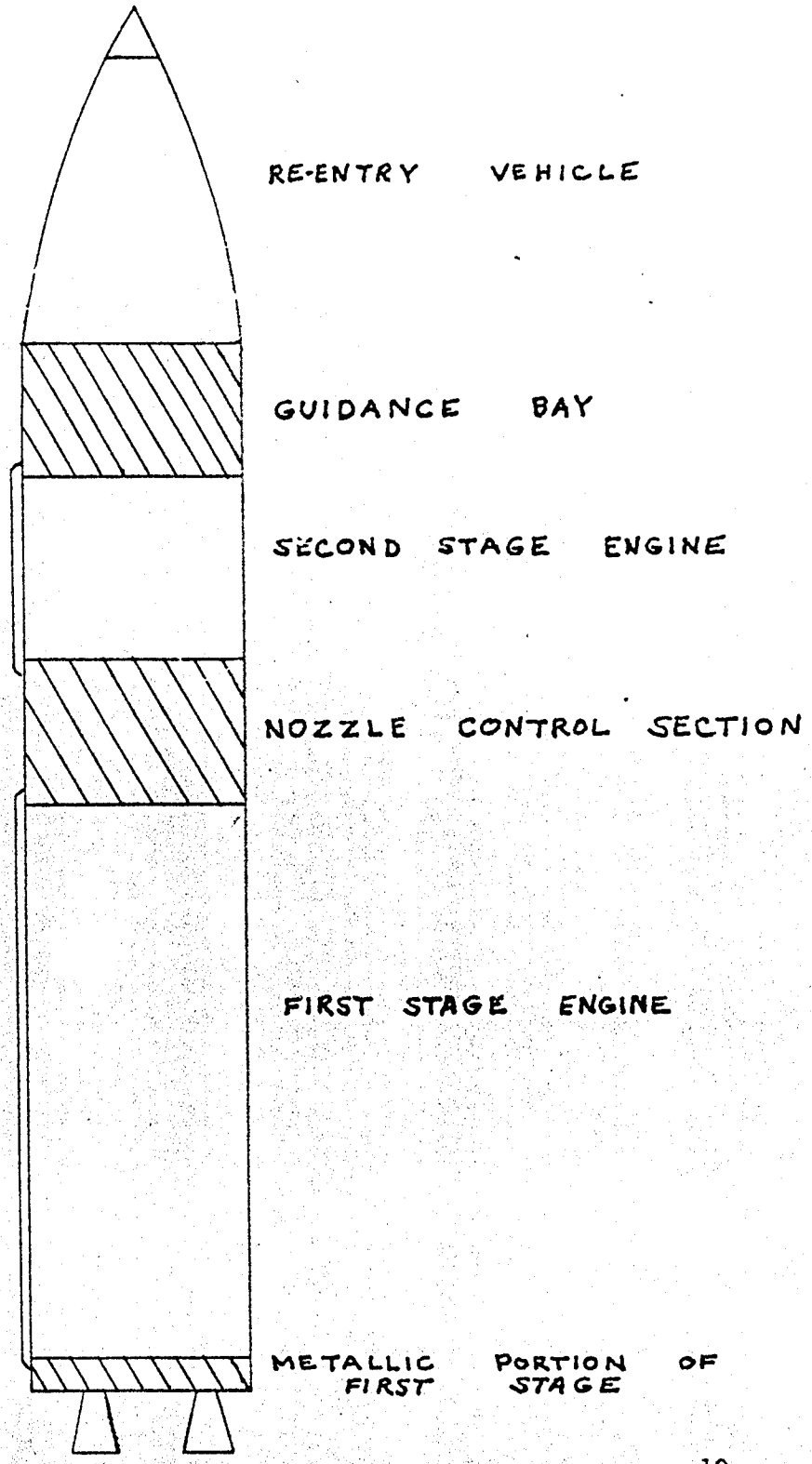
[redacted]

FIGURE 1

T-902 1630

BASIC SECTIONS OF POLARIS MISSILE

UNCLASSIFIED



METALLIC PORTIONS

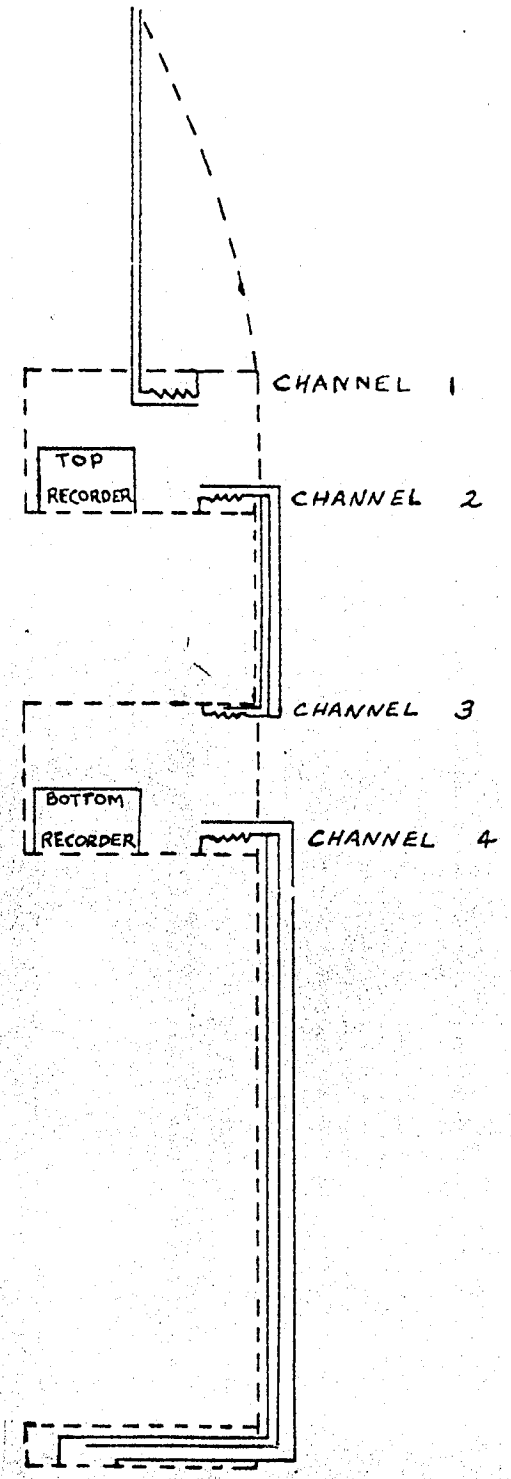
UNCLASSIFIED

8-11

[redacted]

POLARIS MODEL WIRING DIAGRAM

UNCLASSIFIED



UNCLASSIFIED

UNCLASSIFIED

1632

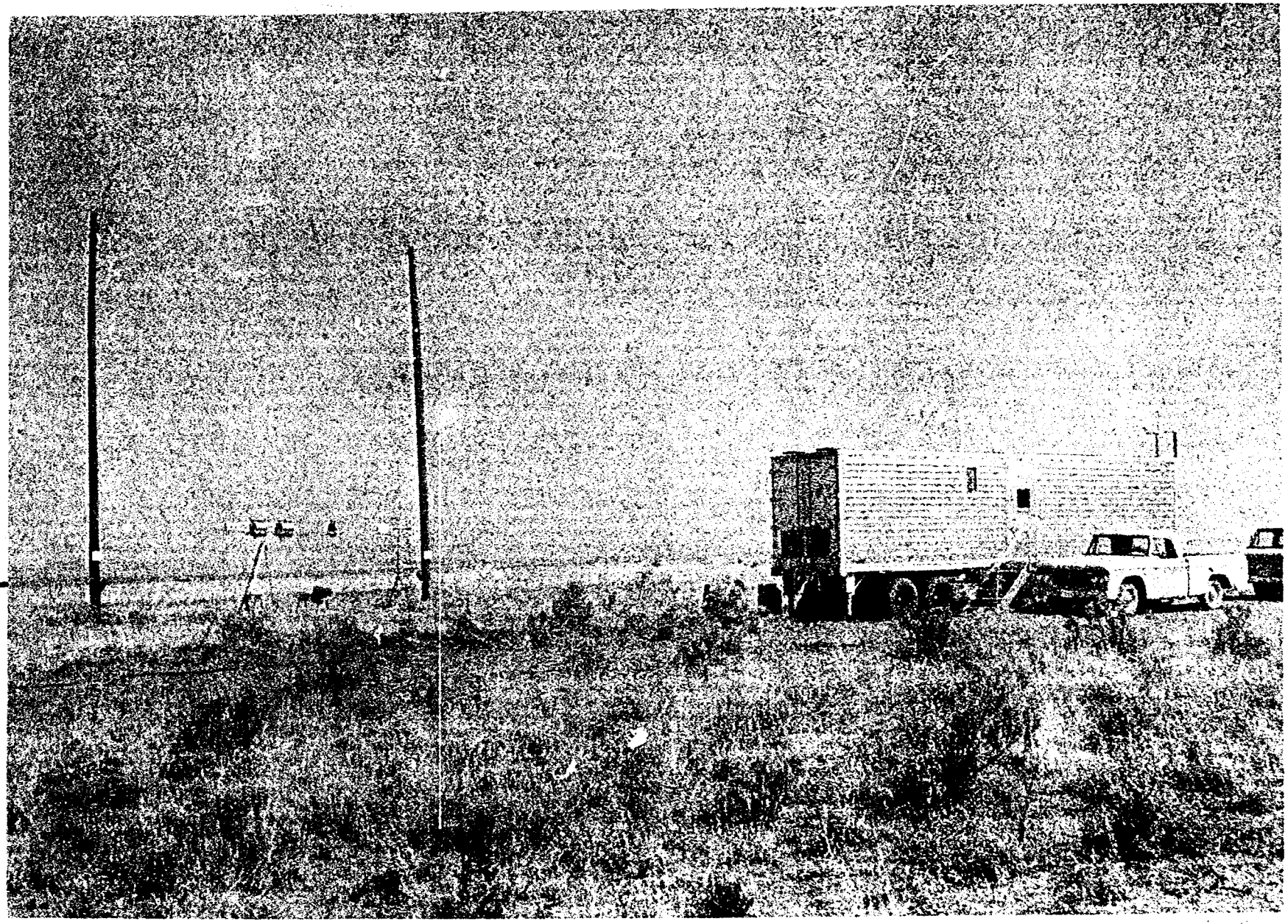


FIGURE 3

AREA III TEST SITE

T-90266

UNCLASSIFIED

DHW-10190

8-13

[redacted]

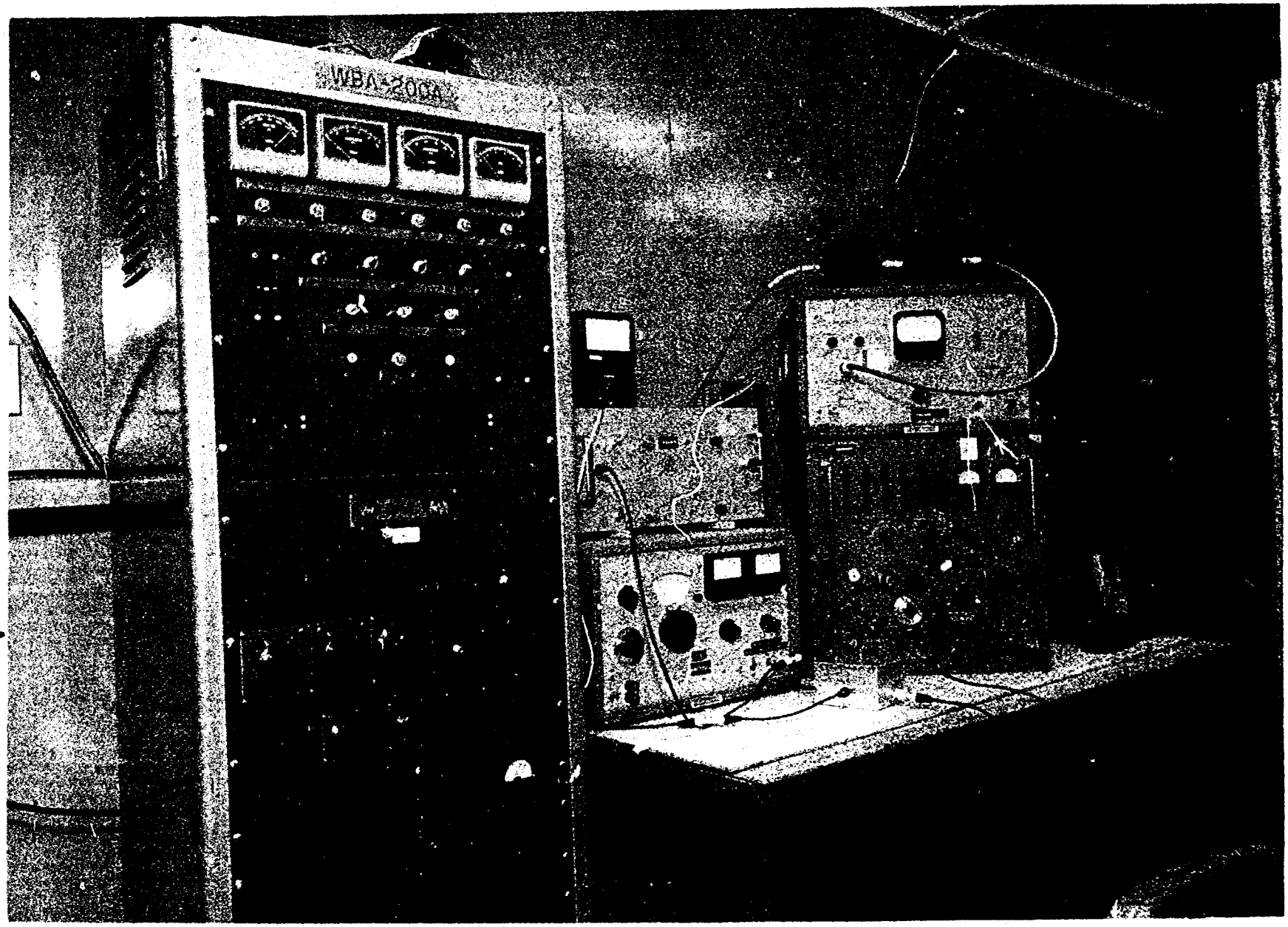


FIGURE 4

TRANSMITTER SETUP

T-90266

[redacted]

[redacted]

[redacted]

UNCLASSIFIED

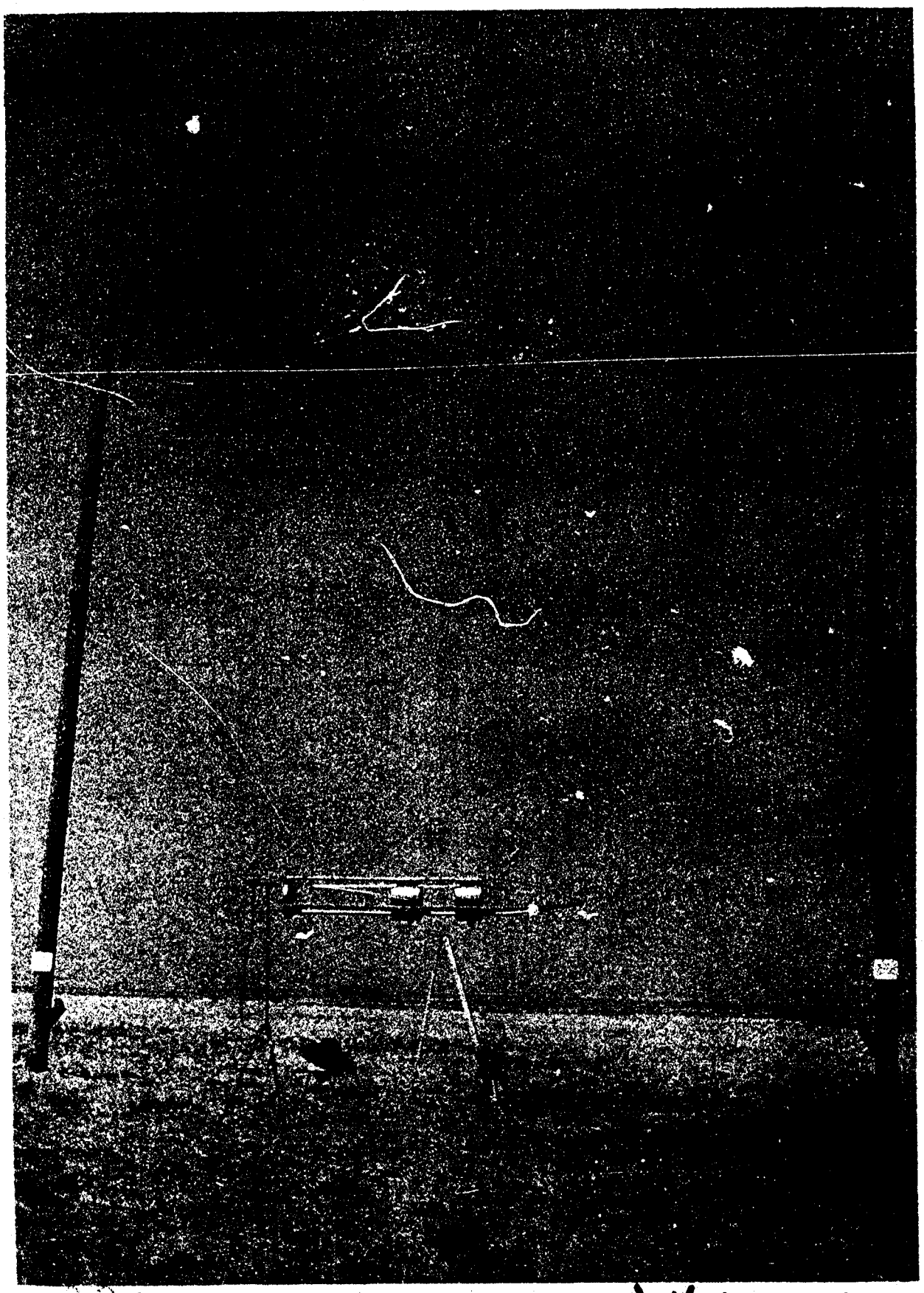


FIGURE 5

D#64-10188.

8-15

TEST MODEL HELD HORIZONTALLY

UNCLASSIFIED

[redacted]

T-90266

UNCLASSIFIED

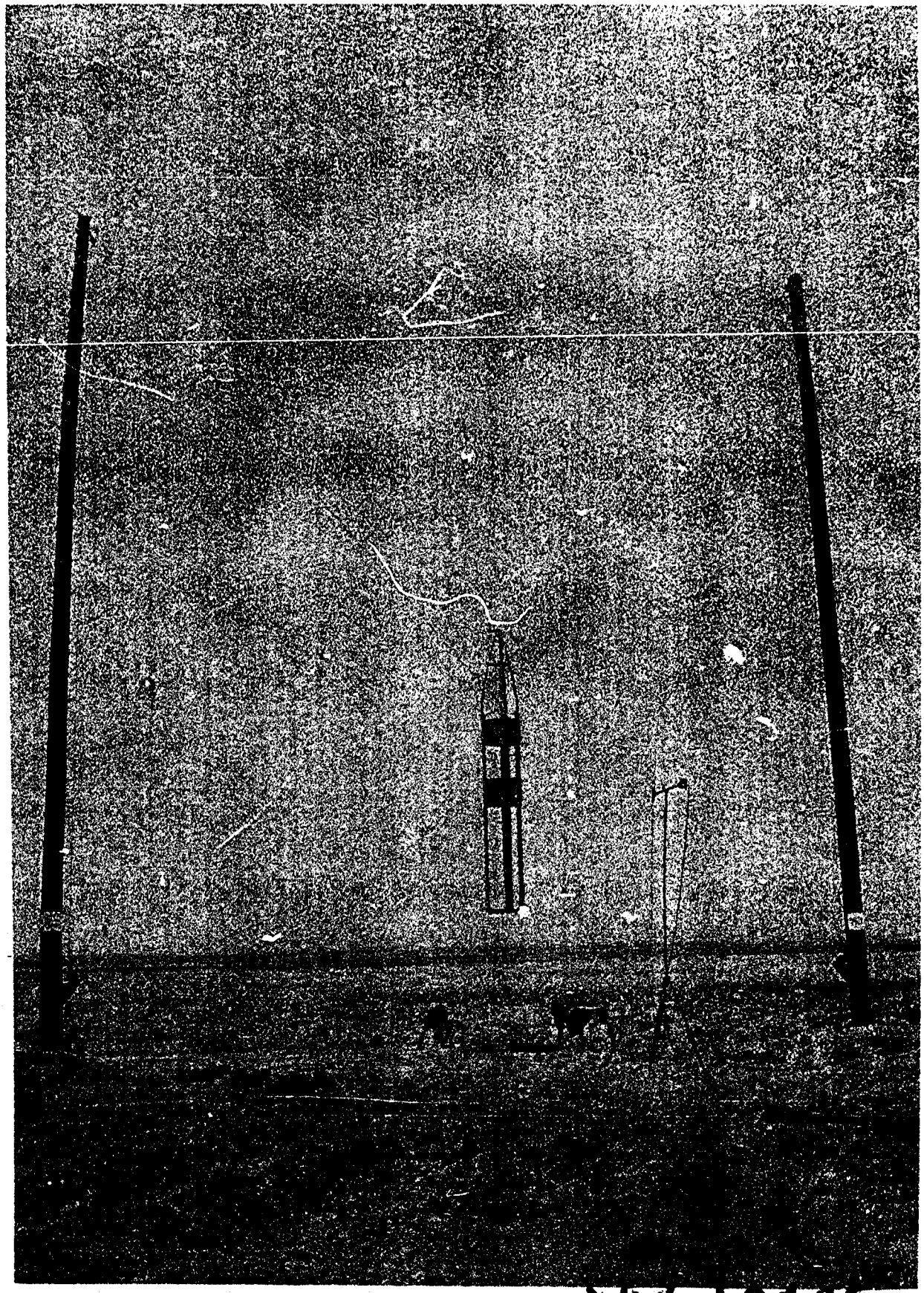


FIGURE 6

D64-10446

8-16

UNCLASSIFIED

TEST MODEL HELD VERTICALLY

T-90266

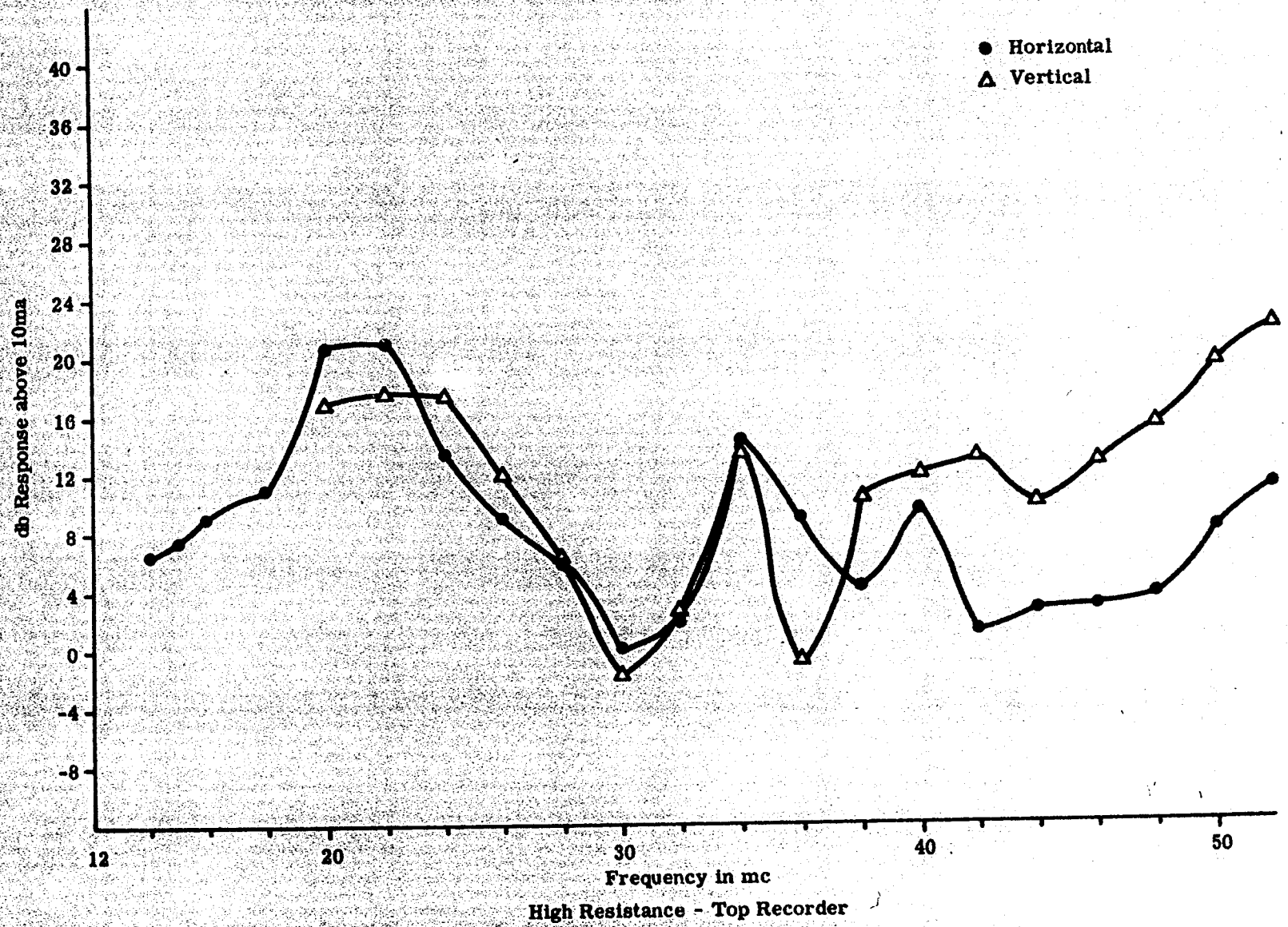
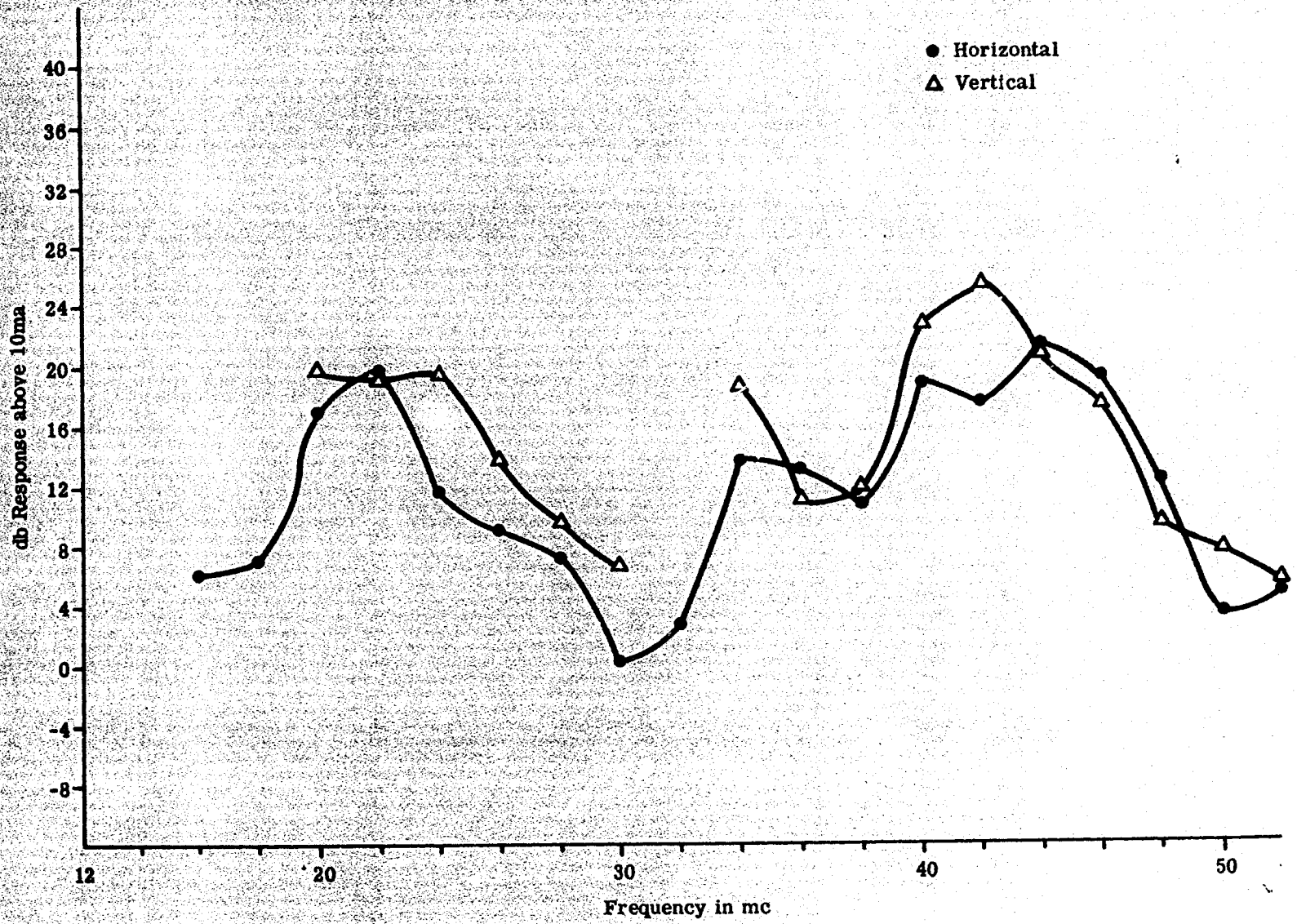


FIGURE 7 - CHANNEL 1 TEST RESPONSE IN 10 VOLT PER METER ENVIRONMENT.

T-90266

UNCLASSIFIED

[redacted]



Low Resistance - Top Recorder

FIGURE 8 - CHANNEL 2 TEST RESPONSE IN 10 VOLT PER METER ENVIRONMENT.

T-90266

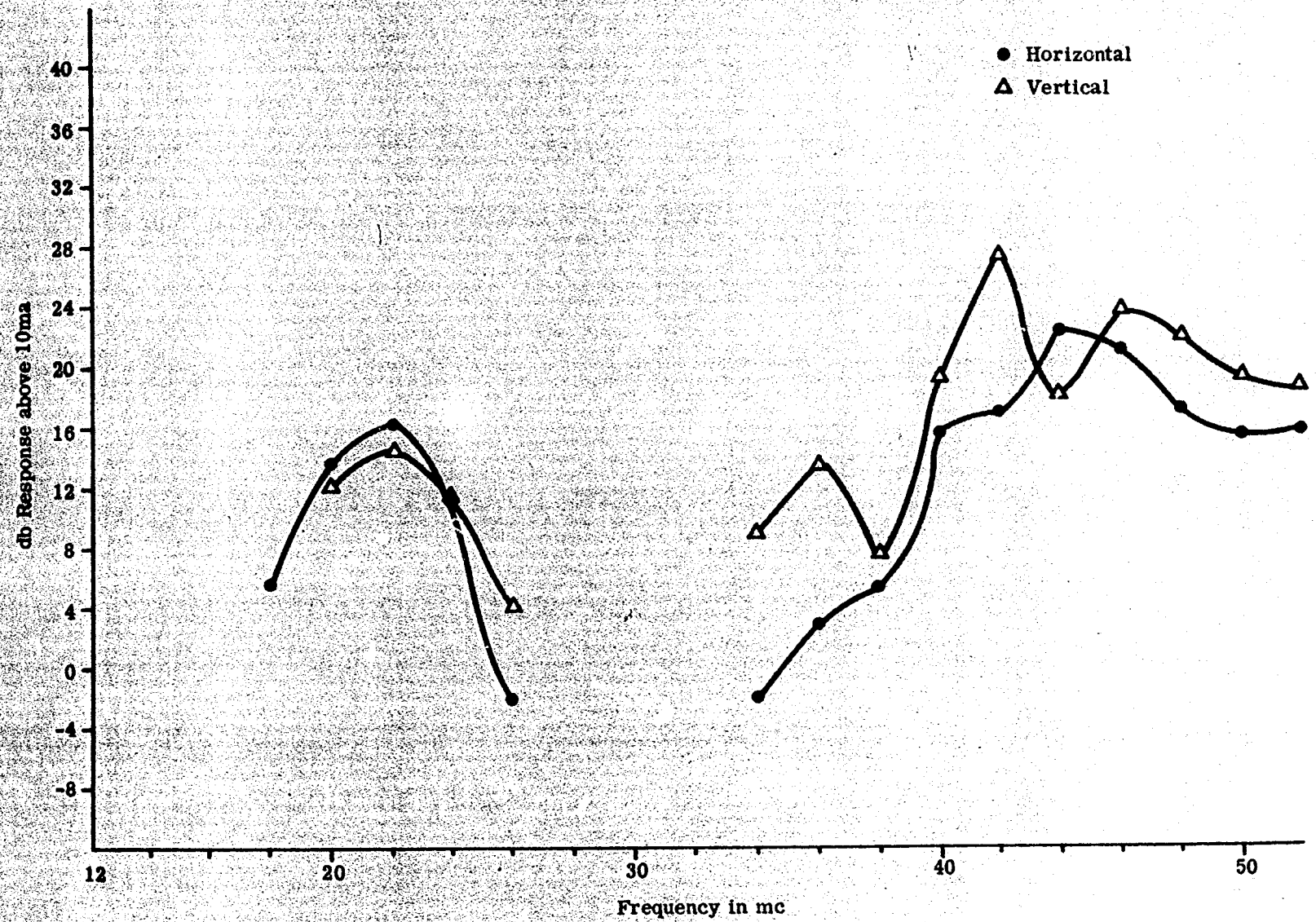
[redacted]

UNCLASSIFIED

1637

UNCLASSIFIED

[redacted]



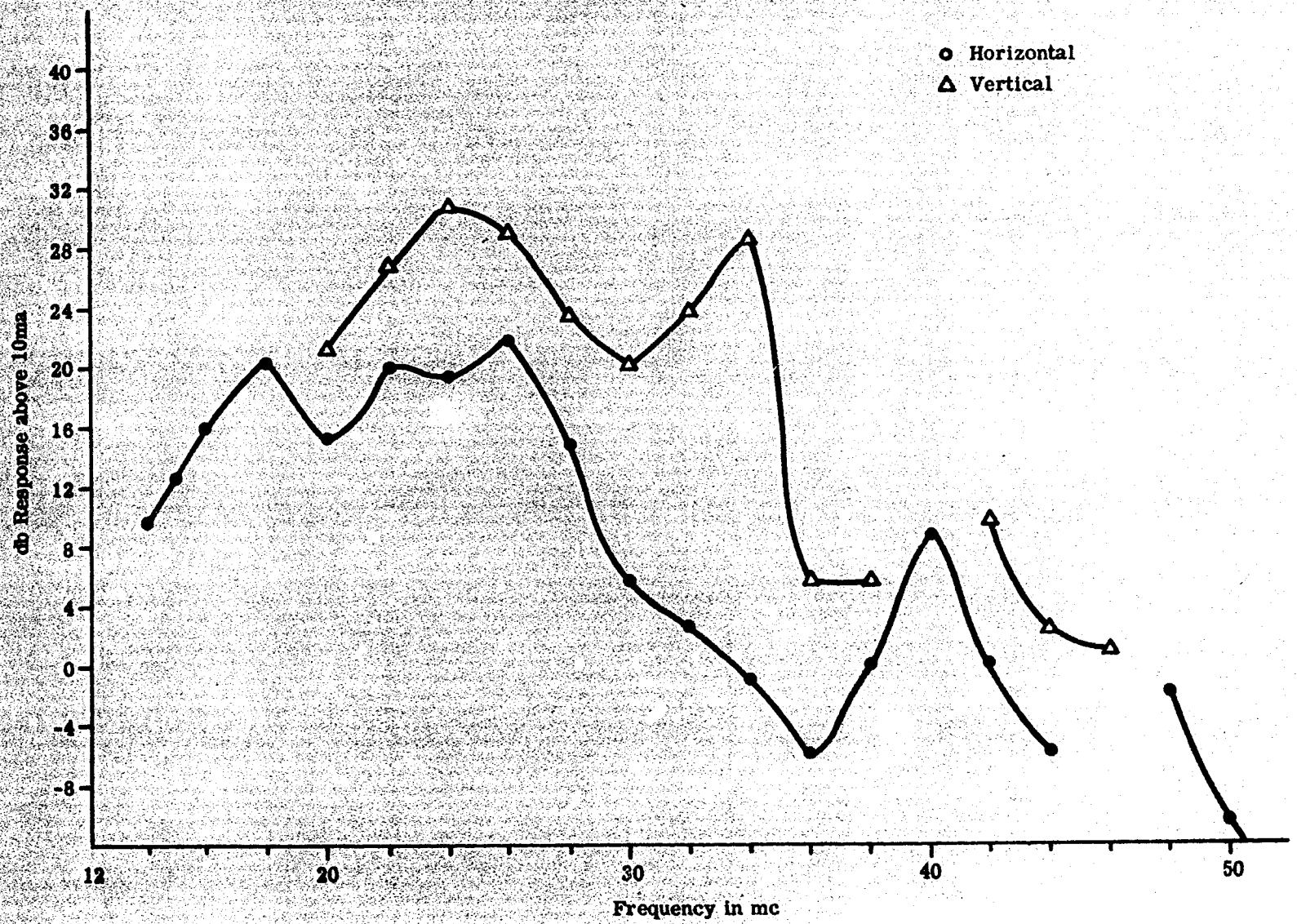
Low Resistance - Bottom Recorder

FIGURE 9 - CHANNEL 3 TEST RESPONSE IN 10 VOLT PER METER ENVIRONMENT

T-90266

[redacted]

UNCLASSIFIED



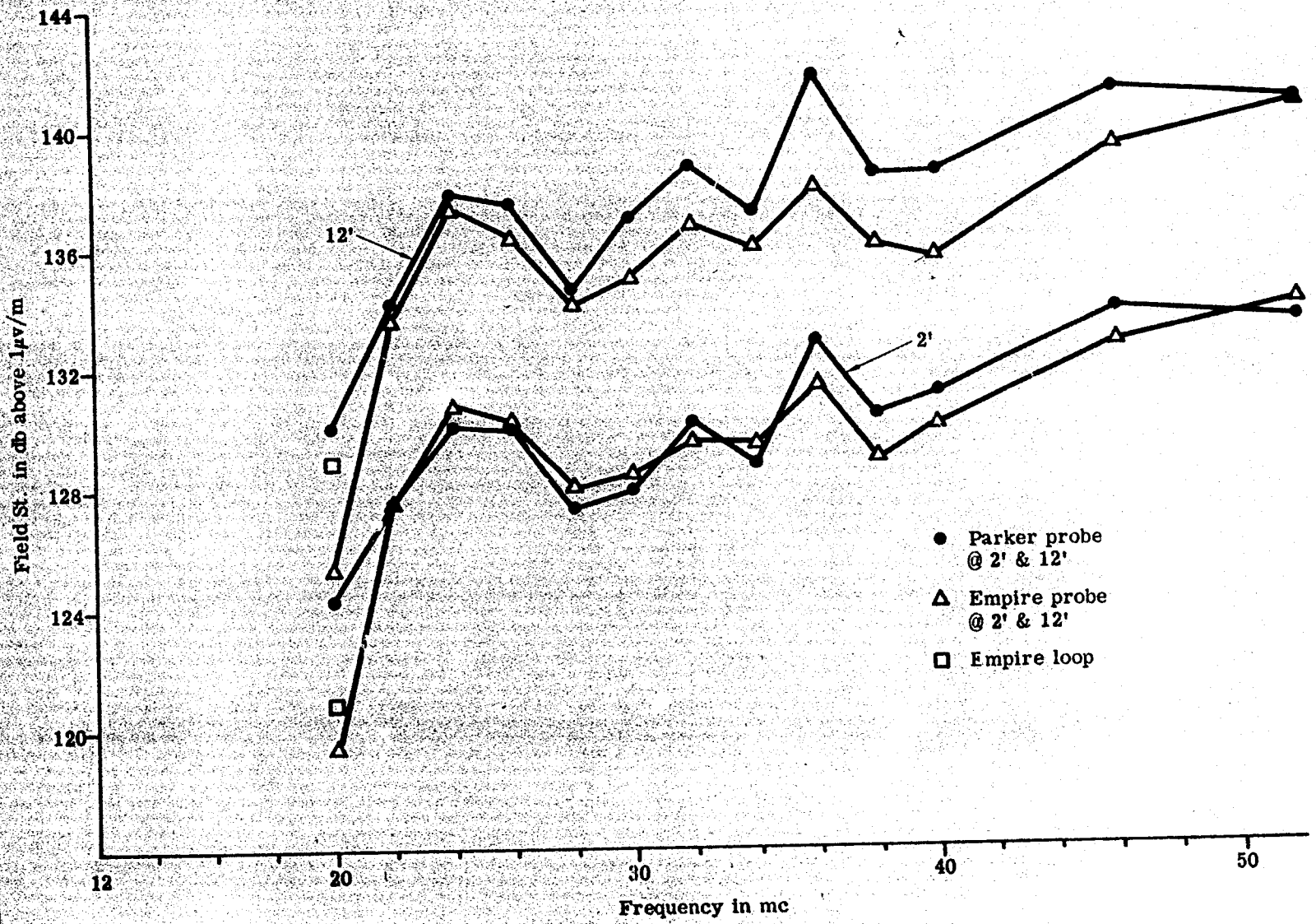
High Resistance - Bottom Recorder

FIGURE 10 - CHANNEL 4 TEST RESPONSE IN 10 VOLT PER METER ENVIRONMENT.

T-90266

UNCLASSIFIED

[redacted]



Comparison of Horizontal Field St. Readings

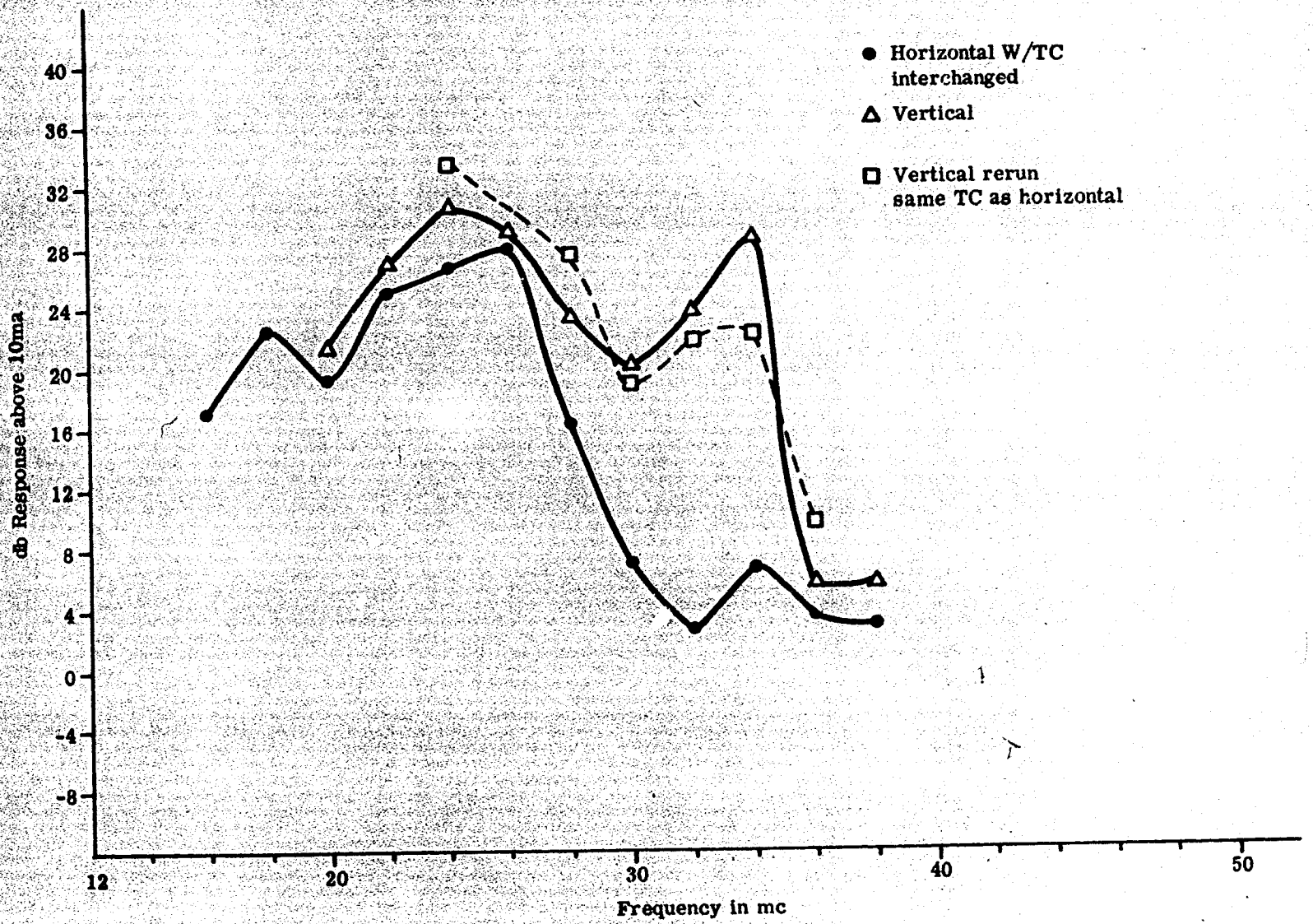
T-90266

FIGURE 11

[redacted]

UNCLASSIFIED

UNCLASSIFIED



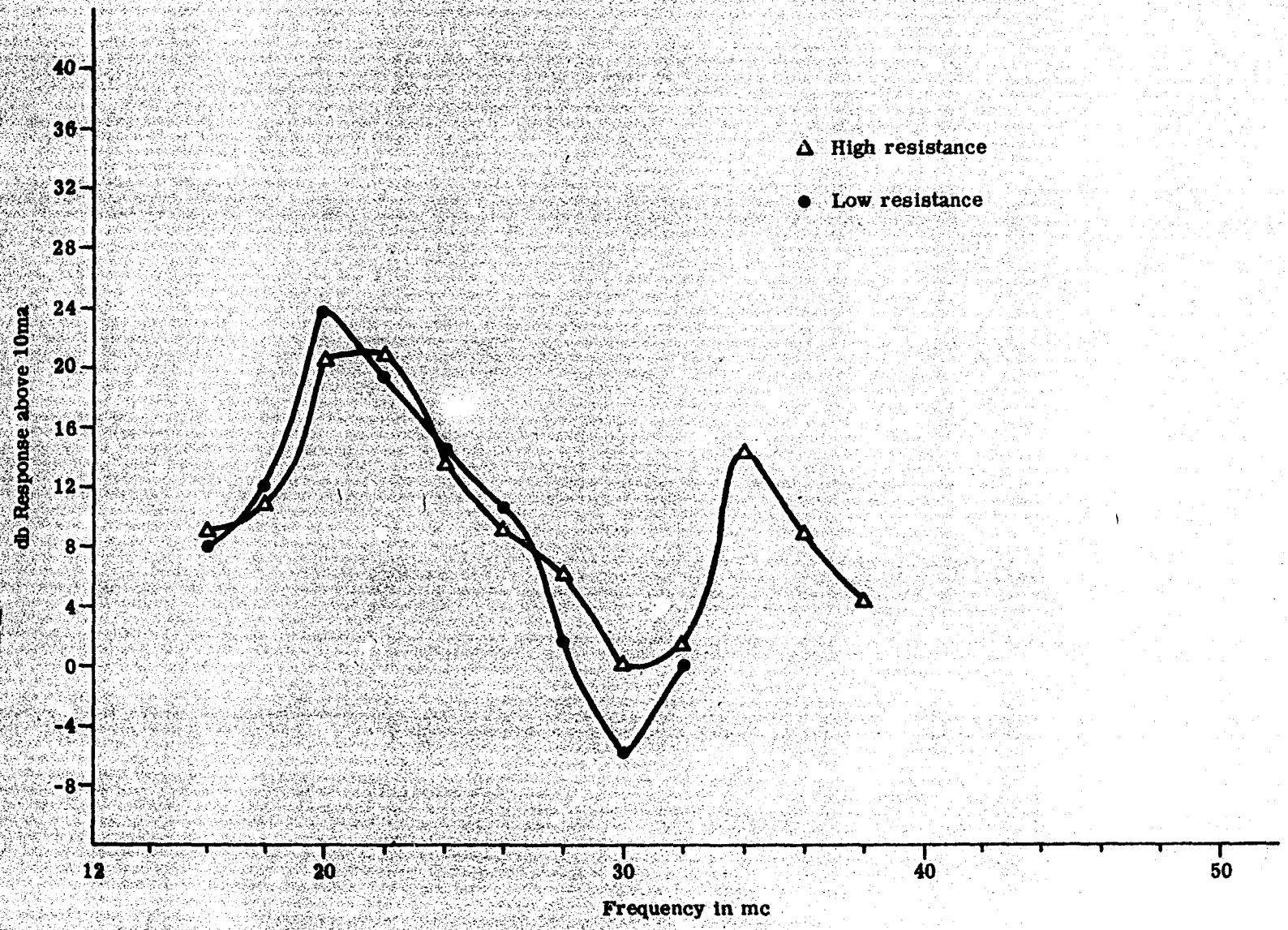
Squib Attached to Bottom External Wire

FIGURE 12 - CHANNEL 4 VERIFICATION OF RESPONSE VARIATIONS BETWEEN HORIZONTAL AND VERTICAL POLARIZATION.

T-90266

UNCLASSIFIED

UNCLASSIFIED



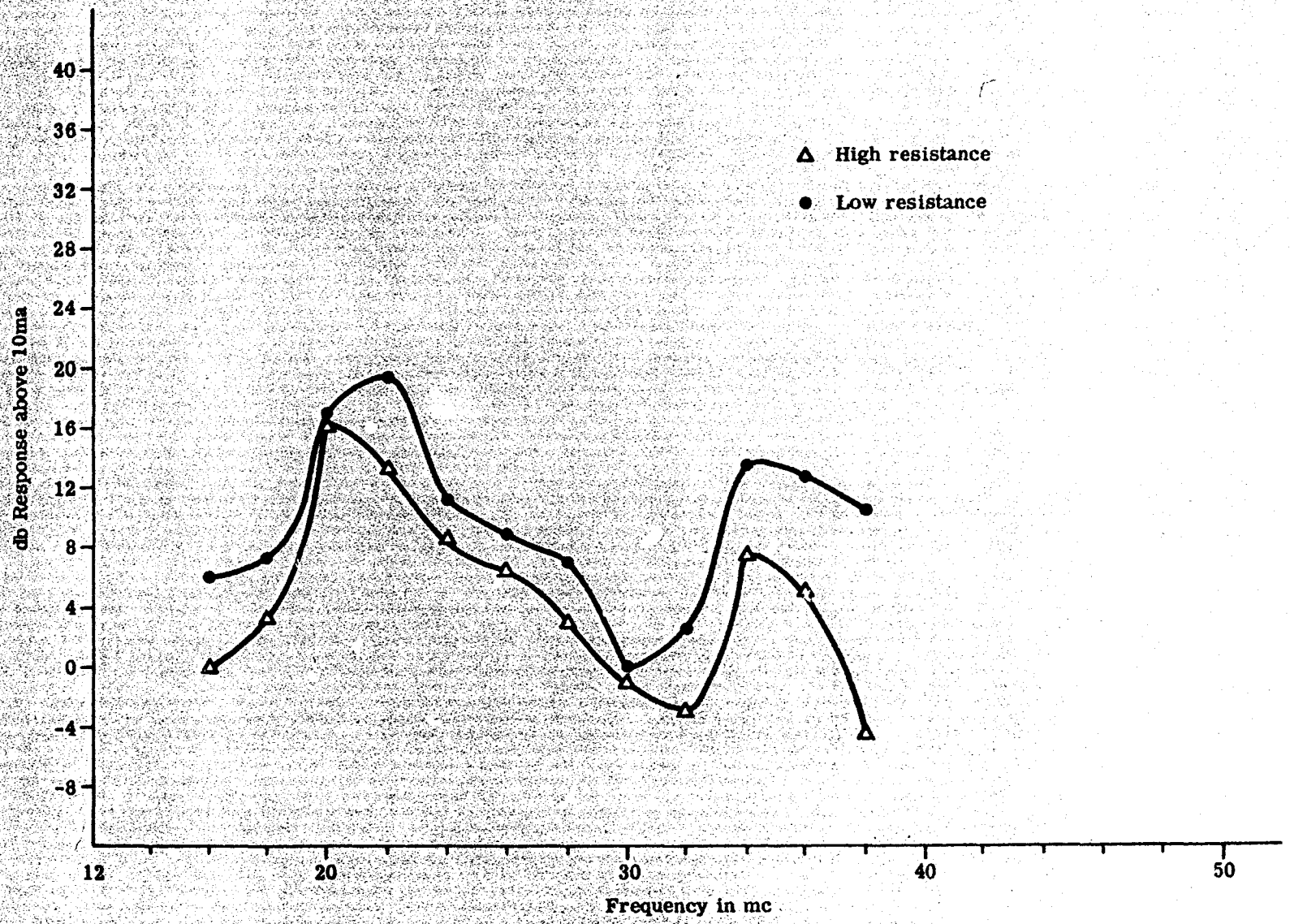
Upper External Line - Horizontal Pol.

FIGURE 13 - CHANNEL 1 EFFECT OF CHANGE IN TERMINATION RESISTANCE BETWEEN 4.5 AND 16 OHM

T-90266

UNCLASSIFIED

UNCLASSIFIED



Upper Interconnecting Squib - Horizontal Pol.

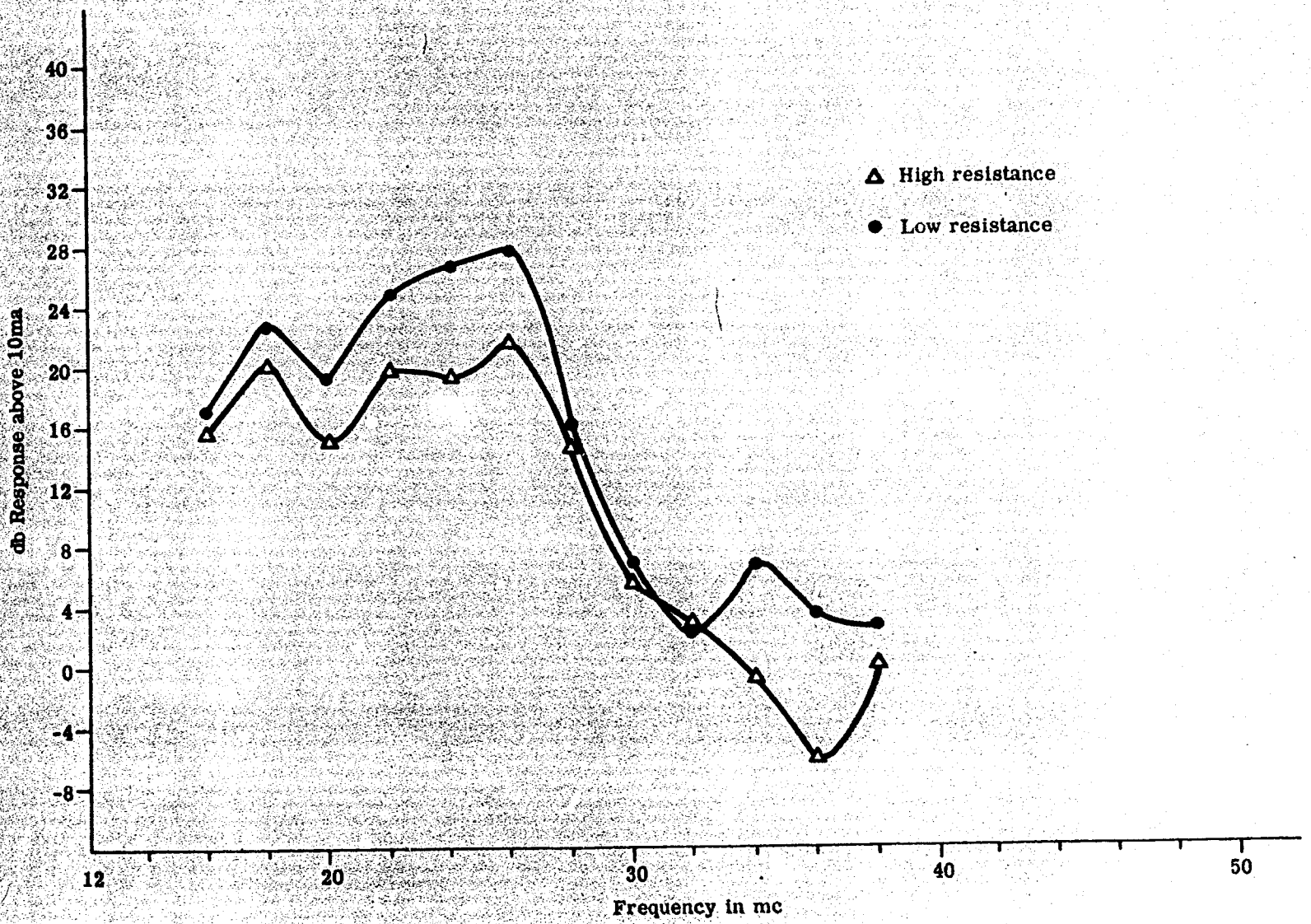
FIGURE 14 - CHANNEL 2 EFFECT OF CHANGE IN TERMINATION RESISTANCE BETWEEN 4.5 AND 16 OHM

T-90266

UNCLASSIFIED

UNCLASSIFIED

[redacted]



Lower External Line - Horizontal Pol.

FIGURE 15 - CHANNEL 4 EFFECT OF CHANGE IN TERMINATION RESISTANCE BETWEEN 4.5 AND 16 OHM

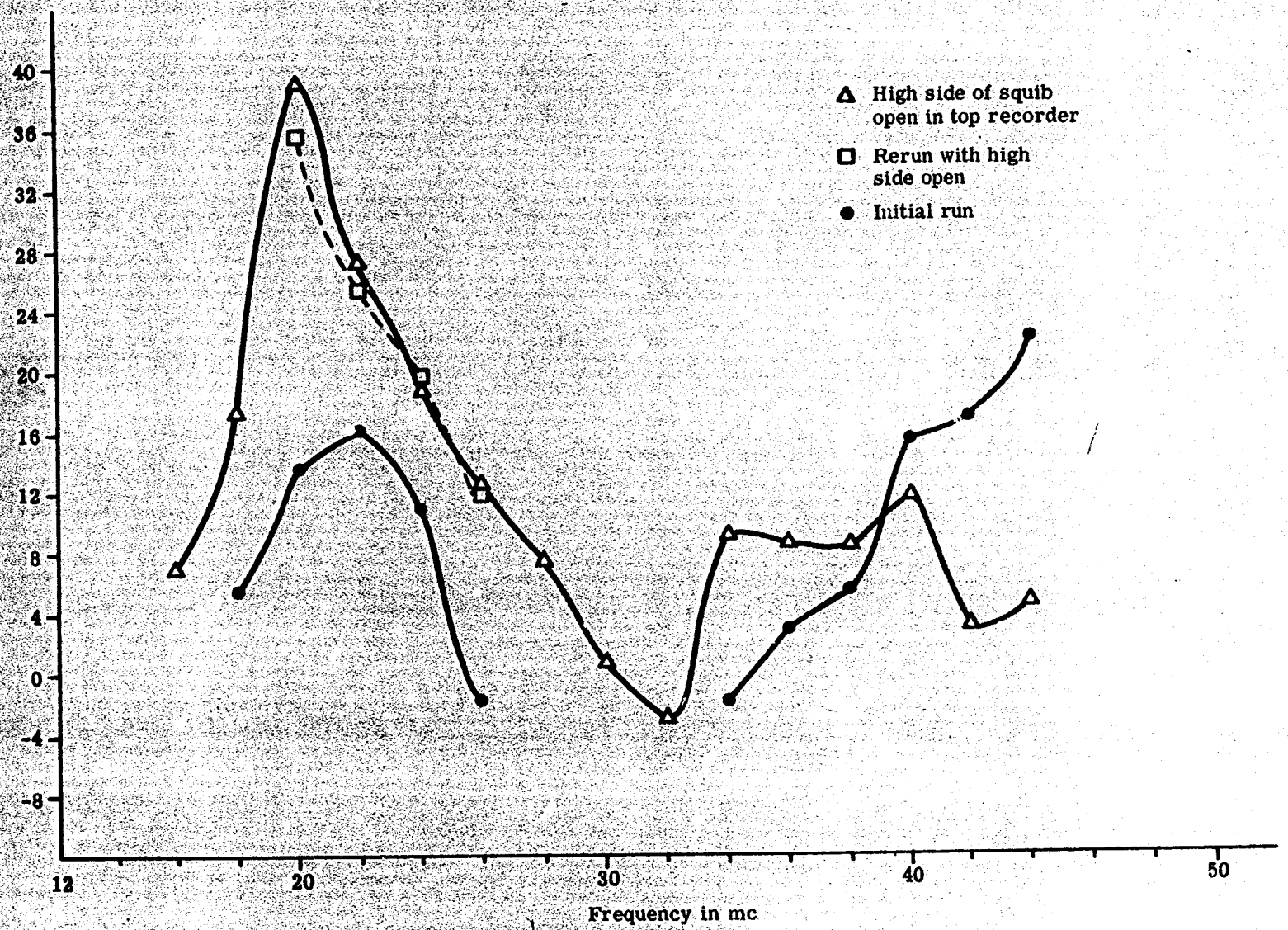
T-90266

[redacted]

UNCLASSIFIED

[redacted]

UNCLASSIFIED



Squib in Bottom Recorder Attached to Interconnecting Line - All Runs Horizontal

FIGURE 16 - CHANNEL 3 EFFECT IN CHANNEL 3 RESPONSE OF CHANGE IN CHANNEL 2 WIRING.

T-90266

UNCLASSIFIED

1645