Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications

IMAGE INTERFERENCE TO UHF TV RECEPTION FROM MOBILE OPERATION IN THE 806-890 MHz BAND

OCTOBER 1979

TELECOMMUNICATION REGULATORY SERVICE

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0.0 EXECUTIVE SUMMARY

0.1 Background

The planned reallocation of the frequency band 806-890 MHz (UHF TV channels 70-83) from broadcasting to mobile service has raised the question of the electromagnetic compatibility of the two services in adjacent bands. Specifically, this concern has centered on the fact that the image frequency responses of UHF TV receivers operating on channels 55-69 fall in the band 806-890 MHz and therefore, the receivers may be subject to interference from mobile service transmissions in that band.

0.2 Evaluation

In order to evaluate the potential for an image interference problem an initial analytical study was carried out. This analysis and report clearly indicated that image interference to TV reception in channels 55-69 can occur from mobile service transmissions in the 806-890 MHz band. To provide substantiation and calibration of these analytical results, field tests were made which realistically simulated conditions which would exist if frequency assignments to mobile services were made in accordance with the planned reallocation. This report describes the field tests, discusses the results, compares them with the results of the analytical study, refines the analysis on the basis of the data obtained from the field tests and draws conclusions regarding the electromagnetic compatibility of the two services.

0.3 Conclusions

0.3.1 Reception of UHF TV on channels 55-69 will be interfered with by the assignment of image-related frequencies (806-890 MHz) to mobile service transmitters in the same area.

0.3.2 The extent of the image interference from any one mobile service transmission varies substantially depending upon the relative power and placement of both the TV and mobile service transmitters. However, random, large scale deployment of mobile service facilities in the coverage area of channel 55-69 TV stations is clearly precluded pending the determination and implementation of image interference corrective measures.

0.3.3 Compatibility can be achieved to a limited degree in the short term through use of administrative and technical constraints on the siting, power and frequency use of stations of both services, at the cost of inefficient use of broadcasting and mobile spectrum. That inefficiency can ultimately be eliminated only by the implementation of improved TV receivers.

1.0 INTRODUCTION

1.1 Background

The proposal for reallocation of UHF-TV channels 70-83 (806-960 MHz) from broadcasting to the mobile services raises questions regarding the possibility of interference between the two services. The specific question of interference to UHF TV reception on channels 55-69 from mobile service emissions on the TV image frequencies in the band 806-890 MHz has been addressed in an analytical study entitled "Analytical Evaluation of The Potential for Image Interference to UHF TV Reception from Mobile Operation in the Band 806-890 MHz" - Annex I to this report. The study gives a generalized analysis of the image interference potential, and indicates that there is a significant probability that image interference to channels 55-69 TV reception will occur from mobile service transmissions in or near the coverage area of such TV stations on image frequencies in the 806-890 MHz band.

1.2 Purpose

Recognizing the fundamental importance of the image interference question to the planning of the future expansion of both services, it was decided that conclusive verification/calibration of the analytical study was necessary. Therefore, field tests were undertaken to collect the necessary data. This report describes the field tests and the results obtained, compares them with the prediction of interference derived analytically and draws conclusions regarding the potential for image interference to UHF TV from mobile service transmitters.

1.3 Study Methodology

The approach used to accomplish the purpose of this study was to:

a) transmit simulated mobile base station signals on the image frequencies and within the coverage areas of two operating UHF TV stations;

b) using a vehicle equipped with TV receivers of known image response characteristics, determine the area about the simulated mobile base station within which TV reception was affected;

c) using the system characteristics of the test system and the prediction techniques of the analytical study (Annex I), predict the interference potential of the test system;

d) compare the results of steps b) and c);

e) refine the prediction technique on the basis of results derived from d).

2.0 FIELD TEST SYSTEM DESCRIPTION

2.1 Television Transmitters

Two UHF TV stations were used in the tests as the off-air TV signal sources. These were CBLFT-17, channel 68, Sarnia, Ontario, and CICO-TV-59, channel 59, Chatham, Ontario. These two stations were selected because they are in the channel 55-69 range potentially affected by image interference from mobile services operating in the 806 to 890 MHz band and are sufficiently close geographically to permit measurement on both channels from the same sites. The pertinent characteristics of these stations are shown in Table 1.

2.2 Mobile Service Base Stations

The base stations for the field measurement were simulated by a high-power frequency generator and omni-directional colinear antenna operated at the image frequencies of the two UHF-TV picture carriers.

The sites for the simulated base station were selected to satisfy to the extent possible, the following criteria:

a) three sites for each TV station; one located in the prime coverage area of the TV transmitter (within the grade A contour), one near the grade A contour and one near the grade B contour;

b) an existing structure permitting installation of the base station antenna at a typical height for operational land mobile systems;

c) ready access to a power source and shelter for the equipment and operator.

In meeting these criteria four sites were selected: one in Chatham within the grade A contour of channel 59; one in Sarnia within the grade A contour of channel 68; one in Oil Springs at both the grade A contour of channel 68 and the grade B contour of channel 59 and one in Wallaceburg at both the grade A contour of channel 59 and the grade B contour of channel 68. Their locations with respect to the TV transmitters are shown in Figure 1A for channel 68 and Figure 1B for channel 59.

HEIGHT (EHAAT)		133 M (438 FT.)		
CHANNEL		68		
FREQUENCY	- CHANNEL	794-800 MHz		
	- VIDEO CARRIER	795.25 MHz		
IMAGE FREQUENCY	- CHANNEL	888-882 MHz		
	- VIDEO CARRIER	886.75 MHz		
TEST SITES (BASE STATIONS)		SARNIA	OIL SPRINGS	WALLACEBURG
DISTANCE TO BASE	- KM	9.64	22.74	35.12
	- MILES	5.99	14.13	21.82
DIRECTION TO BASE	- AZIMUTH FROM NORTH	335°	128°	184.5°
ERP TOWARD BASE	- KW	14.7	58.8	58.8
CALCULATED FIELD STRENGTH AT BASE (dBuV/m)	- F(50,50)	85.5	76.0	67.5
	- FREE SPACE	98.9	97.5	93.7

TABLE 1A

CHARACTERISTICS OF CBLFT-17, SARNIA, ONTARIO

HEIGHT (EHAAT)		218 M (715 FT.)		
CHANNEL		59		
FREQUENCY	- CHANNEL	740-746 MHz		
	- VIDEO CARRIER	741.25 MHz		
IMAGE FREQUENCY	- CHANNEL	834-828 MHz		
	- VIDEO CARRIER	832.75 MHz		
TEST SITES (BASE STATIONS)		CHATHAM	WALLACEBURG	OIL SPRINGS
DISTANCE TO BASE	- KM	12.16	18.50	37.07
	- MILES	7.62	17.71	23.0
DIRECTION TO BASE	- AZIMUTH FROM NORTH	241°	304°	355.5°
ERP - TOWARD BASE	- KW	19.0	20.6	20.0
CALCULATED FIELD STRENGTH AT BASE (dBuV/m)	- F(50,50)	86.5	71.5	66.0
	- FREE SPACE	97.9	91.0	88.6

TABLE 1B

CHARACTERISTICS OF CICO-TV-59, CHATHAM, ONTARIO

The pertinent characteristics of these base stations are provided in Table 2. It should be noted from the table that the ERP levels are not the same in all cases. This is due to two factors: the antenna gain at the transmission frequencies differed considerably from the nominal 7.5 dB gain at the center frequency of the antenna (858 MHz) and at Wallaceburg it was necessary to reduce the transmitter output to overcome a tuning anomaly at 886.75 MHz.

2.3 Measurement System

A block diagram of the measurement system is shown in Figure 2. The entire system was mobile, accommodated in a recreational-type vehicle. The antennas were mounted on a hydraulic mast capable of extension to 10 meters above ground level.

It was intended that the TV receiver system simulate a typical household installation. To accomplish this, a constant-gain preamplifier and variable attenuator were inserted in the antenna line and adjusted to compensate for the insertion loss of the impedance matching network, coaxial switch and power divider, which would not normally be present in a domestic TV receiver installation.

With this equipment complement, the following parameters were measured:

a) TV field strength

b) base station field strength

c) interference perceptibility on TV screen (With two receivers attached to each of two antennas 4 readings of interference perceptibility were taken at each site - these were graded as perceptible, just perceptible or not perceptible.)

d) TV/base station signal ratio at the input to the TV sets (one measurement for each TV antenna)

e) Distance and direction from base station

f) TV signal level at the input to the receivers

g) Remarks - e.g. site characteristics, etc.

From these parameters, others of significance could be derived. Of particular importance were the following:

h) TV/base station field strength ratio [a) minus b)]

i) antenna discrimination with respect to the

BASE STATION	ANTENNA HEIGHT (METERS)	ERP (WATTS)	FREQUENCY (MHz)
SARNIA	26	51	886.75
OIL SPRINGS 68	10	51	886.75
WALLACEBURG 68	26	45	886.75
CHATHAM	38	114	832.75
WALLACEBURG 59	26	114	832.75
OIL SPRINGS 59	10	114	832.75

TABLE 2

CHARACTERISTICS OF BASE STATIONS

base station signal [d) minus h)]

2.4 Television Receivers

Two television receivers were used to determine the perceptibility of interference during the field tests. These were selected from units which were tested in the Department's laboratory to obtain data on receiver image response characteristics reported in Annex I. The criterion for selecting these two units was that they be representative of receivers having the "best" and "worst" image interference characteristics as indicated by the laboratory tests. The laboratory tests measured the image response across the complete 6 MHz image interference passband and the receivers were selected for having the "best" and "worst" characteristics in that passband. However, the field tests were done only at the image of the picture carrier frequency, and at that particular frequency the differences between the two receivers was not as large as it might be if the measurements had been made on a frequency elsewhere in the image response passband. Therefore, although the results of the field tests are representative of the response of typical domestic TV receivers, they cannot be considered to illustrate the extremes of performance which may be anticipated. The picture carrier image response characteristics of the receivers are provided in Table 3.

2.5 Television Receiving Antennas

The antennas used for the field trials were selected as being representative of relatively cheap, directional, broad-band, UHF-TV receiving antennas. One was a corner-reflector antenna, the other a bow-tie style with a plane reflector grid. Their polarization and directional discrimination characteristics were not known.

3.0 FIELD TESTS

3.1 Measurement Strategy

The objective of the field measurement program was to determine the size of the areas surrounding a base station within which interference to a TV receiver was just perceptible or worse, so as to provide a comparison with the results of the analytical study described in Annex I. To accomplish this, it was decided to make measurements on radials extending outward from the simulated base stations until a distance was reached at which the degradation was no longer perceptible. Four radials at right angles were generally used, depending on the availability of roadways along the desired radials. As measurements were made at points along the radials it was necessary to backtrack on some radials to determine more closely where the transition from perceptible to imperceptible degradation

TEST RECEIVER	MINIMUM RATIO OF DESIRED TO UNDESIRED SIGNAL* TO CAUSE JUST PERCEPTIBLE UHF-TV PERFORMANCE DEGRADATION (dB)	
	CHANNEL 59	CHANNEL 68
# 1	6	10
# 2	18	22

TABLE 3

PICTURE CARRIER IMAGE RESPONSE
OF UHF TELEVISION RECEIVERS USED IN FIELD TESTS

* DESIRED SIGNAL - PEAK TV PICTURE CARRIER LEVEL

UNDESIRED SIGNAL - RMS LEVEL OF A SIMULATED MOBILE SIGNAL AT THE IMAGE FREQUENCY OF THE TV PICTURE CARRIER had occurred. From these results, contours of the limit of perceptibility could be drawn using conventional plotting techniques.

3.2 Measurement Procedure

The measurement procedure was standard for each measurement site, to provide an efficient routine for the field crew but primarily to ensure a uniformity of test conditions. After the simulated base station was established and its output stabilized in power and frequency, the following procedure was used at each measurement location.

a) The measurement site was selected taking into consideration:

- extrapolation of previous measurements if any;
- access;
- traffic;
- trees and hydro lines (avoided to the extent possible)

and its location recorded.

b) The antenna mast was raised and rotated for peak TV signal on the corner reflector antenna. The level was recorded.

c) The picture impairment was evaluated for each of the TV receivers connected to the corner reflector antenna.

d) The TV/base station signal ratio from the corner reflector was measured on the spectrum analyzer and recorded.

e) The coaxial switch was switched to the bow-tie antenna and the measurements of steps b) to d) repeated. As the antennas had parallel main beam axes, the antenna mast did not have to be rotated in repeating step b).

f) The TV field strength was determined using the field intensity meter.

g) The simulated base station field strength was determined using the field intensity meter.

3.3 Moving Measurements

At four locations where spot measurements were made, continuous measurements of field strength were recorded while the van was in motion along a radial from the TV station for about 30 meters (100 ft). These measurements were made to verify whether the spot measurements of signal levels were valid over the immediate measurement area. The field strengths of the TV and base stations were recorded simultaneously on separate X-Y plotters.

Four measurements of this type were made, two within the TV stations' grade A contours, one on a grade A contour and one on a grade B cntour.

3.4 House-to-House Survey

As a further measure to determine the degree of realism represented by the TV receivers used in the field measurments, a house to house survey was made in the vicinity of three of the base station sites. In this survey, a member of the field crew selected homes at random and asked if he might observe the reception of the appropriate TV channel on the homeowner's receiver. He then determined and recorded whether interference from the base station was perceptible on the picture.

4.0 FIELD TEST RESULTS

4.1 Interference Contours

In the field tests, for each base station location, four sets of judgements of the perceptibility or imperceptibility of picture degradation were made, one for each combination of two receivers and two antennas. From the data collected, a plan plot of the perceptibility was made, and a contour drawn from it. Inside the contour, degradation was perceptible with the specified receiver and antenna combination, outside the contour it was imperceptible. The twenty-four contours derived are shown in Figures 3 to 26.

The area within the contour is a measure of the interfering effect of the base station in each case and is shown in Table 4 in the columns headed "measured".

It is significant that for each base station site the contours have a similar shape, regardless of the receiver and antenna combination by which they were generated, and that this basic shape changes from one base location to another. The implication of this is that the strongest influence upon the interference contour configuration is that of local propagation effects.

4.2 House-to-House Survey

The results of the house-to-house surveys are plotted on the interference contours shown in Figures 6, 19 and 26. The plots indicate that the transitions from perceptible to imperceptible degradation of the home observations correspond to the field test contours for all practical purposes and, therefore, verify that the test system was representative of normal home receiving systems.

4.3 Propagation

4.3.1 Spot Measurements

The field tests included measurements of the field strength of both TV and base station signals. These measurements are plotted against distance from the transmitter in Figures 27 to 34. In figures 27 and 31 the solid line shows the field strength calculated in accordance with the F(50,50) curves from FCC Report R6602, using the emission characteristics of the UHF TV stations given in the engineering briefs submitted with the applications for the station licenses.

The TV station at Sarnia (Channel 68) has a directional antenna pattern in azimuth so that the ERP on a radial toward Sarnia is less than the ERP on the radials toward Oil Springs and Wallaceburg. As a result, the propagation curve in Figure 27 which appears to be discontinuous is segments of two curves for the different values of ERP, plotted for convenience of consistent comparison with the measured results.

The solid curves in Figures 28, 29, 30, 32, 33 and 34 show the predicted variation of field strength with distance from the simulated base stations, based upon the Egli propagation model, except at short distances where free space propagation was used.

For both the base stations and the TV stations, a significant variation from predicted propagation conditions was observed, ranging to as much as about 30 dB.

4.3.2 Moving Measurements

Figures 35 to 44 are charts of field strength as recorded on the X-Y plotters attached to the outputs of the field intensity meters during short runs of approximately 30 meters (100 ft.) taken at four of the spot measurement locations. Each run was repeated producing a light and dark trace on the same path. The TV and simulated base station signal recordings for each site were done simultaneously, on a radial from the TV station. The horizonal scale in the graphs is not calibrated because the X-axis drive on the plotters was provided from a ramp generator, whereas the speed of the vehicle over the run was subject to start-up acceleration, manual attempts to maintain a constant speed and stopping deceleration. Although not linear, the total length of one plot represents the levels experienced over a distance of about 30 meters.

Some of the graphs show simple multi-path fading characteristics, others show the effect of obstructions on the propagation path. Comparison of Figures 40 and 42 illustrate the influence of a hospital building in blocking line-of-sight visibility of the base station during one run (Figure 40) and another run 15 meters to one side (Figure 42) which was not blocked. The maximum (peak to null) variation measured on any of the 30 meter runs was about 30 dB, with most variations being much less. The levels of the spot measurements corresponding to each moving measurement area are shown in the figures as horizontal dashed lines for comparison purposes in the figures. With one exception (Figure 38) the spot measurements fall within the range of levels measured over the 30 meter runs. In that exception, it should be noted that, because it was necessary to direct the main beam of the horizontal dipole toward the TV transmitter to realize its calibrated gain characteristic, the vertical dipole became shielded from the base station transmitter by the antenna support structure. As a result, the effective gain of the vertical dipole was reduced by about 7 dB while this measurement was made. Because the amount of reduction could not be accurately determined in the field, no attempt was made to recalibrate the measurement system. This means that the field strength level shown for the X-Y plotter output in Figure 38 is too low by about 7 dB, whereas the spot measurement level is correct. In these circumstances, the spot measurment in this case also falls within the adjusted range of the moving measurement. These measurements confirmed that the use of spot measurements is representative of the field strength levels in the locale in which they were made, within a margin of error comparable to that associated with the difference between measured and predicted values.

4.4 Receiver Antenna Discrimination

As indicated in Section 2.3 i) it was possible to derive from the field test data, the discrimination (with respect to the base station) of the UHF TV receiving antennas. The discrimination values which were exhibited by the two antennas were plotted on log normal paper and the mean values obtained. These plots are shown in Figures 45 and 46 for the corner reflector and bow-tie respectively. Their mean values of discrimination, 25.5 dB (corner reflector) and 18.5 dB (bow-tie) include a combination of both polarization and directional discrimination in undetermined proportions. The total range of antenna discriminations measured covers 26 dB in the case of the corner reflector and 29 dB for the bow-tie.

5.0 CALIBRATION OF ANALYTICAL TECHNIQUE

The purpose of the field tests was to provide a validation or calibration of the analytical technique described in the Annex to this report. In order to do so, the analysis method used in Annex I was applied using the parameters of the stations involved in the field tests and the calculated interference areas compared with the results of the field measurements.

5.1 Analytical Procedure

The procedure used for the analysis was as follows. For a particular location, the ratio of signal strength of the UHF TV transmitter in question to the signal strength of the base station was calculated. If this ratio was less than that necessary to prevent perceptible interference to a TV receiver with specific image response characteristics, that location was deemed to be subject to image interference. By plotting all such points found by repeating this process, the area around the base station which would be expected to be subject to image interference was defined. In practice this approach was simplified by using a graphical procedure to provide directly only those points on a locus defining the boundary of the area subject to image interference (referred to as the "interference contour"). The area was then measured.

The system characteristics used were those given in Tables 1A, 1B, 2 and 3. The propagation models which were assumed are those described in section 4.3.1. The TV receiver antenna characteristic assumed was that which was used in the study in the Annex; omnidirectional and independent of frequency and polarization.

5.2 Analytical Results and Adjustment of Analysis

The results of the above analysis are shown in Table 4 in the columns headed "Calculated". For comparison purposes, the measured results are shown in the same table. There is a large disparity between the measured values and those predicted by the analysis technique. The measured areas are in all cases smaller than the calculated areas. The only factor which can account for a systematic error of this size is the assumption, made in the analysis, that the TV receiving antenna does not provide any discrimination against the base station signal. Since the antenna discrimination was measured in the field tests, the analysis was repeated using the median values of the measured discrimination (Sec 4.4). The results of this adjustment are shown in Table 5. It can be seen from this table that, although some disparities exist, they appear to be random in nature, rather than systematic. Such random differences are attributable to local propagation effects and the difference between actual antenna discriminations and the median value used in the

UHF TV STATION	MOBILE BASE STATION	RECEIVER 1			RECEIVER 2		
		CALCUL-ATED	MEASURED		CALCUL-ATED	MEASURED	
			CORNER REFLECTOR	BOW TIE		CORNER REFLECTOR	BOW TIE
SARNIA (68)	SARNIA	10.8	2.5	3.0	53.7	3.6	3.1
"	OIL SPRINGS	12.3	1.8	1.9	50.8	2.5	2.6
"	WALLACEBURG	83.3	4.5	4.6	381.8	5.6	5.2
CHATHAM (59)	CHATHAM	13.5	2.4	2.9	62.0	4.3	5.1
"	WALLACEBURG	52.5	3.7	4.4	462.6	3.7	4.9
"	OIL SPRINGS	37.6	2.0	3.7	149.1	2.6	3.3

TABLE 4

AREA (KM^2) OF THE INTERFERENCE ZONES SURROUNDING THE SIMULATED MOBILE BASE STATIONS AS MEASURED IN THE FIELD TESTS AND AS CALCULATED IN ACCORDANCE WITH THE ANALYTICAL METHOD OF THE ANNEX

UHF TV STATION	MOBILE BASE STATION	RECEIVER 1				RECEIVER 2			
		CALCULATED		MEASURED		CALCULATED		MEASURED	
		CORNER REFLECTOR	BOW TIE	CORNER REFLECTOR	BOW TIE	CORNER REFLECTOR	BOW TIE	CORNER REFLECTOR	BOW TIE
SARNIA (68)	SARNIA	0.5	1.2	2.5	3.0	2.1	4.8	3.6	3.1
"	OIL SPRINGS	0.6	1.4	1.8	1.9	2.5	5.5	2.5	2.6
"	WALLACEBURG	3.9	9.0	4.5	4.6	16.0	35.9	5.6	5.2
CHATHAM (59)	CHATHAM	0.3	0.9	2.4	2.9	1.9	5.0	4.3	5.1
"	WALLACEBURG	2.2	5.6	3.7	4.4	9.9	22.7	3.7	4.9
"	OIL SPRINGS	1.8	4.0	2.0	3.7	7.2	16.0	2.6	3.3

TABLE 5

AREA (KM^2) OF THE INTERFERENCE ZONES SURROUNDING
THE SIMULATED MOBILE BASE STATIONS, AS MEASURED IN THE FIELD TESTS
AND AS CALCULATED IN ACCORDANCE WITH THE ANALYTICAL METHOD OF THE ANNEX WITH
INCLUSION OF MEDIAN TV RECEIVER ANTENNA DISCRIMINATION VALUES DETERMINED IN THE FIELD TRIALS

calculations. Nevertheless, the measured and calculated values of area are of comparable size, indicating that the analytical technique, as modified, provides a good estimator of the interference due to the response of UHF TV receivers to mobile service signals on their image frequency.

5.3 Extension of Analysis to the General Case

Having thus validated the accuracy of a modified analysis model, it remains to apply it to the general case of interference between land mobile service stations and UHF TV broadcasting reception.

5.3.1 System Characteristics Assumed for the General Case

Except for one parameter, described below, the characteristics assumed as representative of the general case are those used in the analytical study of Annex I. For convenience, these are summarized below.

a) Mobile Service Transmitters

As representative land mobile stations, two categories of base station transmitter and a mobile station are used. Their significant parameters are shown in Table 6.

CATEGORY	ANTENNA HEIGHT (EHAAT)	ERP (AT 0° ELEVATION)
BASE		
- Maximum Parameter	152 m (500 ft)	500 W
- Typical	46 m (150 ft)	150 W
MOBILE	2 m (6 ft)	100 W

TABLE 6

Categories and Characteristics of Transmitters Considered Representative of Those Used in the Mobile Service Band 806-960 mHz

b) UHF TV Broadcast Service Transmitters

Table 7 shows the categories of UHF TV transmitters used to represent those which may be authorized in Canada and the United States.

CATEGORY	ANTENNA HEIGHT (EHAAT)	ERP (in the horizontal direction)
A B C	91 m (300 ft) 152 m (500 ft) 305 m (1000 ft)	10 kw 100 kw 1000 kw

TABLE 7

Categories and Characteristics of Transmitters Considered Representative of Those Used in the UHF TV Broadcast Service

c) Siting Configurations

The siting configurations considered as being most illustrative of the variation of image interference over a UHF TV coverage area are given in Table 8.

CATEGORY	DESCRIPTION
CO-SITED	UHF TV and Mobile transmitters co-sited
IN GRADE A	Mobile transmitter within the Grade A service contour of the UHF-TV transmitter (90 dB μV/m)
ON GRADE A	Mobile transmitter at the Grade A service contour of the UHF TV transmitter (74 dB μV/m)
ON GRADE B	Mobile transmitter at the Grade B service contour of the UHF TV transmitter (64 dB μV/m)

TABLE 8

Locations of Mobile System Transmitters Considered Within a UHF TV Broadcasting Service Area to Illustrate the Effect of Image Interference

d) Propagation

UHF TV - The propagation model used for the TV signal was the F(50,50) model from FCC Report 6602.

Land Mobile - The propagation model used for the mobile and base station signals was the Egli model.

Both of these models were modified at very short distances to correspond to a free-space propagation condition.

e) Transmitting Antennas

The transmitting antenna characteristics for both the UHF-TV stations and land mobile service stations were chosen to be representative of those that would typically be used for those services, and incorporate the assumption of a discrimination pattern in the vertical plane. These characteristics are described in detail in Annex I.

f) Interference Criterion

The TV receiver image response interference criterion was based upon measurements of a sample of TV receivers. It was taken to be D/U = 20 dB.

g) Receiving Antennas

The single variation from the analysis in Annex I is the assumption of a more realistic UHF TV receiving antenna characteristic. The original study assumed an antenna which was equally responsive to both the desired UHF TV signal and the mobile signal. The two antennas used in the field tests, although not particularly sophisticated nor expensive and fairly typical of minimal external UHF TV antenna installations, demonstrated that this assumption was not valid. The antennas provided significant discrimination against the mobile system signals. As described in Sec. 4.4, the median values of discrimination which they demonstrated were 18.5 and 25.5 dB. Therefore, for the extension of this analysis to the general interference case, the TV receiving antenna discrimination which is assumed is 20 dB. This falls between the median values displayed by the two antennas used in the field tests, slightly favoring the worse one, but the large variations about the median measured for both the units does not support further refinement.

Therefore, the desired-to-undesired field strength ratio which may be assumed for just perceptible degradation of the picture is 0 dB (20 dB desired-to-undesired signal ratio at the receiver input terminals minus 20 dB antenna discrimination).

5.3.2 Results of Refined Analysis

A graphical solution was used to determine the interference zones surrounding the mobile service stations, as described in Section 5.1. Figures 47-52 show the contours derived by this method for the three categories of UHF TV station, and two types of mobile base station. The resulting areas of the interference zones for these situations, the mobile station cases and the cases in which the TV and base stations are co-sited are summarized in Table 9.

It appears from this table that the area of the interference zone is generally less when the base station is located on the Grade B service contour than when it is located on the Grade A contour. However, reference to, say, Figure 47 shows that this is the result of including only that area which is common to the interference zone and the Grade B service contour, the latter being taken as the limit of the area in which TV reception is provided protection from interference. In fact, the area of interference from a given mobile service station generally increases with increased distance between the base station and the TV station.

The results in Table 9 indicate that depending upon the parameters of the transmitting stations involved, the interference from a single mobile service transmitter to the reception of an image-related UHF TV signal will occur over an area ranging from a few to a few hundred square kilometers.

In order to avoid interference entirely, it is necessary to move image related mobile service transmitters outside the service area of a UHF TV broadcasting station. Table 10 shows the distance separation between mobile and broadcasting service transmitters required to satisfy the condition that the mobile service field strength within the Grade B service contour not exceed that which would cause interference to a TV receiver. The separations range from one to fifteen kilometers beyond the Grade B service contour of a UHF TV station, depending upon the power of the mobile service transmitter.

One alternative to avoiding the assignment of image related frequencies in the same area, is the use of an improved TV receiver. If one assumes that it is permitted for a base station to have an interference zone of 100 meters radius maximum at the edge of a UHF TV coverage area (Grade B Service contour), this would require that the TV receiver image interference rejection capability be improved by 40 dB with respect to the value used in this study.

CATEGORY OF TV TRANSMITTER	MOBILE TRANSMITTER LOCATION	CATEGORY OF MOBILE TRANSMITTER		
		TYPICAL MOBILE	TYPICAL BASE	MAXIMUM PARAMETER BASE
A	COSITED	N/A	1.6	20.8
	IN GRADE A (90 dBuV/m)	.2	6.5	82.3
	GRADE A (74 dBuV/m)	1.2	42.1	304.5
	GRADE B (64 dBuV/m)	3.9	40.6	173.7
B	COSITED	N/A	NIL	NIL
	IN GRADE A	.2	5.5	26.0
	GRADE A	1.2	36.4	341.3
	GRADE B	3.9	46.6	208.2
C	COSITED	N/A	NIL	NIL
	IN GRADE A	.2	6.2	24.9
	GRADE A	1.2	41.4	291.7
	GRADE B	3.9	48.5	217.2

TABLE 9

AREA (KM^2) WITHIN THE COVERAGE AREA OF A
UHF TV BROADCAST STATION OF THE INTERFERENCE ZONE SURROUNDING
A MOBILE SERVICE TRANSMITTER OPERATING ON THE IMAGE FREQUENCY OF THE TV TRANSMITTER

CATEGORY OF TV TRANSMITTER	CATEGORY OF MOBILE SERVICE TRANSMITTER		
	TYPICAL MOBILE	TYPICAL BASE	MAXIMUM PARAMETER BASE
A	25.3	30.3	39.3
B	46.2	51.2	60.3
C	70.3	75.4	84.4

TABLE 10

DISTANCE (km) BY WHICH TRANSMITTERS OF THE MOBILE AND UHF TV BROADCASTING SERVICES MUST BE SEPARATED TO AVOID IMAGE INTERFERENCE TO RECEPTION OF UHF TV WITHIN THE GRADE B SERVICE CONTOUR OF THE BROADCAST STATION

5.4 Limitations of the Analysis

The analysis carried out in Section 5.3.2 has been done to simulate, to the extent possible, a realistic evaluation of the potential for interference from transmitters in the band 806-890 MHz to reception of UHF TV on the image related channels 55-69. Nevertheless, there are some obvious and other not so obvious additional considerations which deserve recognition.

The first of these is variance. With the single exception of the image response characteristics of the TV receivers tested, median values of all other parameters - antennas, propagation (TV and Mobile), etc. - have been used. Each of these median values has associated with it a significant variance, in some cases ± 20 dB or more, If, for example, the +20 dB situation applied to 10% of the viewers involved, the interference areas discussed in 5.3.2 would be effectively 100 times larger than the calculations indicate.

Another factor which is not considered in the analysis relates to the response characteristics of the TV receivers. The entire analysis assumes that they respond only to signals received via the antenna. It was previously suspected and confirmed in the field tests, that coupling of interfering electromagnetic fields directly to the receiver can and does occur. A rigourous quantitative assessment was not carried out, but in the field the problem generally occurred when the ratio of desired to undesired fields was about 0 dB, and the additional discrimination provided by the antenna was sufficient to bring the desired to undesired signal ratio within the range which should not have caused perceptible interference to the TV picture. In many of these cases the interference was still perceptible. The solution used in the field tests was to turn the test vehicle around so that the receivers, mounted in the back window of the van, were furnished additional shielding by the body of the van, and the anomalous interference vanished. The pertinent point here is that it was demonstrated in the field tests that an antenna isolation in the range of 20-30 dB or more may exceed the decoupling between the receiver and the electromagnetic environment, providing little improvement in overall isolation. The same situation would apply to isolation filters in the antenna line.

In considering the isolation provided by the receiving antennas it should be noted that the discrimination is a combination of directional and polarization discrimination. In the analysis of 5.3.2, the co-sited situation does not afford any directional discrimination advantage. In addition, the increasing practice of transmitting TV signals on both vertical and horizontal polarizations, if carried over to the use of dual polarized receiving antennas will afford no significant polarization discrimination against vertically-polarized mobile service signals.

As a final caveat, it should be noted that this analysis considered the image interference response of a television receiver to only one mobile service signal. The image of the 6 MHz UHF TV passband encompasses 240 mobile channels, any of which can produce interference as described here. The combined effect of a number of mobile systems operating simultaneously has not been investigated, but it is certain to be additive to some degree, in terms of time as well as power.

6.0 CONCLUSIONS

6.1 The results of this analysis show that the reception of UHF TV channels 55-69 has a high potential for being degraded by mobile service transmissions in the band 806-890 MHz because of the response of current television receivers to signals at their image frequencies. Furthermore, quantitative substantiation of this conclusion has been established by the results of field tests.

6.2 The degradation due to a single mobile or base station in the land mobile service will occur over an area extending from a few to a few hundred square kilometers, depending upon the relative placement and power of the UHF-TV and land mobile service transmitters.

6.3 Therefore, random, large-scale deployment of mobile stations in an image-related UHF TV coverage area would cause interference throughout the coverage area.

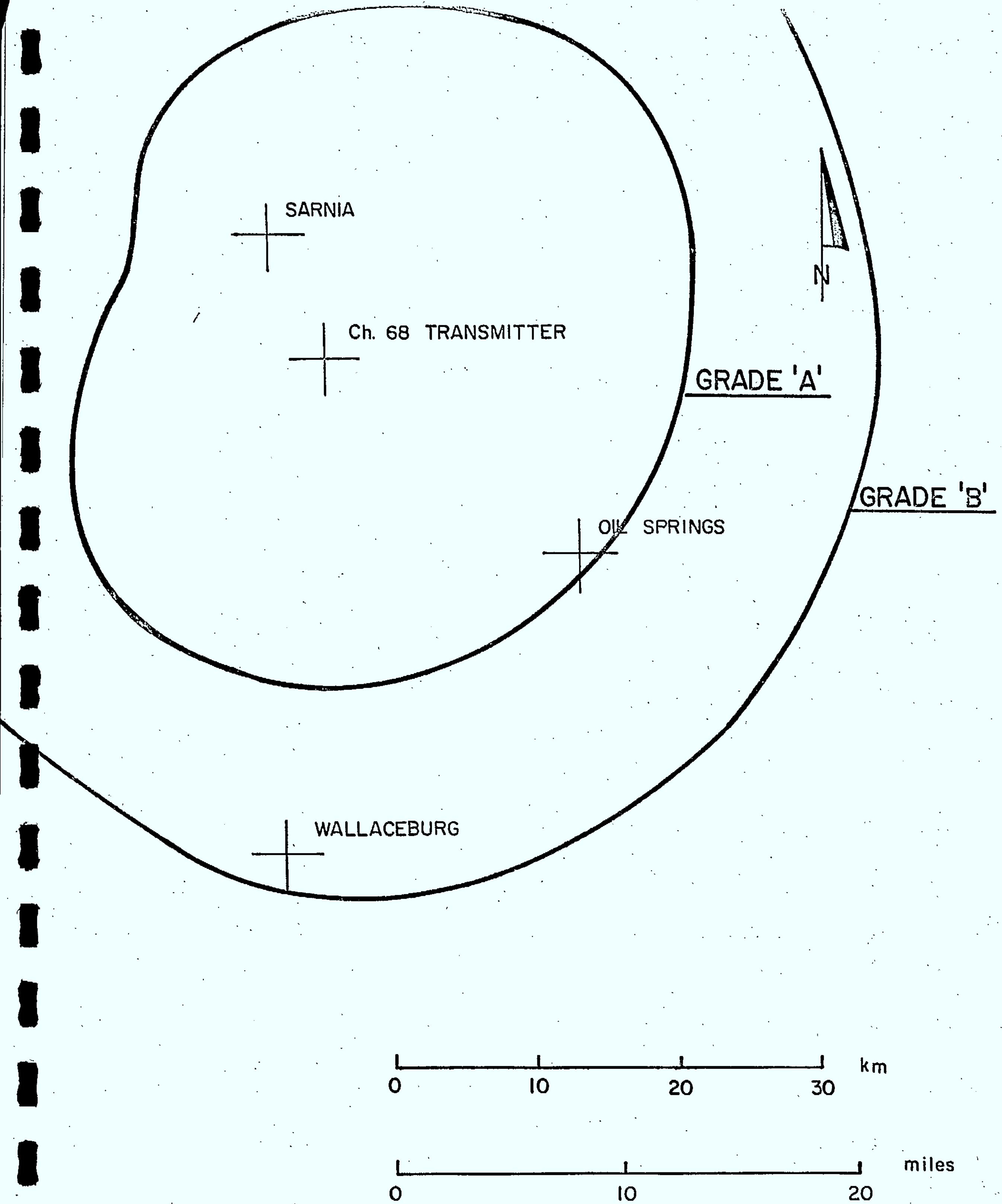
6.4 Compatible operation of mobile services in the band 806-890 MHz and UHF TV broadcasting on channels 55-69 can be achieved in three ways:

a) by engineering the assignment of frequencies to both services on a case-by-case basis to minimize the occurrence of incompatible configurations;

b) by avoiding the assignment of image-related frequencies where both services are operating in the same area;

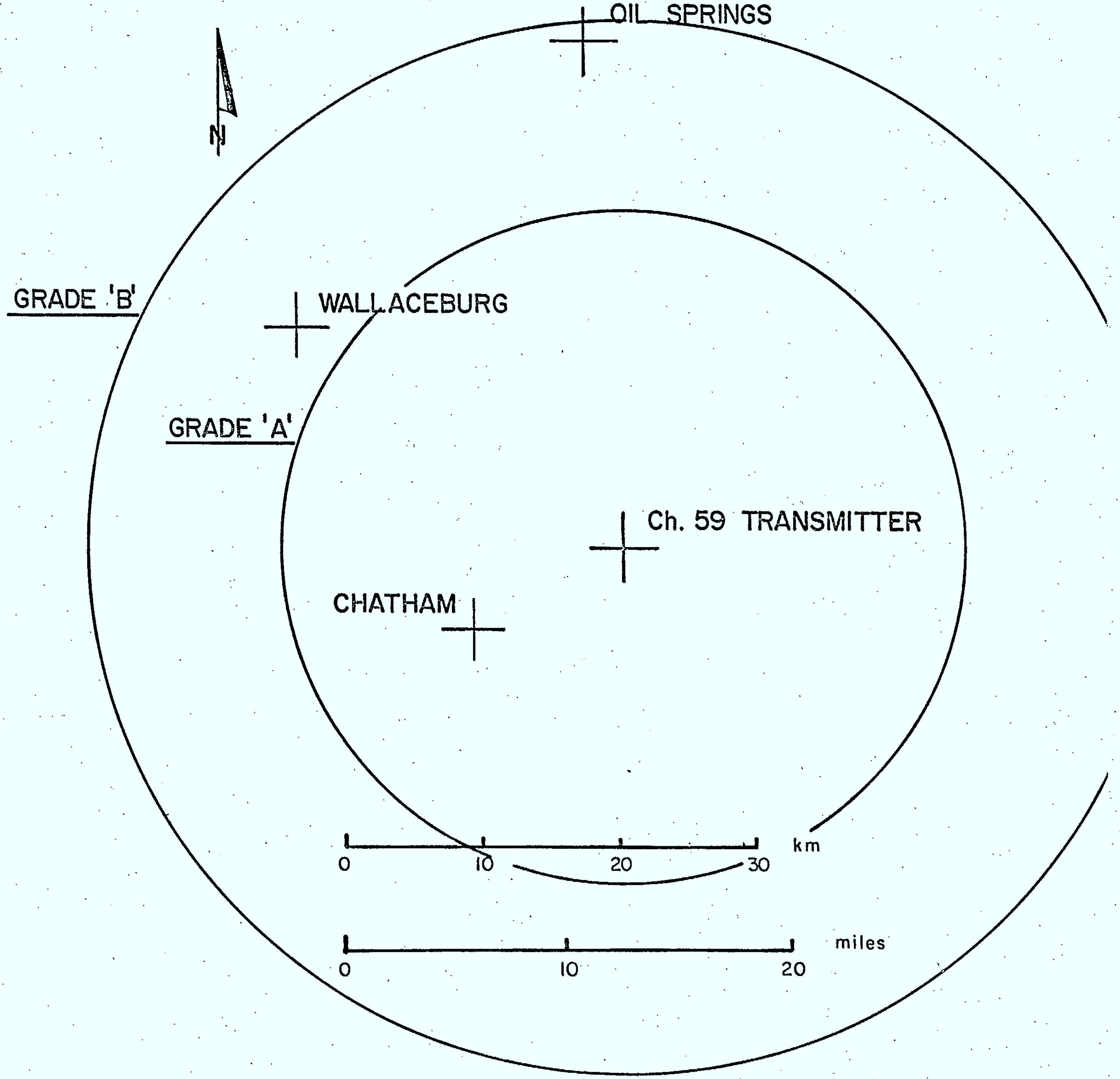
c) by improving the image response of the UHF TV receiver to an extent that it is not responsive to antenna conducted signals on its image frequency and simultaneously improving, to a corresponding degree, the radiated susceptibility of the TV receiver to image frequency signals in its environment.

The first two solutions are not spectrum-efficient. That is, at some stage, saturation will occur, preventing further utilization of what would be otherwise usable spectrum. The last is a long-term solution requiring replacement of all receivers now in existence by a new generation of receivers. Any final solution would appear to require the scheduled incorporation of facets of all three approaches.



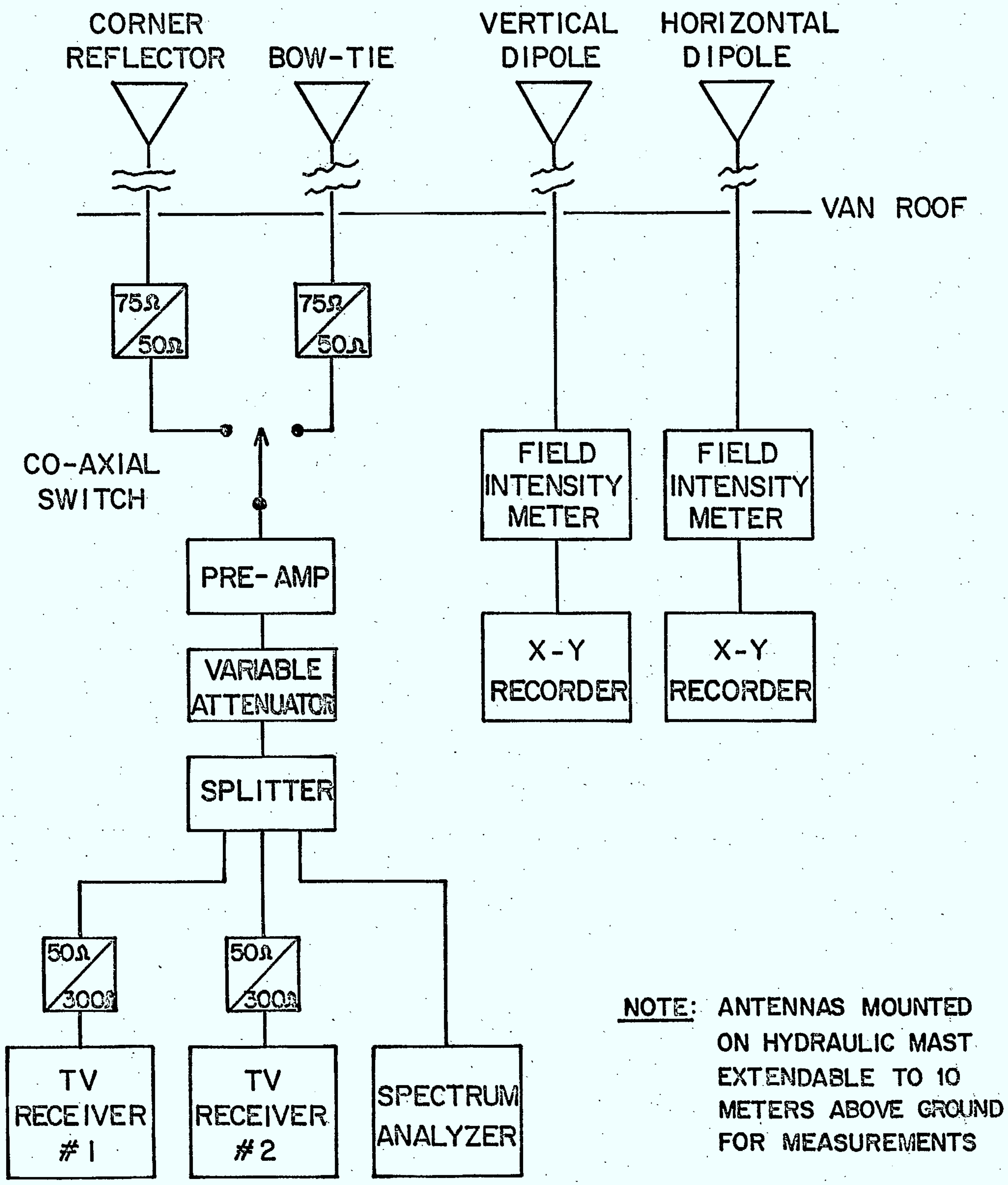
PLAN VIEW OF
SITE LOCATIONS FOR CHANNEL 68

FIGURE I-A



PLAN VIEW OF
SITE LOCATIONS FOR CHANNEL 59

FIGURE I-B



MEASUREMENT SYSTEM
BLOCK DIAGRAM

FIGURE-2

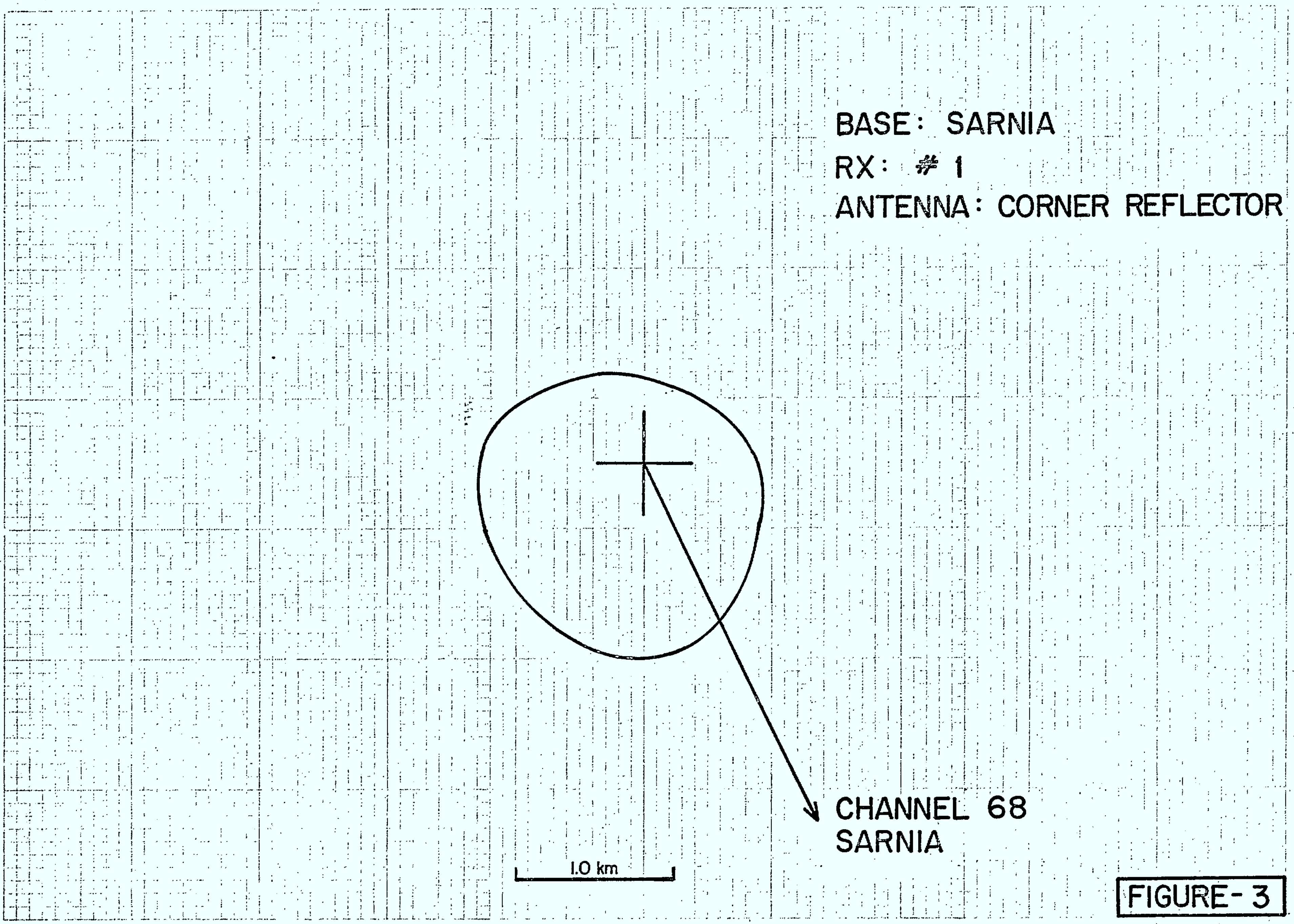

BASE: SARNIA
RX: # 1
ANTENNA: CORNER REFLECTOR
CHANNEL 68
SARNIA
1.0 km

FIGURE- 3

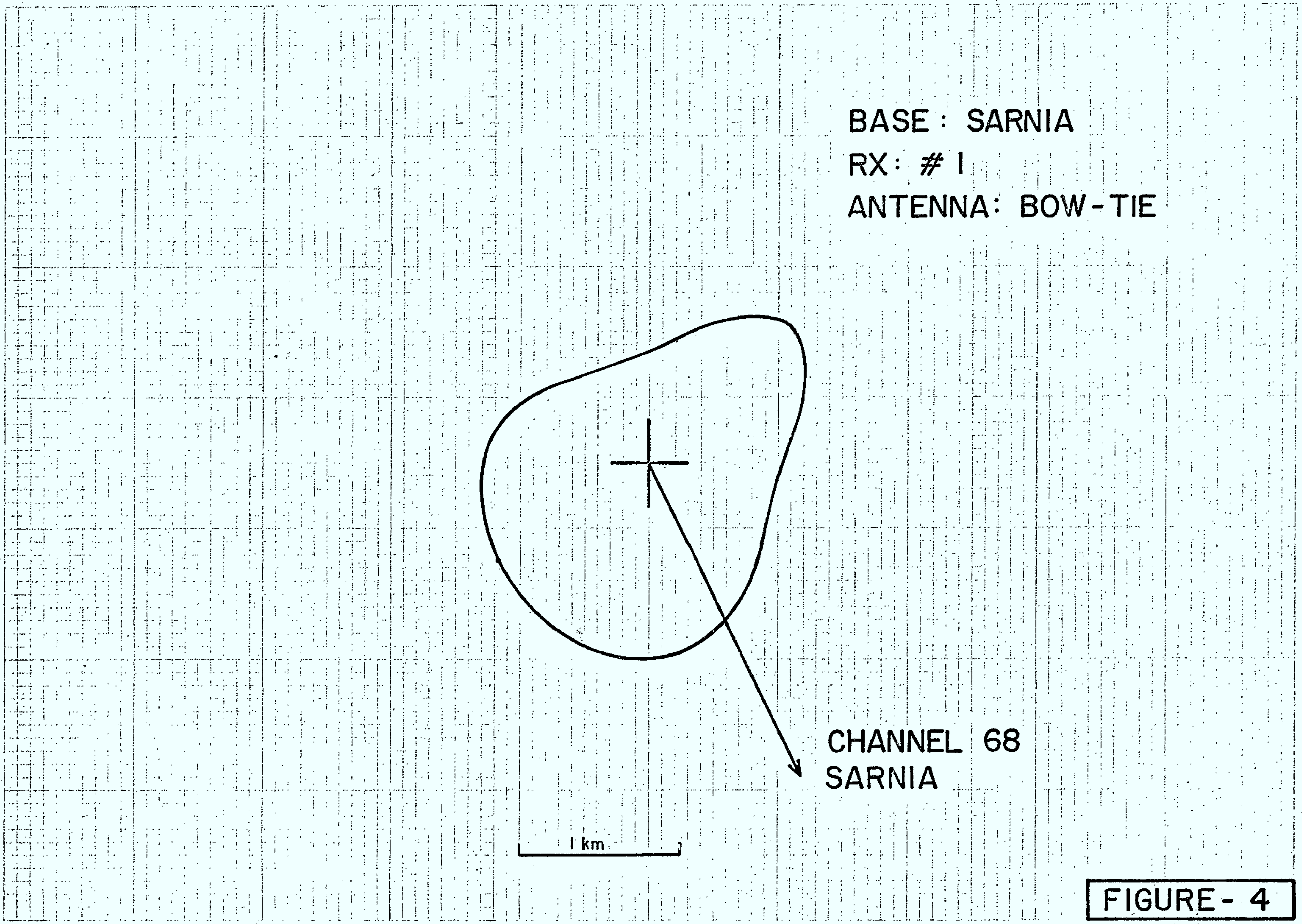


FIGURE- 4

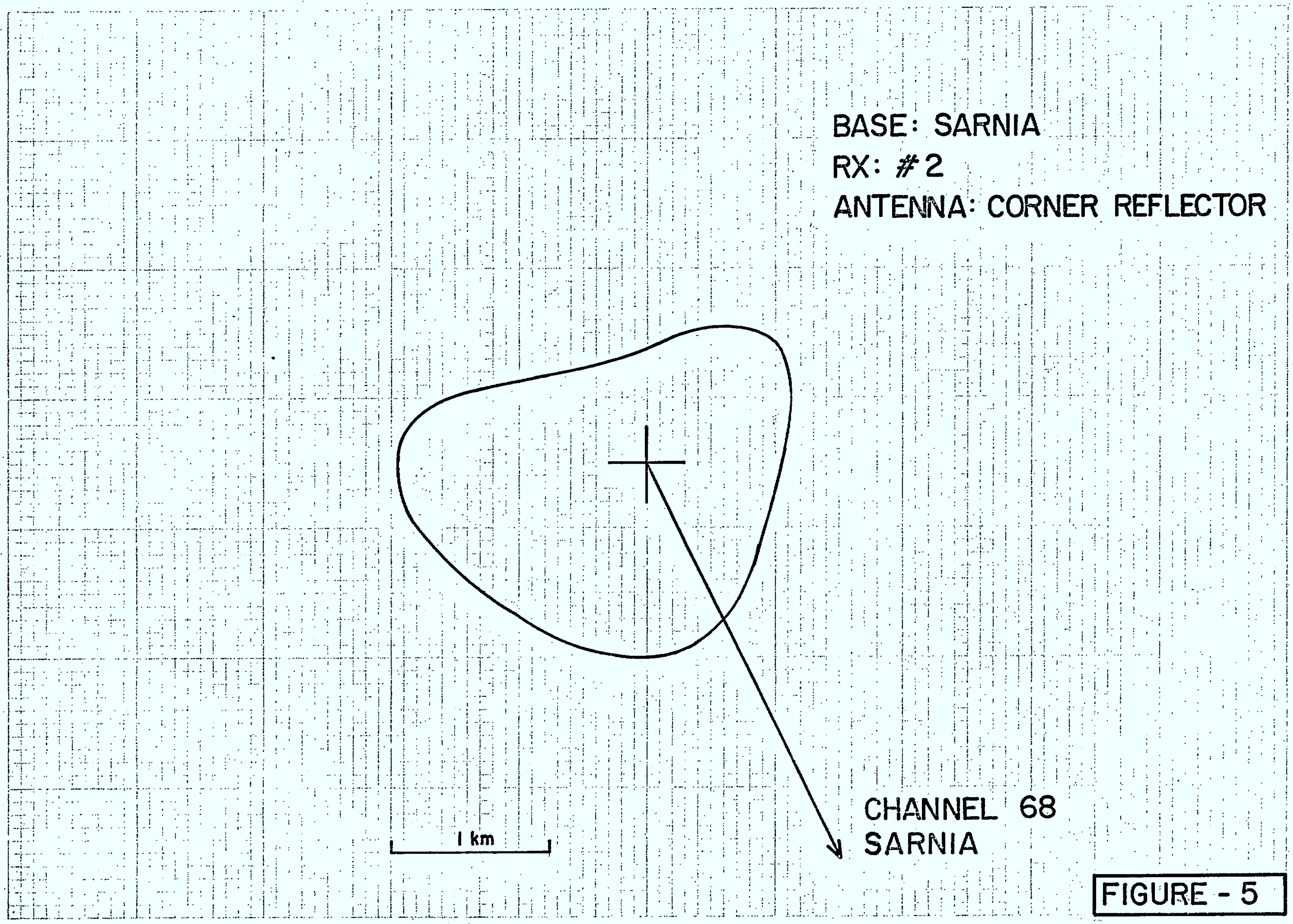

BASE: SARNIA
RX: #2
ANTENNA: CORNER REFLECTOR
1 km
CHANNEL 68
SARNIA

FIGURE - 5

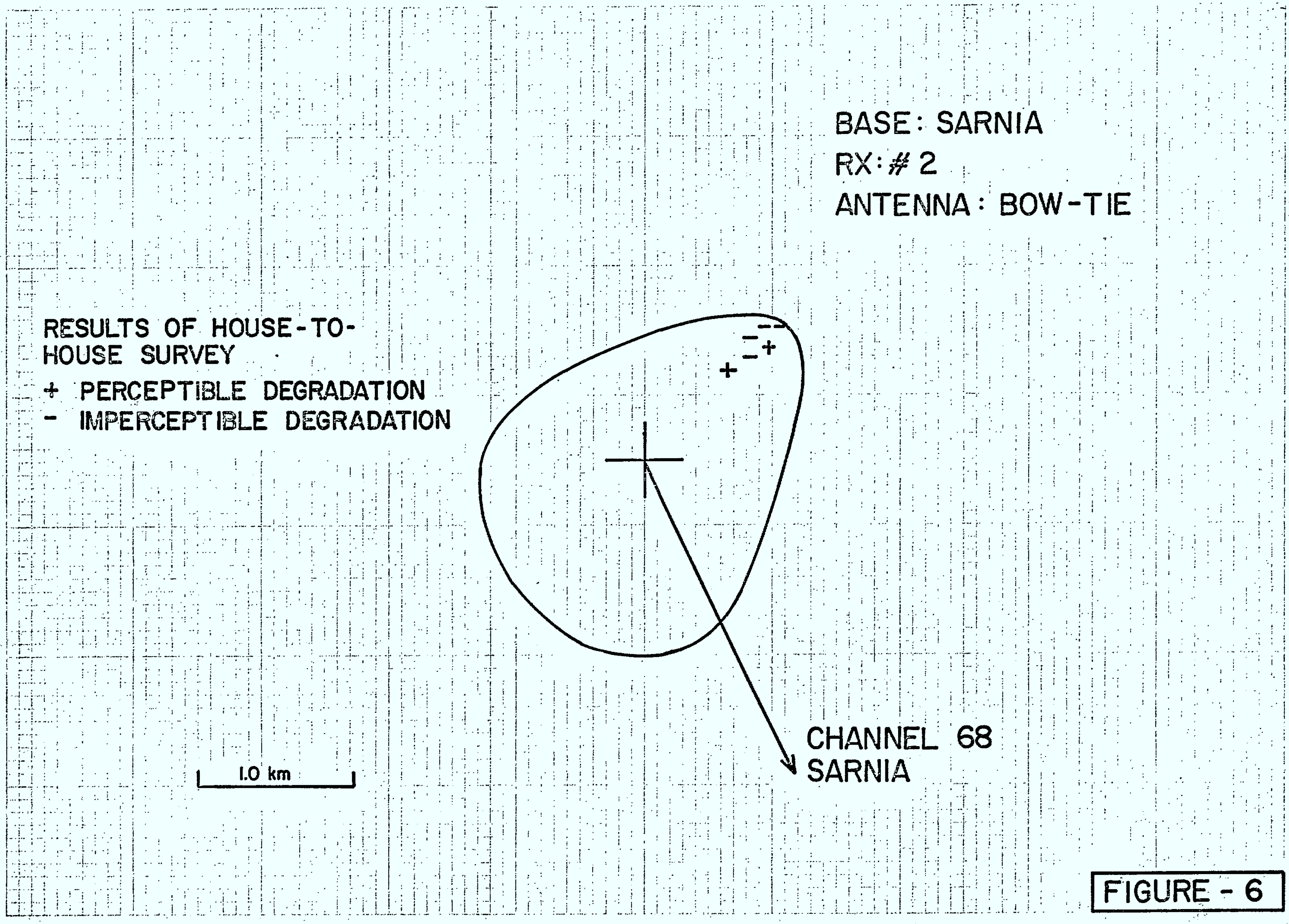
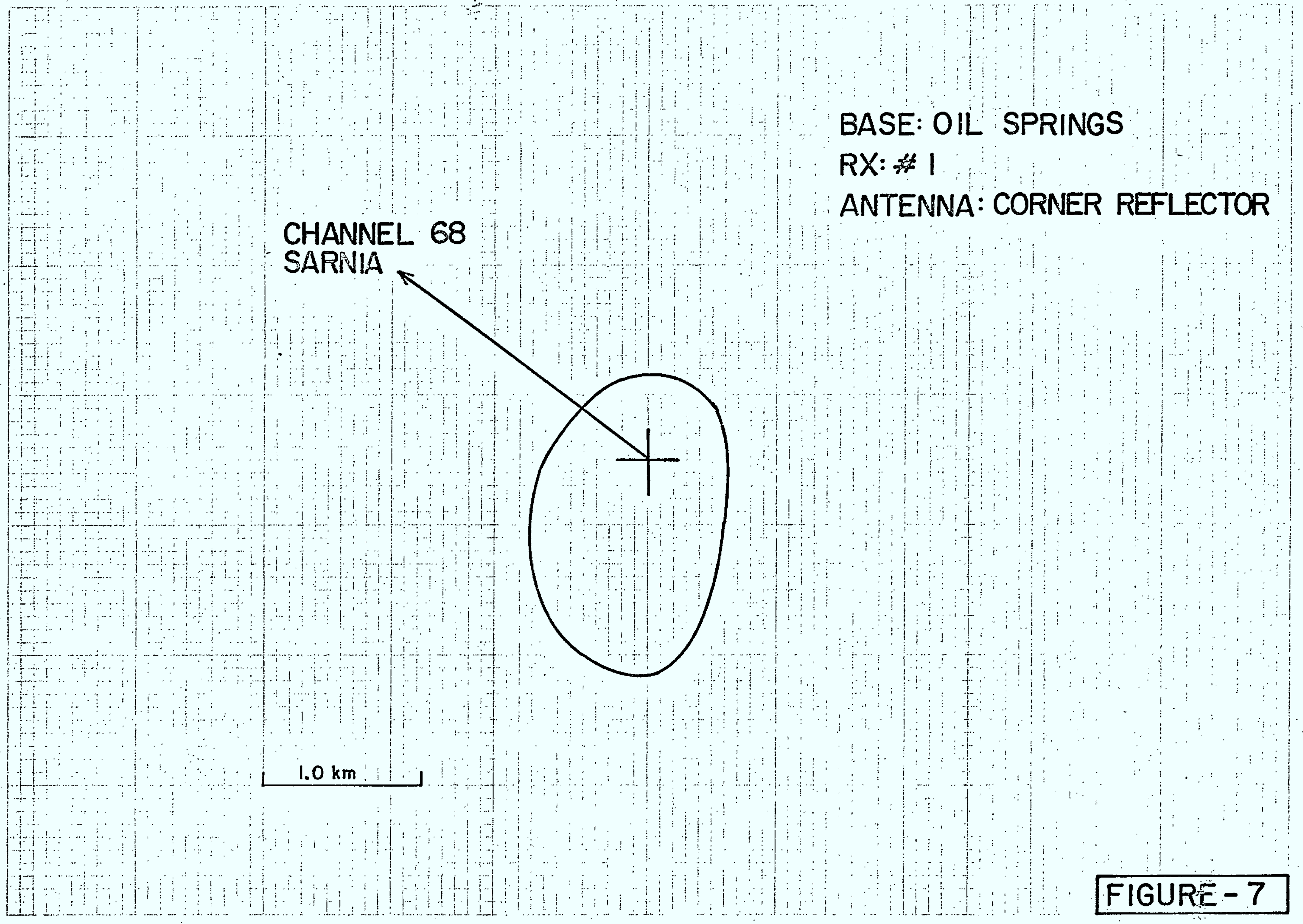

BASE: SARNIA
RX: # 2
ANTENNA: BOW-TIE
RESULTS OF HOUSE-TO-HOUSE SURVEY
+ PERCEPTIBLE DEGRADATION
- IMPERCEPTIBLE DEGRADATION
CHANNEL 68
SARNIA
1.0 km

FIGURE - 6



BASE: OIL SPRINGS
RX: # 1
ANTENNA: CORNER REFLECTOR
CHANNEL 68
SARNIA
1.0 km

FIGURE - 7

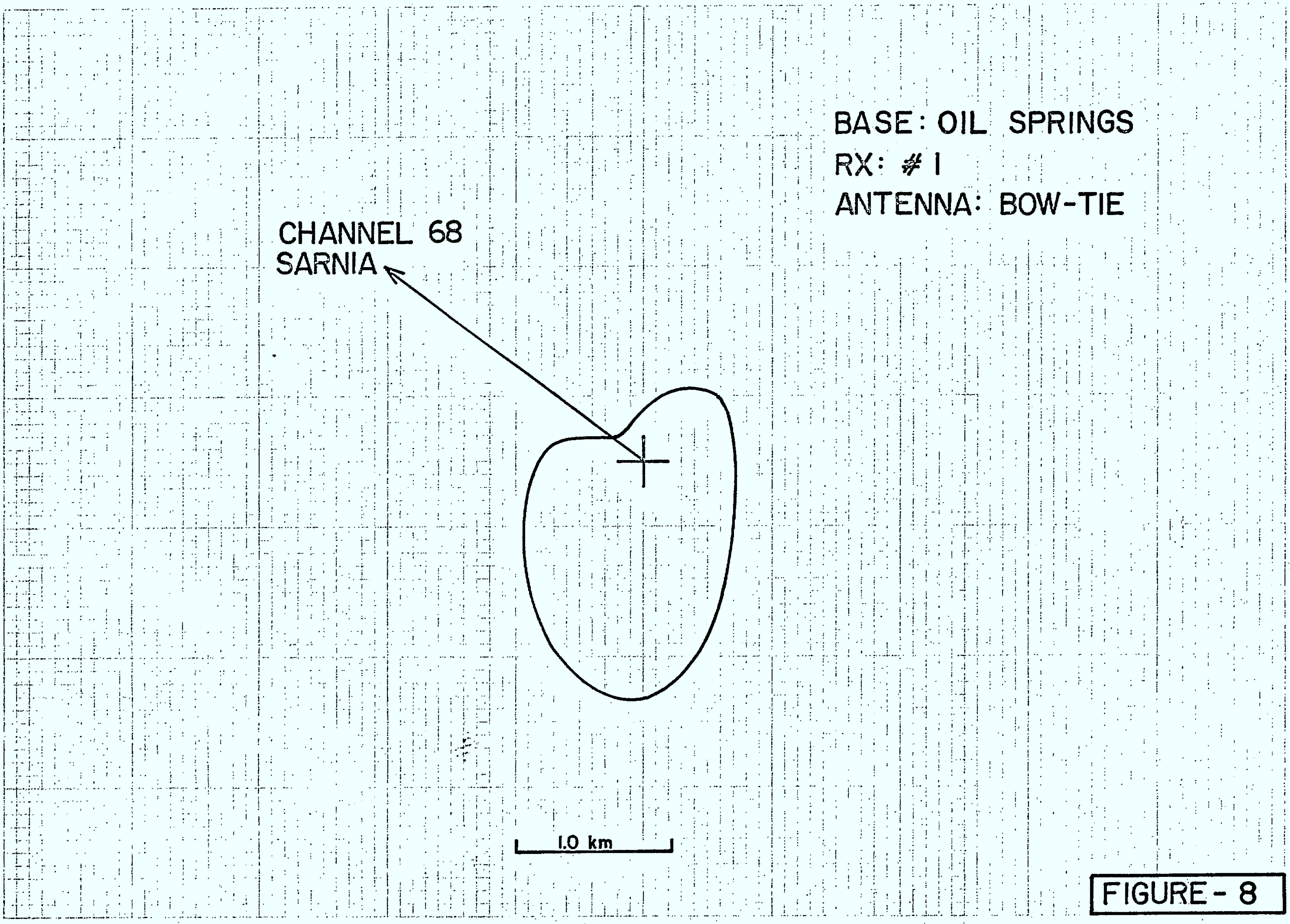


FIGURE - 8

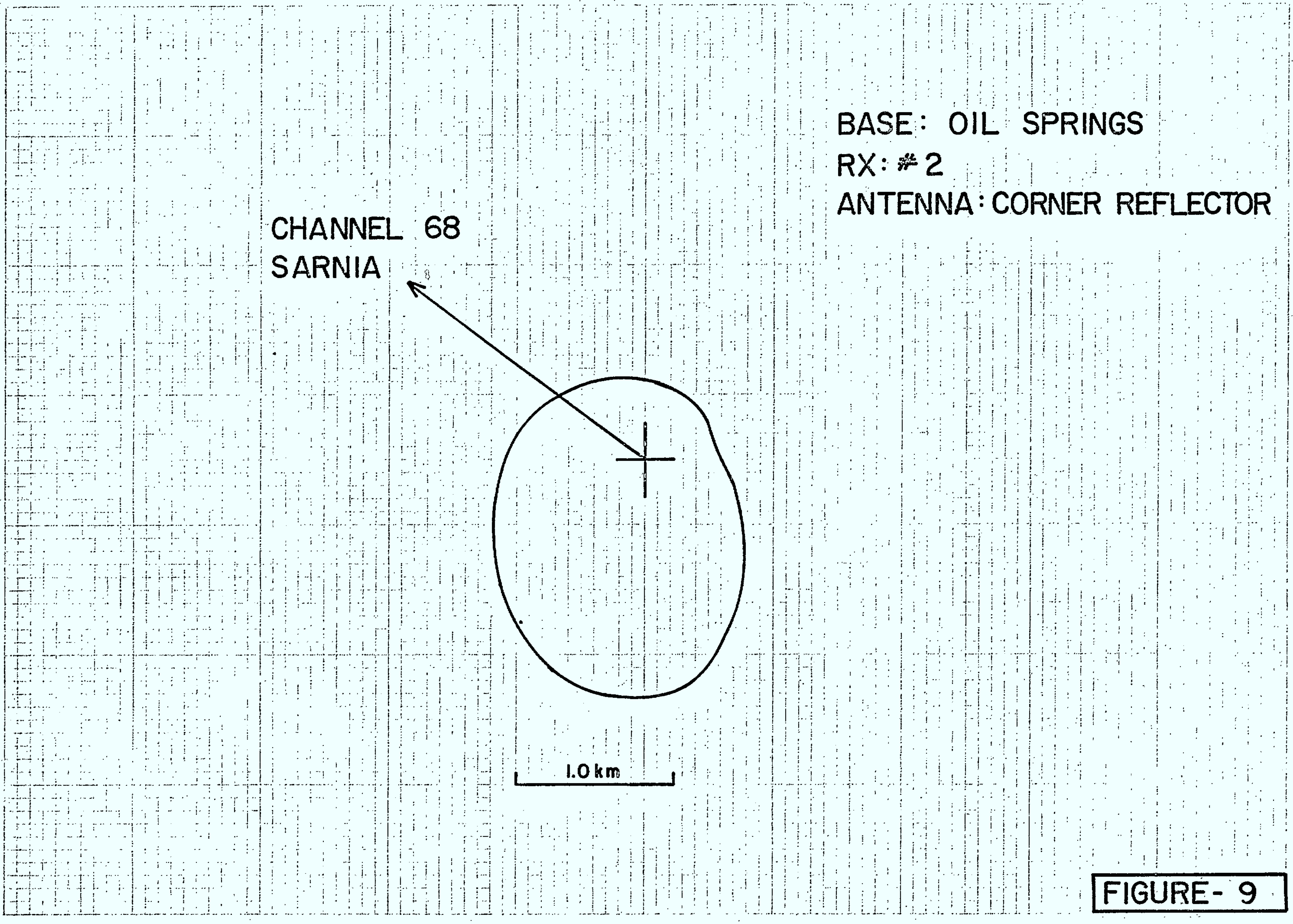

BASE: OIL SPRINGS
RX: #2
ANTENNA: CORNER REFLECTOR
CHANNEL 68
SARNIA
1.0 km

FIGURE- 9

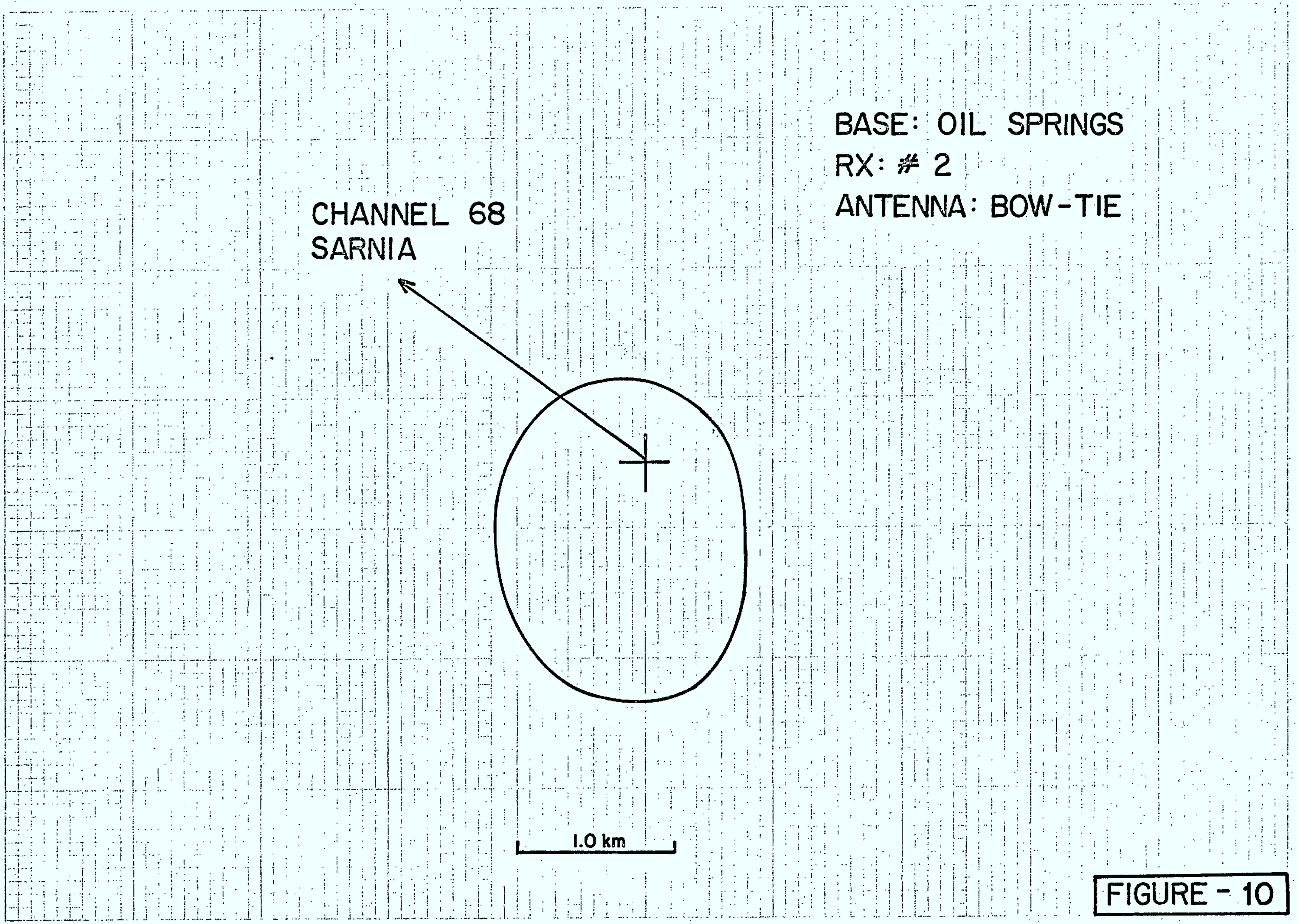


FIGURE - 10

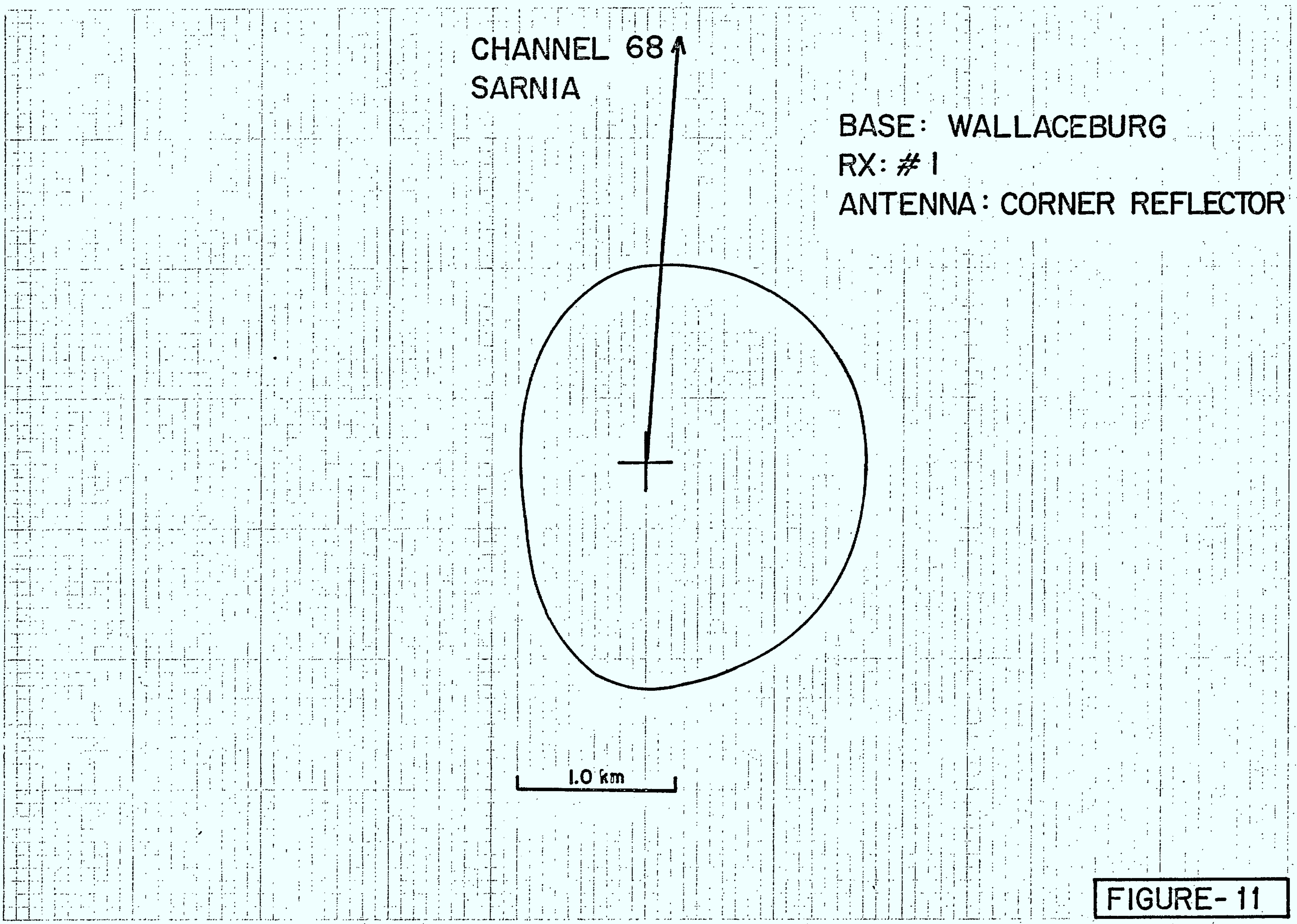

CHANNEL 68
SARNIA
BASE: WALLACEBURG
RX: # 1
ANTENNA: CORNER REFLECTOR
1.0 km

FIGURE- 11

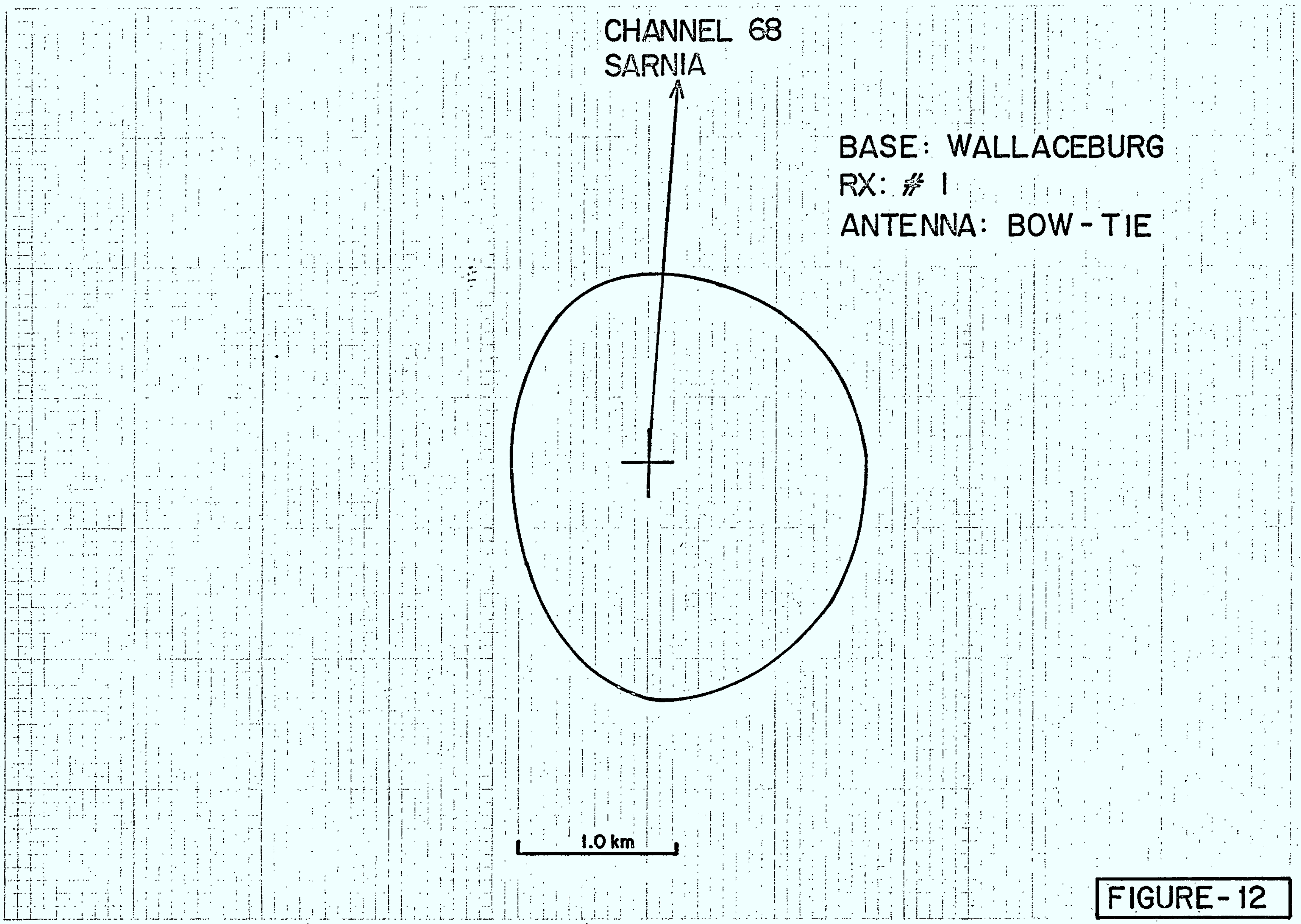

CHANNEL 68
SARNIA
BASE: WALLACEBURG
RX: # 1
ANTENNA: BOW-TIE
1.0 km

FIGURE-12

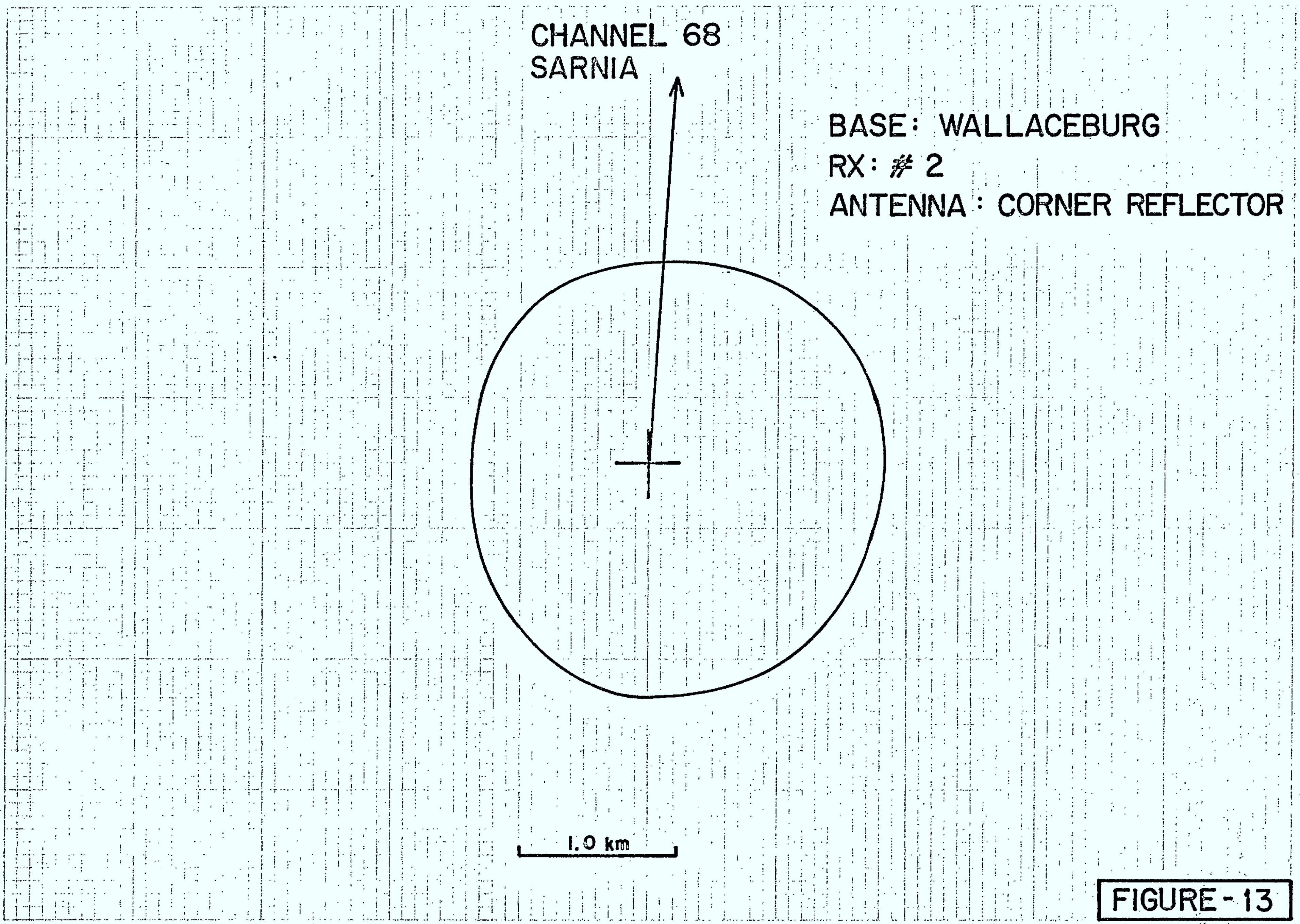

CHANNEL 68
SARNIA
BASE: WALLACEBURG
RX: # 2
ANTENNA: CORNER REFLECTOR
1.0 km

FIGURE - 13

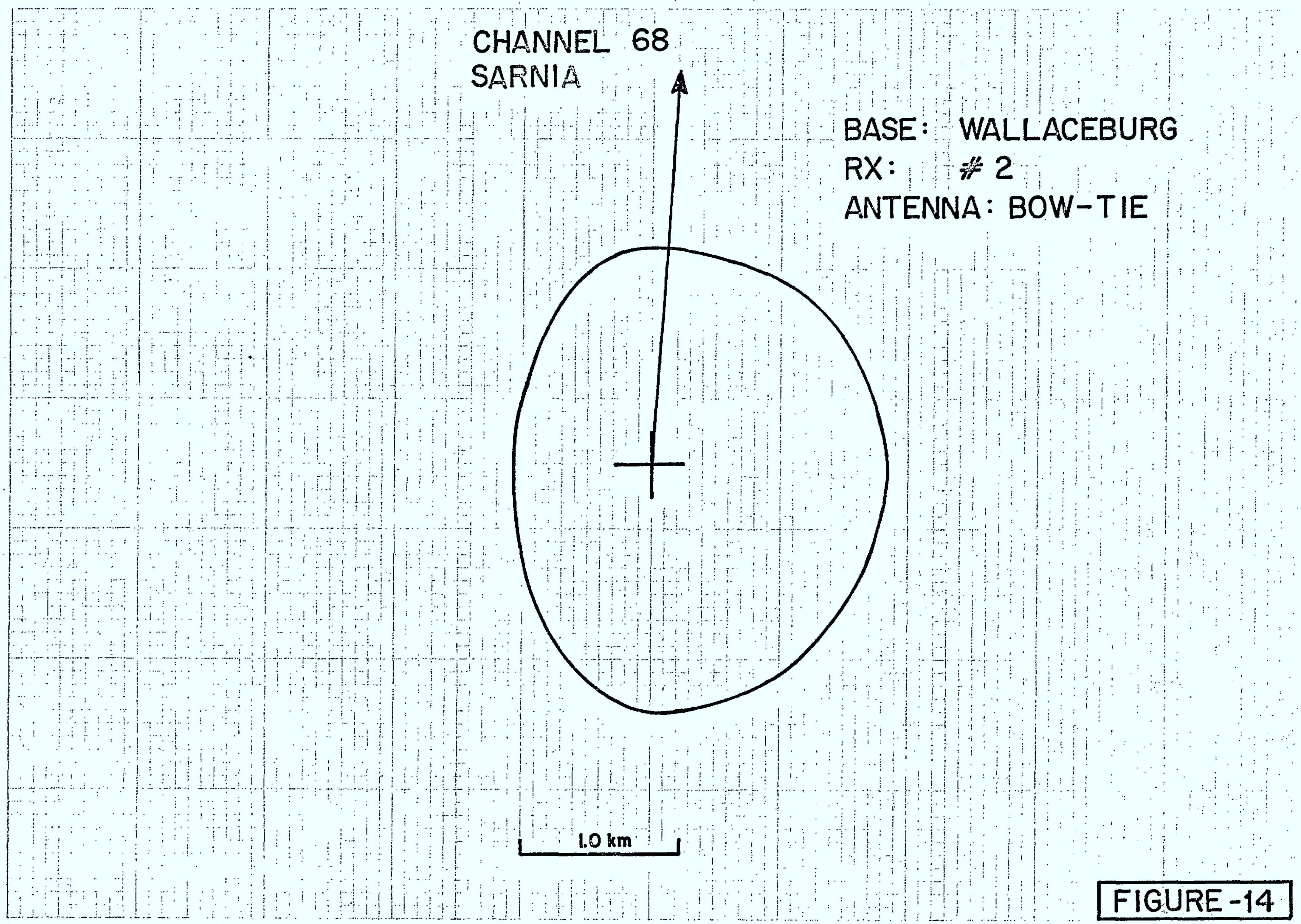
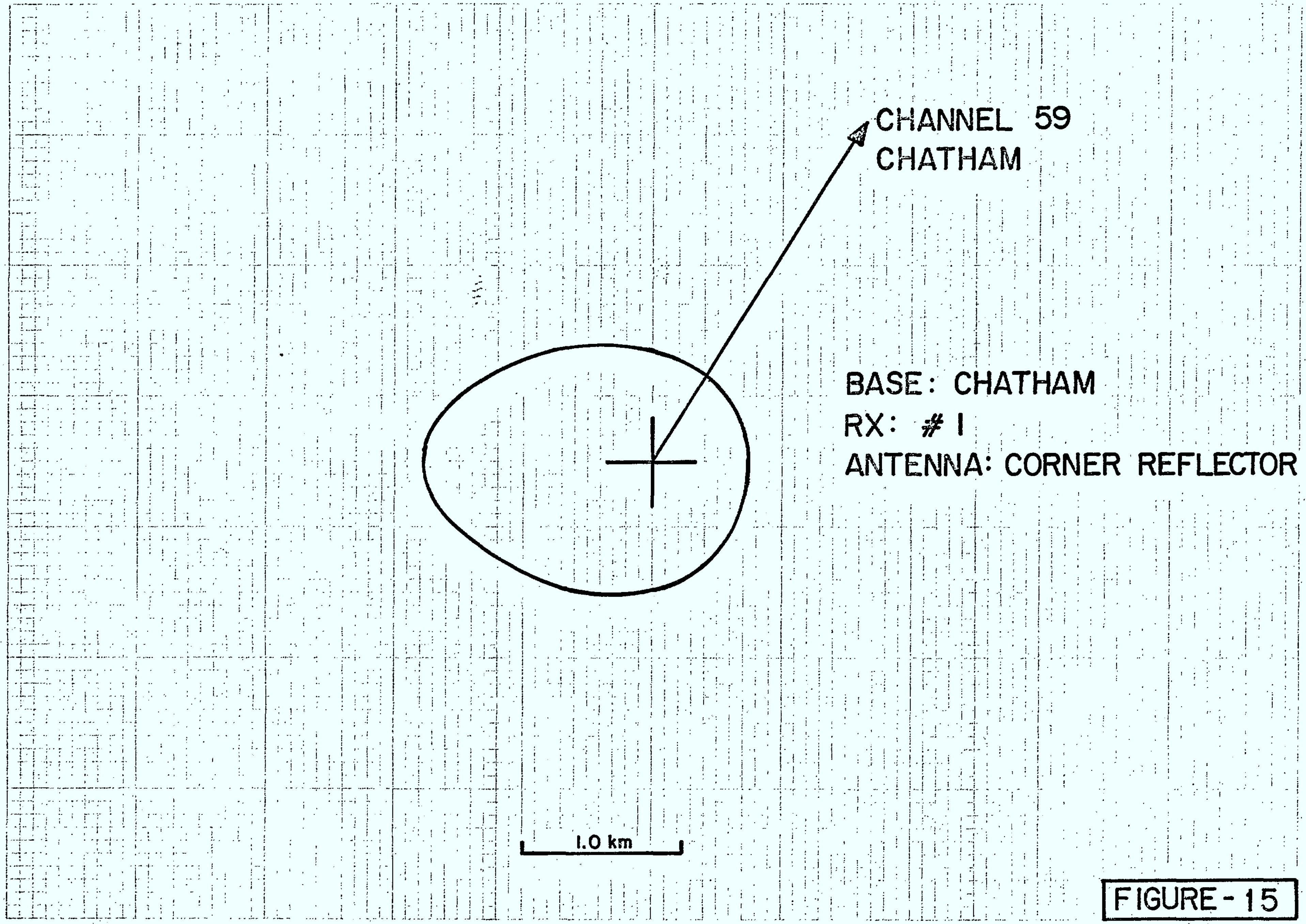

CHANNEL 68
SARNIA
BASE: WALLACEBURG
RX: # 2
ANTENNA: BOW-TIE
1.0 km

FIGURE-14


CHANNEL 59
CHATHAM
BASE: CHATHAM
RX: # 1
ANTENNA: CORNER REFLECTOR
1.0 km
FIGURE - 15

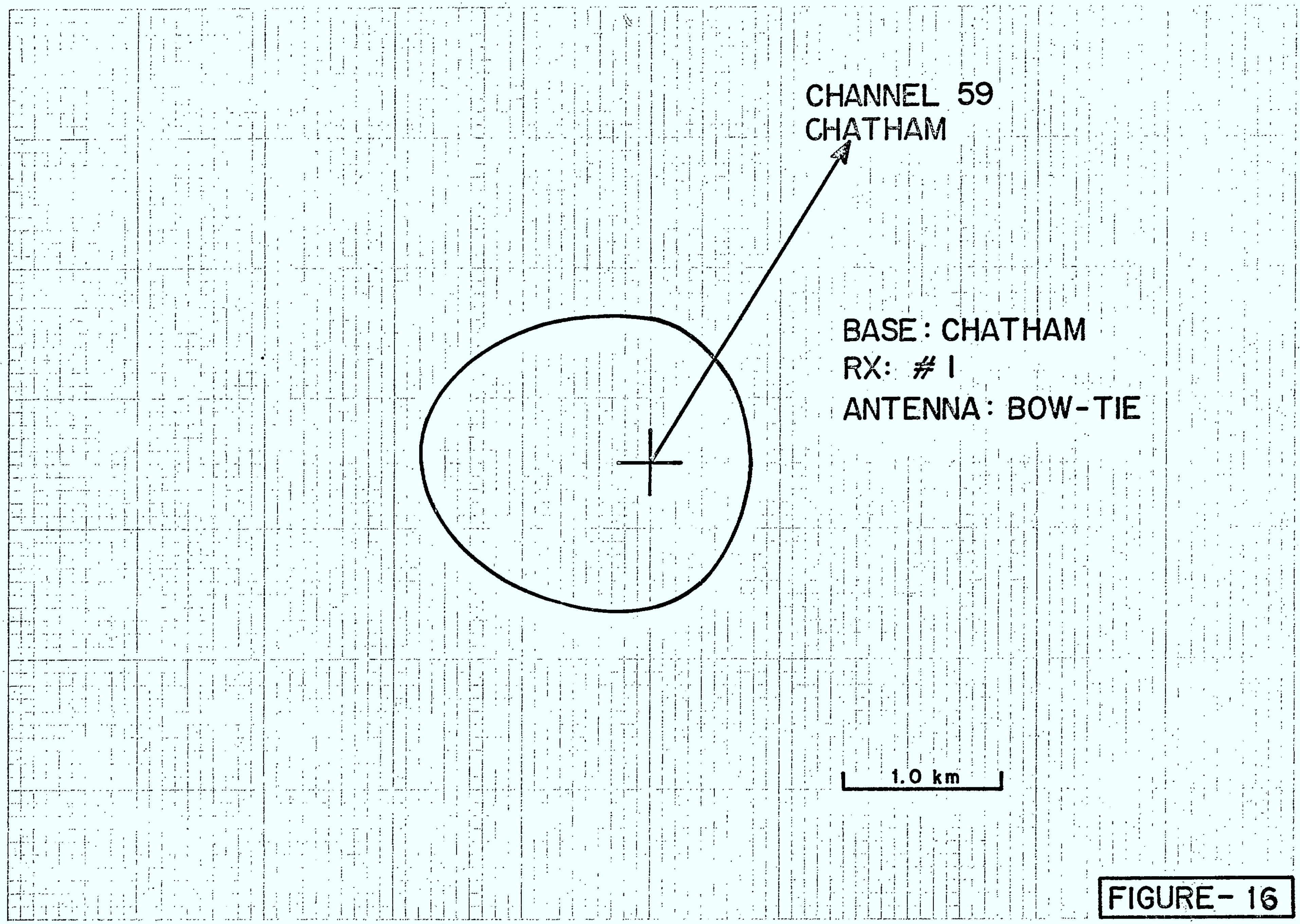
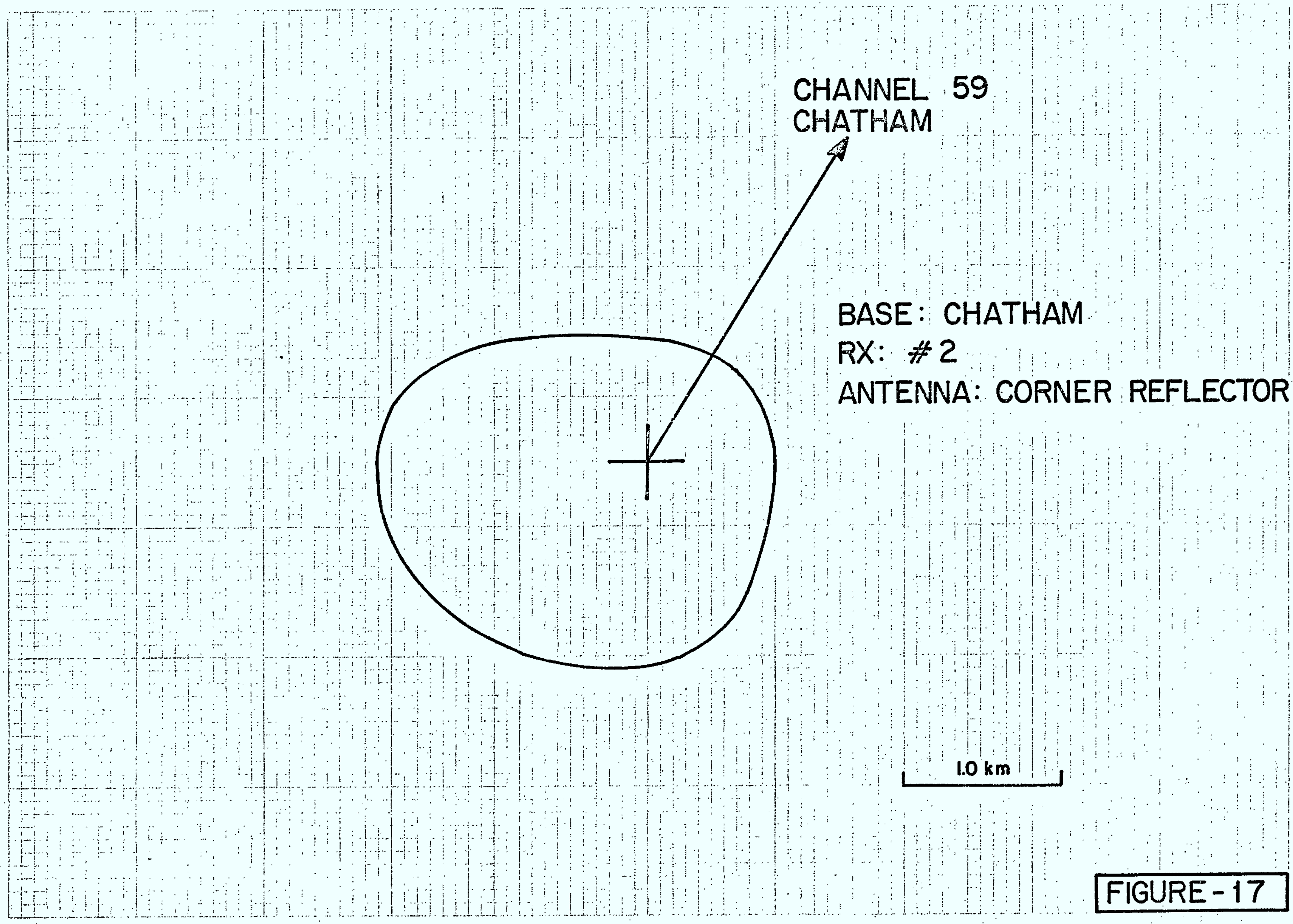


FIGURE- 16


CHANNEL 59
CHATHAM
BASE: CHATHAM
RX: #2
ANTENNA: CORNER REFLECTOR
1.0 km
FIGURE - 17

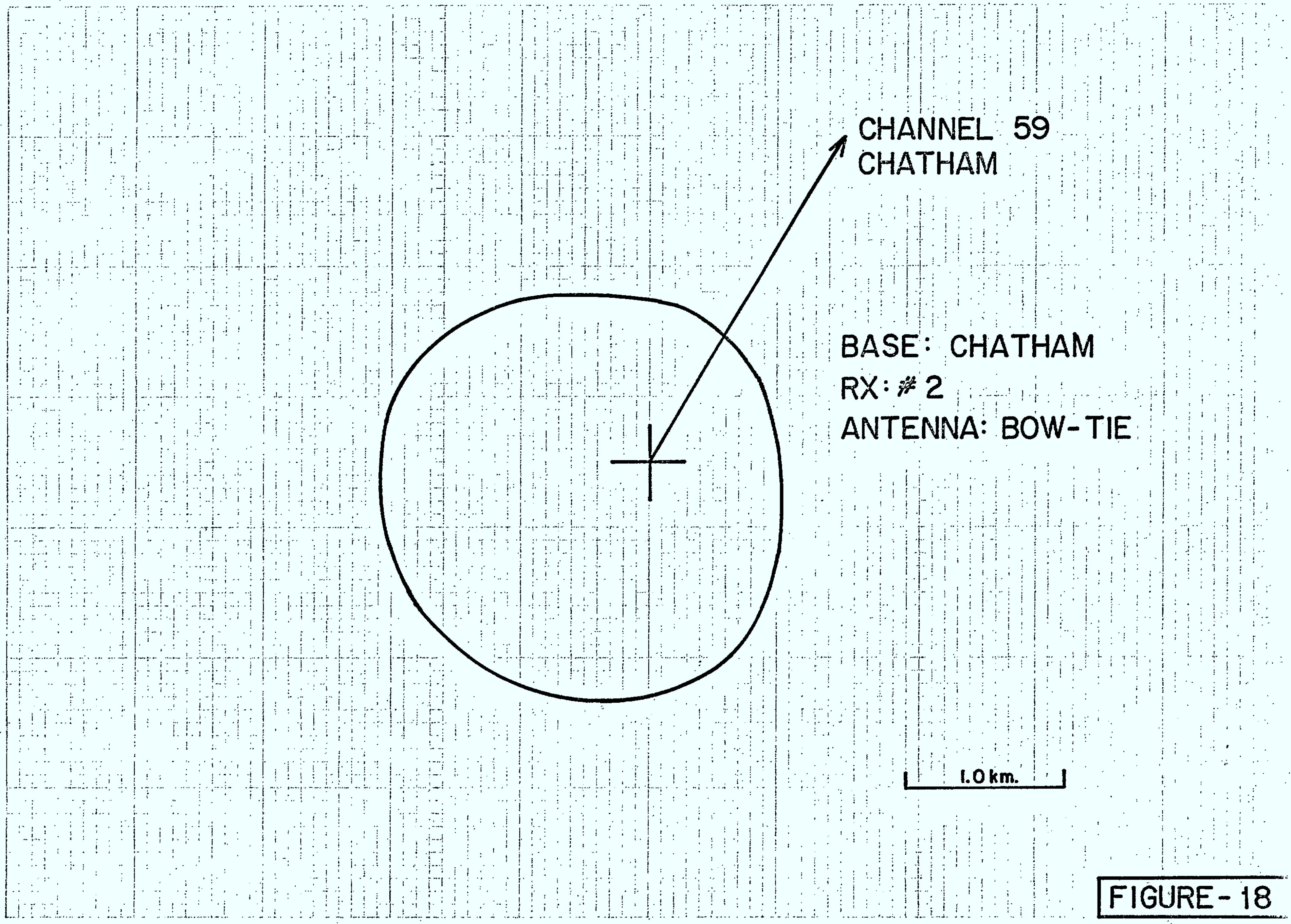


FIGURE-18

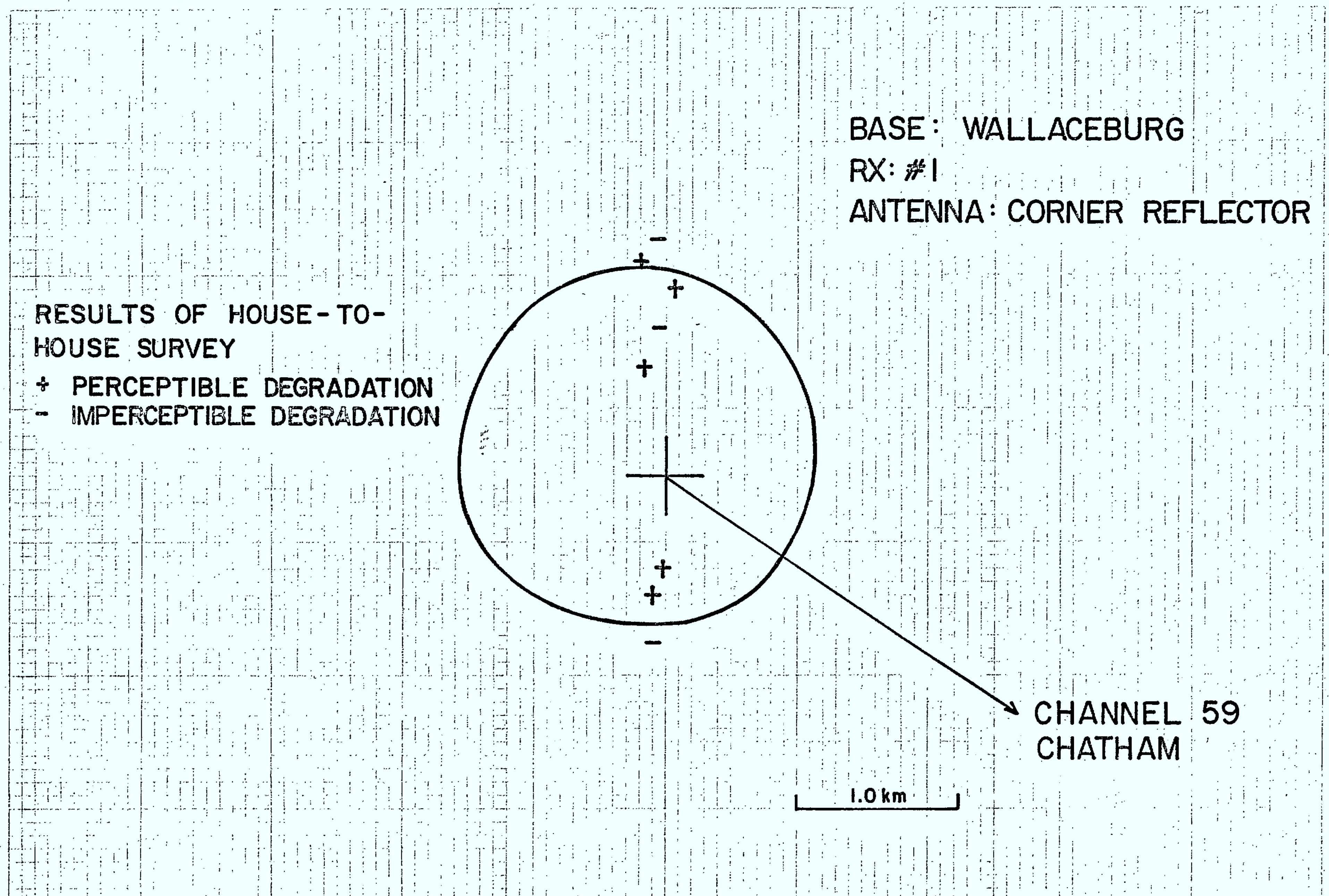

BASE: WALLACEBURG
RX: #1
ANTENNA: CORNER REFLECTOR
RESULTS OF HOUSE-TO-HOUSE SURVEY
+ PERCEPTIBLE DEGRADATION
- IMPERCEPTIBLE DEGRADATION
CHANNEL 59
CHATHAM
1.0 km

FIGURE-19

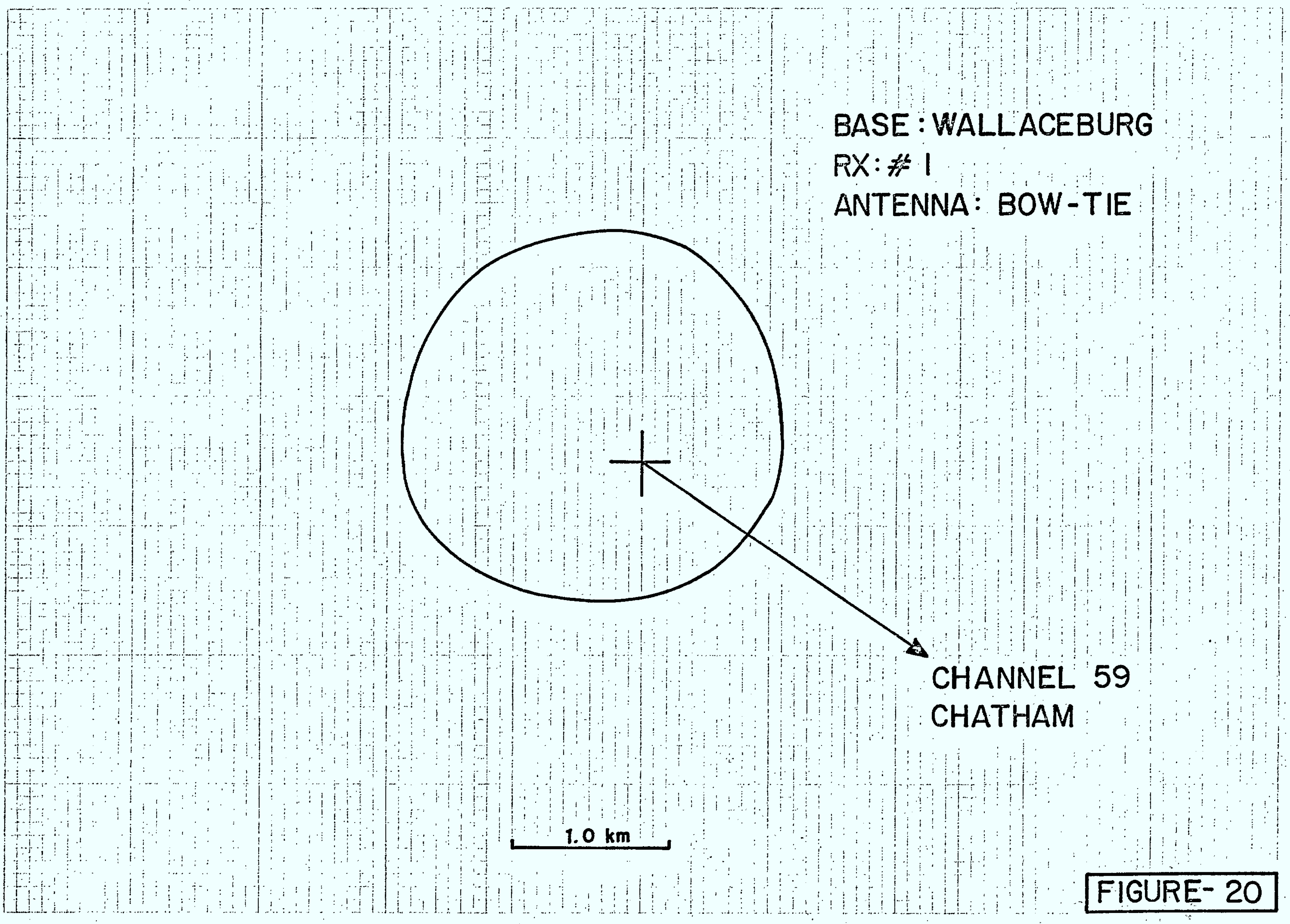

BASE : WALLACEBURG
RX : # 1
ANTENNA : BOW-TIE
CHANNEL 59
CHATHAM
1.0 km

FIGURE- 20

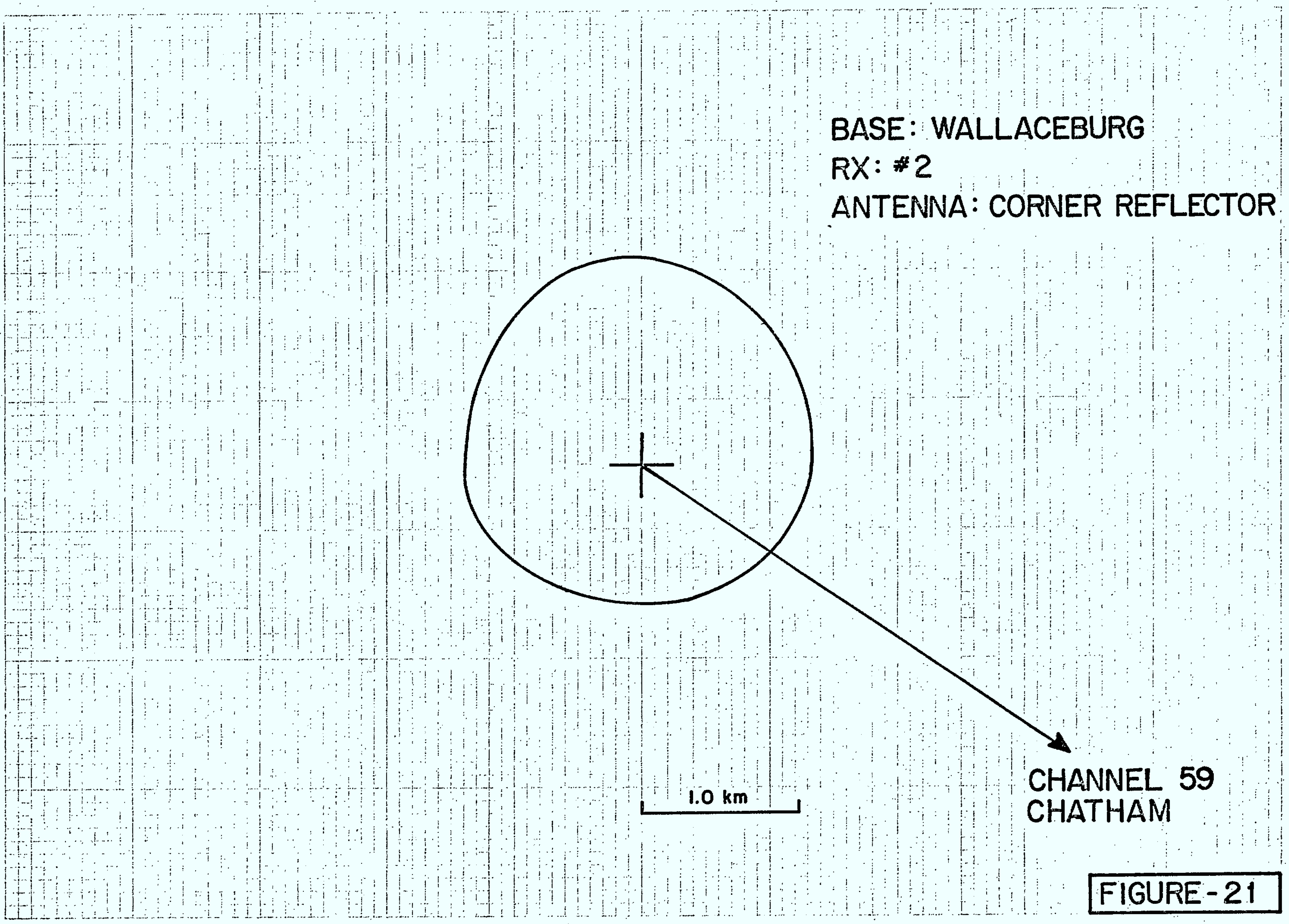

BASE: WALLACEBURG
RX: #2
ANTENNA: CORNER REFLECTOR
1.0 km
CHANNEL 59
CHATHAM

FIGURE-21

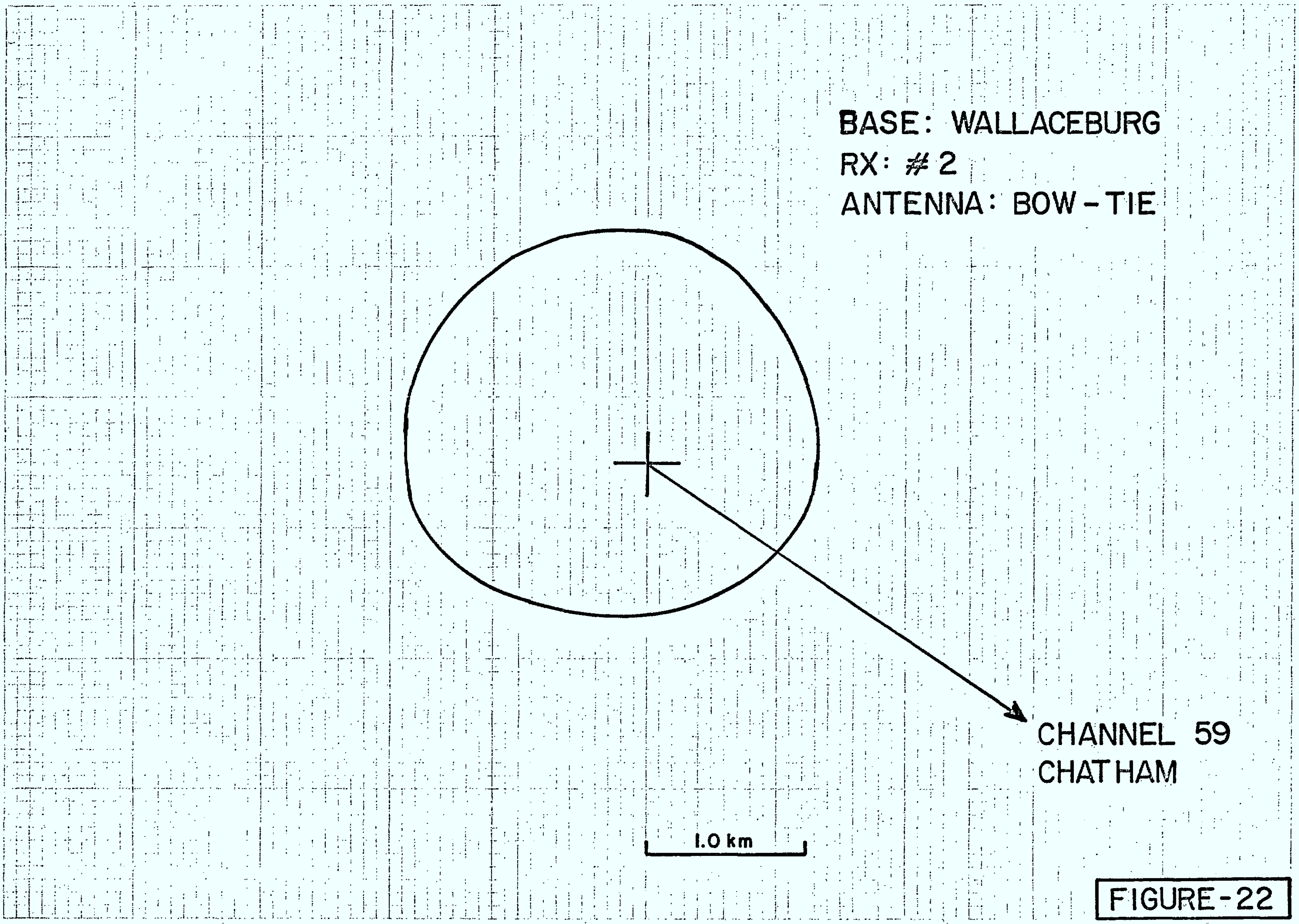

BASE: WALLACEBURG
RX: # 2
ANTENNA: BOW - TIE
CHANNEL 59
CHATHAM
1.0 km

FIGURE-22

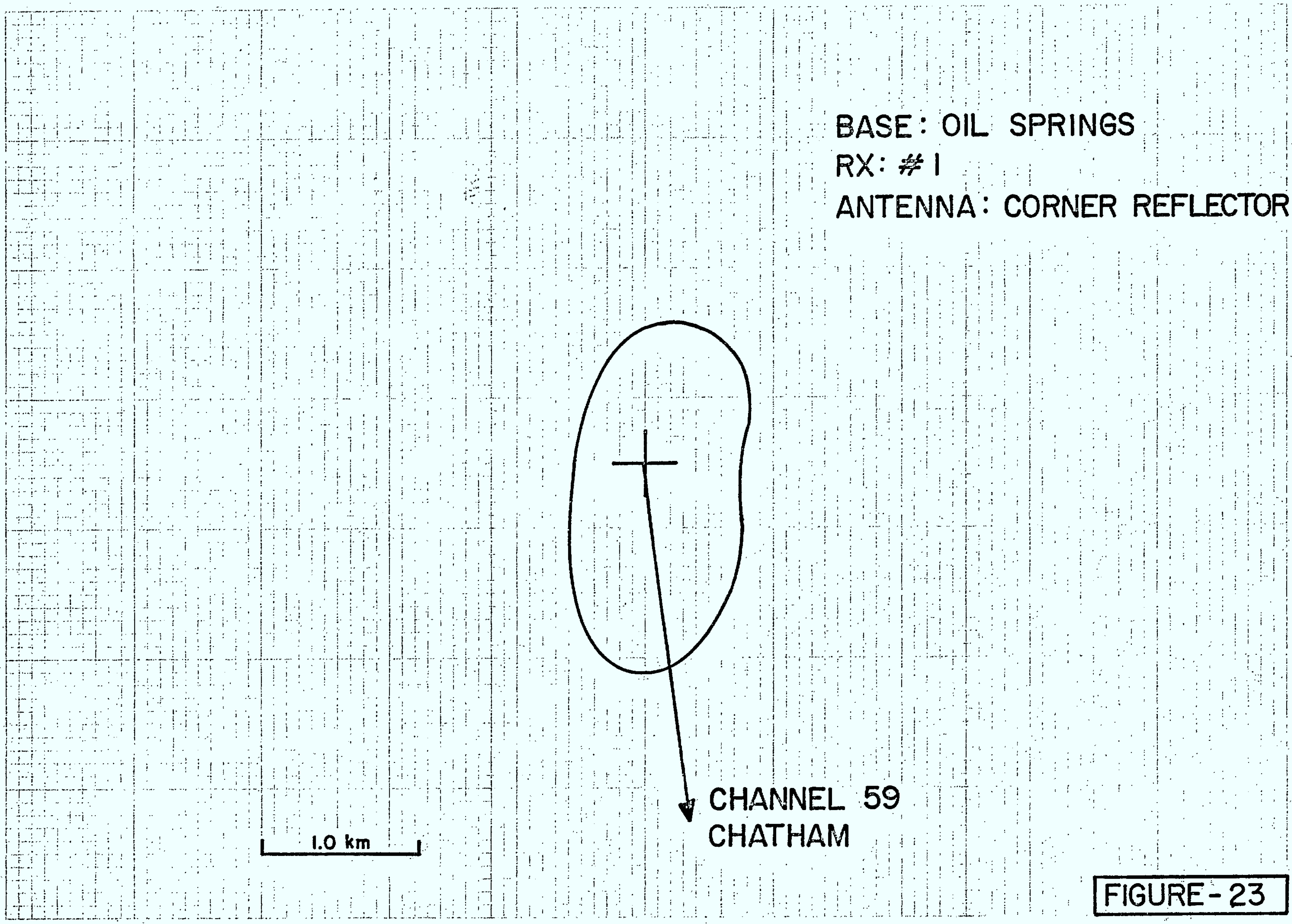

BASE: OIL SPRINGS
RX: # 1
ANTENNA: CORNER REFLECTOR
CHANNEL 59
CHATHAM
1.0 km

FIGURE-23

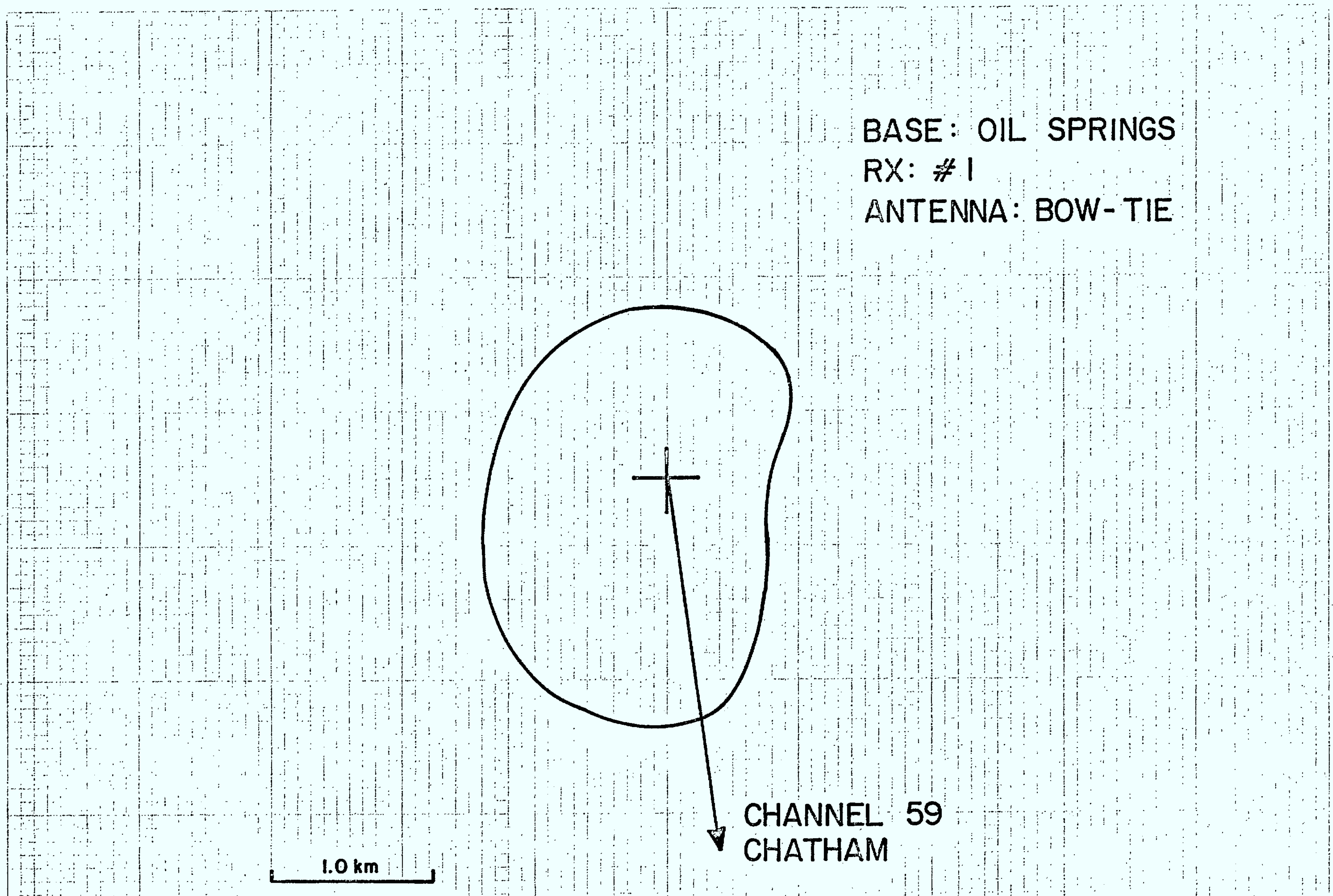

BASE: OIL SPRINGS
RX: #1
ANTENNA: BOW-TIE
CHANNEL 59
CHATHAM
1.0 km

FIGURE-24

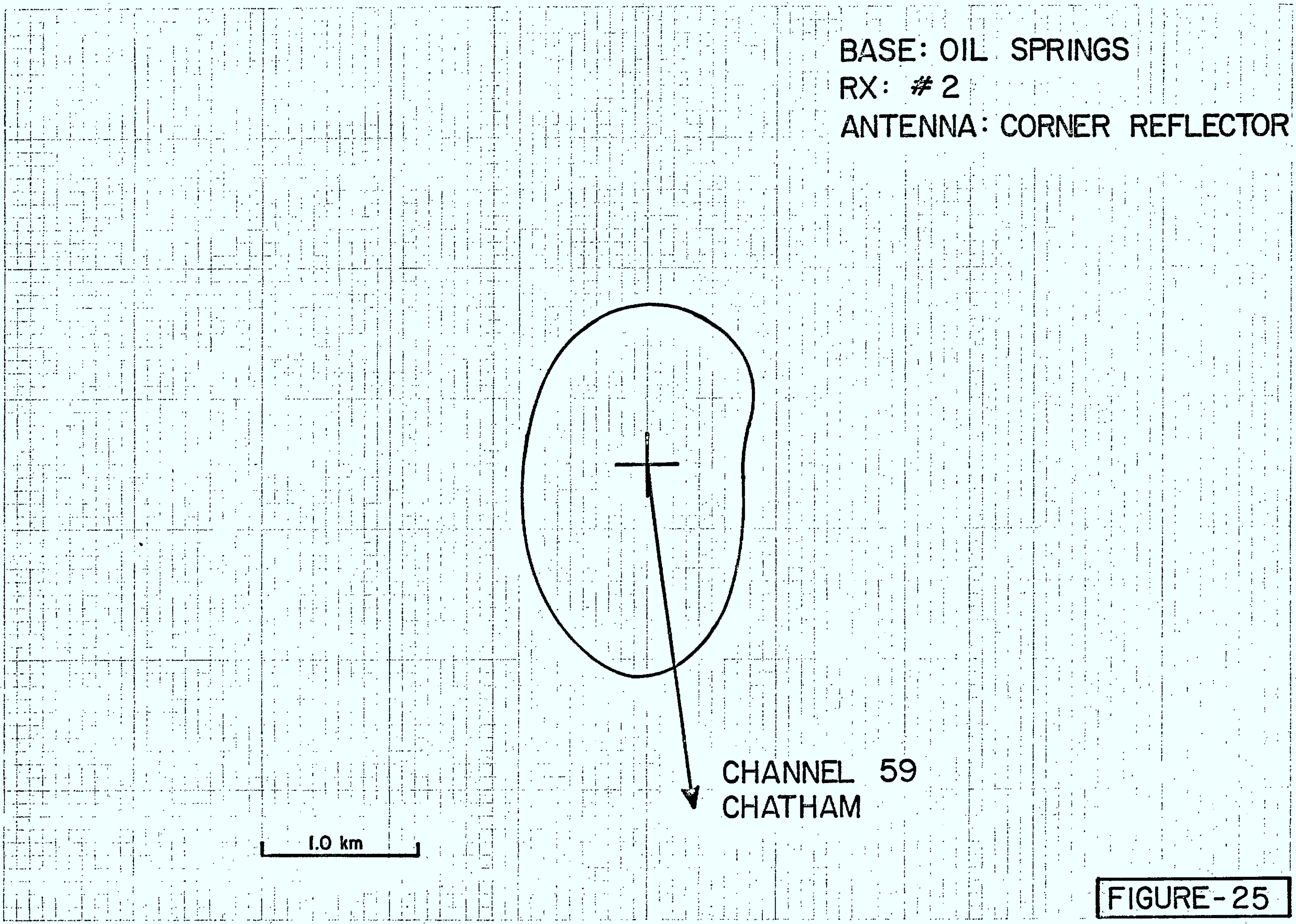
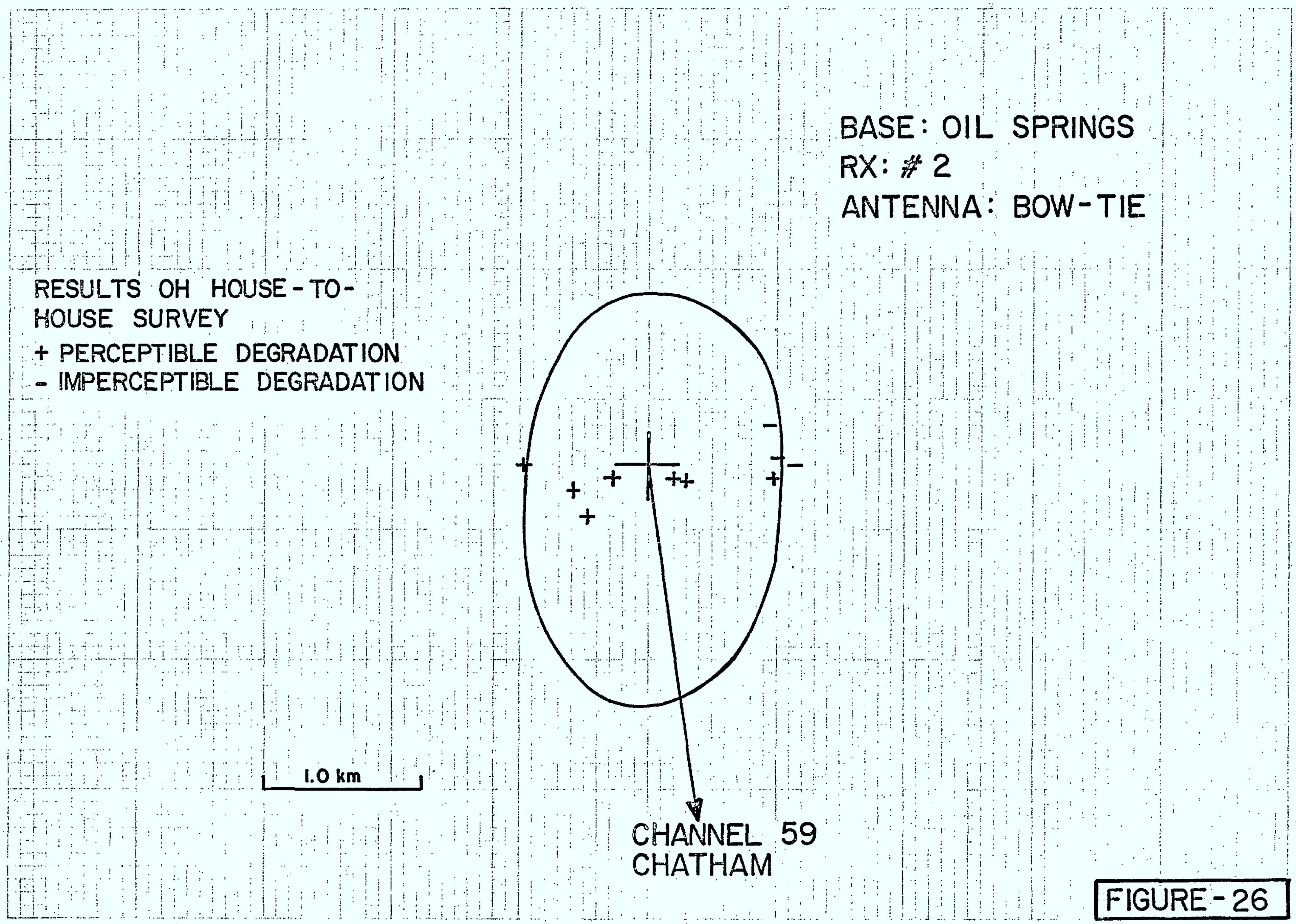

BASE: OIL SPRINGS
RX: # 2
ANTENNA: CORNER REFLECTOR
CHANNEL 59
CHATHAM
1.0 km

FIGURE-25



BASE: OIL SPRINGS
RX: # 2
ANTENNA: BOW-TIE
RESULTS OH HOUSE-TO-HOUSE SURVEY
+ PERCEPTIBLE DEGRADATION
- IMPERCEPTIBLE DEGRADATION
1.0 km
CHANNEL 59
CHATHAM

FIGURE - 26

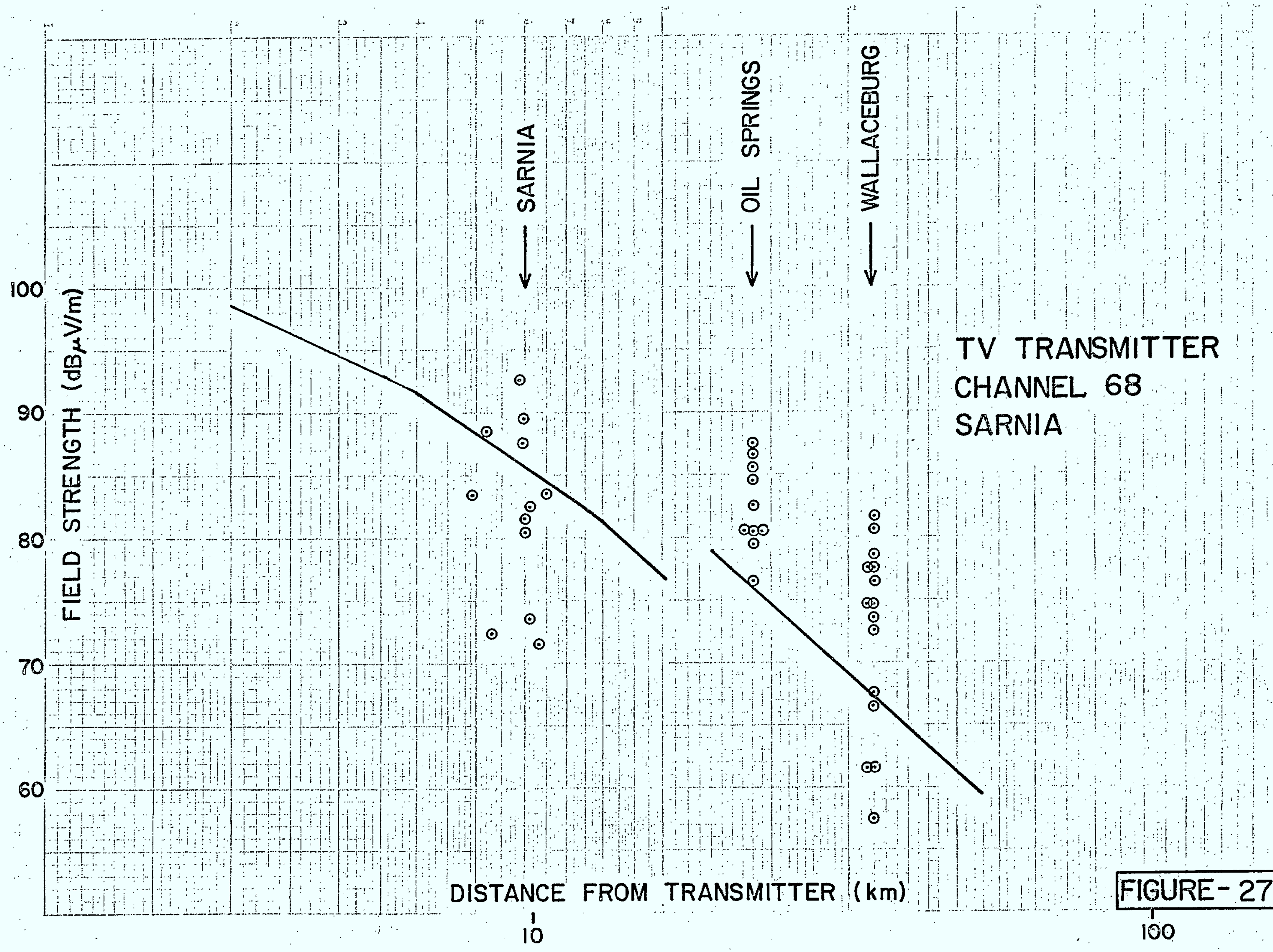

SARNIA
OIL SPRINGS
WALLACEBURG
100
90
80
70
60
FIELD STRENGTH (dBμV/m)
TV TRANSMITTER
CHANNEL 68
SARNIA
DISTANCE FROM TRANSMITTER (km)
10
100

FIGURE- 27

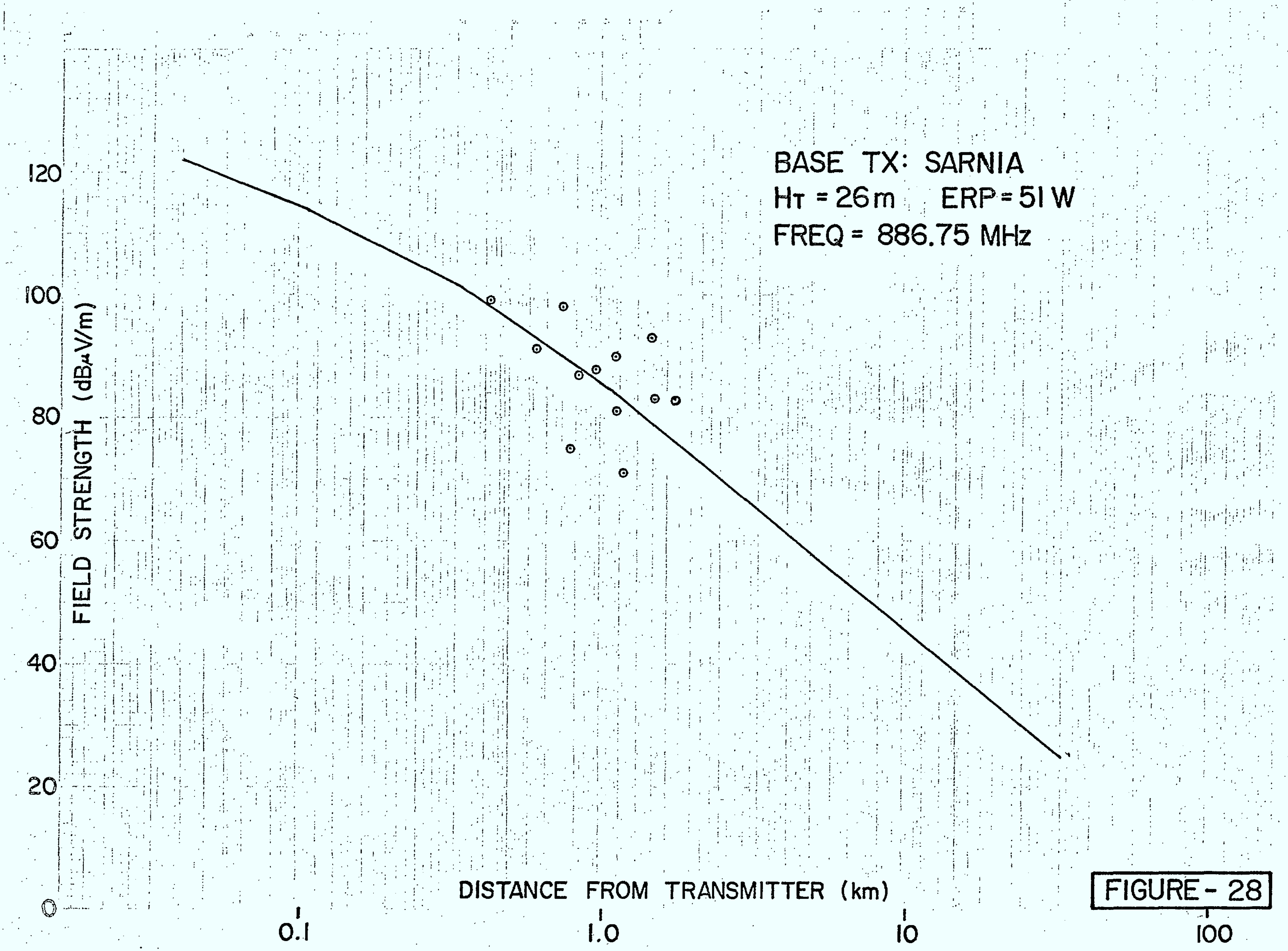

BASE TX: SARNIA
HT = 26m ERP = 51 W
FREQ = 886.75 MHz
FIELD STRENGTH (dBμV/m)
120
100
80
60
40
20
0
DISTANCE FROM TRANSMITTER (km)
0.1
1.0
10
100

FIGURE - 28

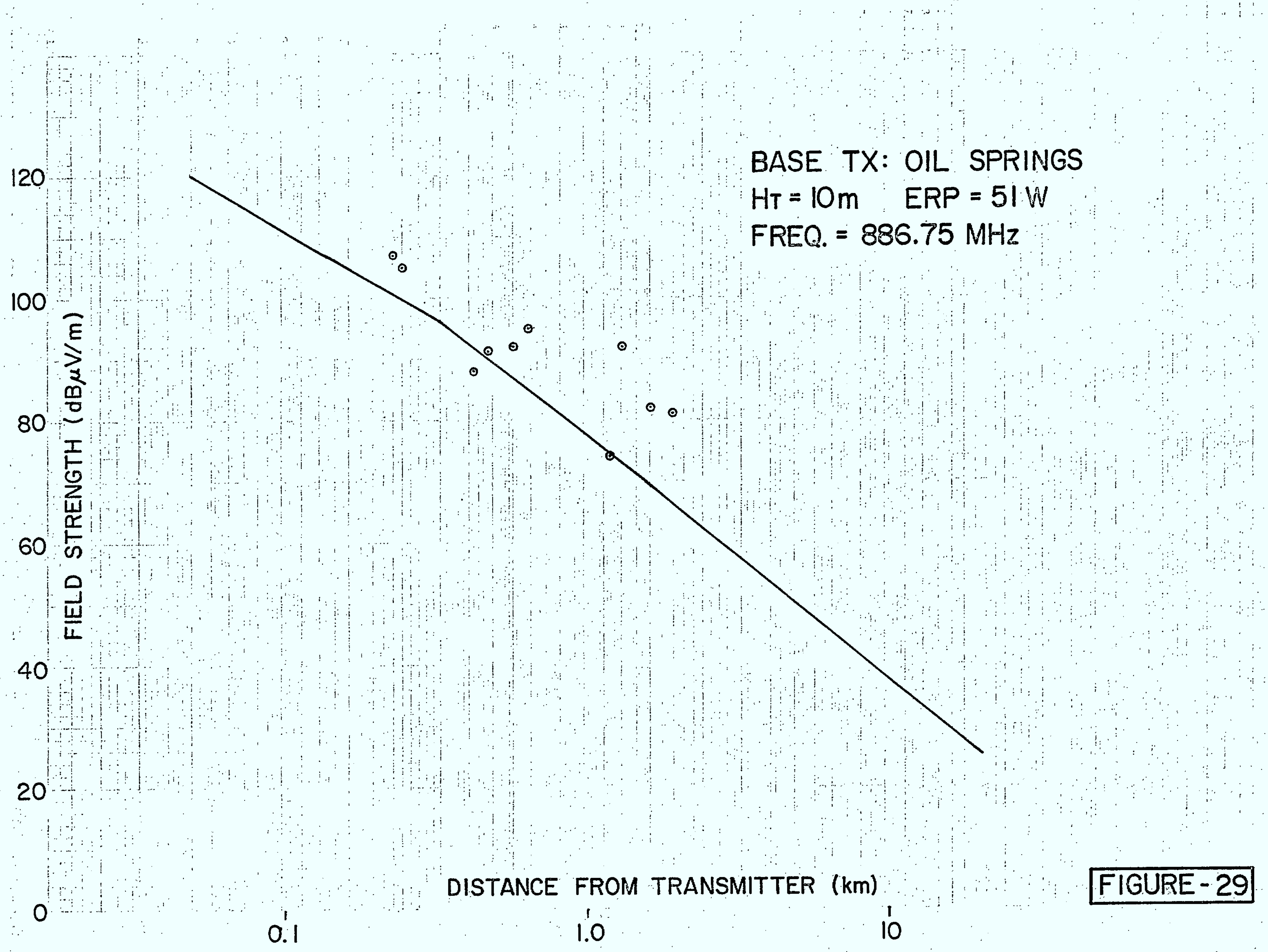
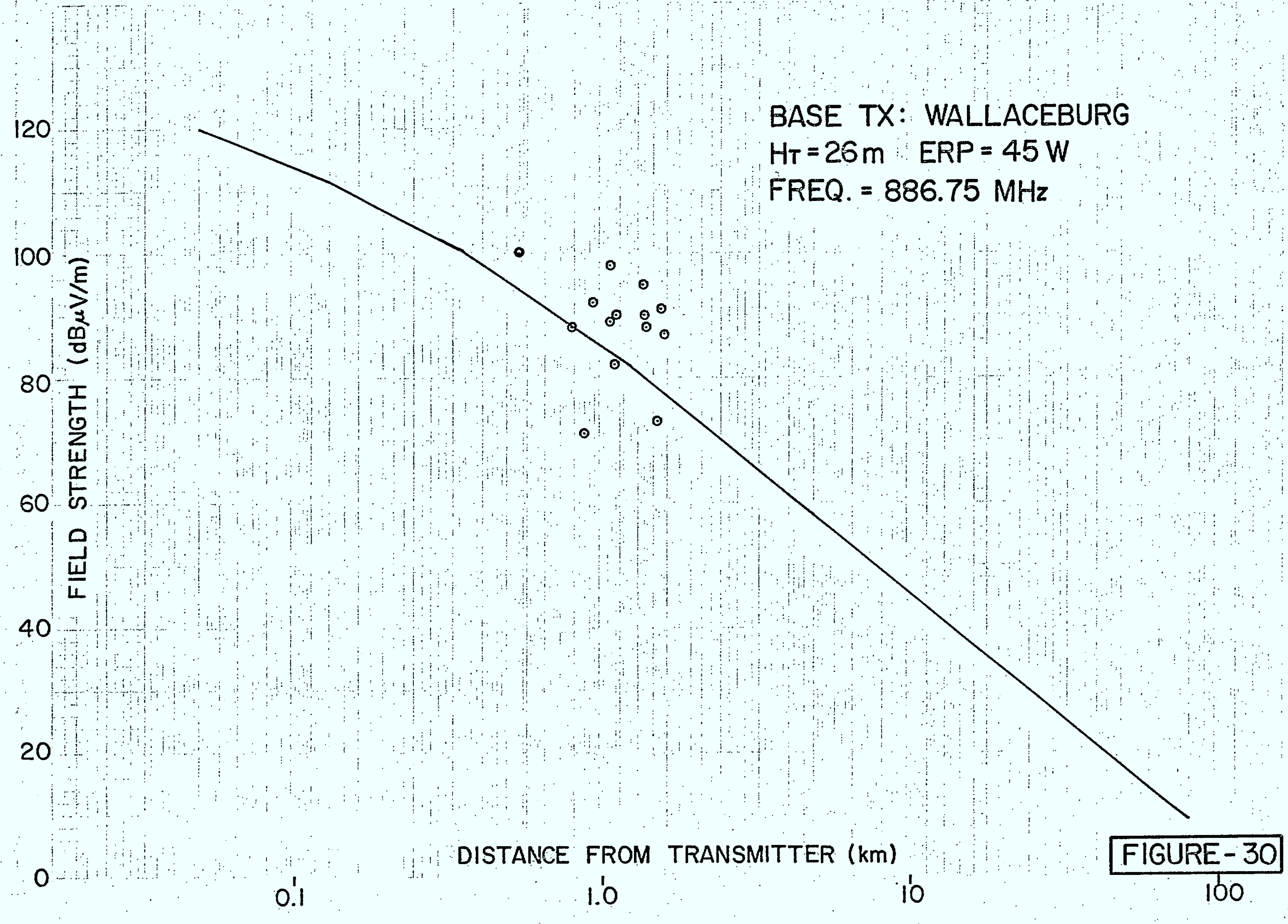
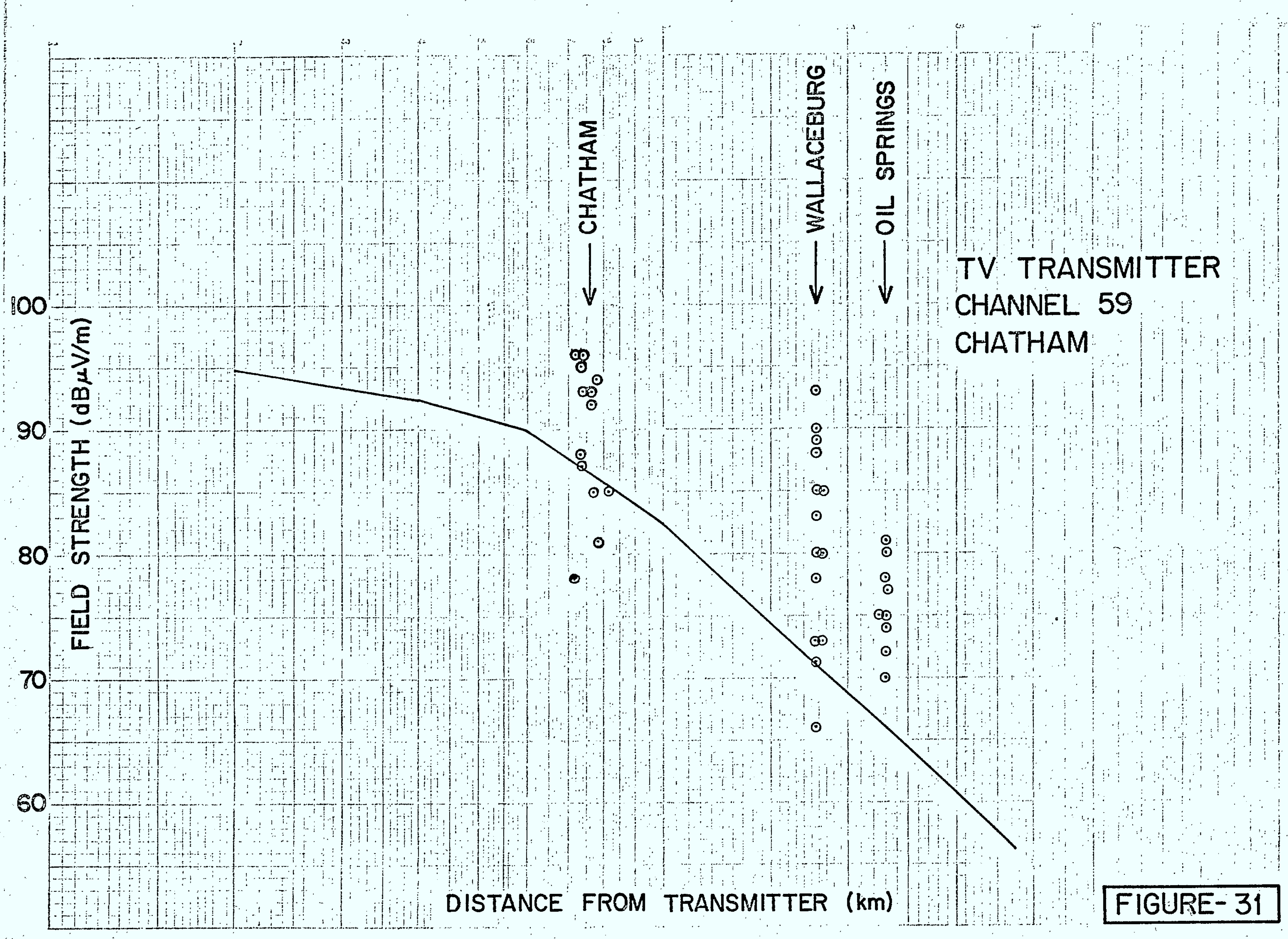

BASE TX: OIL SPRINGS
HT = 10m ERP = 51 W
FREQ. = 886.75 MHz
FIELD STRENGTH (dBμV/m)
DISTANCE FROM TRANSMITTER (km)
0
20
40
60
80
100
120
0.1
1.0
10

FIGURE - 29



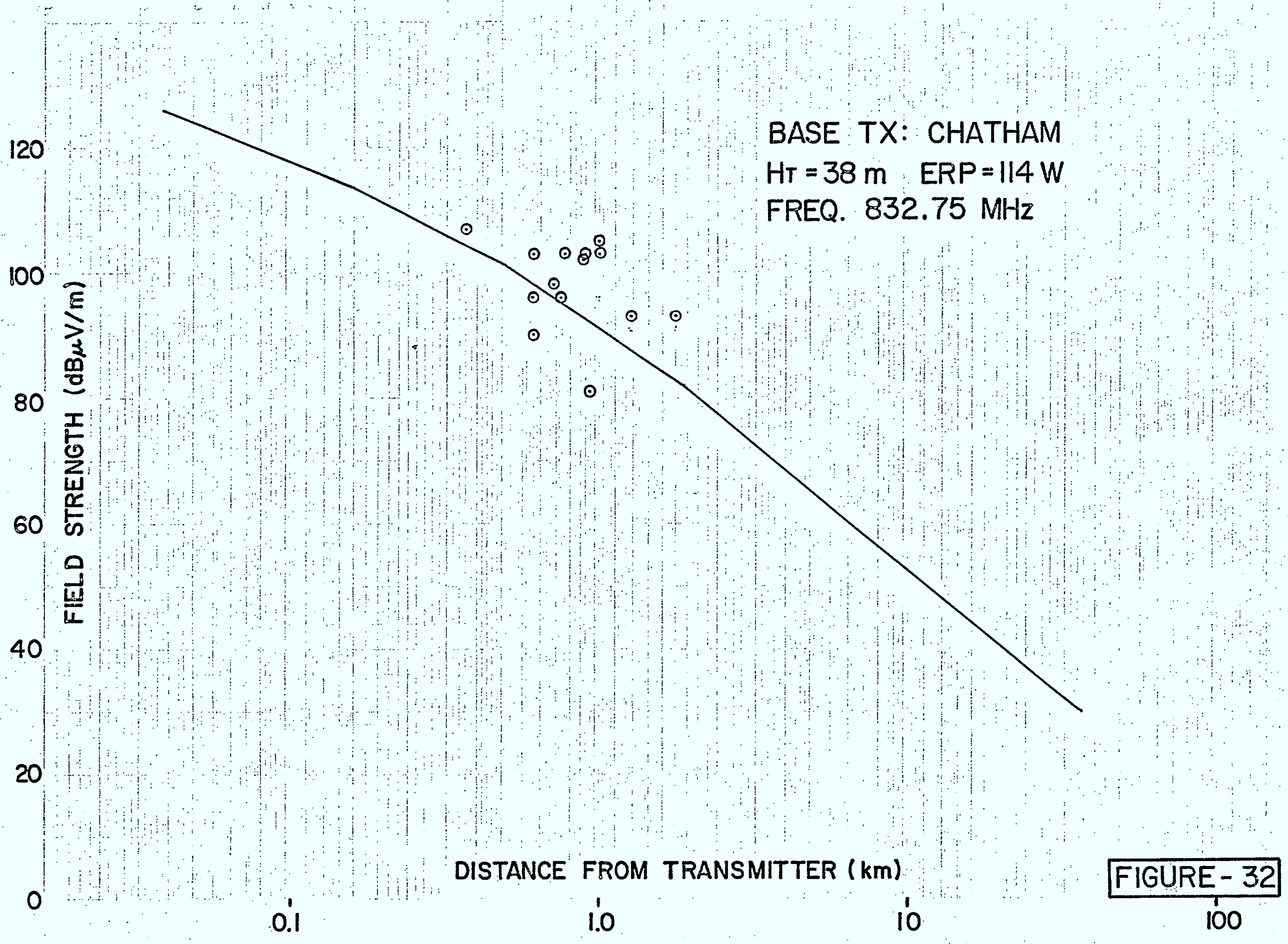
BASE TX: WALLACEBURG
HT = 26 m ERP = 45 W
FREQ. = 886.75 MHz
FIELD STRENGTH (dBμV/m)
120
100
80
60
40
20
0
0.1
1.0
10
100
DISTANCE FROM TRANSMITTER (km)

FIGURE - 30



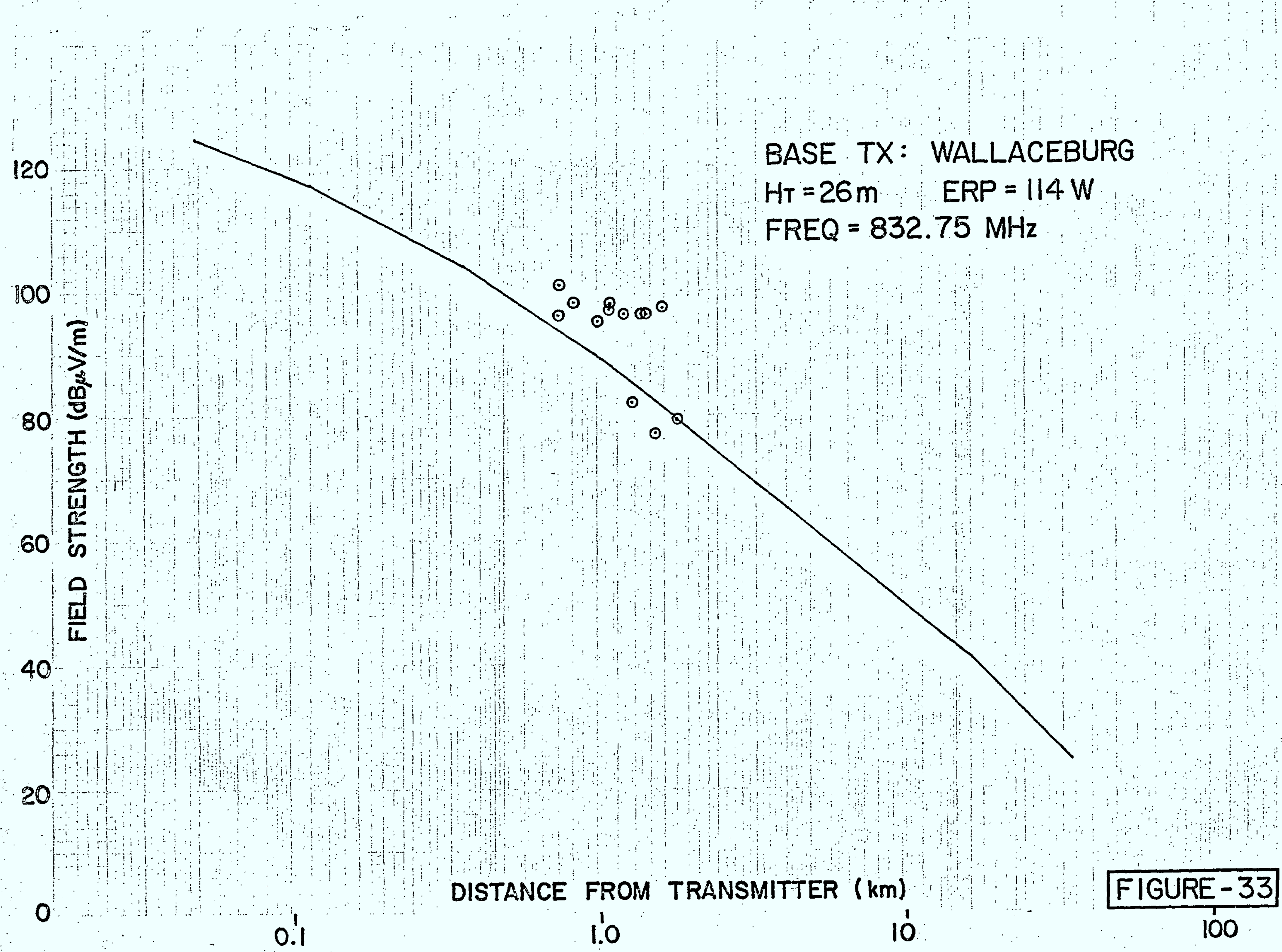
100
90
80
70
60
FIELD STRENGTH (dBμV/m)
CHATHAM
WALLACEBURG
OIL SPRINGS
TV TRANSMITTER
CHANNEL 59
CHATHAM
DISTANCE FROM TRANSMITTER (km)

FIGURE- 31



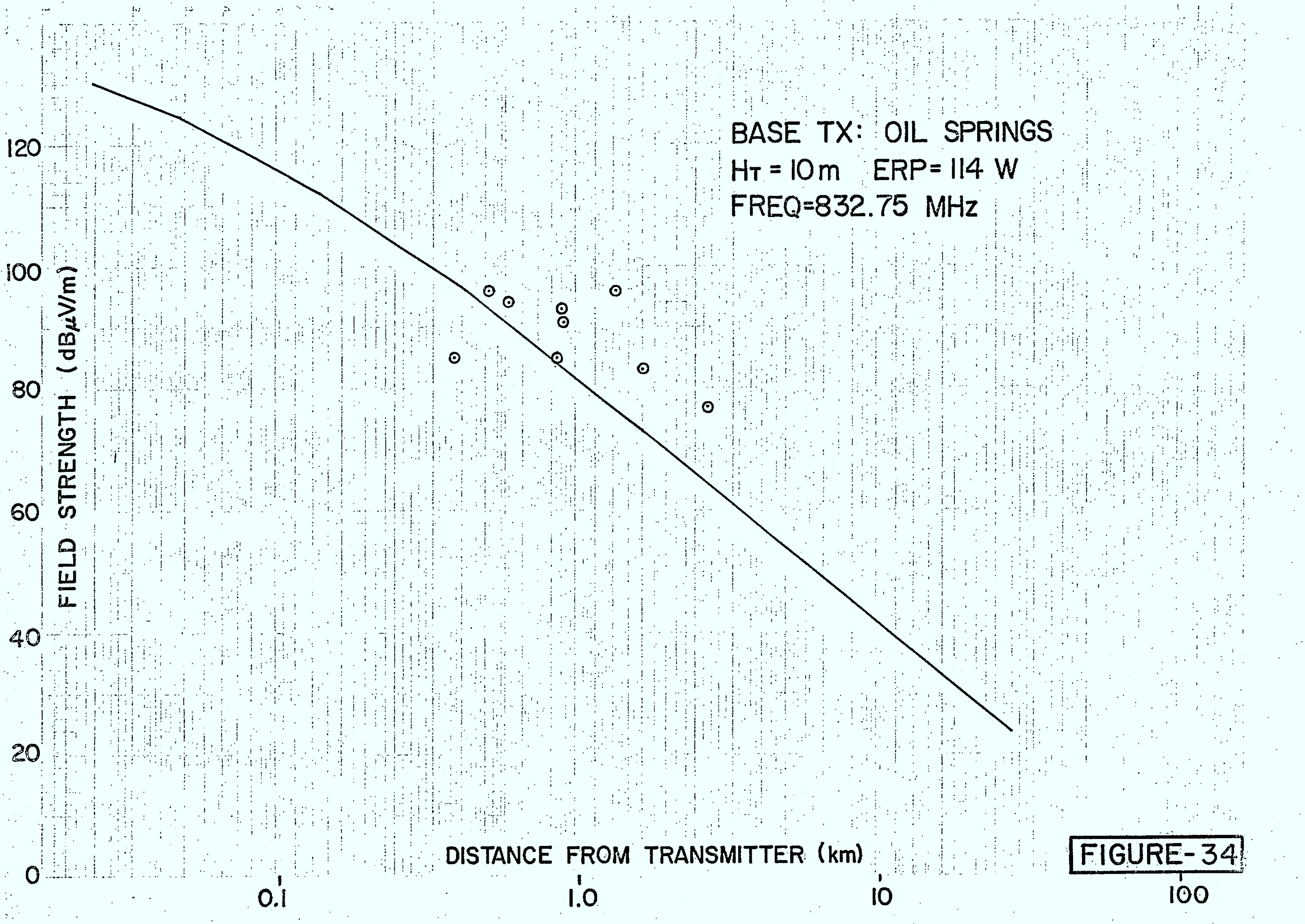
BASE TX: CHATHAM
HT = 38 m ERP = 114 W
FREQ. 832.75 MHz
FIELD STRENGTH (dBμV/m)
120
100
80
60
40
20
0
DISTANCE FROM TRANSMITTER (km)
0.1
1.0
10
100

FIGURE - 32



BASE TX: WALLACEBURG
HT = 26 m ERP = 114 W
FREQ = 832.75 MHz
FIELD STRENGTH (dBμV/m)
DISTANCE FROM TRANSMITTER (km)
120
100
80
60
40
20
0
0.1
1.0
10
100

FIGURE - 33



BASE TX: OIL SPRINGS
HT = 10 m ERP = 114 W
FREQ=832.75 MHz
FIELD STRENGTH (dBμV/m)
0
20
40
60
80
100
120
DISTANCE FROM TRANSMITTER (km)
0.1
1.0
10
100

FIGURE-34

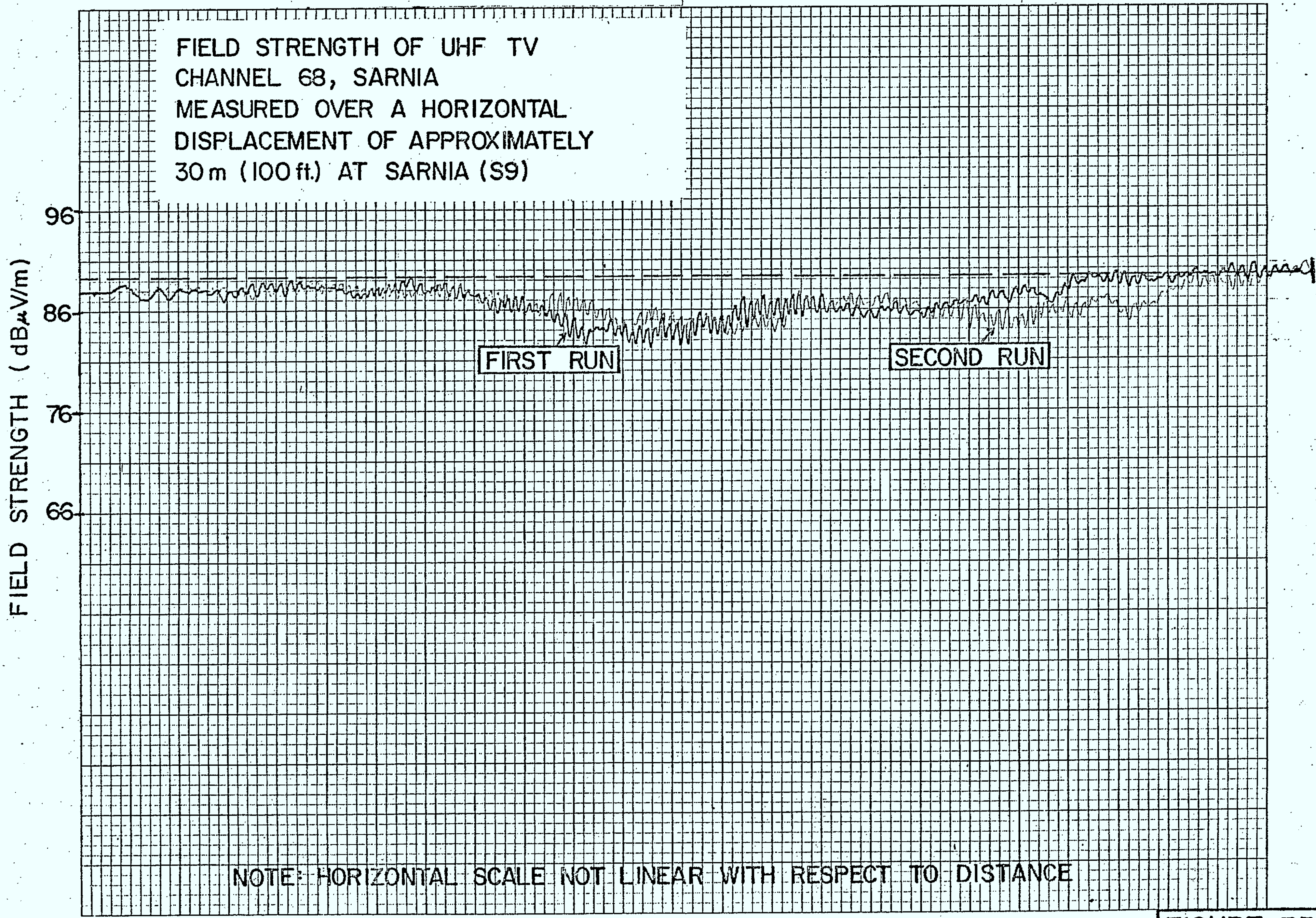

FIELD STRENGTH OF UHF TV
CHANNEL 68, SARNIA
MEASURED OVER A HORIZONTAL
DISPLACEMENT OF APPROXIMATELY
30 m (100 ft.) AT SARNIA (S9)
FIELD STRENGTH (dBμV/m)
96
86
76
66
FIRST RUN
SECOND RUN
NOTE: HORIZONTAL SCALE NOT LINEAR WITH RESPECT TO DISTANCE

FIGURE-35

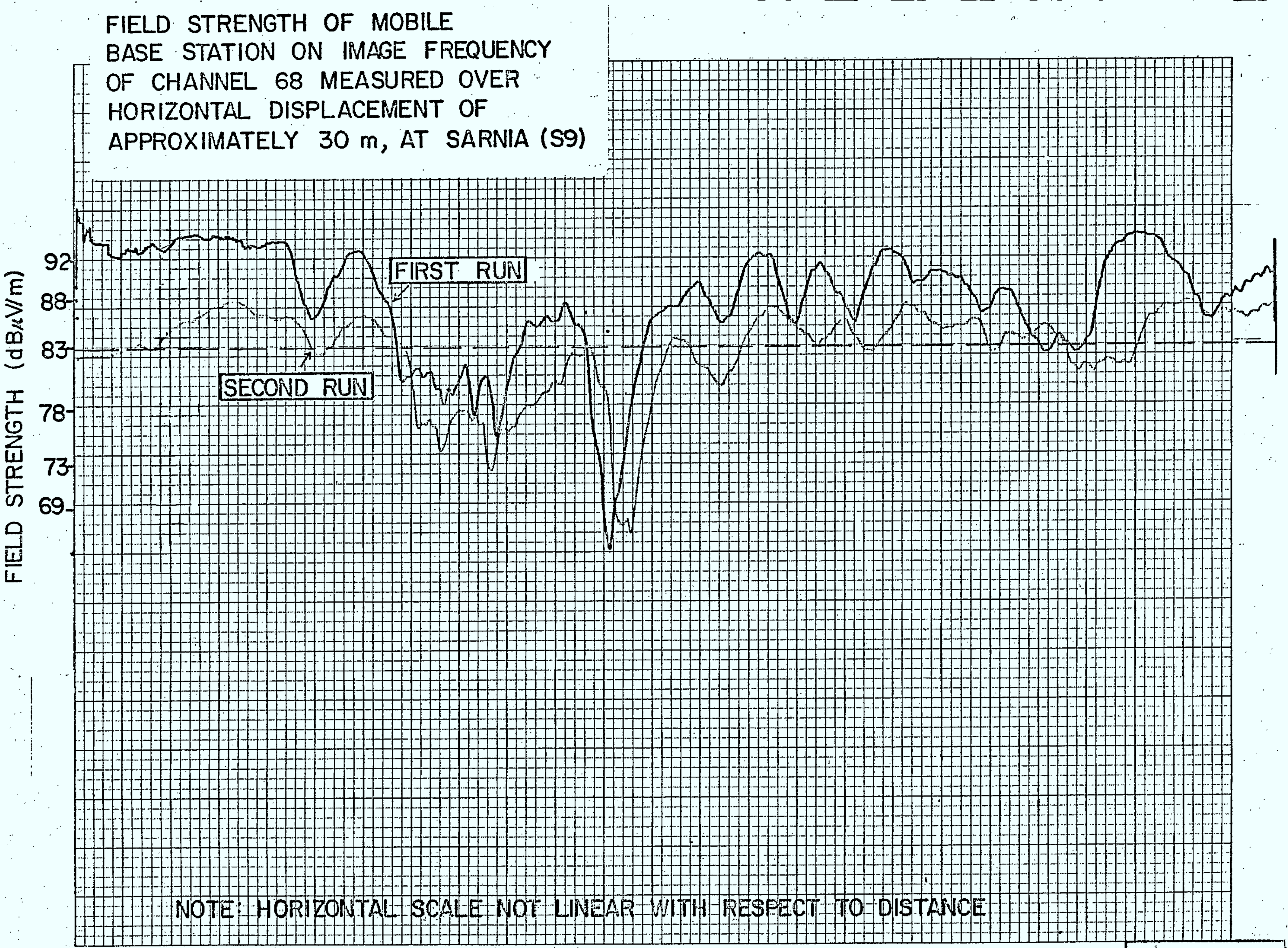

FIELD STRENGTH OF MOBILE BASE STATION ON IMAGE FREQUENCY OF CHANNEL 68 MEASURED OVER HORIZONTAL DISPLACEMENT OF APPROXIMATELY 30 m, AT SARNIA (S9)
FIELD STRENGTH (dBμV/m)
92
88
83
78
73
69
FIRST RUN
SECOND RUN
NOTE: HORIZONTAL SCALE NOT LINEAR WITH RESPECT TO DISTANCE

FIGURE-36

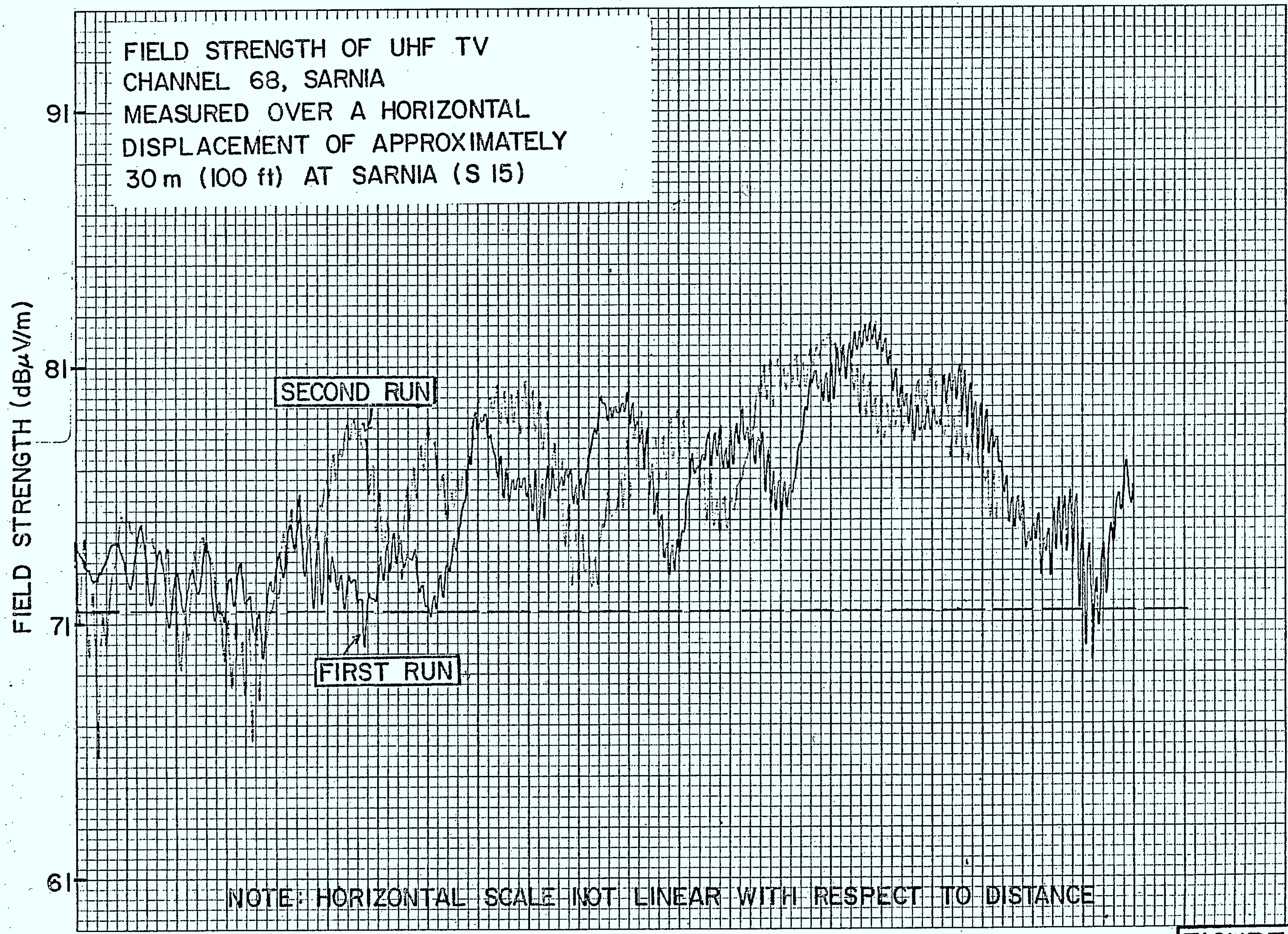

FIELD STRENGTH OF UHF TV
CHANNEL 68, SARNIA
MEASURED OVER A HORIZONTAL
DISPLACEMENT OF APPROXIMATELY
30 m (100 ft) AT SARNIA (S 15)
91
81
71
61
FIELD STRENGTH (dBμV/m)
SECOND RUN
FIRST RUN
NOTE: HORIZONTAL SCALE NOT LINEAR WITH RESPECT TO DISTANCE

FIGURE-37

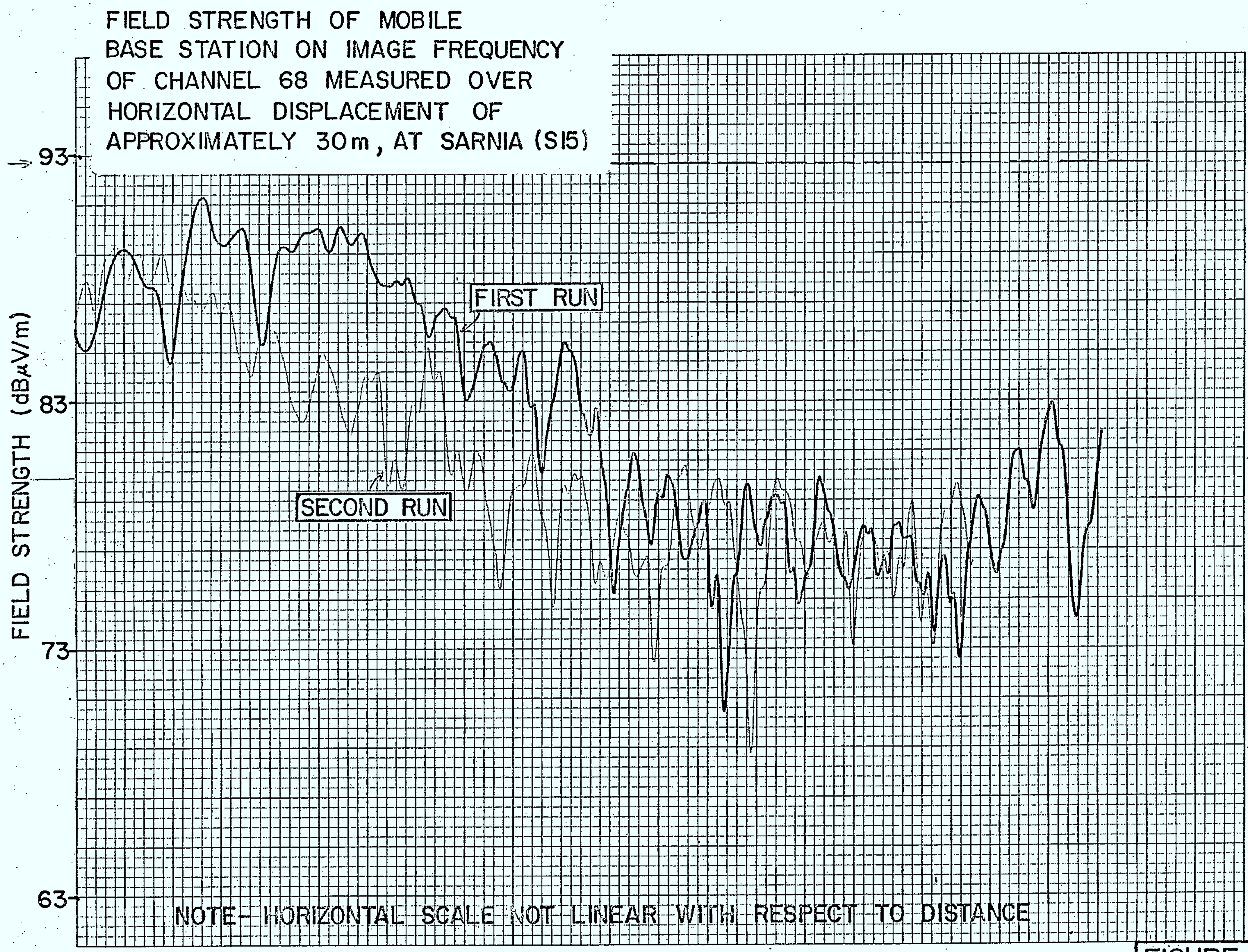

FIELD STRENGTH OF MOBILE BASE STATION ON IMAGE FREQUENCY OF CHANNEL 68 MEASURED OVER HORIZONTAL DISPLACEMENT OF APPROXIMATELY 30m, AT SARNIA (S15)
FIELD STRENGTH (dBμV/m)
93
83
73
63
FIRST RUN
SECOND RUN
NOTE- HORIZONTAL SCALE NOT LINEAR WITH RESPECT TO DISTANCE

FIGURE-38

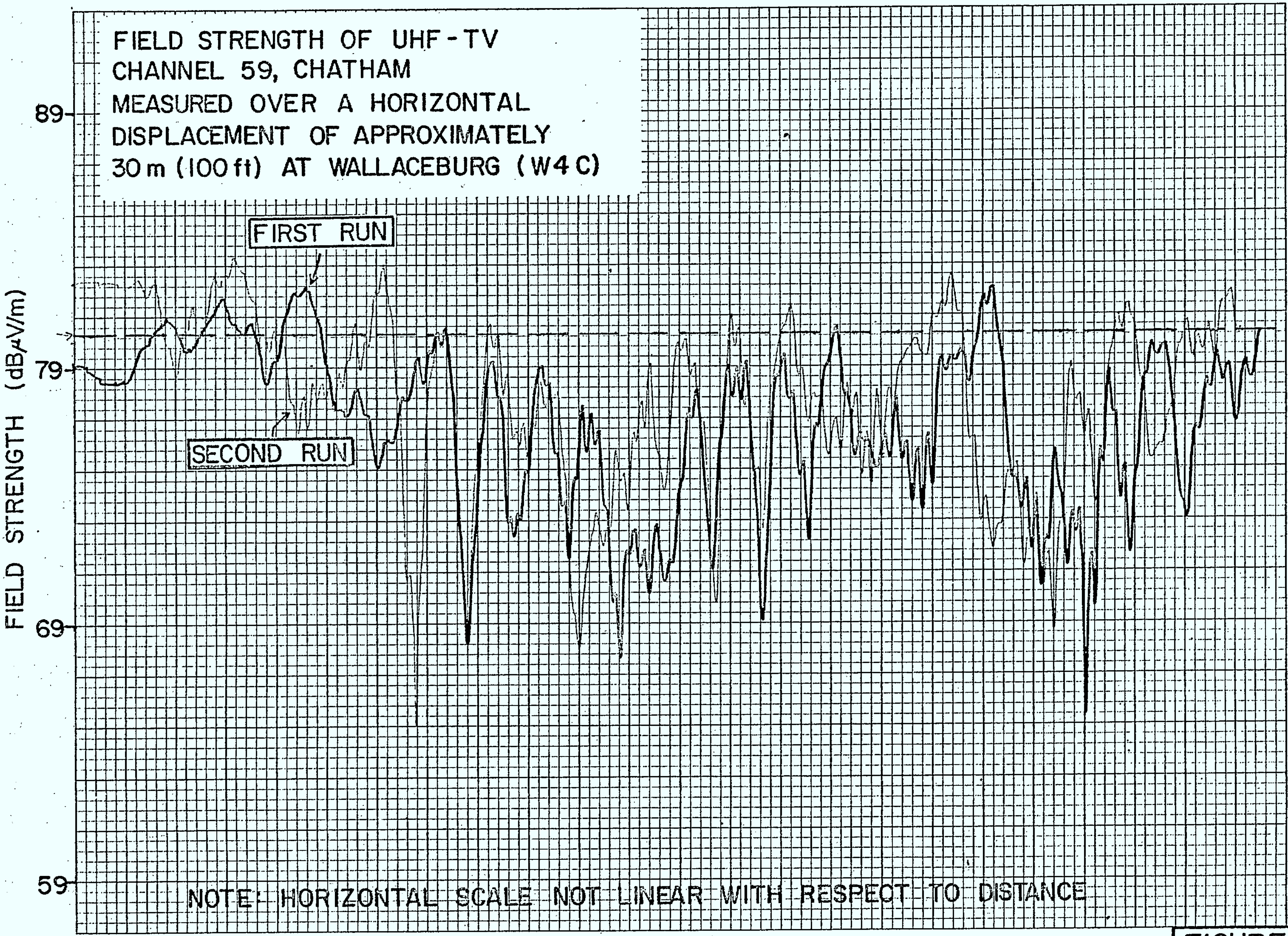

FIELD STRENGTH OF UHF-TV CHANNEL 59, CHATHAM MEASURED OVER A HORIZONTAL DISPLACEMENT OF APPROXIMATELY 30 m (100 ft) AT WALLACEBURG (W4C)
FIRST RUN
SECOND RUN
FIELD STRENGTH (dBμV/m)
89
79
69
59
NOTE: HORIZONTAL SCALE NOT LINEAR WITH RESPECT TO DISTANCE

FIGURE-39

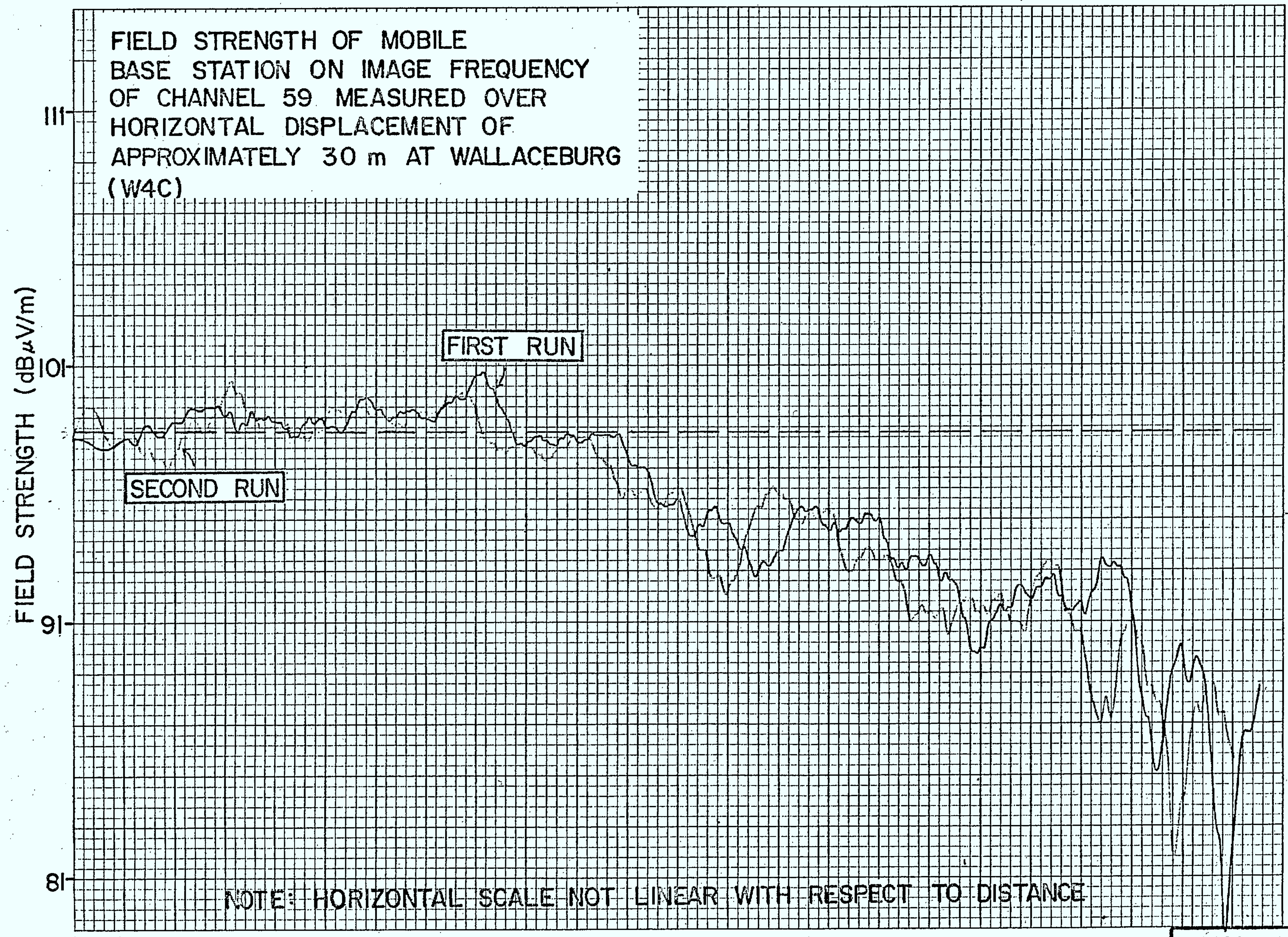

FIELD STRENGTH OF MOBILE BASE STATION ON IMAGE FREQUENCY OF CHANNEL 59 MEASURED OVER HORIZONTAL DISPLACEMENT OF APPROXIMATELY 30 m AT WALLACEBURG (W4C)
FIELD STRENGTH (dBμV/m)
111
101
91
81
FIRST RUN
SECOND RUN
NOTE: HORIZONTAL SCALE NOT LINEAR WITH RESPECT TO DISTANCE

FIGURE-40

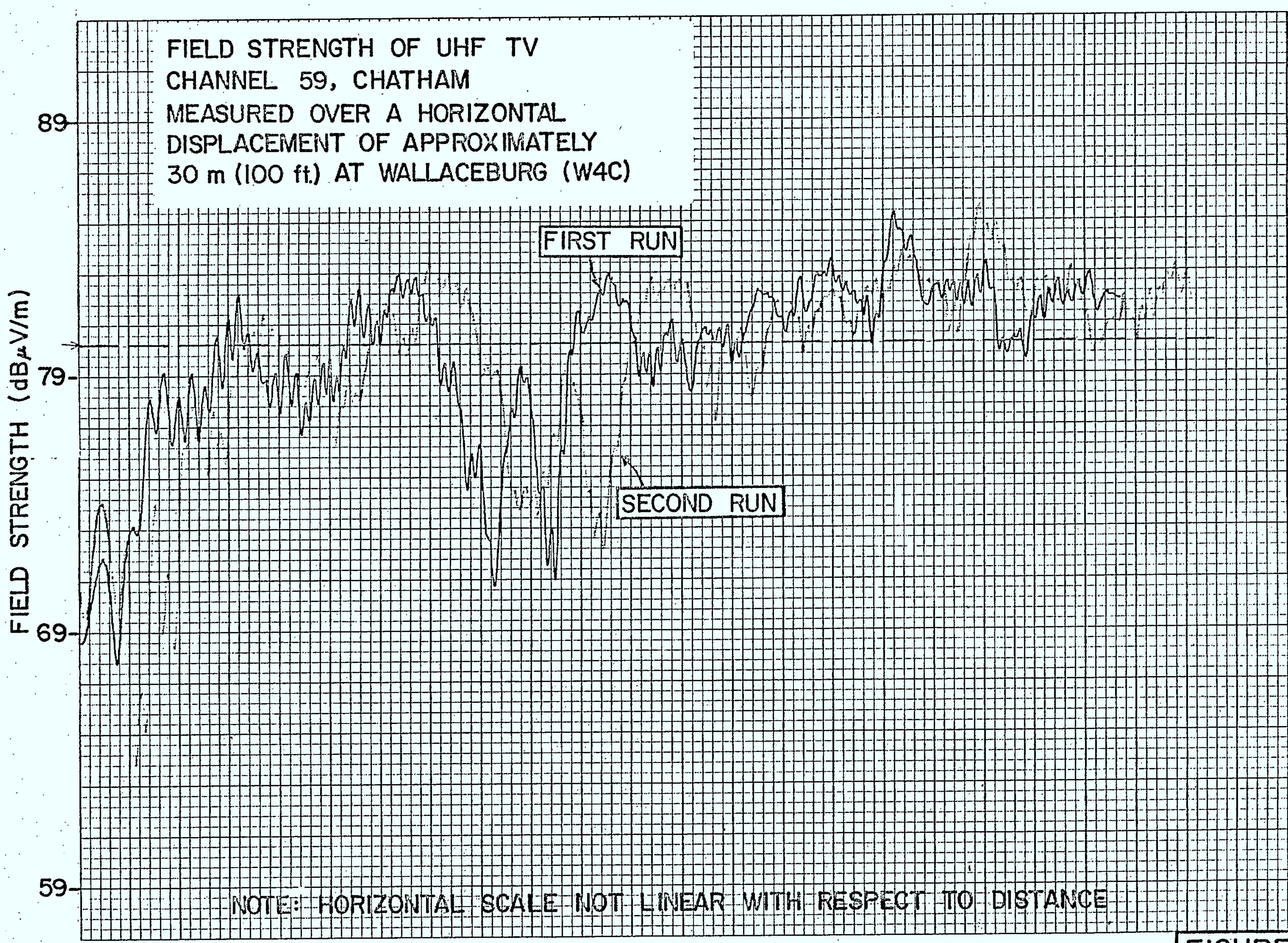
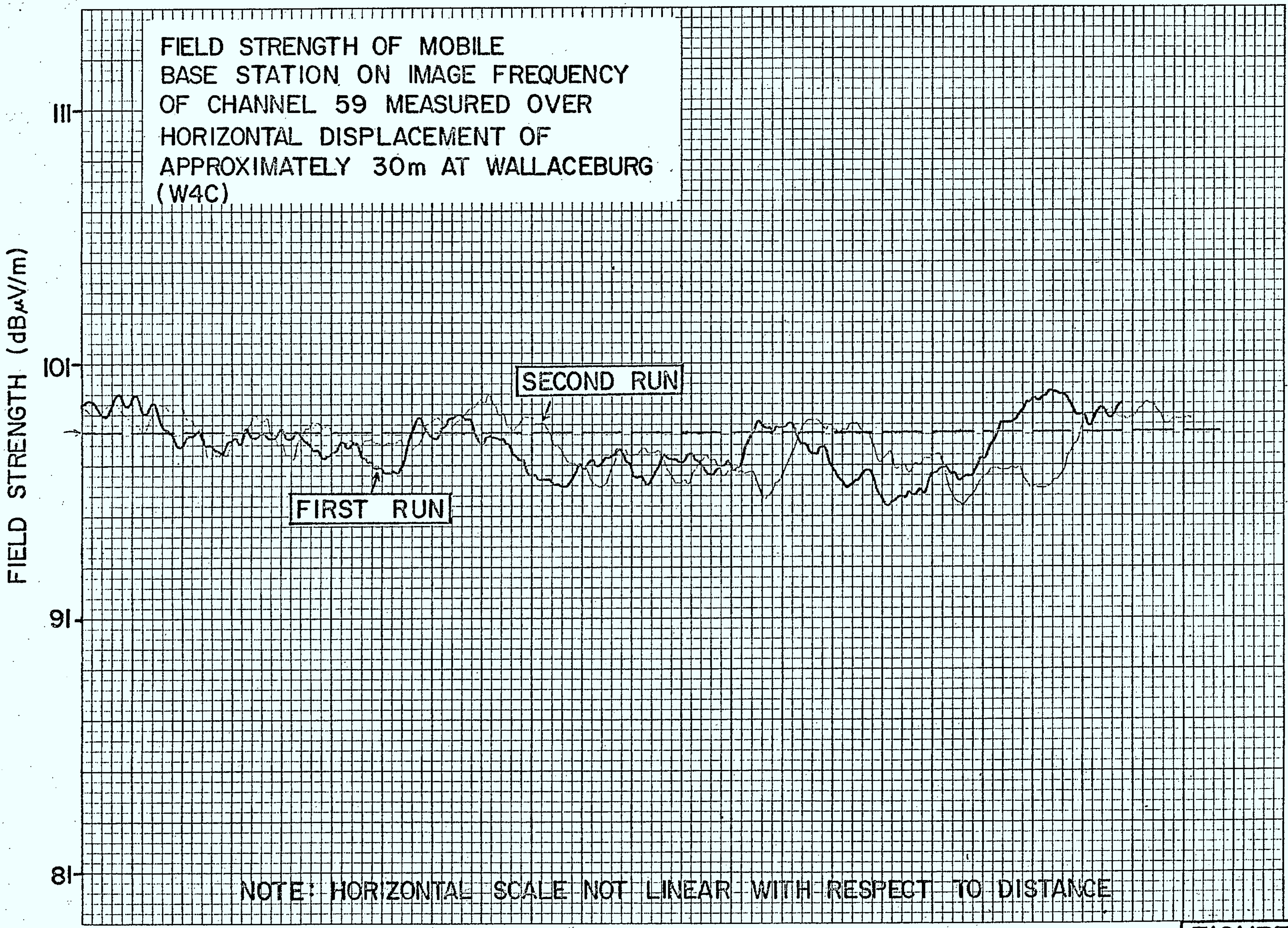

FIELD STRENGTH OF UHF TV
CHANNEL 59, CHATHAM
MEASURED OVER A HORIZONTAL
DISPLACEMENT OF APPROXIMATELY
30 m (100 ft.) AT WALLACEBURG (W4C)
FIRST RUN
SECOND RUN
FIELD STRENGTH (dBμV/m)
89
79
69
59
NOTE: HORIZONTAL SCALE NOT LINEAR WITH RESPECT TO DISTANCE

FIGURE-41



FIELD STRENGTH OF MOBILE BASE STATION ON IMAGE FREQUENCY OF CHANNEL 59 MEASURED OVER HORIZONTAL DISPLACEMENT OF APPROXIMATELY 30m AT WALLACEBURG (W4C)
FIELD STRENGTH (dBμV/m)
111
101
91
81
SECOND RUN
FIRST RUN
NOTE: HORIZONTAL SCALE NOT LINEAR WITH RESPECT TO DISTANCE

FIGURE-42

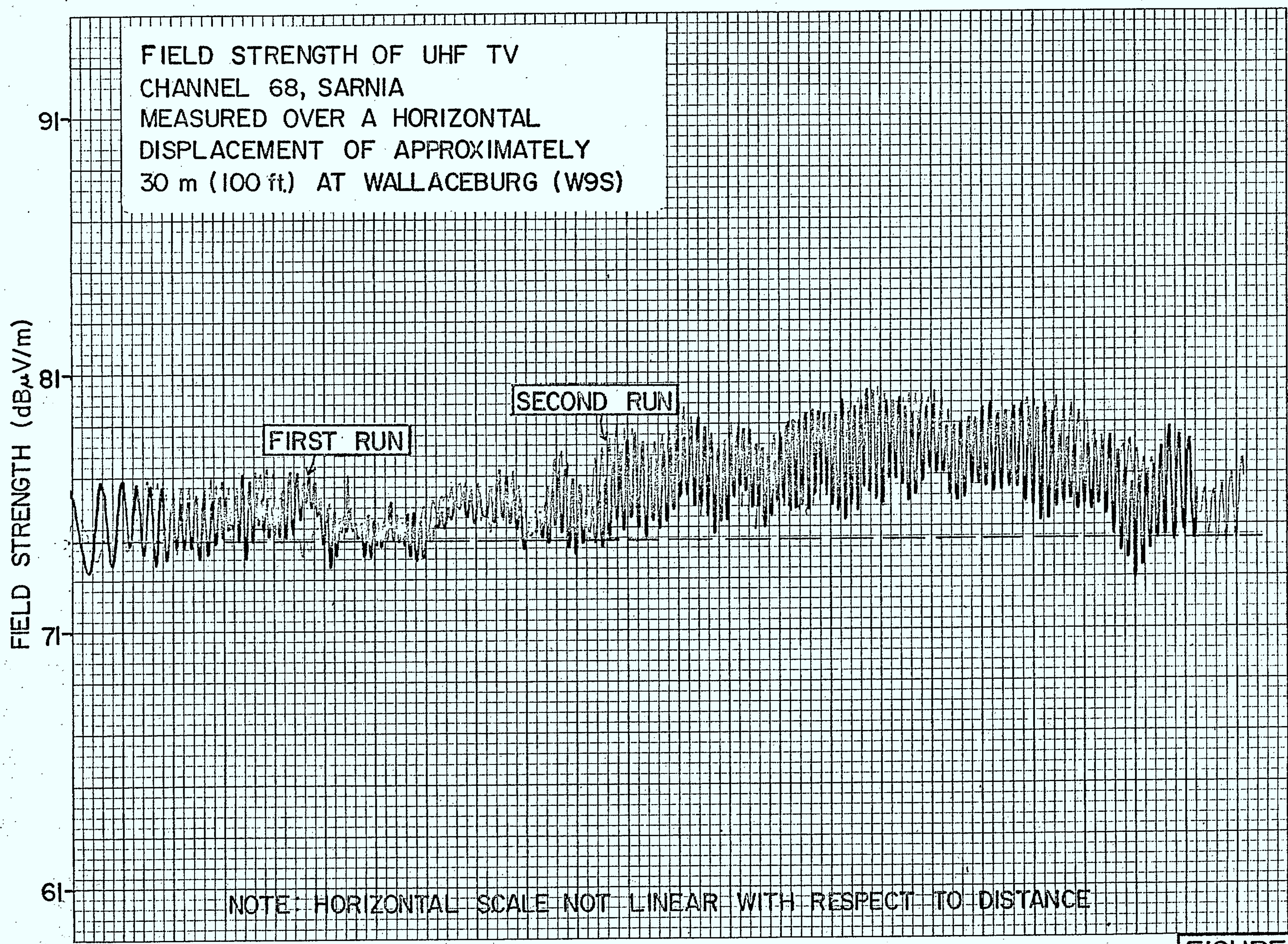
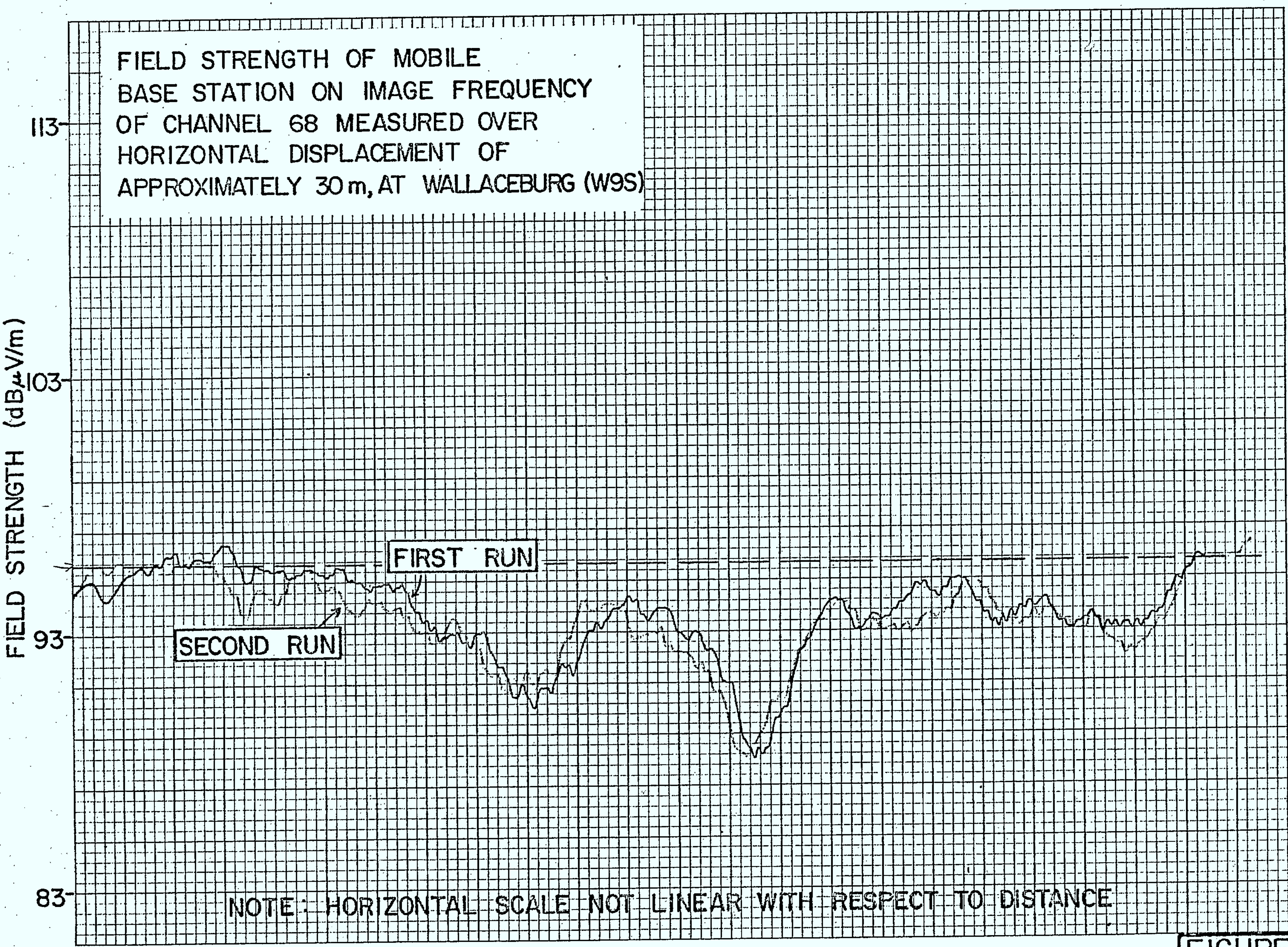

FIELD STRENGTH OF UHF TV
CHANNEL 68, SARNIA
MEASURED OVER A HORIZONTAL
DISPLACEMENT OF APPROXIMATELY
30 m (100 ft.) AT WALLACEBURG (W9S)
FIELD STRENGTH (dBμV/m)
91
81
71
61
FIRST RUN
SECOND RUN
NOTE: HORIZONTAL SCALE NOT LINEAR WITH RESPECT TO DISTANCE

FIGURE-43



FIELD STRENGTH OF MOBILE BASE STATION ON IMAGE FREQUENCY OF CHANNEL 68 MEASURED OVER HORIZONTAL DISPLACEMENT OF APPROXIMATELY 30 m, AT WALLACEBURG (W9S)
113
103
93
83
FIELD STRENGTH (dBμV/m)
FIRST RUN
SECOND RUN
NOTE: HORIZONTAL SCALE NOT LINEAR WITH RESPECT TO DISTANCE

FIGURE-44

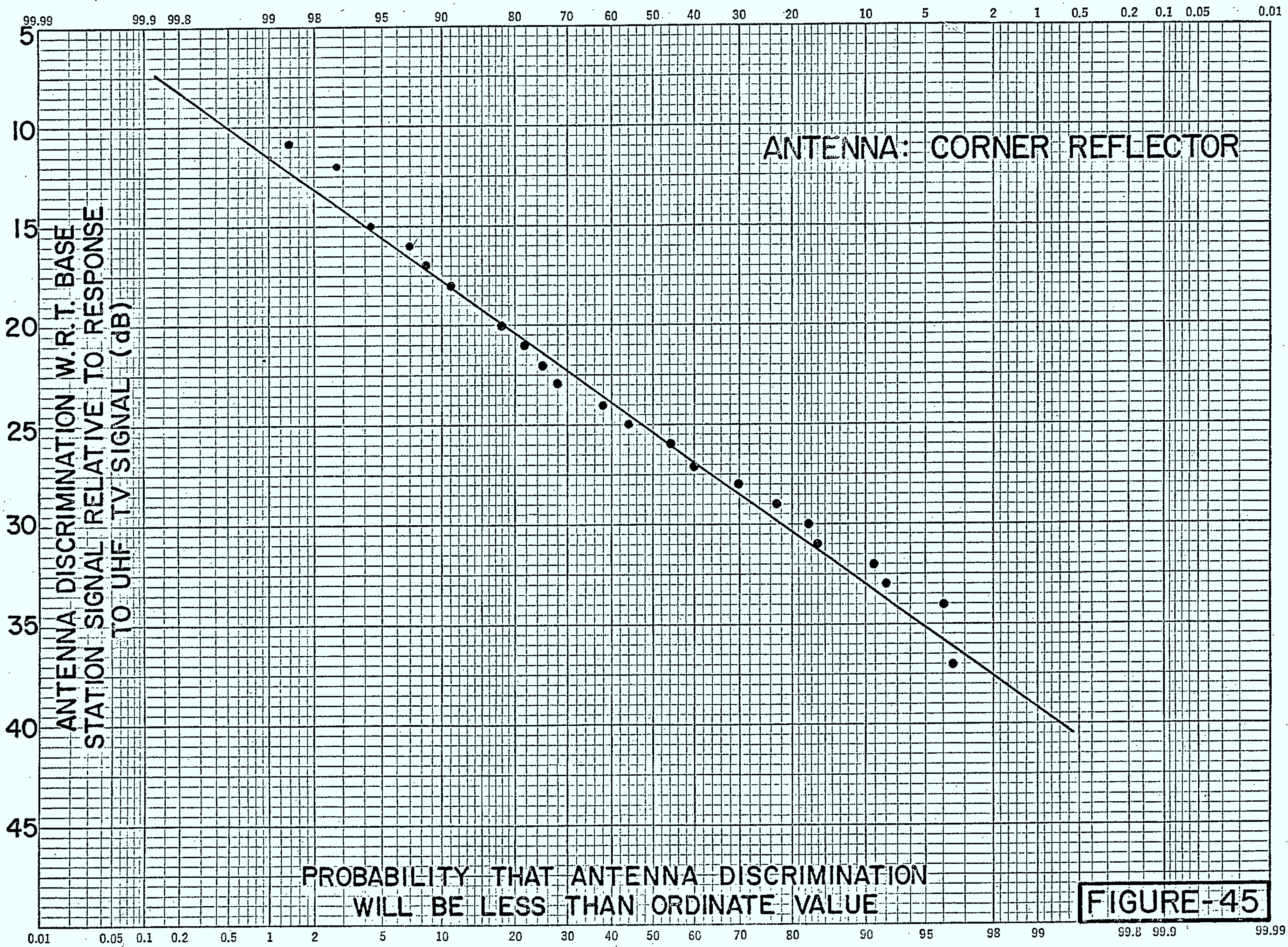

ANTENNA: CORNER REFLECTOR
ANTENNA DISCRIMINATION W.R.T. BASE STATION SIGNAL RELATIVE TO RESPONSE TO UHF TV SIGNAL (dB)
PROBABILITY THAT ANTENNA DISCRIMINATION WILL BE LESS THAN ORDINATE VALUE
5
10
15
20
25
30
35
40
45
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99

FIGURE-45

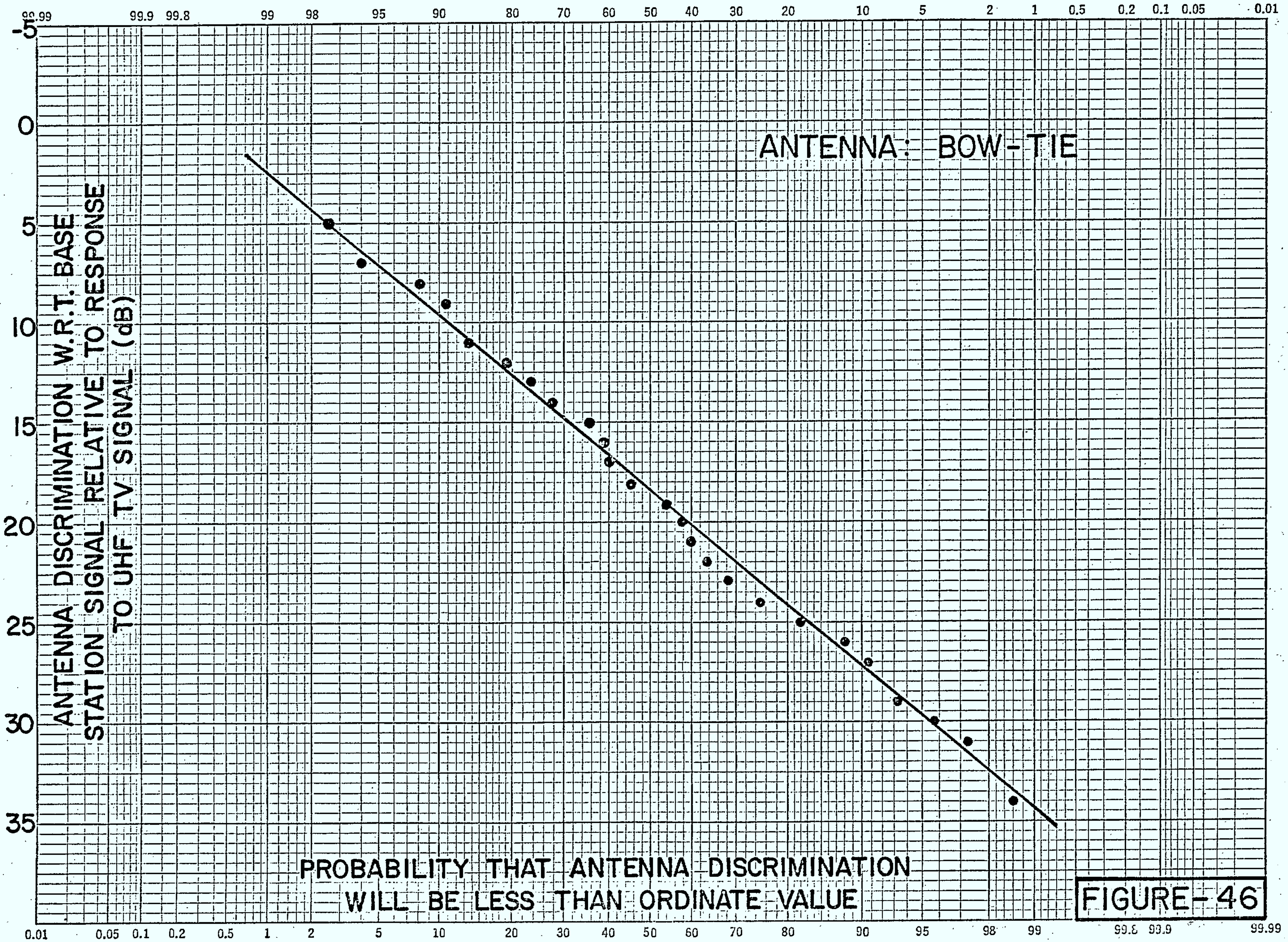

ANTENNA: BOW-TIE
ANTENNA DISCRIMINATION W.R.T. BASE STATION SIGNAL RELATIVE TO RESPONSE TO UHF TV SIGNAL (dB)
PROBABILITY THAT ANTENNA DISCRIMINATION WILL BE LESS THAN ORDINATE VALUE

FIGURE-46

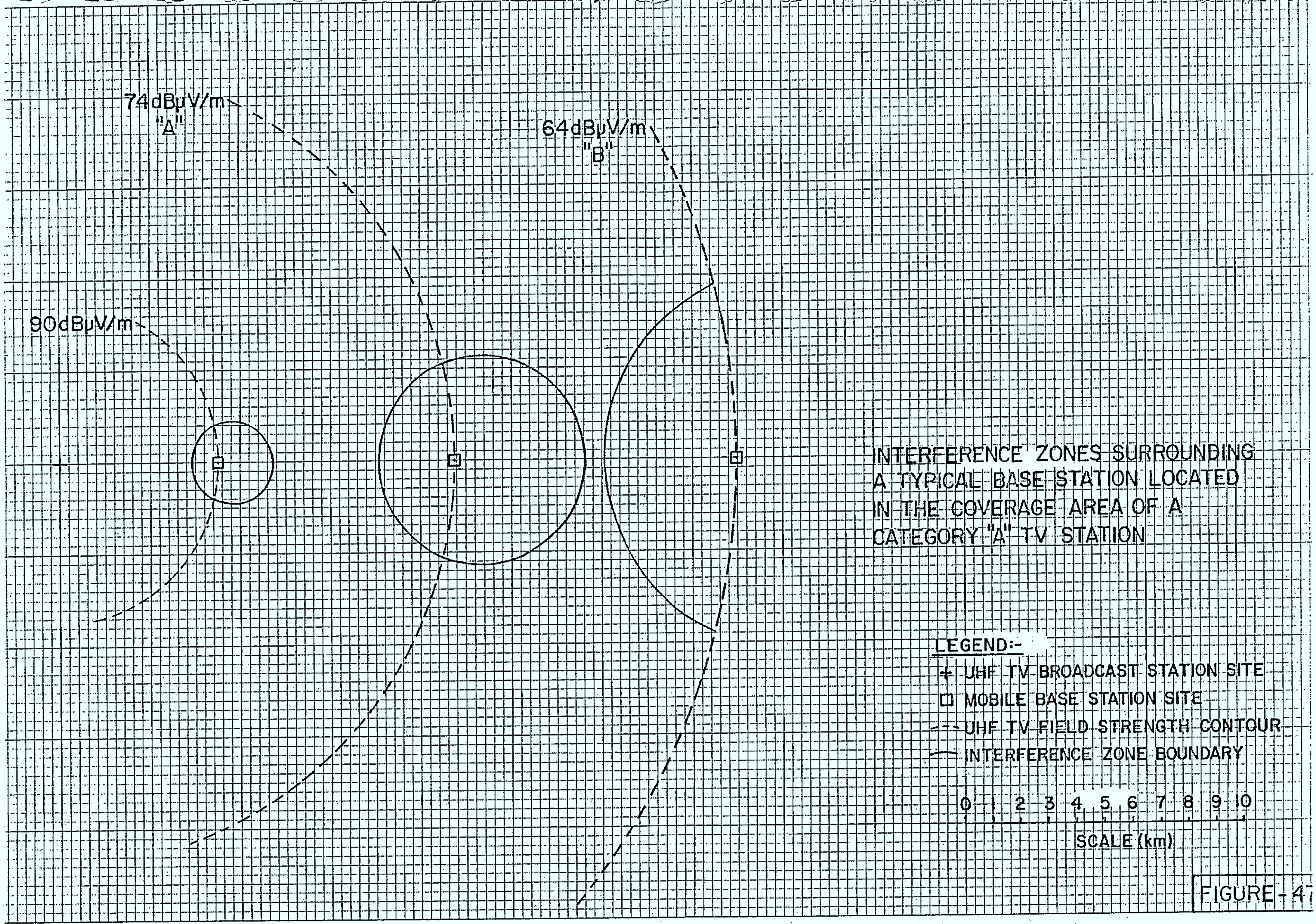
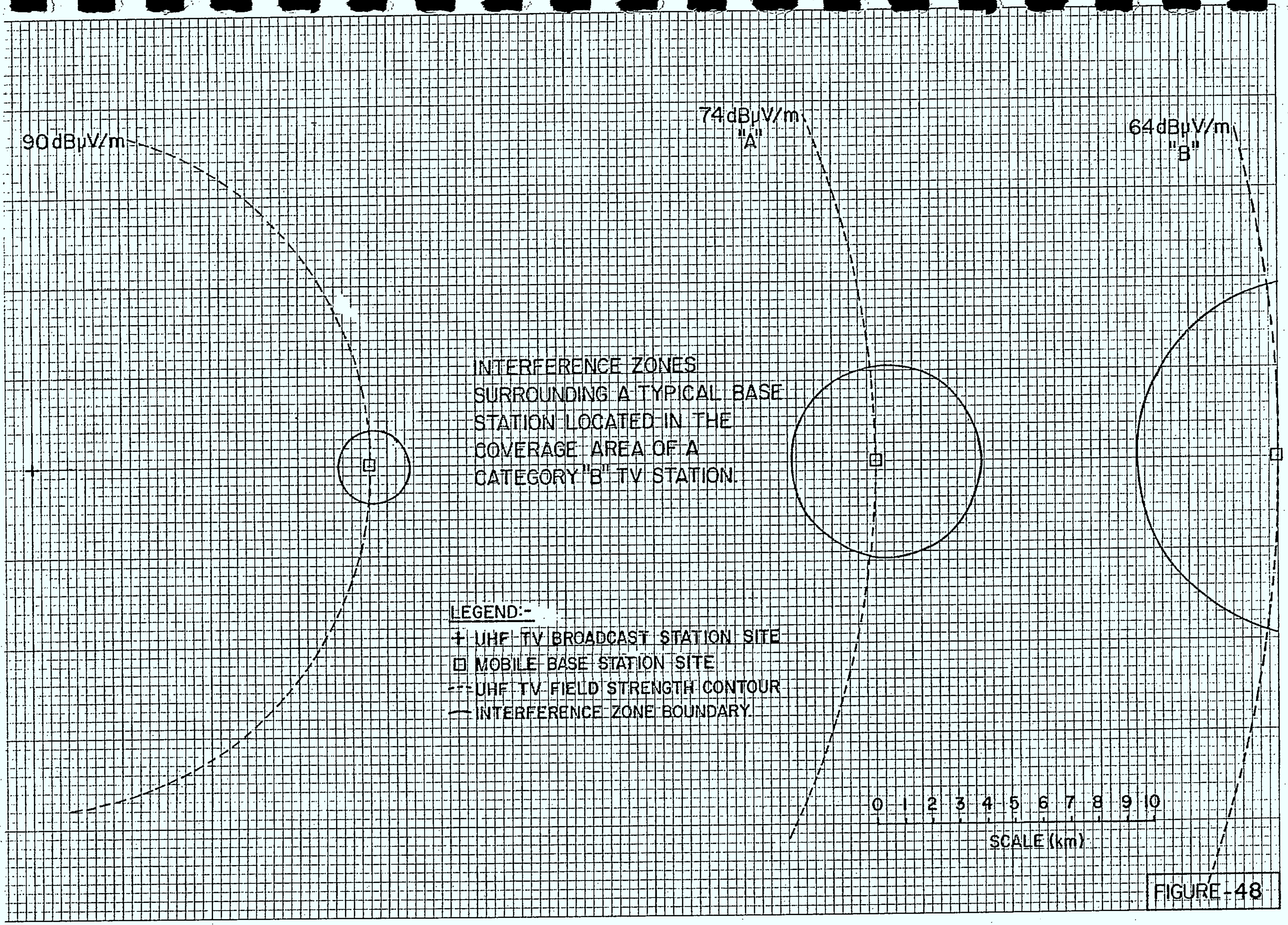

74dBμV/m
"A"
64dBμV/m
"B"
90dBμV/m
INTERFERENCE ZONES SURROUNDING A TYPICAL BASE STATION LOCATED IN THE COVERAGE AREA OF A CATEGORY "A" TV STATION
LEGEND:-
+ UHF TV BROADCAST STATION SITE
□ MOBILE BASE STATION SITE
--- UHF TV FIELD STRENGTH CONTOUR
— INTERFERENCE ZONE BOUNDARY
0 1 2 3 4 5 6 7 8 9 10
SCALE (km)

FIGURE - 47



90 dBμV/m
74 dBμV/m
"A"
64 dBμV/m
"B"
INTERFERENCE ZONES SURROUNDING A TYPICAL BASE STATION LOCATED IN THE COVERAGE AREA OF A CATEGORY "B" TV STATION.
LEGEND:-
+ UHF TV BROADCAST STATION SITE
⊡ MOBILE BASE STATION SITE
--- UHF TV FIELD STRENGTH CONTOUR
— INTERFERENCE ZONE BOUNDARY.
0 1 2 3 4 5 6 7 8 9 10
SCALE (km)

FIGURE - 48

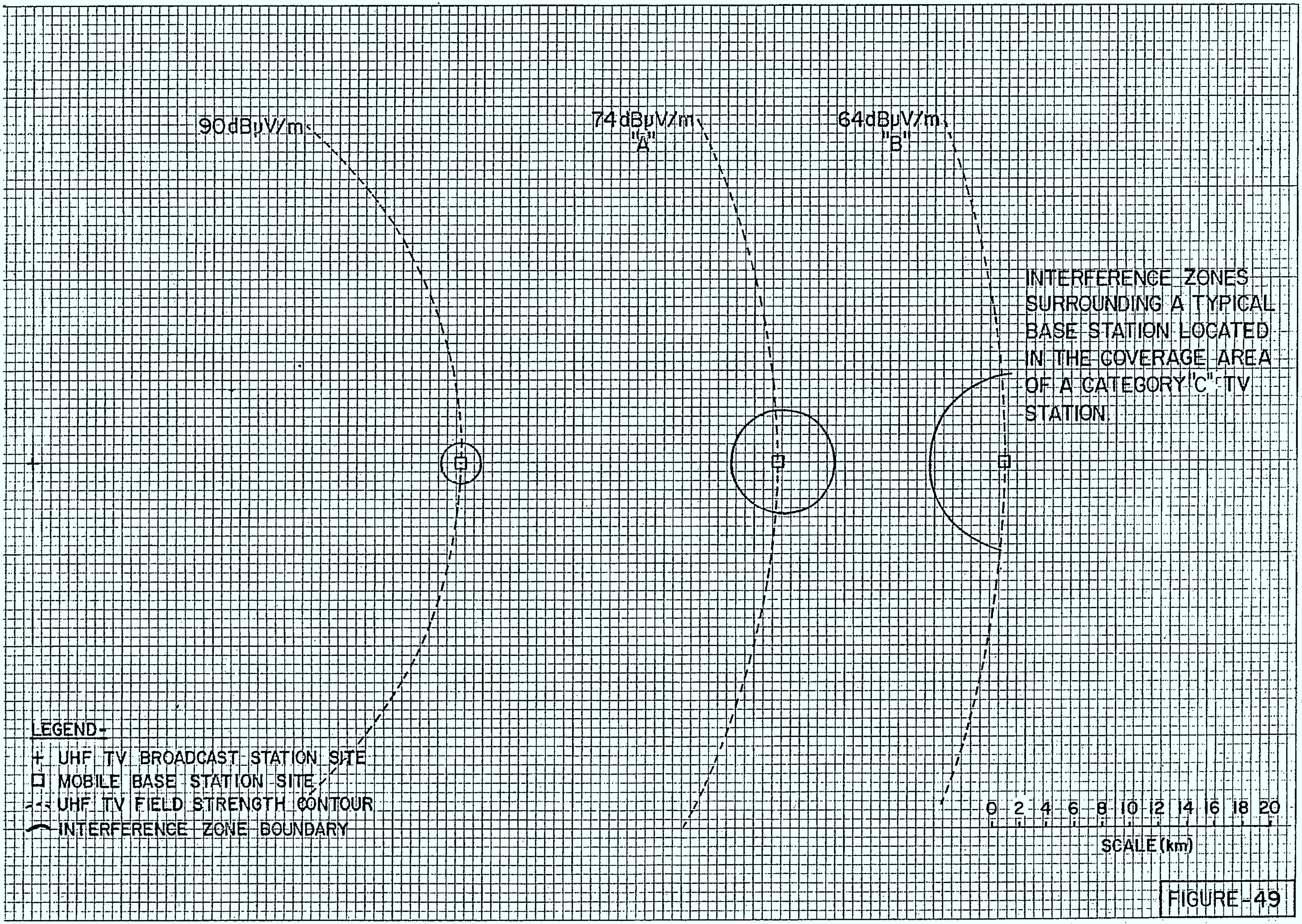
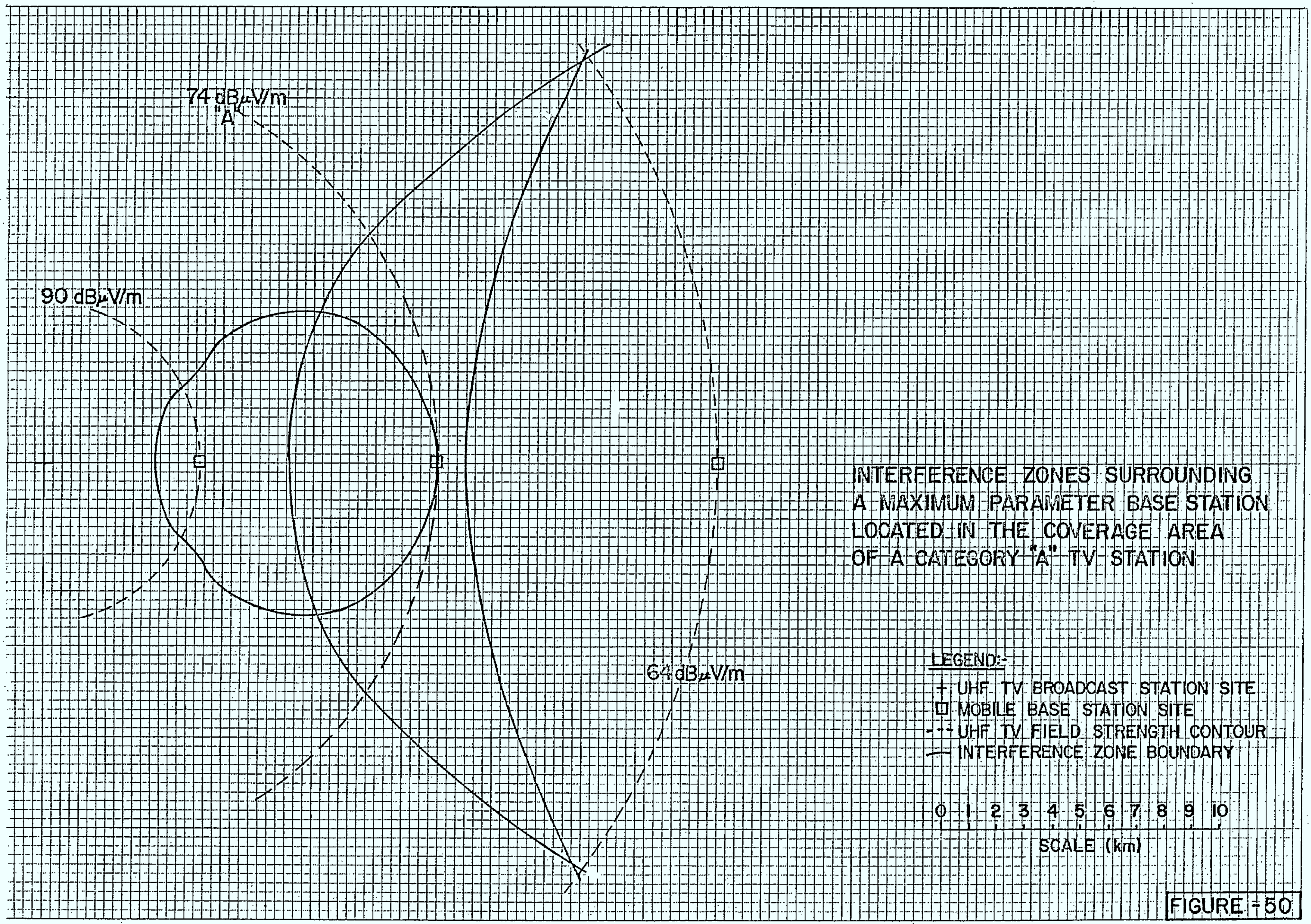

90dBμV/m
74dBμV/m
"A"
64dBμV/m
"B"
INTERFERENCE ZONES SURROUNDING A TYPICAL BASE STATION LOCATED IN THE COVERAGE AREA OF A CATEGORY "C" TV STATION
LEGEND-
UHF TV BROADCAST STATION SITE
MOBILE BASE STATION SITE
UHF TV FIELD STRENGTH CONTOUR
INTERFERENCE ZONE BOUNDARY
0 2 4 6 8 10 12 14 16 18 20
SCALE (km)

FIGURE-49



INTERFERENCE ZONES SURROUNDING A MAXIMUM PARAMETER BASE STATION LOCATED IN THE COVERAGE AREA OF A CATEGORY "A" TV STATION

FIGURE - 50

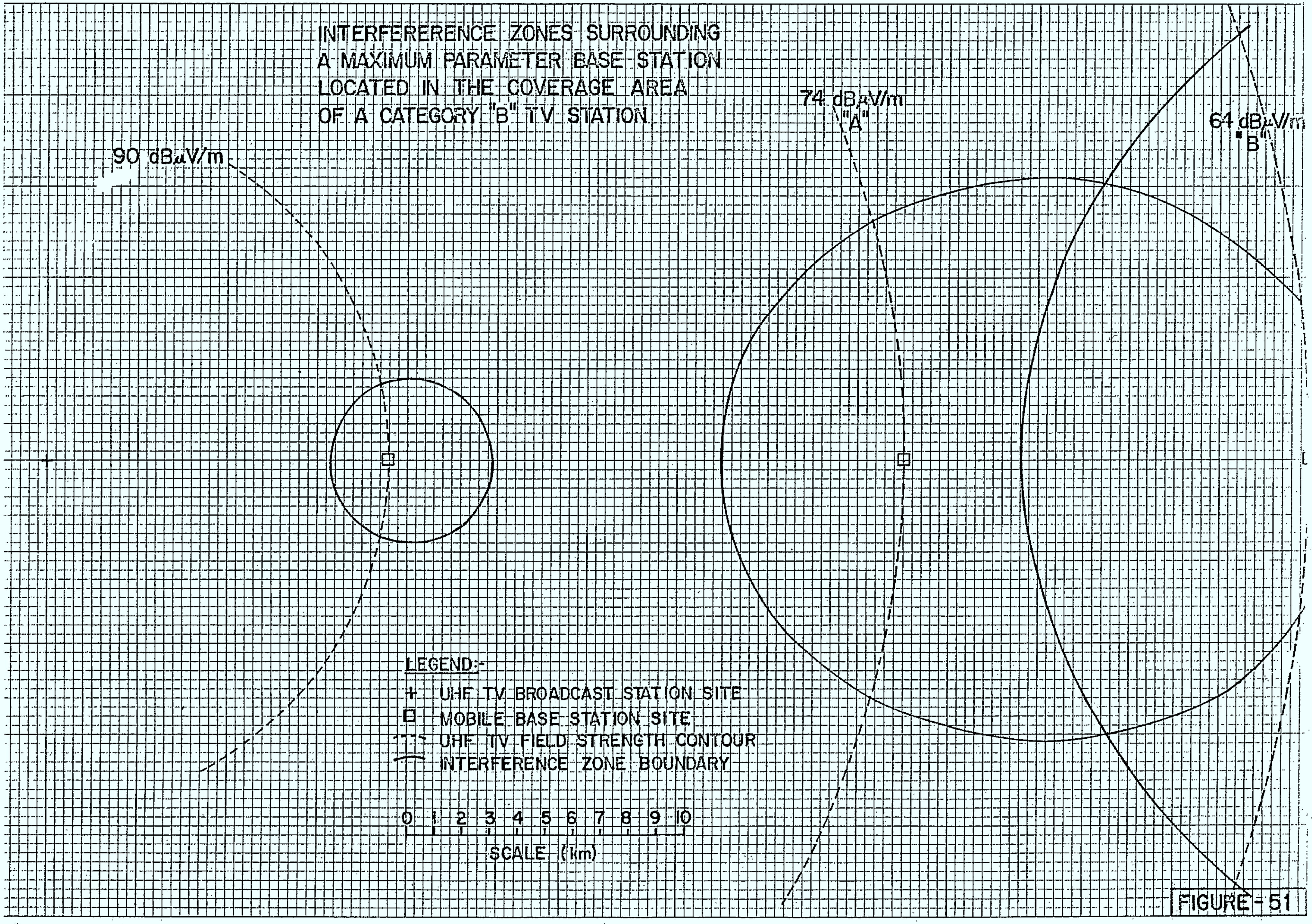
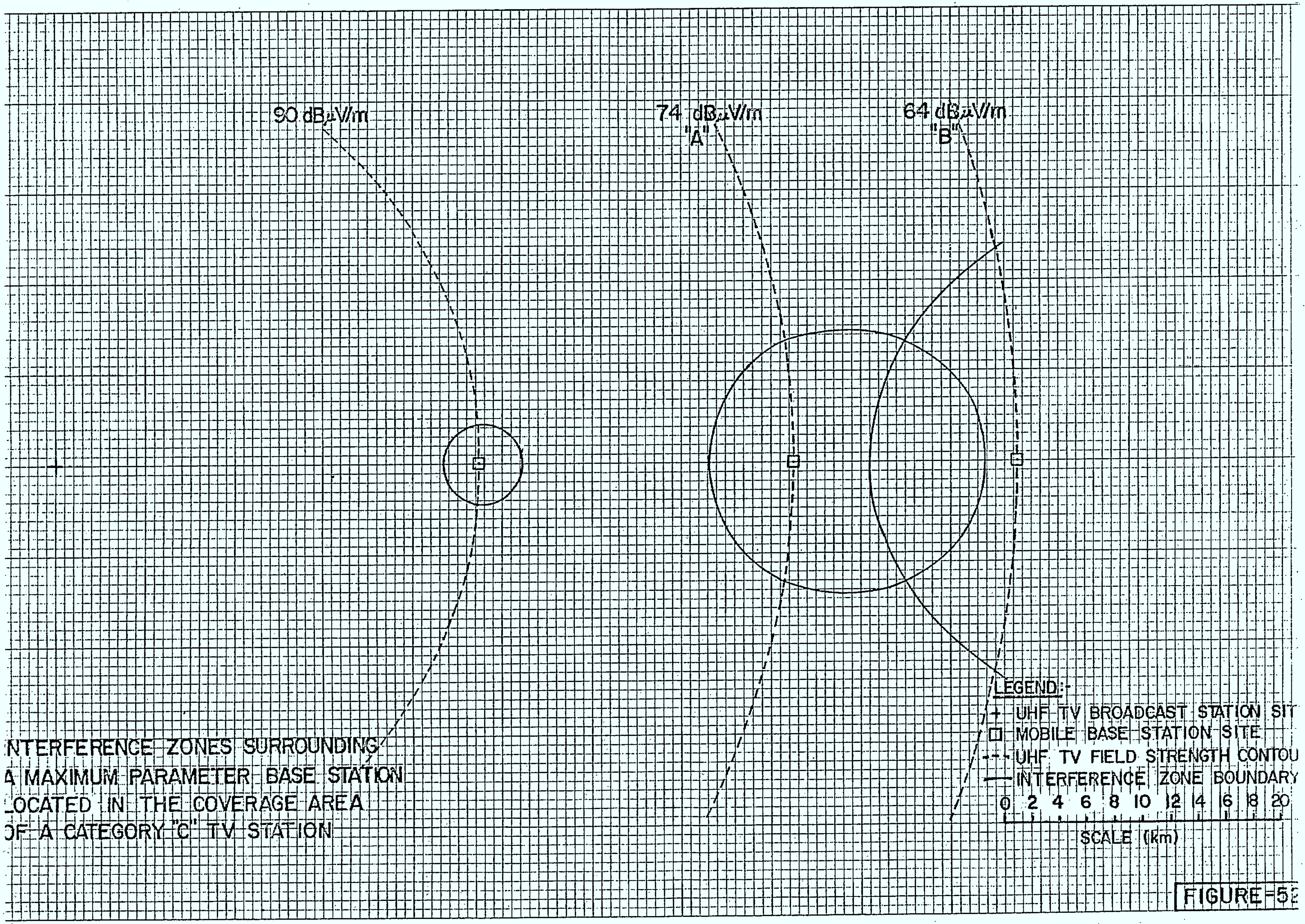

INTERFERERENCE ZONES SURROUNDING
A MAXIMUM PARAMETER BASE STATION
LOCATED IN THE COVERAGE AREA
OF A CATEGORY "B" TV STATION
90 dBμV/m
74 dBμV/m
"A"
64 dBμV/m
"B"
LEGEND:-
UHF TV BROADCAST STATION SITE
MOBILE BASE STATION SITE
UHF TV FIELD STRENGTH CONTOUR
INTERFERENCE ZONE BOUNDARY
0 1 2 3 4 5 6 7 8 9 10
SCALE (km)

FIGURE - 51



NTERFERENCE ZONES SURROUNDING
A MAXIMUM PARAMETER BASE STATION
LOCATED IN THE COVERAGE AREA
OF A CATEGORY "C" TV STATION

FIGURE-5

Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications

ANNEX I

ANALYTICAL EVALUATION OF THE POTENTIAL FOR IMAGE INTERFERENCE TO UHF TV RECEPTION FROM MOBILE OPERATION IN THE 806 - 890 MHz BAND

MARCH 1979

EMC ANALYSIS DIVISION
TELECOMMUNICATION REGULATORY SERVICE

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Background

The proposal for reallocation of UHF TV channels 70-83 (806-890 MHz) from Broadcasting to Mobile services raises questions regarding the possibility of interference between the two services. Most radio receivers are designed with some degree of rejection for signals outside the band in which they operate. However, current TV receivers have been designed to operate in the range 806-890 MHz and therefore may be expected to be unusually sensitive to emissions which fall in this band. Of particular concern is the image response of the receivers, as the band 806-890 corresponds to the image frequencies of TV receivers tuned to channels 55-69. This report investigates the potential for such interference to occur and the extent of restrictions on the deployment of mobile radio that could ensue as a result.

1.2 Image Responses

The image response of any receiver comes about through the action of the mixer which is designed to translate the received signal down to the receiver intermediate frequency (I.F.) for amplification and bandwidth limiting purposes. The mixer produces frequency combinations of the form $\pm (f_{LO} - fr)$ where f_{LO} is the local oscillator frequency and fr is the frequency of any component of the spectrum impinging upon the front end of the receiver. The positive form of this relationship is the desired function of the mixing stage, the negative form is that which results in an image response. Figure 1 is an illustration of the frequency translations which take place in a receiver, resulting in image interference.

Relating this response mechanism to the particular allocation proposal of concern, that of putting land mobile services in the band 806-890 MHz, Figure 2 illustrates the frequency relationship between the proposed allocations and the TV receiver image responses of channels 55-69.

1.3 Purpose of Study

The purpose of this study is to determine the probability and extent of image interference that could be caused to UHF-TV receivers tuned to channels 55-69 by land mobile and base stations operating on their image frequencies in the band 806-890 MHz.

1.4 Study Methodology

The study was conducted in two stages as outlined below.

1.4.1 Receiver Measurements

Limited reliable data regarding the image response characteristics of current TV receivers was available in the literature. Because this information was essential to the study, laboratory tests were conducted on a representative sample of TV receivers to determine their susceptibility to interference through image responses. The susceptibility was quantified in terms of the minimum TV to mobile signal ratio tolerable for perceptible TV degradation.

1.4.2 Compatibility Analysis

On the basis of the image response characteristics derived from the laboratory tests, calculations were carried out to determine the conditions of distance separation from TV and mobile transmitters which would result in signal ratios at the TV receivers which would cause perceptible interference.

2.0 TV RECEIVER IMAGE RESPONSE MEASUREMENTS

2.1 Measurement Method

The method used in determining the image response of TV receivers was basically to inject a television signal and a simulated mobile signal into the antenna terminals of the receiver . The mobile signal (undesired or U) was injected at various frequencies across the image response band of the TV receiver. For each frequency, the minimum ratio of the TV signal (desired or D) to the mobile signal (undesired or U) which caused perceptible degradation of the television audio or video output was recorded. This test was repeated over a range of parameters as follows:

Sets - Nine receivers acquired by rental from retail outlets

Desired Signal - Colour bar for all sets on two channels*
- Off-air for one set, one channel
- Three input levels**

Undesired Signal - Amplitude and frequency variable
- Frequency modulated by 1 KHz at 3 KHz deviation for all sets on two channels

Degradation Criterion - just perceptible degradation of video or audio output.

* The channels used were 56 and 64. These were selected as arbitrarily representative of the range 55 - 69, but also for having image responses within the bands 806-821 and 851-866 MHz, proposed for allocation to trunk and conventional mobile systems, for the base stations and mobile stations, respectively.

** The input levels used were -55, -35 and -15 dBm at the 300 ohm antenna input terminals. These levels were used to determine whether there was a dependency of the image response upon the absolute levels of the desired and undesired signals as well as upon the relative levels. They correspond to signals which would be received at the Grade B contour, somewhat within the Grade A contour and, in the case of a category C TV transmitter, at 8 miles from the station, respectively.

2.2 Results

The results of the receiver tests are summarized in Figure 3. In this figure the abscissa is a scale in MHz of frequency of interfering signal relative to the image frequency of the top edge of the TV channel being impaired. That is, zero corresponds to a frequency 41 MHz above the local oscillator. The ordinate is the ratio in dB of the interfering signal level to TV picture carrier level (U/D) at which perceptible degradation of video or audio signal occurred. The points on the graph in Figure 3 are all of the points measured for 9 sets, 2 channels each, using only the colour bar as the desired signal.

Figure 4, which is a representation similar to Figure 3, shows the relationship between the responses of a single television for a color-bar modulated desired signal and an off-air modulated signal. It illustrates the difference between the perceptibility of interference imposed upon a fixed picture versus that affecting a moving picture, all other parameters being fixed. The observer found interference to the moving picture had to be increased by about 3 dB relative to that for a colour bar picture to be perceptible.

All of the points from Figure 3 were assumed to have, for each frequency, a normal distribution. Based on this assumption, the D/U ratios necessary to avoid perceptible interference for 50% and 90% of the sets represented by the test sample were plotted in Figure 5. For analysis of the interference potential (See Sec. 3) it was decided to use the value represented by the 95% confidence level as characterizing TV receiver image response. That is, any TV which is exposed to a D/U ratio of 20 dB (U/D = -20 dB, from Figure 5) is deemed to suffer perceptible video or audio degradation.

3.0 ANALYSIS OF INTERFERENCE POTENTIAL

3.1 Analysis Method

For the purposes of the analytical investigation the approach used was to determine, for a combination of TV and Mobile system transmitters, in what geographic configurations the image response criterion (D/U = 20 dB) would not be met. To do this, a field strength vs. distance curve was developed for the TV stations and for the mobile service stations. From these, representative "zones of interference" were calculated and plotted.

To derive the field strength versus distance curves, specific characteristics were assumed for the powers, radiator heights, antenna patterns and propagation conditions, as described in the following sections.

3.2 Television System Characteristics

3.2.1 Transmitters

Three categories of television transmitters were assumed for this study, designated A, B and C. Their significant characteristics are given in Table 1.

TABLE 1: TV TRANSMITTER CHARACTERISTICS

CATEGORY	ANTENNA HEIGHT (EHAAT)	ERP (in the horizontal direction)
A	300 ft	10 kw
B	500 ft	100 kw
C	1000 ft	1000 kw

3.2.2 Receivers

On the basis of the results described in Sec. 2.2, the receiver was assumed to have the characteristic that it would be interfered with when exposed to a mobile service emission greater than a level 20 dB below the received signal level from the TV station (D/U = 20 dB).

3.2.3 Antennas

a) TV Transmitter - The vertical radiation pattern assumed for the TV transmit antennas is shown in Figure 6, Curve A. This pattern is typical of the minimum envelope of antennas used for TV broadcasting in the range of gains from 25 to 45 (28 - 33 dB). The effect of the vertical radiation pattern is significant at all distances from the transmitter which are in the range

$$d = \frac{\text{height}}{\tan(\frac{1}{2}\text{ beamwidth})} .$$

b) TV Receiver - The antenna characteristics implicitly assumed for the TV receiver are dual polarized, independent of frequency and isotropic. The assumed height was 30 ft.

3.2.4 Propagation

Propagation assumed for the television signal was based on FCC report 6602, for average terrain height variation of 50 meters. The specific curves used were those for UHF TV (channels 14-83) for 50% of the time and 50% of the locations. At distances less than about 10 miles, these curves were modified by the antenna vertical radiation pattern to account for reductions in the emitted ERP at elevation angles below the main beam of the radiator. At distances less than 1 mile, where the Report 6602 curves are not applicable, free space propagation was assumed.

On the basis of these conditions, field strength vs distance curves were derived which were applicable to the three categories of TV transmitters considered. These are shown in Figures 7, 8 and 9 for categories A, B and C respectively.

3.3 Land Mobile System Characteristics

3.3.1 Base Station

Two categories of land mobile base stations were considered: a typical base station and a maximum parameter base station. The latter corresponds to the maximum emission levels which would be permitted in the band allocated to conventional and trunked base stations. See Table 2 for the pertinent characteristics assumed.

3.3.2 Mobile Stations

Only one mobile configuration was assumed for this analysis. Its characteristics are shown in Table 2.

TABLE 2: LAND MOBILE CHARACTERISTICS

CATEGORY	ANTENNA HEIGHT (EHAAT)	ERP (AT 0^{o} ELEVATION)
Maximum Parameter Base	500 ft	500 watts
Typical Base	150 ft	150 watts
Mobile	6 ft	100 watts

3.3.3 Antennas

a) Base Stations - The antenna vertical radiation pattern assumed for this study is shown in Figure 6, Curve B. This pattern is typical of the maximum envelope of antennas omni-directional in azimuth with gains in the range 6-10 dB.

b) **Mobile Stations** - Because mobile antennas are strongly influenced in their directional characteristics by the vehicle mounting, no directional pattern was deemed to be applicable to the mobile antenna in the vertical plane. For this study, the antenna was assumed to be an isotrope.

3.3.4 Propagation

Land Mobile Base Stations - Field strength vs distance curves similar to those for the TV stations were derived and are shown in Figures 9 and 10 for the 'typical' and 'maximum parameter' base stations respectively. They include the effects of the vertical radiation pattern of the antenna (see Fig. 6, Curve B). The propagation model used in developing these curves was that of Egli, "Radio Propagation Above 40 MC Over Irregular Terrain", Proceedings of the IRE, October, 1957.

3.4 Interference Criterion

For the purposes of this analysis it was decided to use a single criterion for judging whether interference would or would not occur to TV reception because of responses to transmissions on the image frequencies. The measure which was used, as described in Sec. 2.2, was a picture carrier to land mobile signal ratio (D/U) of 20 dB. That is, any D/U value greater than 20 dB was deemed acceptable, any lesser value was considered to represent an interference situation.

Recognizing that the assumptions leading to this criterion are critical to the analysis, a trial to determine the sensitivity of this analysis to variations in the criterion was made. To do this it was arbitrarily assumed that the criterion was improved by 25 dB (ie. D/U = -5 dB) and the analysis was duplicated using this new criterion. The results are compared in Sec. 4.2.

3.5 Determination of System Interactions

To carry out the analysis a graphical method was used. First, it was assumed that the potentially interfering mobile station was located at an arbitrary distance from a television transmitter, within its grade B contour coverage area. Then for distances from the TV transmitter, close to the transmitter separation distance, the TV signal field strength was determined, and by subtracting 20 dB, the mobile field strength necessary to cause interference was calculated. From the field strength curve for the mobile transmitter, the distance which corresponded to this field strength was determined. Using these two distances as radii, arcs were drawn about the TV and mobile stations respectively, their points of intersection defining two points on a curve. This procedure was repeated to give sufficient points that a continuous curve could be sketched. This was called the interference contour. All locations on the side of the contour closer to the mobile service transmitter do not meet the interference criterion, and were deemed to be areas in which image interference would occur.

This procedure was repeated for a variety of transmitter configurations and transmitter types to yield the interference contours shown in Figures 12, 13 and 16. Figures 14 and 15, which have identical parameters to 12 and 13 respectively were derived in exactly the same way except that the interference criterion used was D/U = -5 dB (See Sec. 3.4).

4.0 RESULTS OF ANALYSIS

4.1 Interference Potential

Examination of Figures 12, 13 and 16 indicates that the potential for interference at the image responses of TV receivers from UHF mobile signals occurs at distances in the order of miles from the mobile service transmitters. Recognizing the potential densities of TV receivers and mobile stations within the coverage area of a TV transmitter, the situation is clearly unsatisfactory on the basis of this analysis. It is possible that most of the TV receivers in a TV broadcast service area could fall within the interference zone of one or more mobile system transmitters.

4.2 Sensitivity Analysis

As described in Sec. 3.4 an arbitrary improvement of the situation by 25 dB was introduced into the calculation to determine whether the analysis results would show a significant improvement in the potential interference situation. Examination of Figures 14 and 15 clearly shows that although there is some reduction in the interference zones, the result is still unsatisfactory. Further calculation shows that to achieve a maximum 1000' interference radius at the Grade B service contour of a TV transmitter would require that the TV image response for no interference be D/U = -40 dB, a 60 dB improvement over the criterion used in this analysis.

As another approach to reaching a reasonable sharing criterion the concept of the exclusion of land mobile service transmitters from the TV service areas which their emissions would affect was tried. It was stipulated that the TV service area was defined by the grade B contour, and calculations were done to determine the minimum distance from that contour that a mobile station could be placed such that the 20 dB D/U criterion could be met.

The results of these calculations are shown in Table 3 for the range of TV and mobile system parameters assumed in this study. It should be noted that, although Table 3 includes separation distances for the interference criterion D/U = -5 dB, there is no technological basis for assuming this criterion to be a valid estimator of current or future UHF-TV receiver image performance.

5.0 CONCLUSIONS

The results of this analysis clearly show that for the system parameters assumed, the reception of television channels 55-69 has a high potential for being degraded by mobile service transmissions in the band 806-890 MHz. Furthermore, the sensitivity analysis indicates that a significant improvement in the isolation assumed, whether through improved receiver parameters or changes in other parameters of the interference model, does not provide substantial improvement in the prognosis for compatible operation of the two services.

The only remaining basis for compatible operation of the two services appears to be through an arrangement of geographical sharing. That is, the only mobile frequencies that can be assigned in the vicinity of a TV coverage area are those which do not fall on the image of the TV channel(s) assigned.

There is no improvement in TV image response rejection anticipated in the near future which will ameliorate this situation.

TV TRANSMITTERS	LAND MOBILE SERVICE TRANSMITTERS					
	BASE EHAAT 150 ft ERP 150 W		BASE EHAAT 500 ft ERP 500 W		MOBILE EHAAT 6 ft ERP 100 W	
	D/U = 20 dB	D/U = -5 dB	D/U = 20 dB	D/U = -5 dB	D/U = 20 dB	D/U = -5 dB
Category "A" EHAAT 300 ft ERP 10 kW	29	19	48	24	17	16
Category "B" EHAAT 500 ft ERP 100 kW	42	32	61	37	30	29
Category "C" EHAAT 1000 ft ERP 1000 kW	57	47	76	52	45	44

TABLE 3 - Minimum Separation Distance (Miles) Required Between Mobile and TV Transmitters to Prevent Image Interference to VHF TV Channels 55-69.

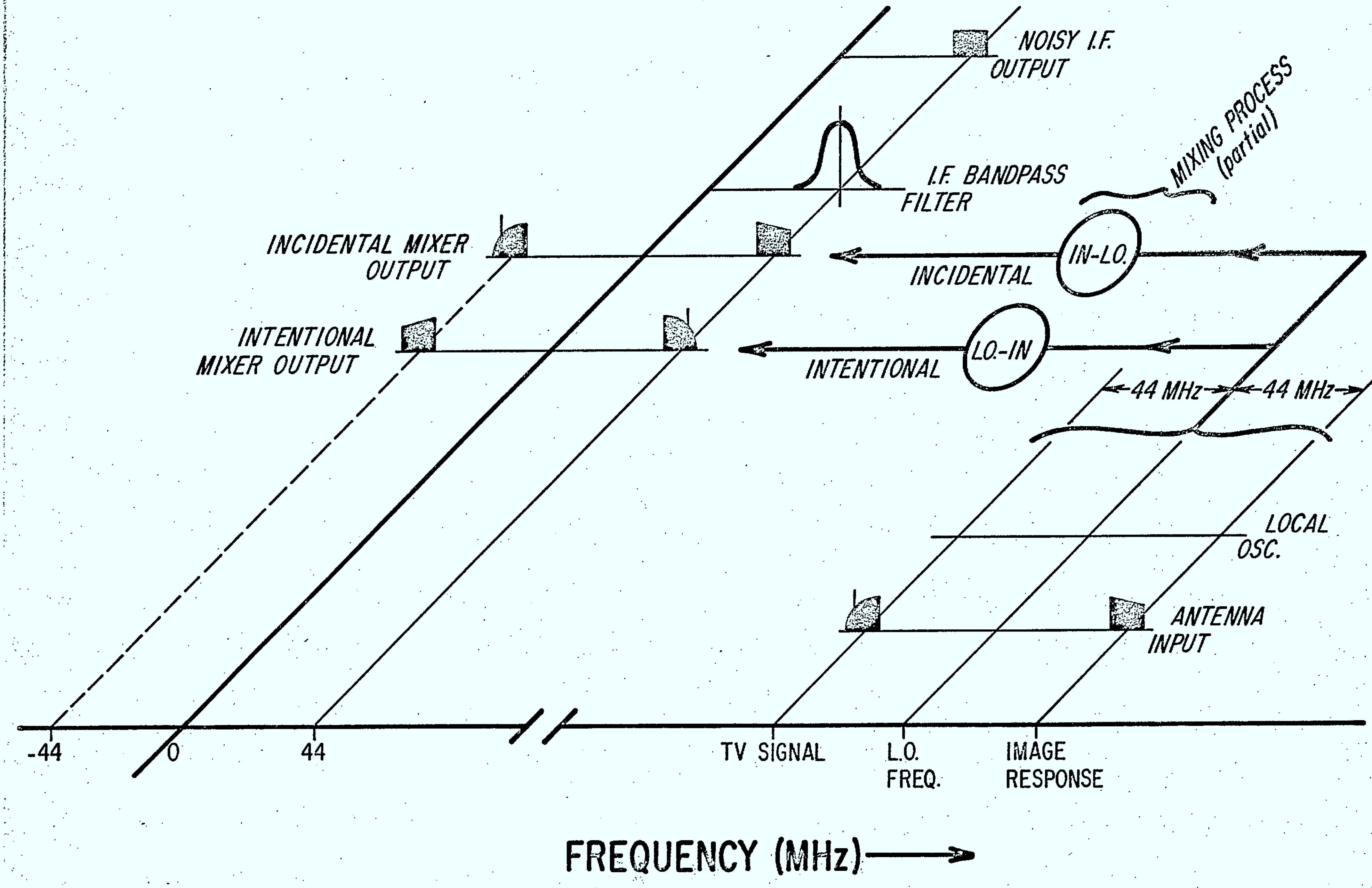
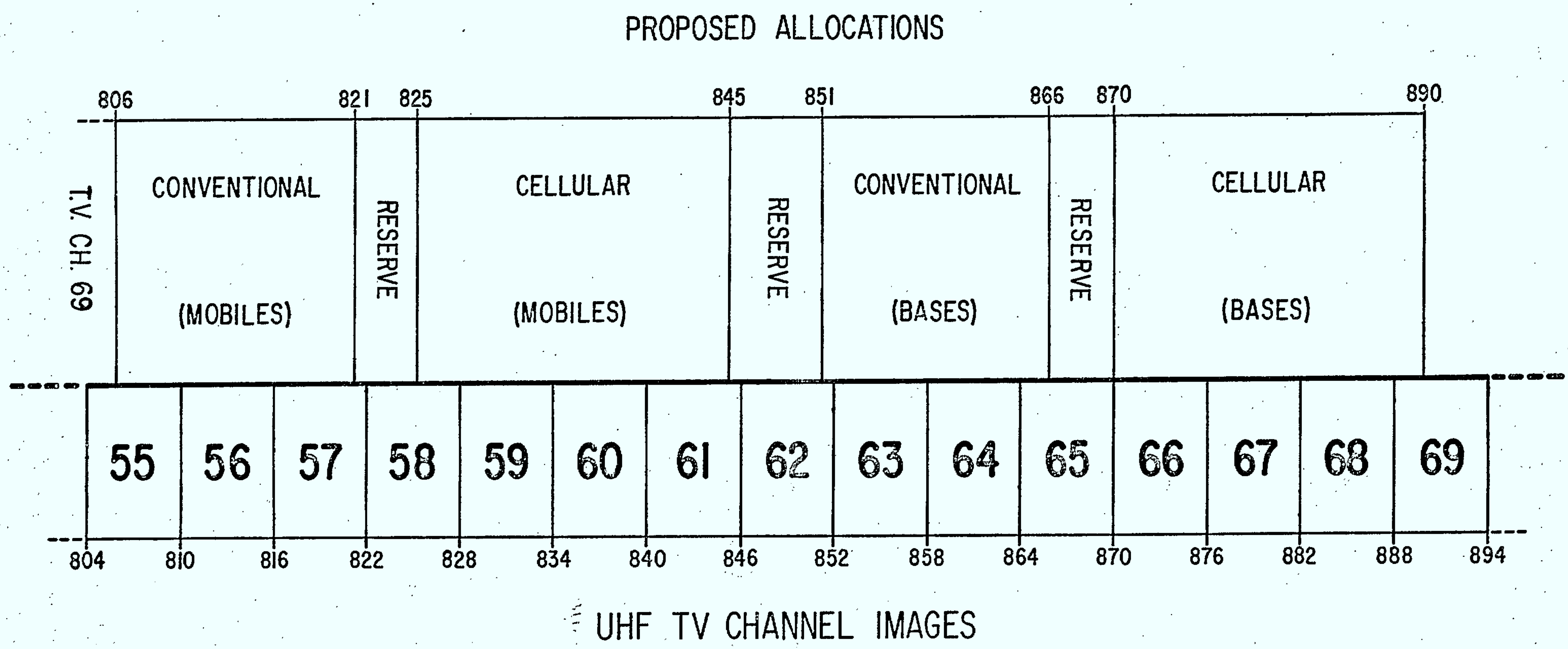
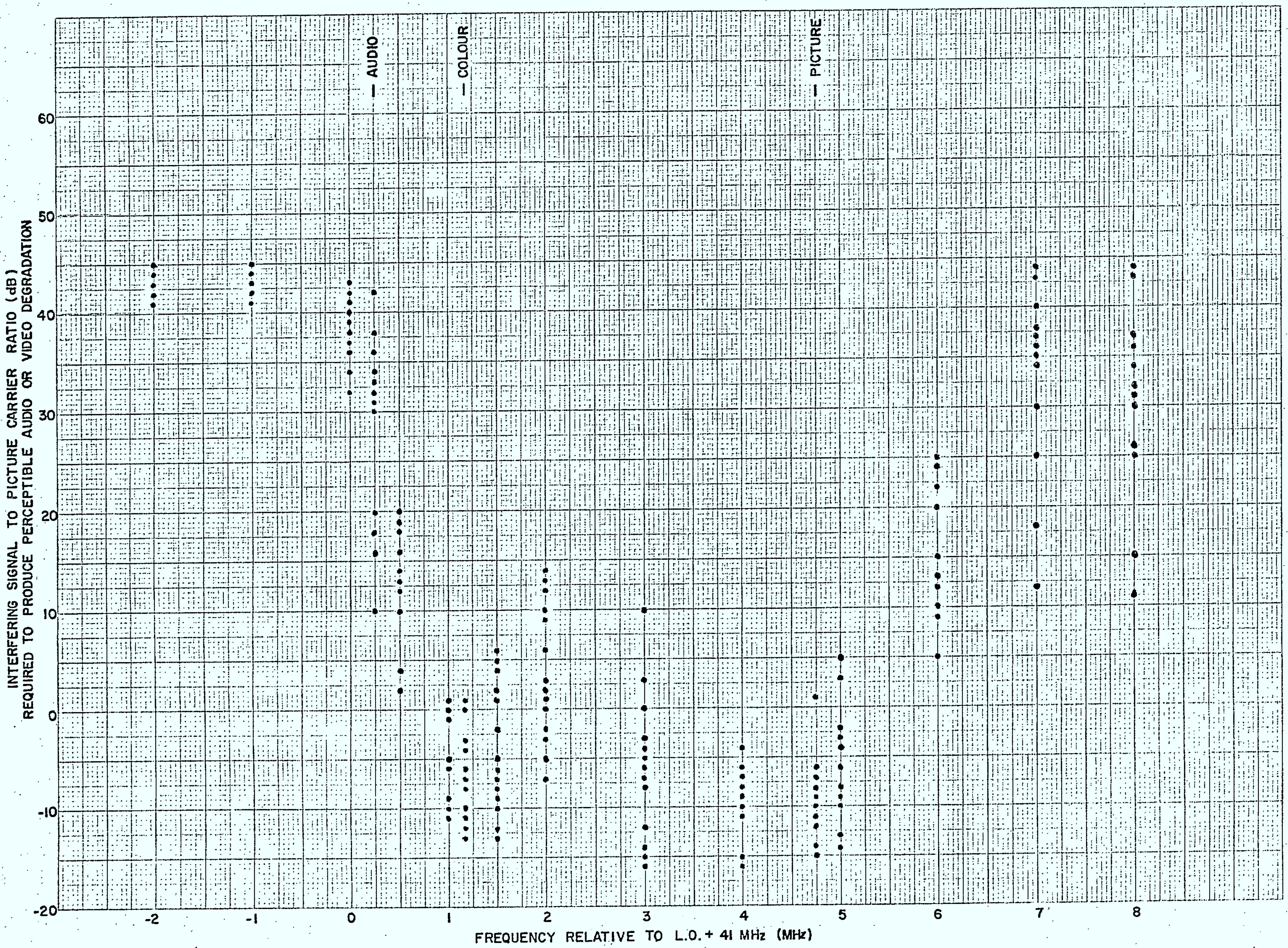

NOISY I.F.
OUTPUT
MIXING PROCESS
(partial)
I.F. BANDPASS
FILTER
INCIDENTAL MIXER
OUTPUT
IN-LO.
INCIDENTAL
INTENTIONAL
MIXER OUTPUT
LO.-IN
INTENTIONAL
44 MHz
44 MHz
LOCAL
OSC.
ANTENNA
INPUT
-44
0
44
TV SIGNAL
L.O.
FREQ.
IMAGE
RESPONSE
FREQUENCY (MHz)

FIGURE 1



RELATIONSHIP BETWEEN PROPOSED MOBILE ALLOCATIONS AND UHF TV IMAGE RESPONSES

FIGURE 2



INTERFERING SIGNAL TO PICTURE CARRIER RATIO (dB)
REQUIRED TO PRODUCE PERCEPTIBLE AUDIO OR VIDEO DEGRADATION
60
50
40
30
20
10
0
-10
-20
AUDIO
COLOUR
PICTURE
-2
-1
0
1
2
3
4
5
6
7
8
FREQUENCY RELATIVE TO L.O. + 41 MHz (MHz)

FIGURE 5

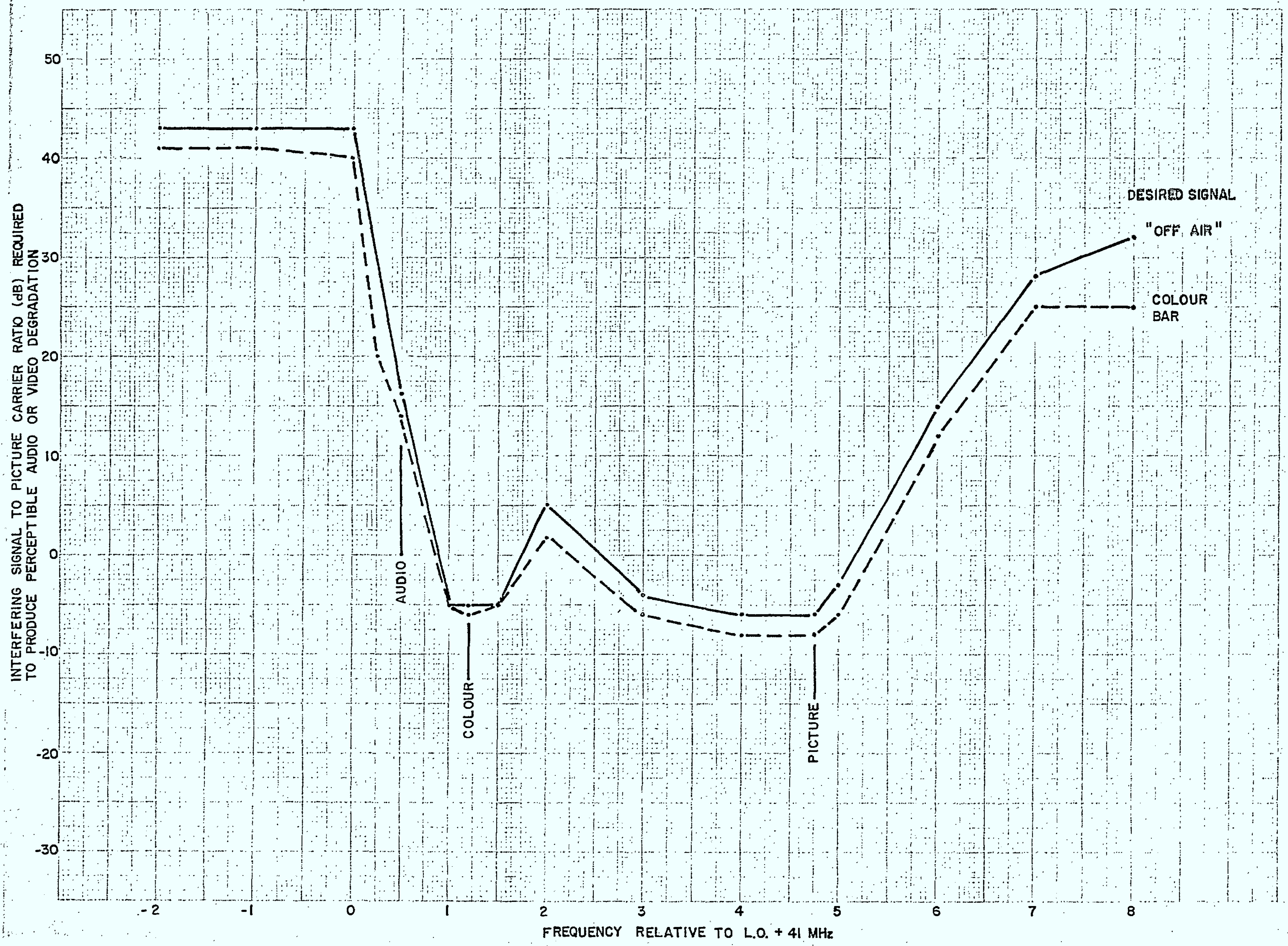

INTERFERING SIGNAL TO PICTURE CARRIER RATIO (dB) REQUIRED TO PRODUCE PERCEPTIBLE AUDIO OR VIDEO DEGRADATION
50
40
30
20
10
0
-10
-20
-30
DESIRED SIGNAL
"OFF AIR"
COLOUR BAR
AUDIO
COLOUR
PICTURE
-2
-1
0
1
2
3
4
5
6
7
8
FREQUENCY RELATIVE TO L.O. + 41 MHz

FIGURE 4

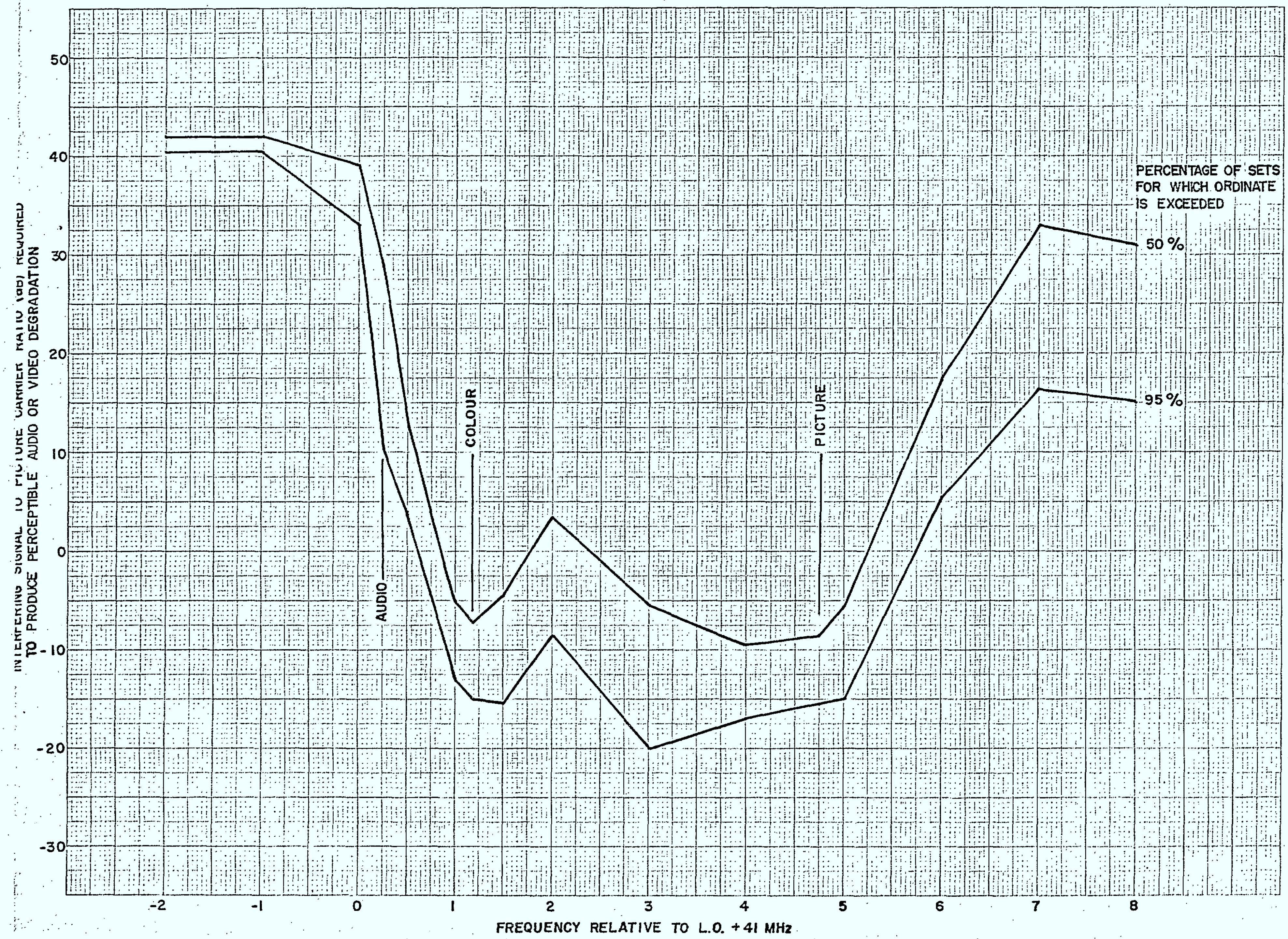
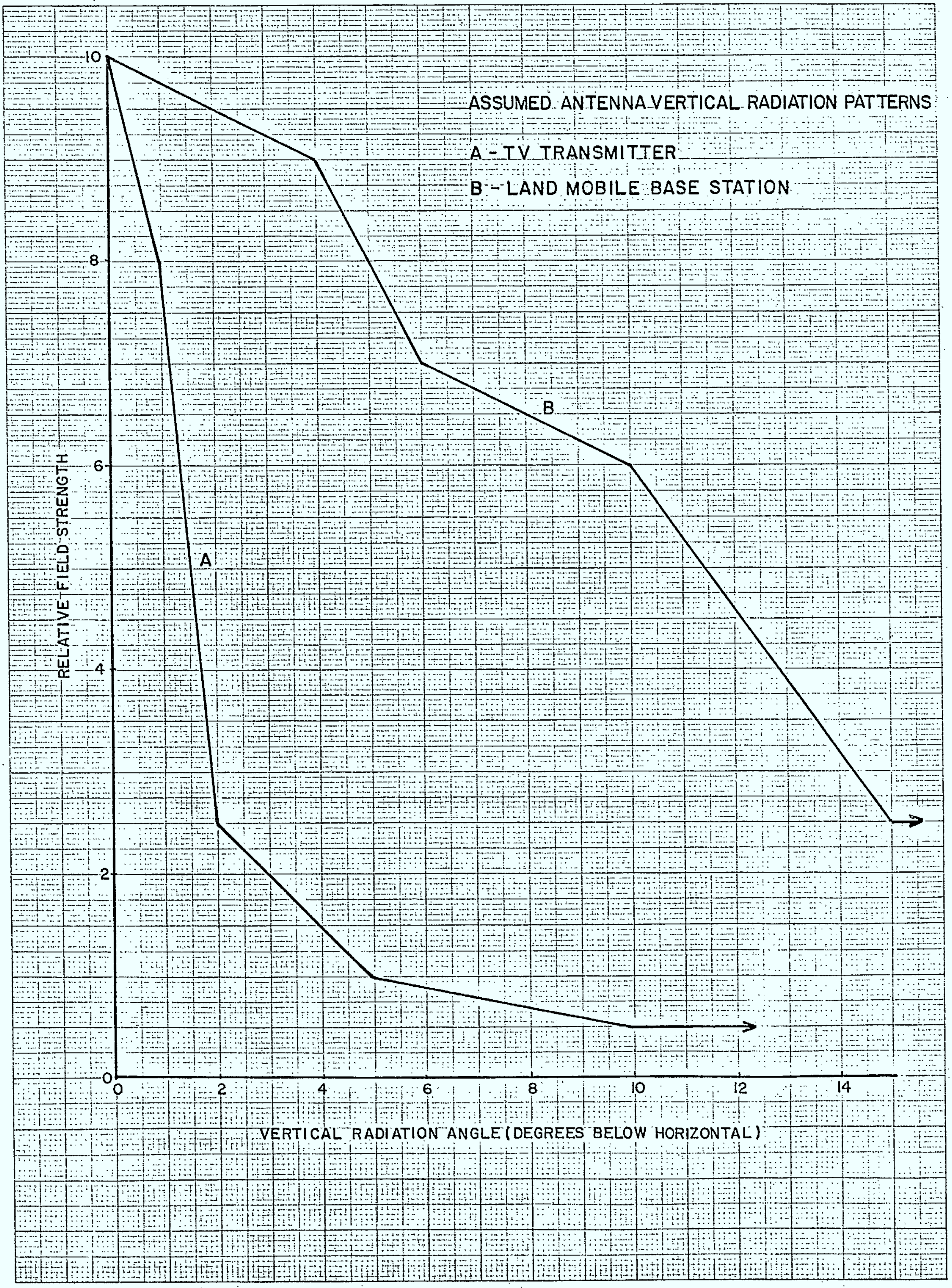

INTERFERING SIGNAL TO PICTURE CARRIER RATIO (dB) REQUIRED
TO PRODUCE PERCEPTIBLE AUDIO OR VIDEO DEGRADATION
50
40
30
20
10
0
-10
-20
-30
-2
-1
0
1
2
3
4
5
6
7
8
FREQUENCY RELATIVE TO L.O. + 41 MHz
PERCENTAGE OF SETS FOR WHICH ORDINATE IS EXCEEDED
50 %
95 %
AUDIO
COLOUR
PICTURE

FIGURE 5

FIGURE 6


ASSUMED ANTENNA VERTICAL RADIATION PATTERNS
A - TV TRANSMITTER
B - LAND MOBILE BASE STATION
RELATIVE FIELD STRENGTH
10
8
6
4
2
0
A
B
0
2
4
6
8
10
12
14
VERTICAL RADIATION ANGLE (DEGREES BELOW HORIZONTAL)

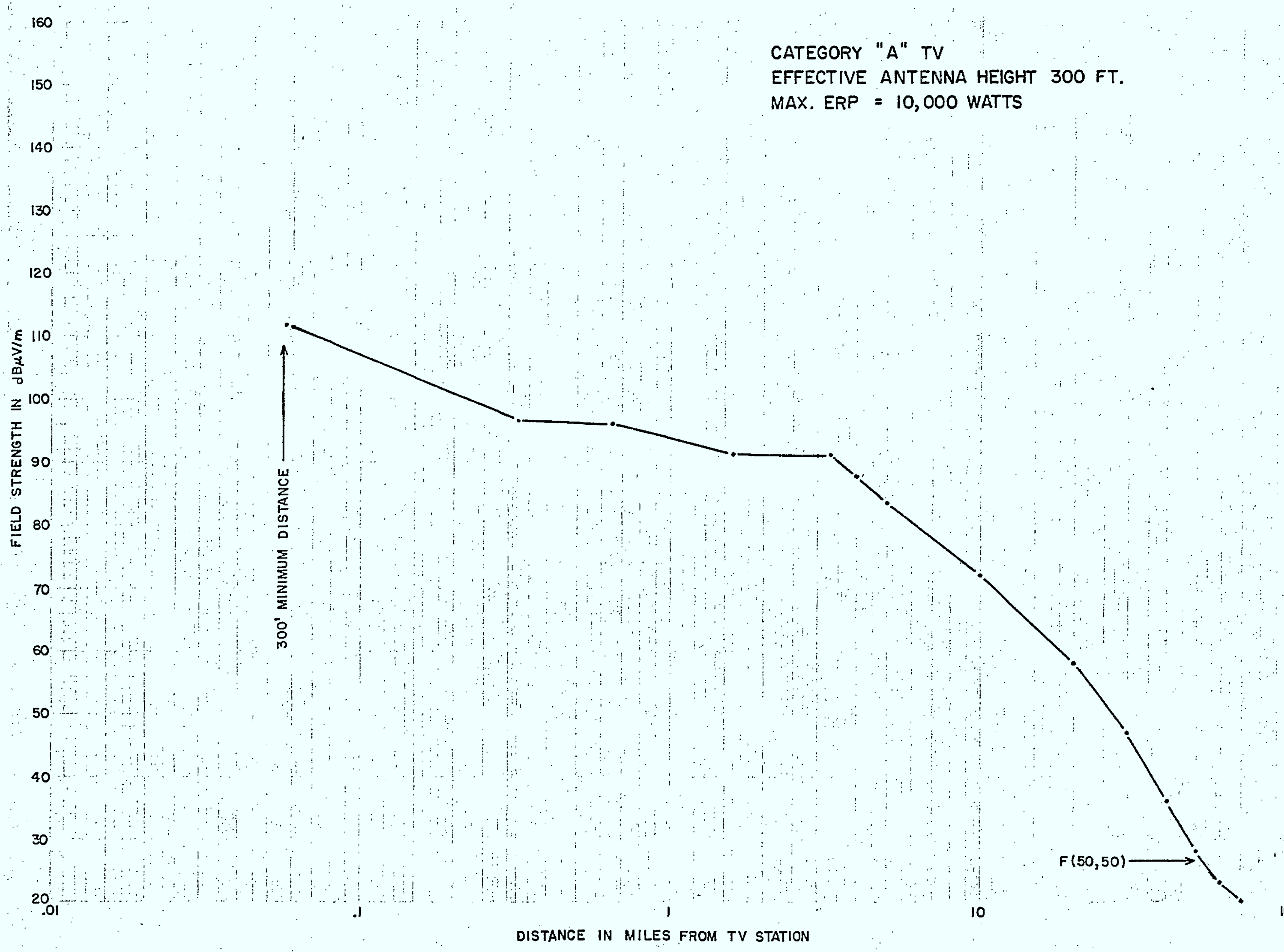

CATEGORY "A" TV
EFFECTIVE ANTENNA HEIGHT 300 FT.
MAX. ERP = 10,000 WATTS
FIELD STRENGTH IN dBμV/m
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
300' MINIMUM DISTANCE
F(50,50)
.01
.1
1
10
100
DISTANCE IN MILES FROM TV STATION

FIGURE 7

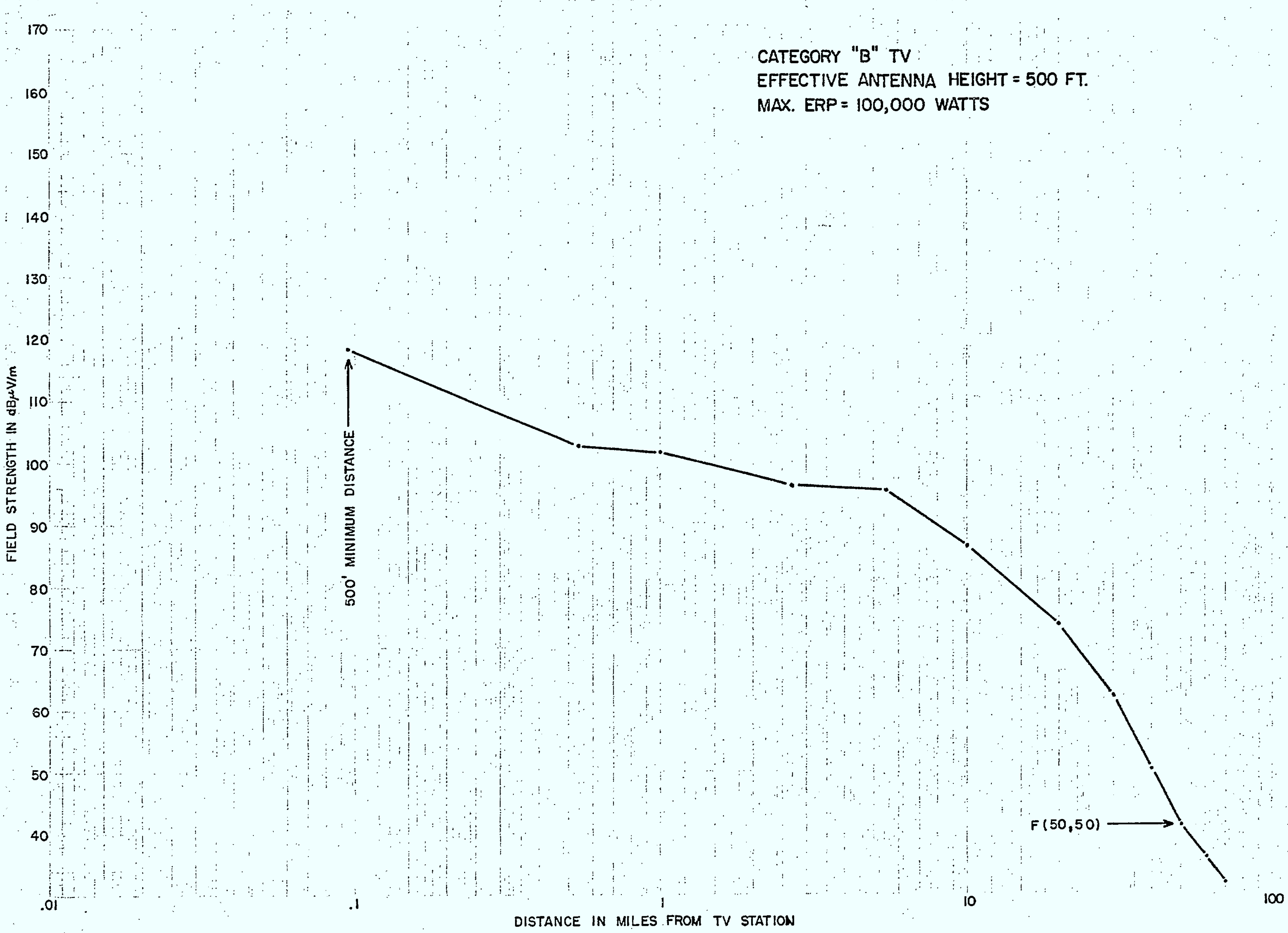

CATEGORY "B" TV
EFFECTIVE ANTENNA HEIGHT = 500 FT.
MAX. ERP = 100,000 WATTS
FIELD STRENGTH IN dBμV/m
170
160
150
140
130
120
110
100
90
80
70
60
50
40
500' MINIMUM DISTANCE
F (50,50)
.01
.1
1
10
100
DISTANCE IN MILES FROM TV STATION

FIGURE 3

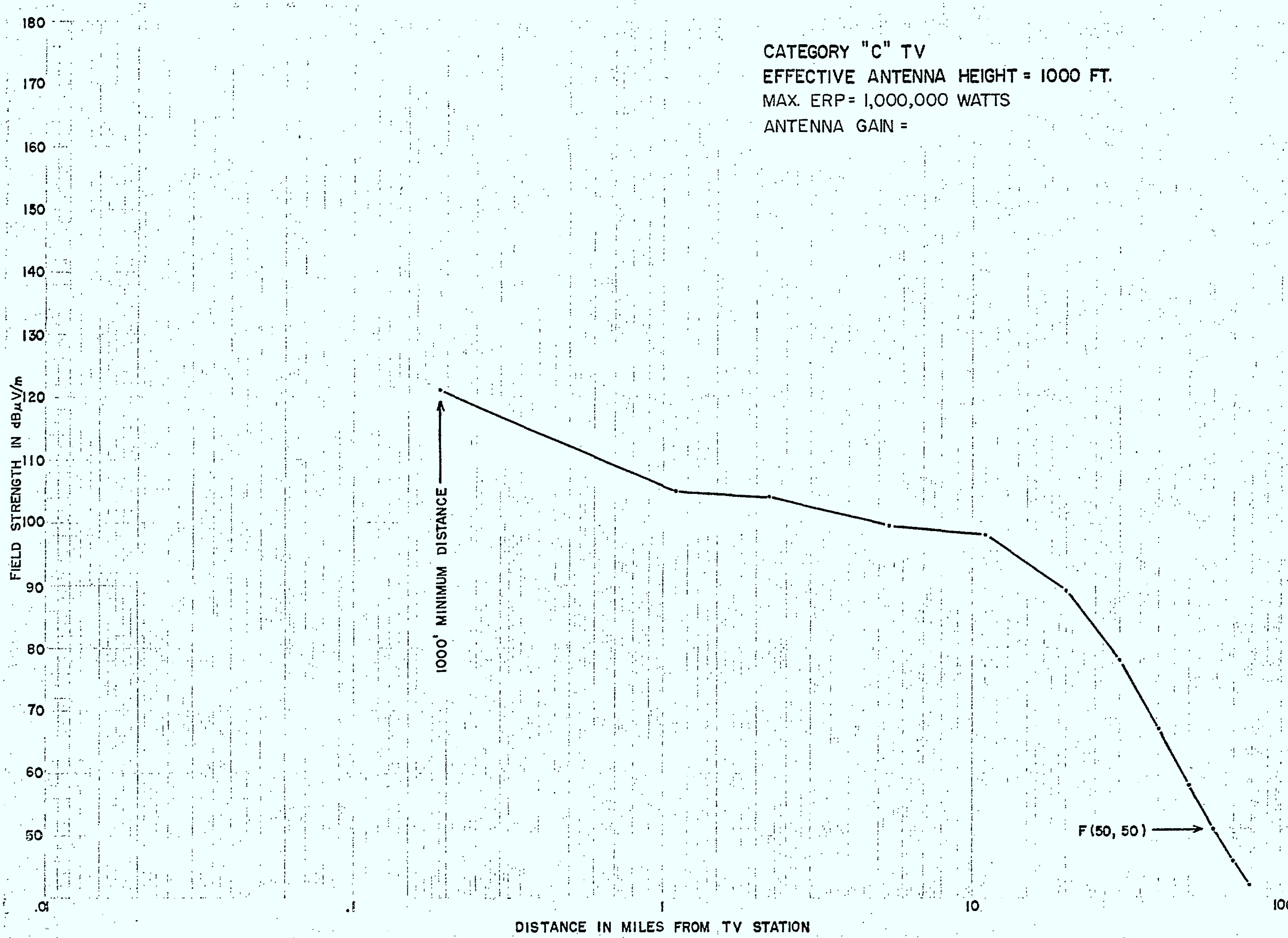

CATEGORY "C" TV
EFFECTIVE ANTENNA HEIGHT = 1000 FT.
MAX. ERP = 1,000,000 WATTS
ANTENNA GAIN =
FIELD STRENGTH IN dBμV/m
180
170
160
150
140
130
120
110
100
90
80
70
60
50
1000' MINIMUM DISTANCE
F(50, 50)
.01
.1
1
10
100
DISTANCE IN MILES FROM TV STATION

FIGURE 9

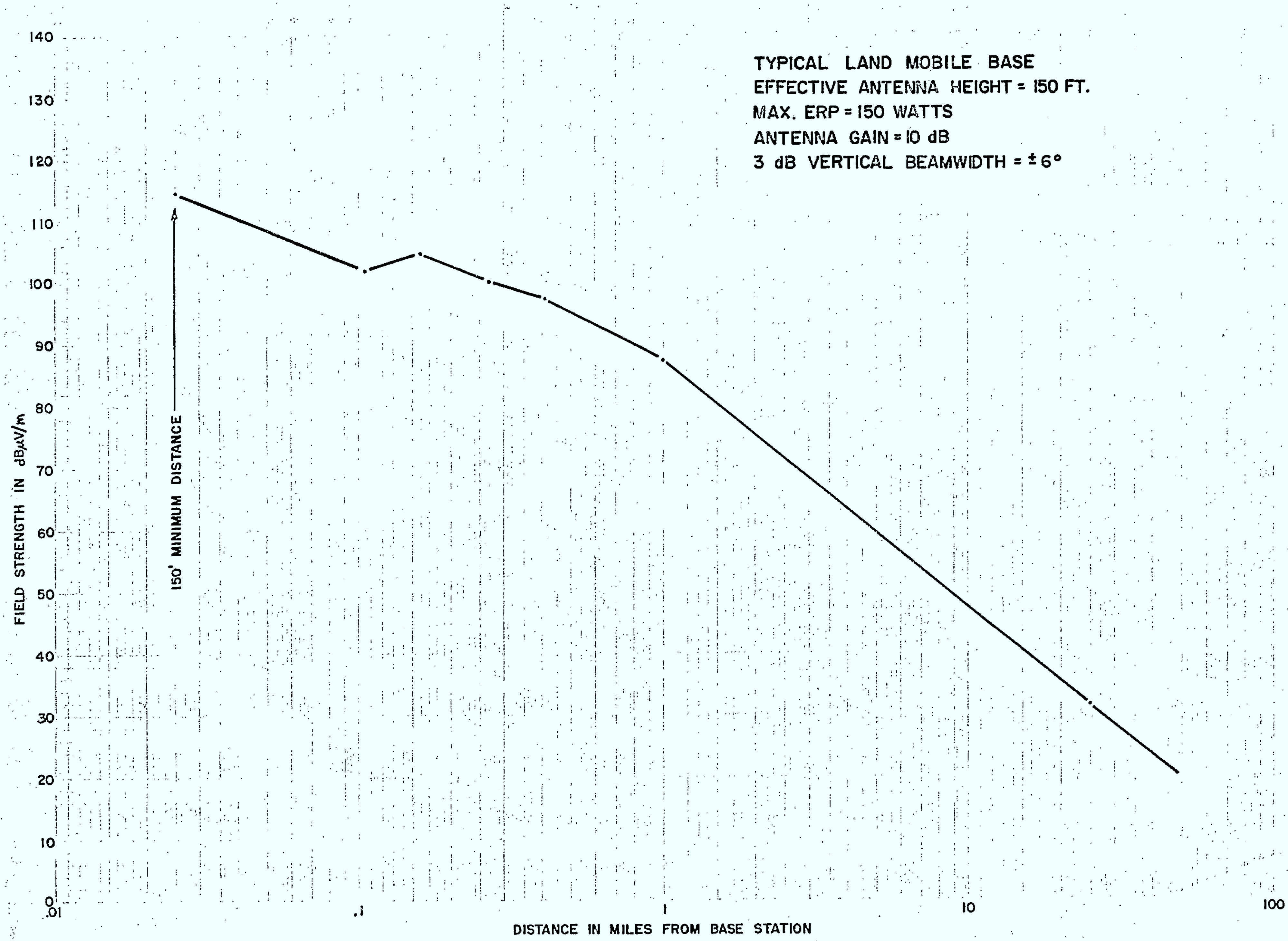

TYPICAL LAND MOBILE BASE
EFFECTIVE ANTENNA HEIGHT = 150 FT.
MAX. ERP = 150 WATTS
ANTENNA GAIN = 10 dB
3 dB VERTICAL BEAMWIDTH = ± 6°
150' MINIMUM DISTANCE
FIELD STRENGTH IN dBμV/m
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
.01
.1
1
10
100
DISTANCE IN MILES FROM BASE STATION

FIGURE 10

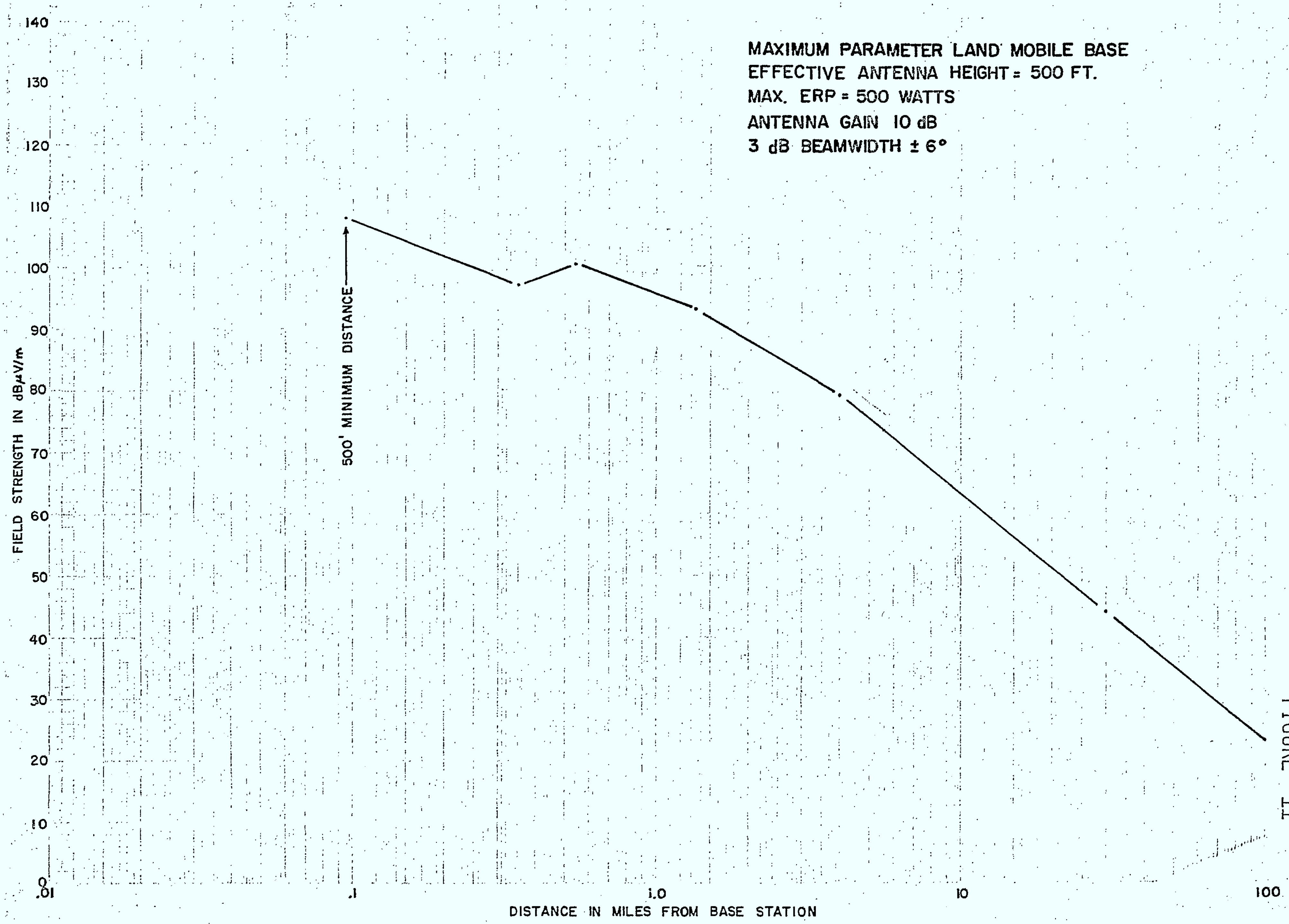
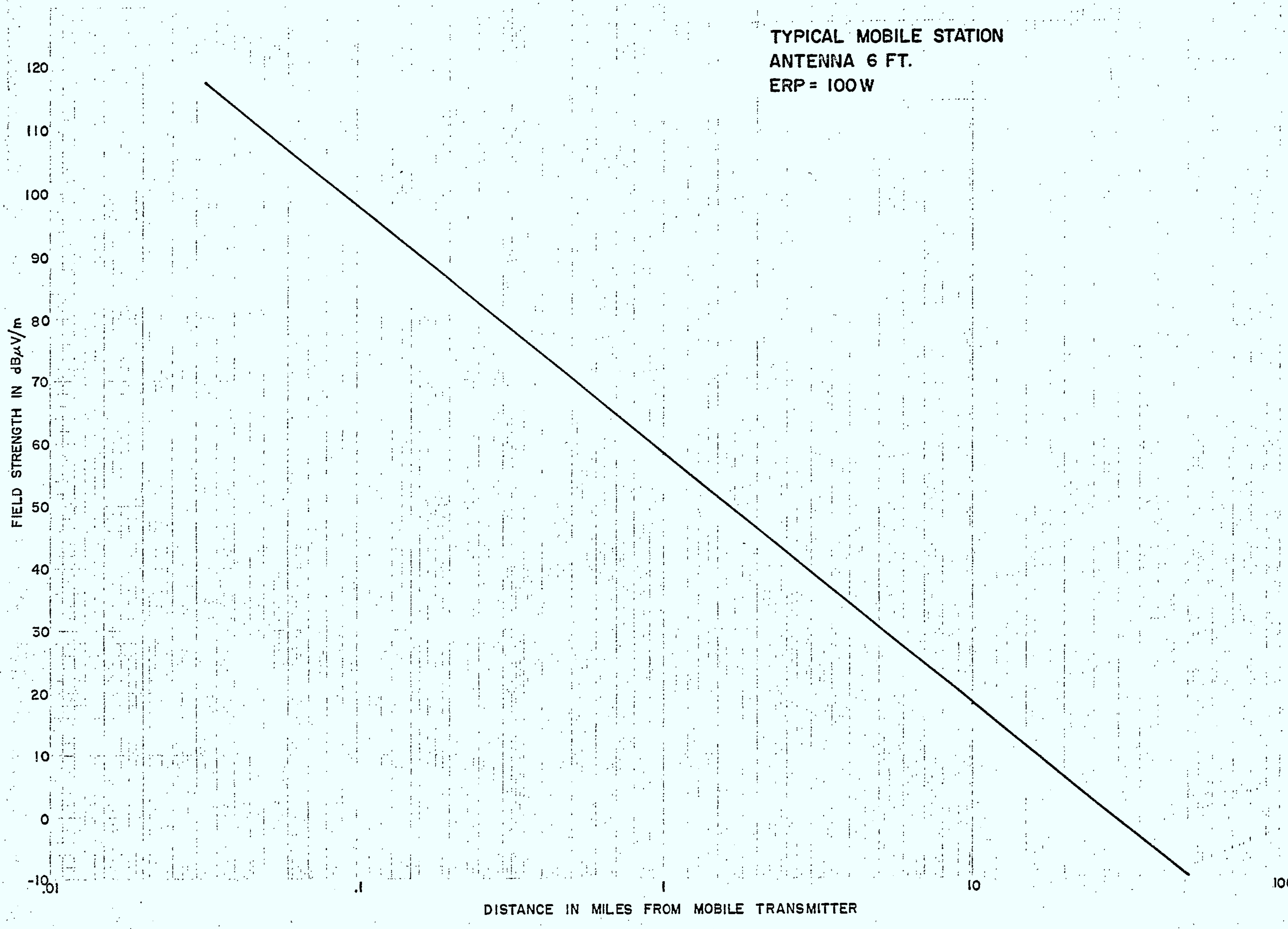

MAXIMUM PARAMETER LAND MOBILE BASE
EFFECTIVE ANTENNA HEIGHT = 500 FT.
MAX. ERP = 500 WATTS
ANTENNA GAIN 10 dB
3 dB BEAMWIDTH ± 6°
500' MINIMUM DISTANCE
FIELD STRENGTH IN dBμV/m
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
.01
.1
1.0
10
100
DISTANCE IN MILES FROM BASE STATION

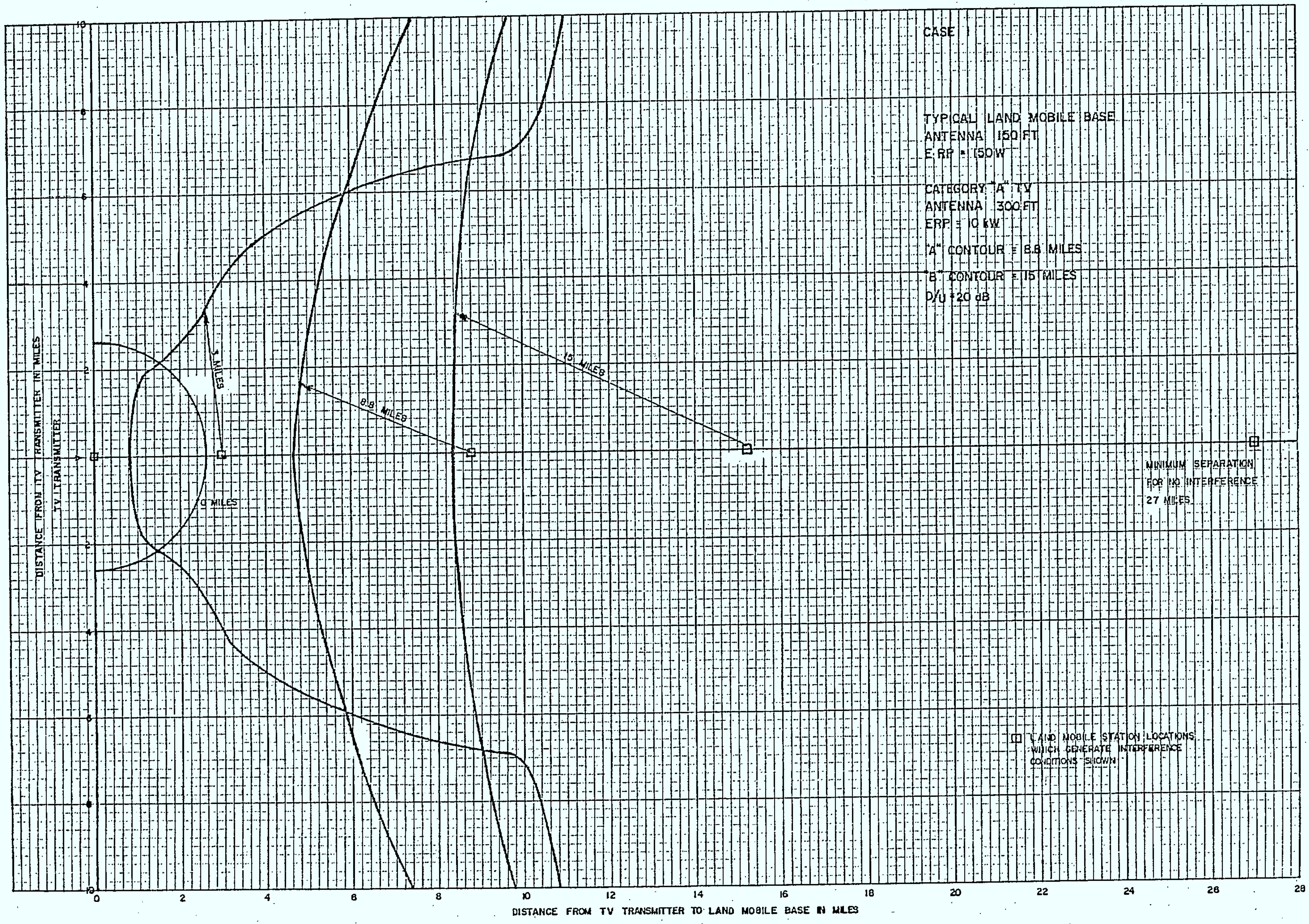
FIGURE 11



TYPICAL MOBILE STATION
ANTENNA 6 FT.
ERP = 100 W
FIELD STRENGTH IN dBμV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
.01
.1
1
10
100
DISTANCE IN MILES FROM MOBILE TRANSMITTER

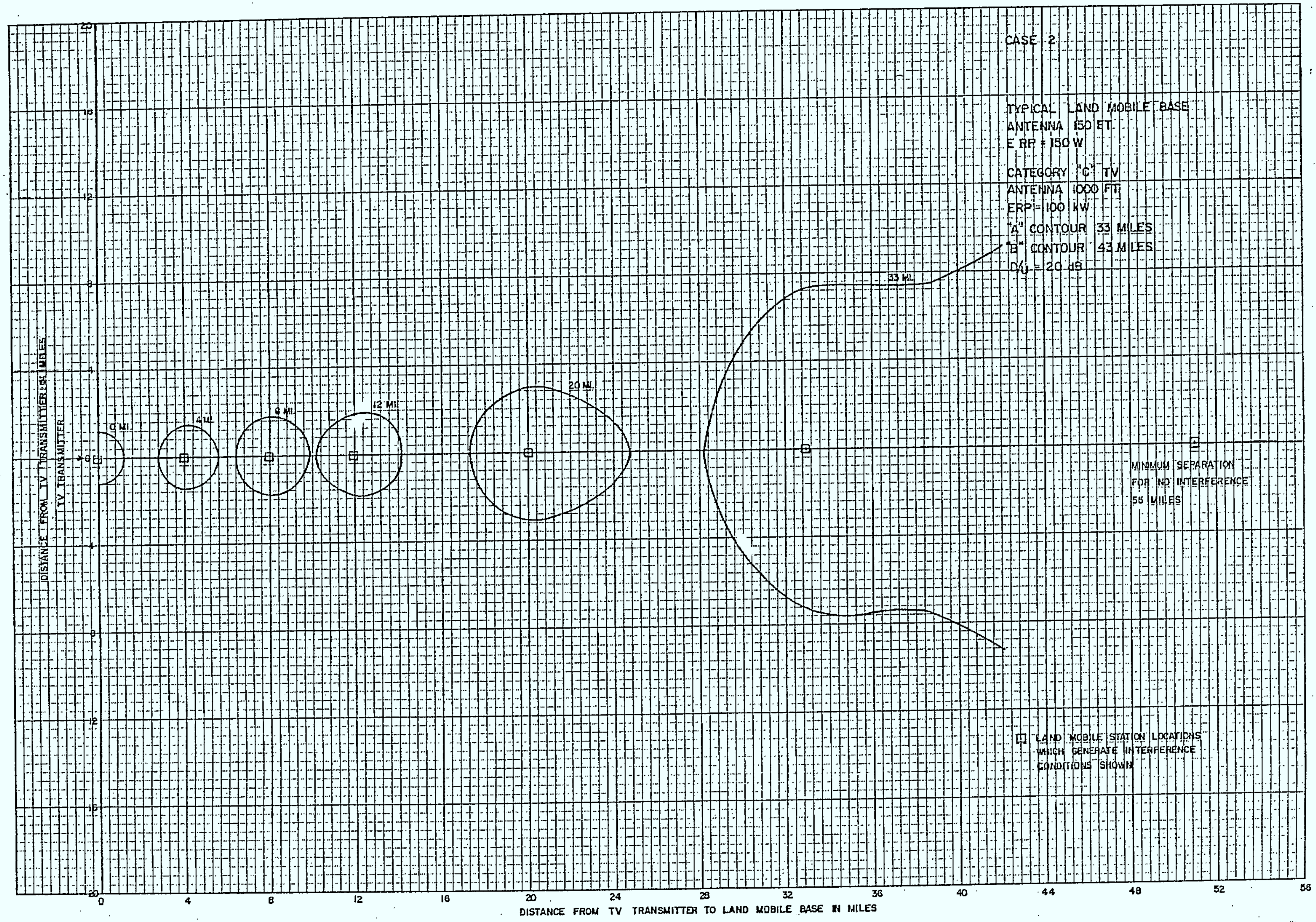
FIGURE 12

FIGURE 13



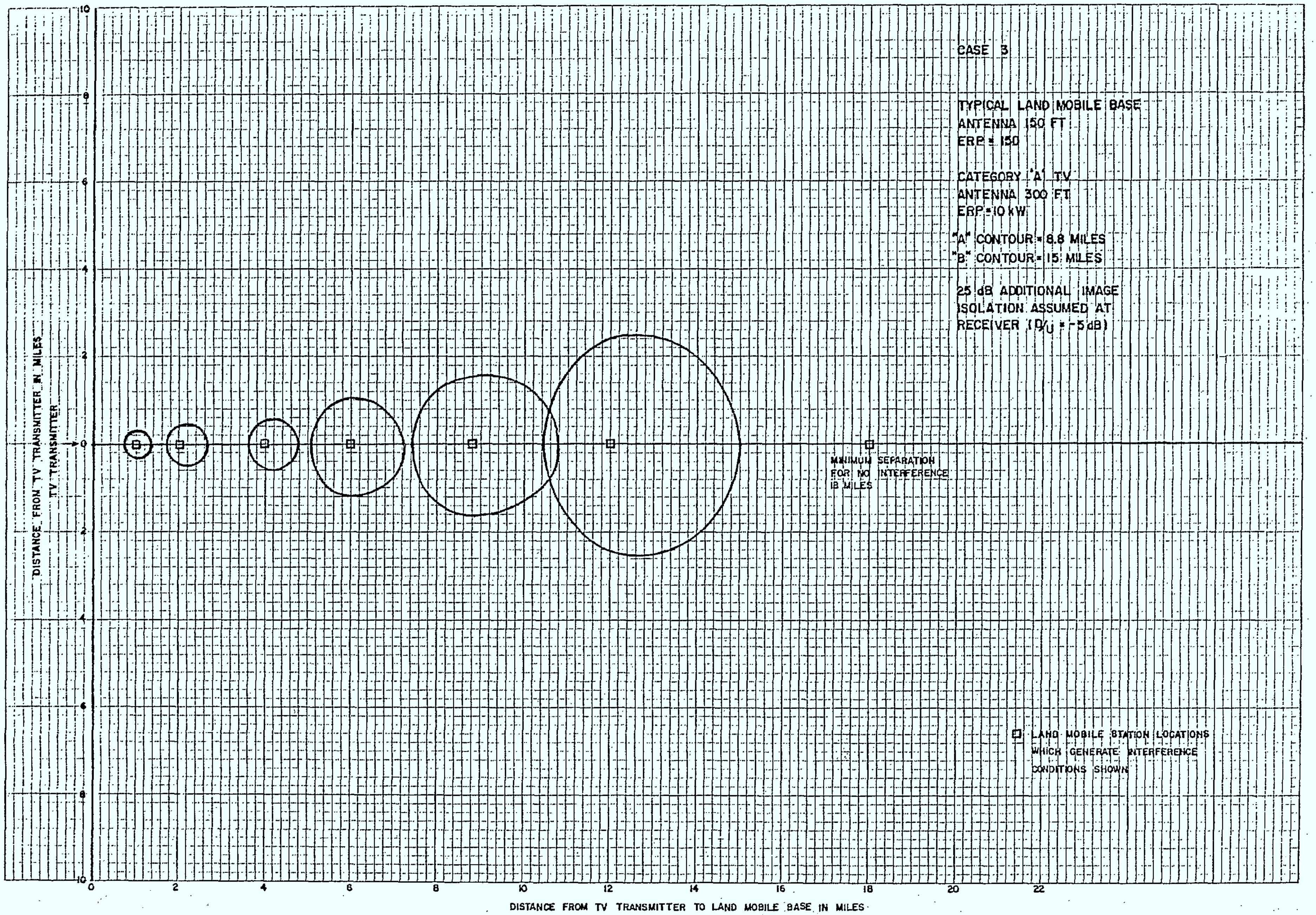
CASE
TYPICAL LAND MOBILE BASE
ANTENNA 150 FT
ERP = 150 W
CATEGORY "A" TV
ANTENNA 300 FT
ERP = 10 kW
"A" CONTOUR = 8.8 MILES
"B" CONTOUR = 15 MILES
D/U = 20 dB
3 MILES
8.8 MILES
15 MILES
0 MILES
MINIMUM SEPARATION FOR NO INTERFERENCE 27 MILES
LAND MOBILE STATION LOCATIONS WHICH GENERATE INTERFERENCE CONDITIONS SHOWN
DISTANCE FROM TV TRANSMITTER IN MILES
TV TRANSMITTER
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
DISTANCE FROM TV TRANSMITTER TO LAND MOBILE BASE IN MILES

FIGURE 14



CASE 2
TYPICAL LAND MOBILE BASE
ANTENNA 150 FT
E RP = 150 W
CATEGORY "C" TV
ANTENNA 1000 FT
ERP = 100 KW
"A" CONTOUR 33 MILES
"B" CONTOUR 43 MILES
D/U = 20 dB
0 MI.
4 MI.
8 MI.
12 MI.
20 MI.
33 MI.
MINIMUM SEPARATION
FOR NO INTERFERENCE
56 MILES
LAND MOBILE STATION LOCATIONS
WHICH GENERATE INTERFERENCE
CONDITIONS SHOWN
DISTANCE FROM TV TRANSMITTER
TV TRANSMITTER
20
16
12
8
4
0
4
8
12
16
20
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
DISTANCE FROM TV TRANSMITTER TO LAND MOBILE BASE IN MILES

FIGURE 15



CASE 3
TYPICAL LAND MOBILE BASE
ANTENNA 150 FT
ERP = 150
CATEGORY 'A' TV
ANTENNA 300 FT
ERP = 10 kW
"A" CONTOUR = 8.8 MILES
"B" CONTOUR = 15 MILES
25 dB ADDITIONAL IMAGE
ISOLATION ASSUMED AT
RECEIVER (D/U = -5 dB)
MINIMUM SEPARATION
FOR NO INTERFERENCE
18 MILES
LAND MOBILE STATION LOCATIONS
WHICH GENERATE INTERFERENCE
CONDITIONS SHOWN
DISTANCE FROM TV TRANSMITTER IN MILES
TV TRANSMITTER
DISTANCE FROM TV TRANSMITTER TO LAND MOBILE BASE IN MILES

FIGURE 16

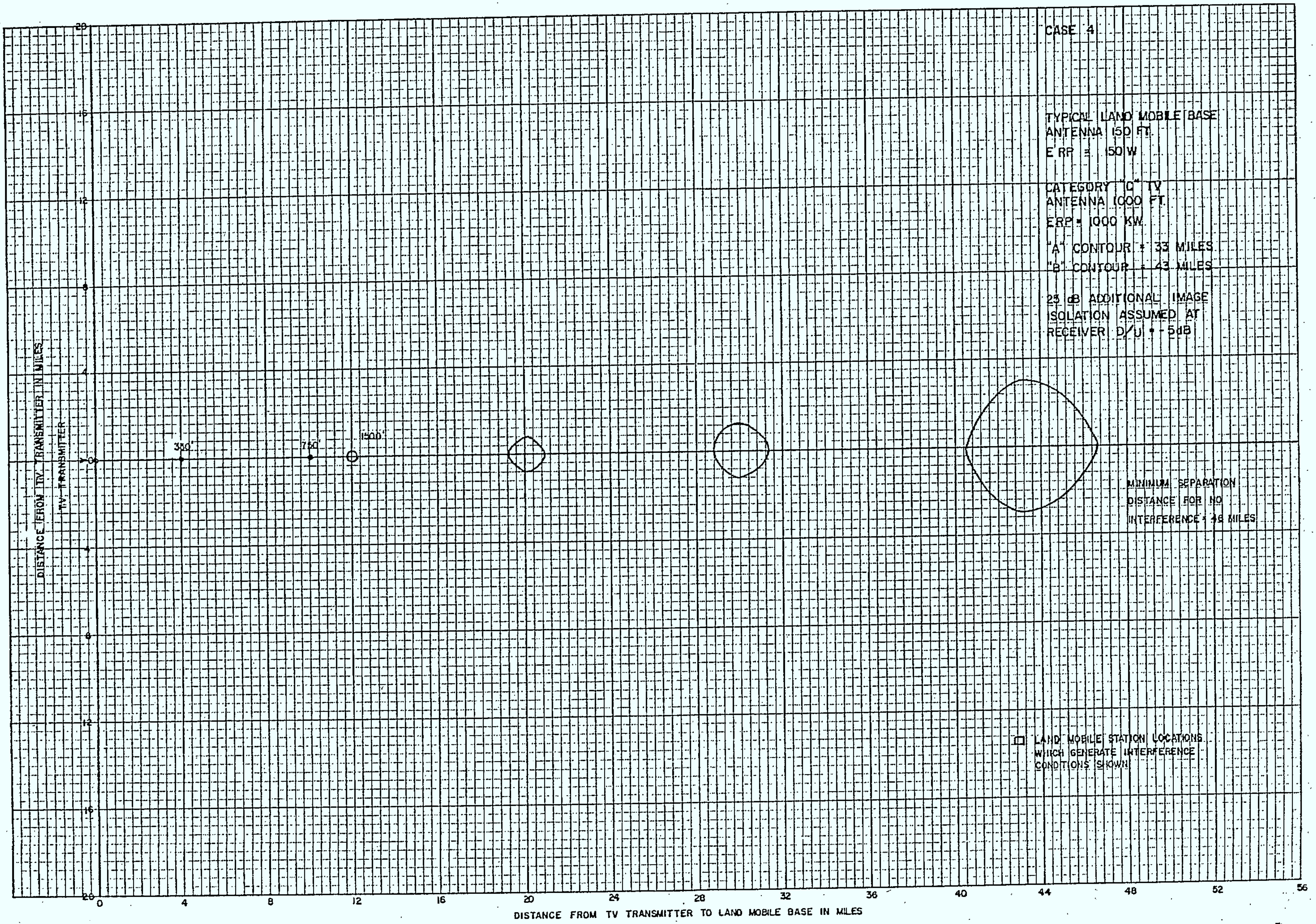
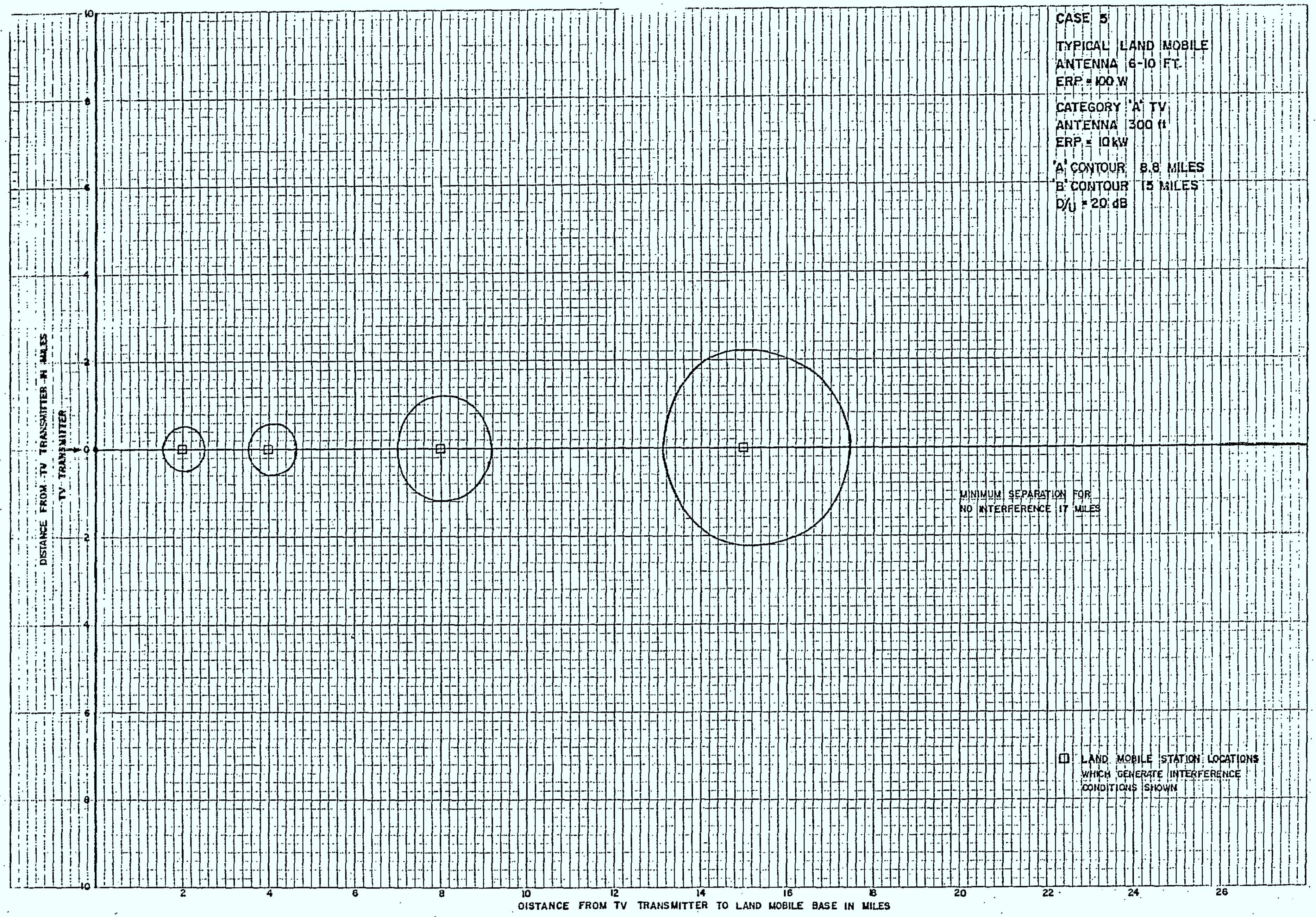

CASE 4
TYPICAL LAND MOBILE BASE
ANTENNA 150 FT.
ERP = 150 W
CATEGORY "C" TV
ANTENNA 1000 FT.
ERP = 1000 KW
"A" CONTOUR = 33 MILES
"B" CONTOUR = 43 MILES
25 dB ADDITIONAL IMAGE
ISOLATION ASSUMED AT
RECEIVER D/U = -5dB
350'
750'
1500'
MINIMUM SEPARATION
DISTANCE FOR NO
INTERFERENCE = 46 MILES
LAND MOBILE STATION LOCATIONS
WHICH GENERATE INTERFERENCE
CONDITIONS SHOWN
DISTANCE FROM TV TRANSMITTER IN MILES
TV TRANSMITTER
20
16
12
8
4
0
4
8
12
16
20
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
DISTANCE FROM TV TRANSMITTER TO LAND MOBILE BASE IN MILES

FIGURE 17



CASE 5
TYPICAL LAND MOBILE
ANTENNA 6-10 FT.
ERP = 100 W
CATEGORY 'A' TV
ANTENNA 300 ft
ERP = 10 kW
'A' CONTOUR 8.8 MILES
'B' CONTOUR 15 MILES
D/U = 20 dB
MINIMUM SEPARATION FOR
NO INTERFERENCE 17 MILES
LAND MOBILE STATION LOCATIONS
WHICH GENERATE INTERFERENCE
CONDITIONS SHOWN
DISTANCE FROM TV TRANSMITTER IN MILES
TV TRANSMITTER
10
8
6
4
2
0
2
4
6
8
10
2
4
6
8
10
12
14
16
18
20
22
24
26
DISTANCE FROM TV TRANSMITTER TO LAND MOBILE BASE IN MILES

IMAGE INTERFERENCE TO UHF TV RECEPTION FROM MOBILE OPERATION IN THE 806-890 MHz BAND