SECTION III

Shielding of Drop Wire and Associated Hardware

SECTION III

Shielding of Drop Wire and Associated Hardware

"THE EVALUATION OF INGRESS AND EGRESS

PROBLEMS IN THE C.A.T.V. SUB LOW FREQUENCY SPECTRUM"

#18 ST - 36100 - 8 - 1367

March 28, 1980

CONTENTS

II
FIGURES

III

FIGURES (cont'd.)

IV
TABLES

3.0 INTRODUCTION

In C.A.T.V. systems today a large percentage of service calls are related to drops. A high percentage of VHF radiation and ingress problems are also drop related. The industry faces excessive maintenance costs because of this. The largest amount of cable in a C.A.T.V. network is drop wire and the largest number of connectors in a system are "F" or drop connectors.

The objectives of the drop tests are as follows:

1) To determine the shielding effectiveness of drop wires and associated hardware.
2) To determine if there is a "weak link" in the drop and hardware and, if so, what it is.
3) To compare the shielding of drops and distribution lines and to determine which is most critical for HF transmission.

There are many types of 75Ω drop wire available. The shield of these drop wires is usually either a single metal braid (single shield) or a single metal braid over a metal foil (double shield).

Braids are either copper (bare or tinned) or aluminum. The shielding given by the braid is related to the amount of metal is usually braid as well as its material. The amount of metal is usually expressed as percent coverage of the braid. All other things being equal, the higher the percent coverage, the better the shielding effectiveness of the drop wire.

The metal foil on double shielded cable is aluminum. In some cables the foil is loosely wrapped around the dielectric, in others it is "bonded".

3.1 DROP WIRE SHIELDING AND BRAID PERCENTAGE

Twelve different types of drop wire were tested for shielding effectiveness as described in Appendix 2.3. Results of the shielding tests for each cable are shown in Fig. 3.1 to Fig. 3.12. These results can be compared in Fig. 3.13.

The braid percentage for each type of drop wire was calculated using the method described in Appendix 3.1. Braid measurements and drop cable descriptions are shown in Table 3.1.

TABLE 3.1 DROP WIRE BRAID MEASUREMENTS AND DESCRIPTIONS

CABLE SAMPLES

#	*P	N	C	D	d	A	K
1	6.2	2	16	.160	.0065	24.19	35.46
2	5.0	3	16	.154	.0063	18.09	50.92
3	6.5	3	16	.150	.0065	22.59	55.10
4	7.2	7	16	.150	.0060	24.60	92.50
5	6.5	3	14	.143	.0060	24.33	48.73
6	8.0	7	16	.154	.0060	27.54	92.52
7	7.0	3	14	.150	.0060	26.97	47.84
8	8.0	7	16	.146	.0036	26.48	95.63
9	8.0	7	16	.150	.0060	26.97	93.28
10	6.0	3	14	.154	.0060	24.08	45.92
11	8.0	3	16	.154	.0065	27.54	56.09
12	9	7	16	.147	.0064	29.45	96.8

* P Number of picks

N Number of strands per carry

C Number of carriers

D Diameter of Dielectric under Braid (in)

A Angle of Intersecting Picks (degrees)

K Calculated percent of braid

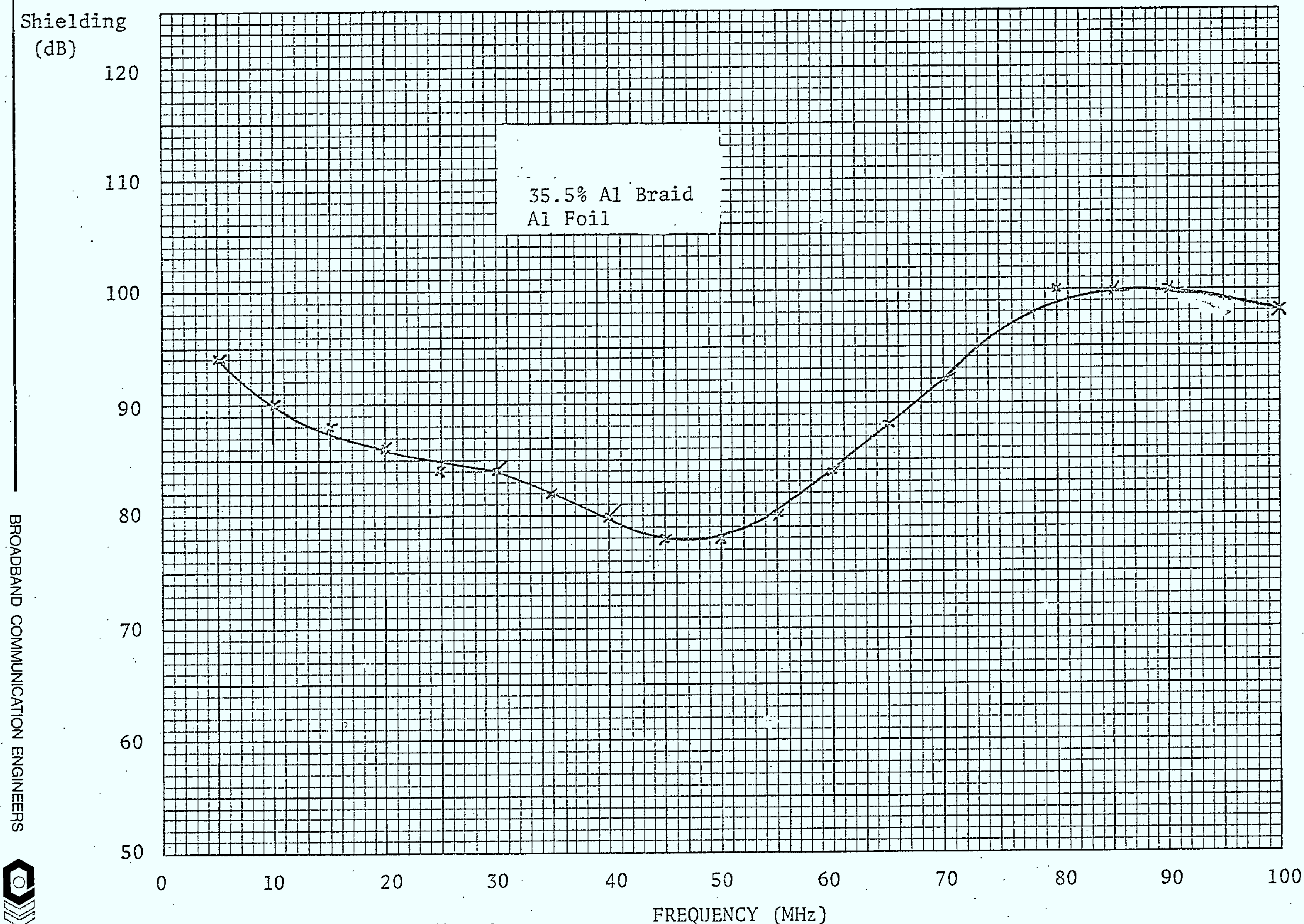


Fig. 3.1 Drop Shielding Spectrum

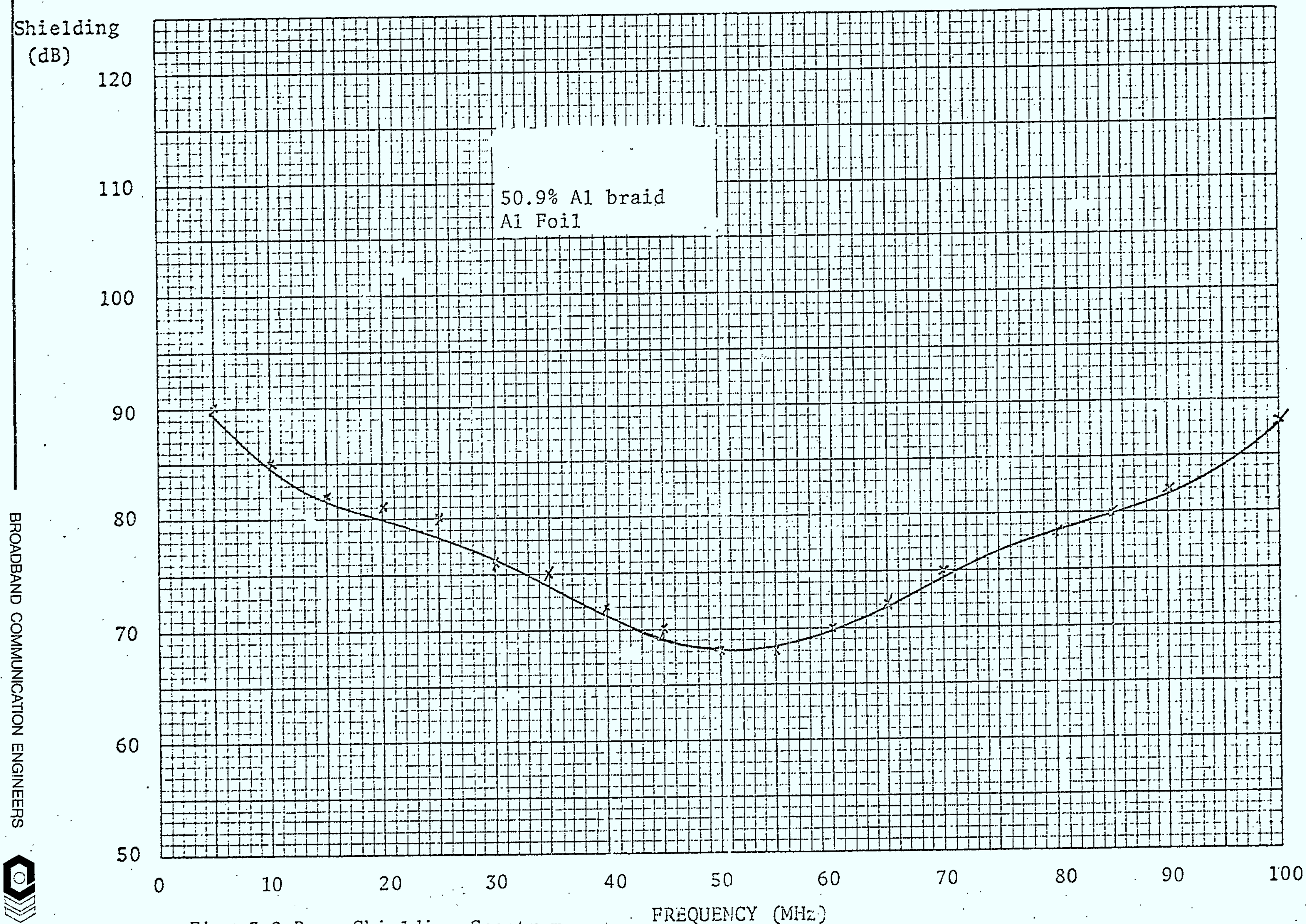


Fig. 3.2 Drop Shielding Spectrum

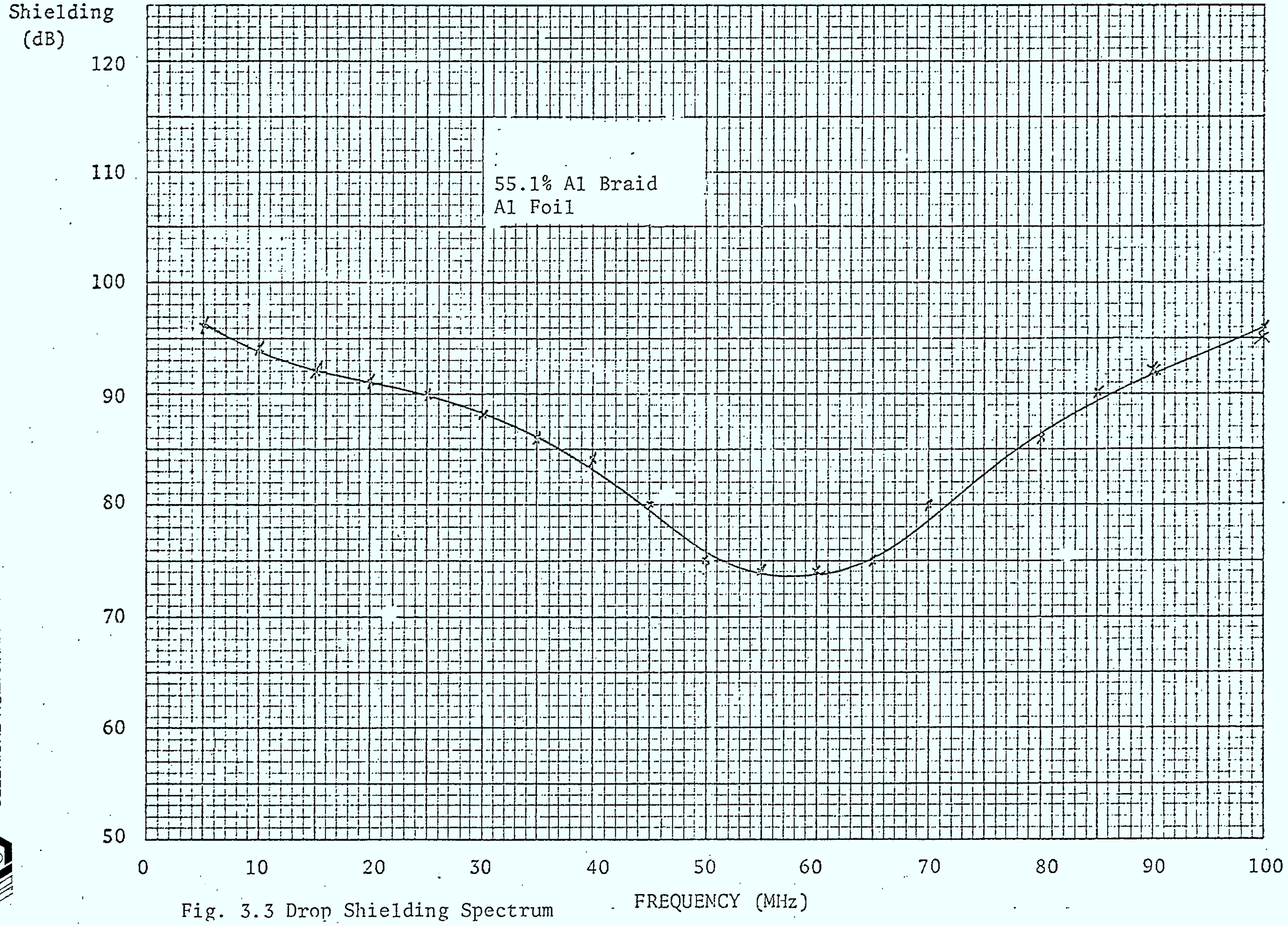


Fig. 3.3 Drop Shielding Spectrum

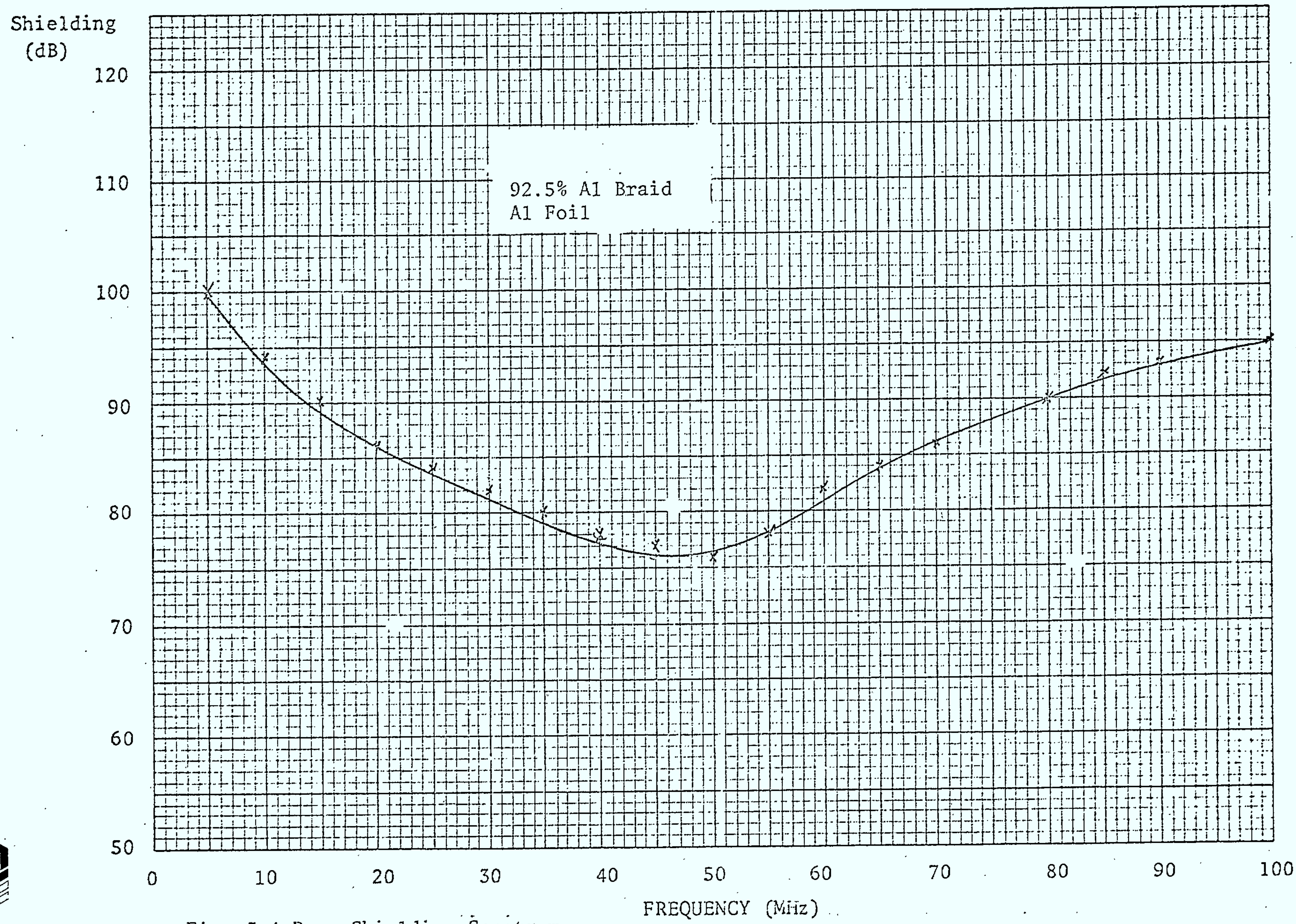


Fig. 3.4 Drop Shielding Spectrum

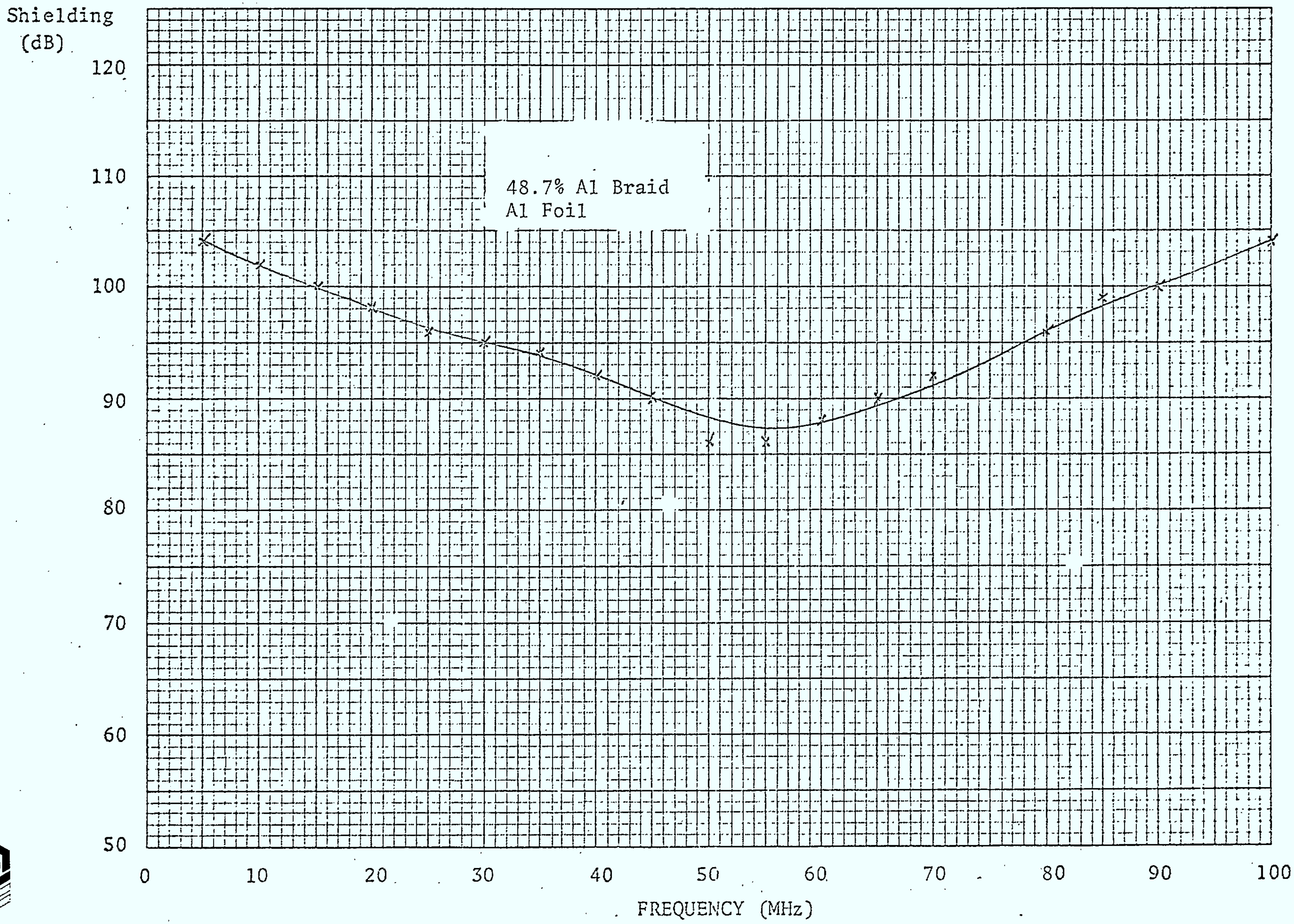


Fig. 3.5 Drop Shielding Spectrum

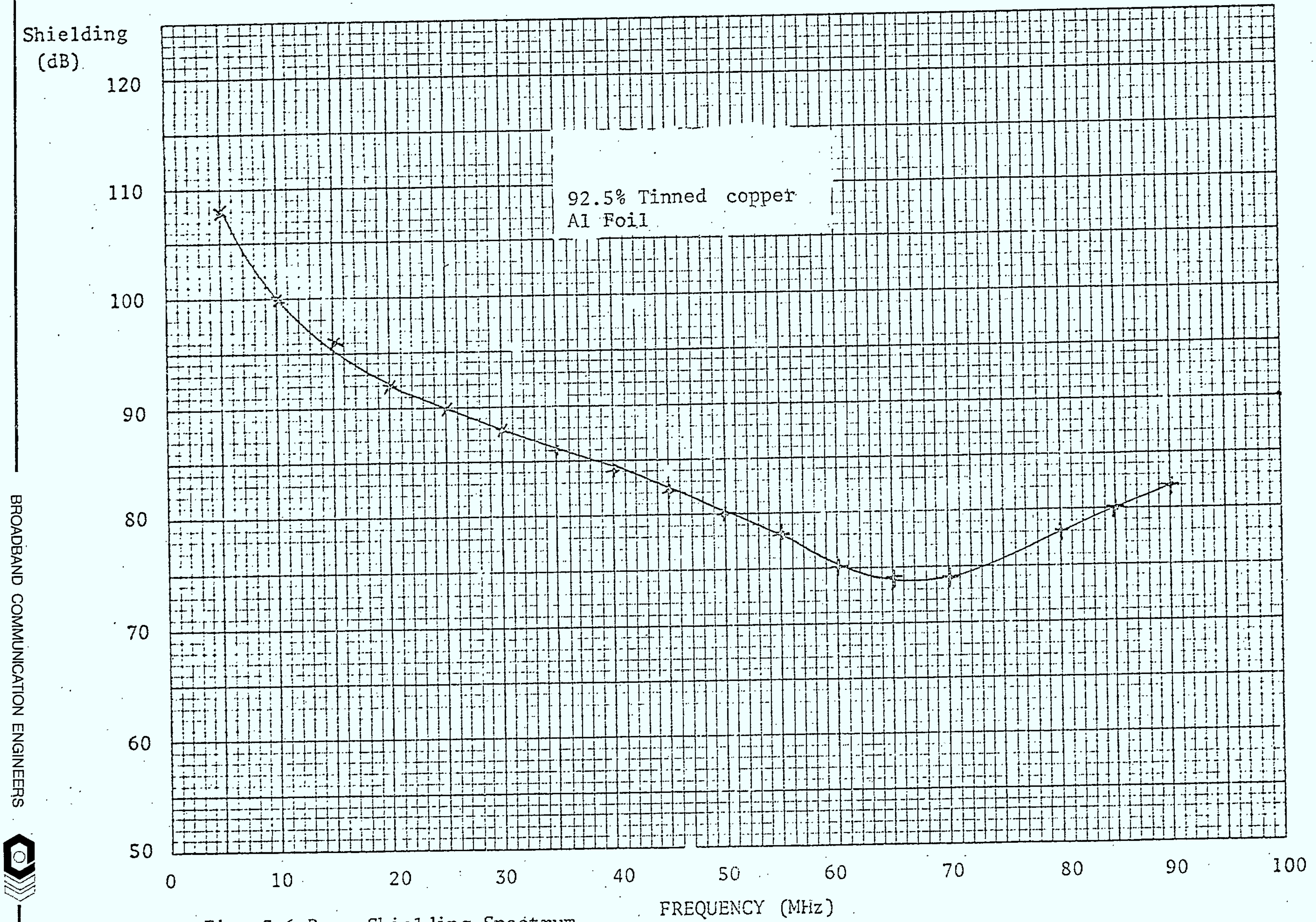


Fig. 3.6 Drop Shielding Spectrum

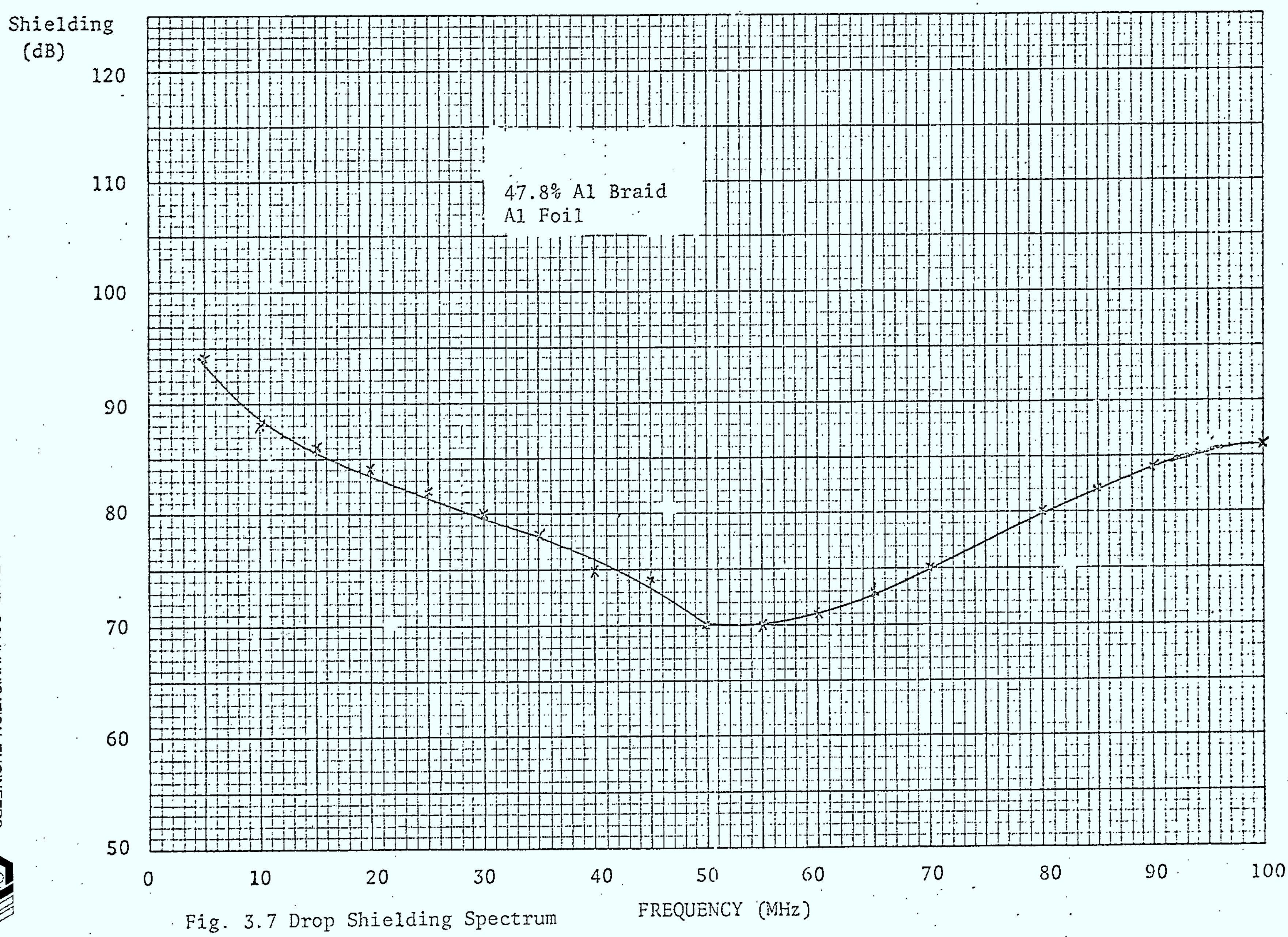


Fig. 3.7 Drop Shielding Spectrum

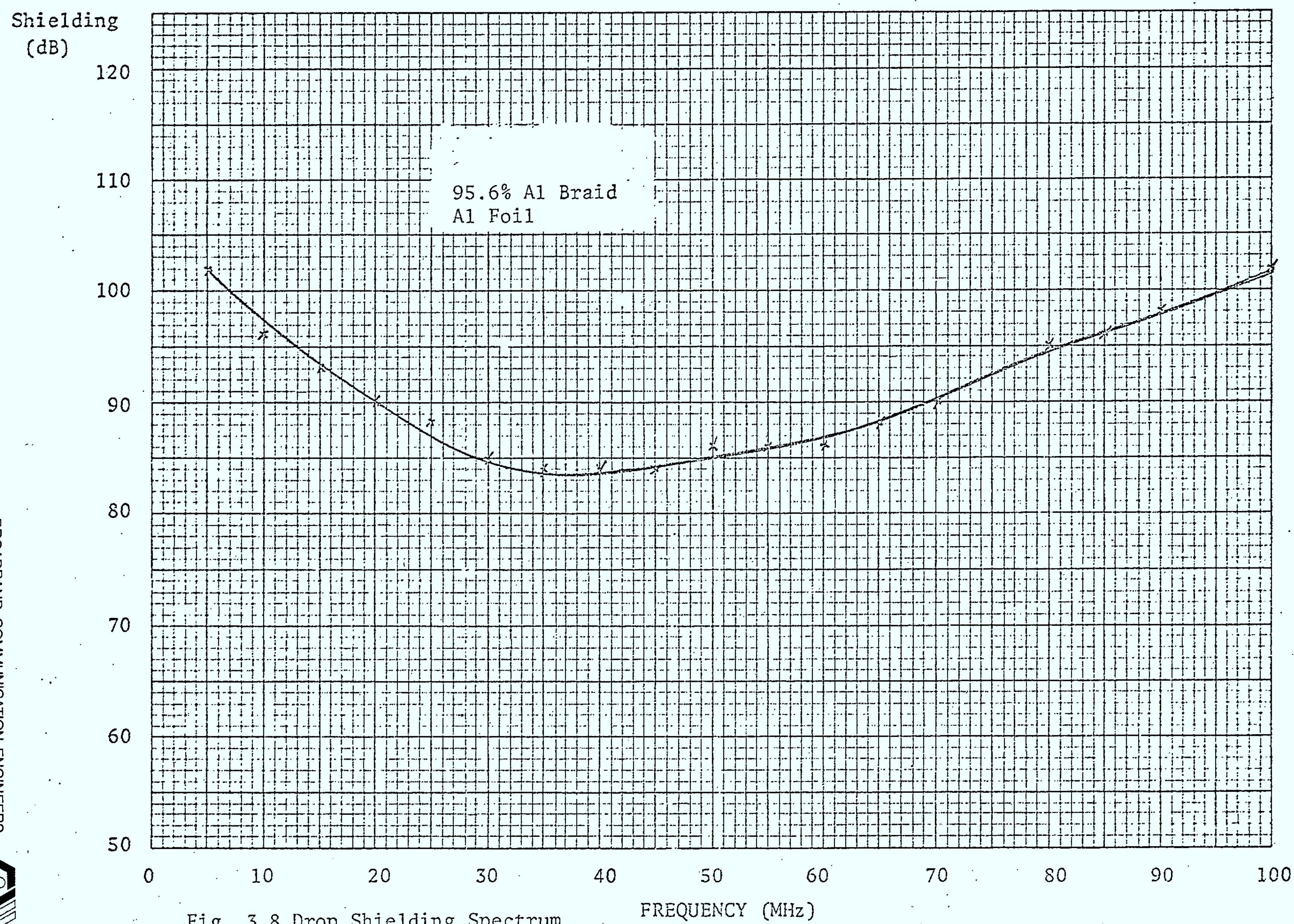


Fig. 3.8 Drop Shielding Spectrum

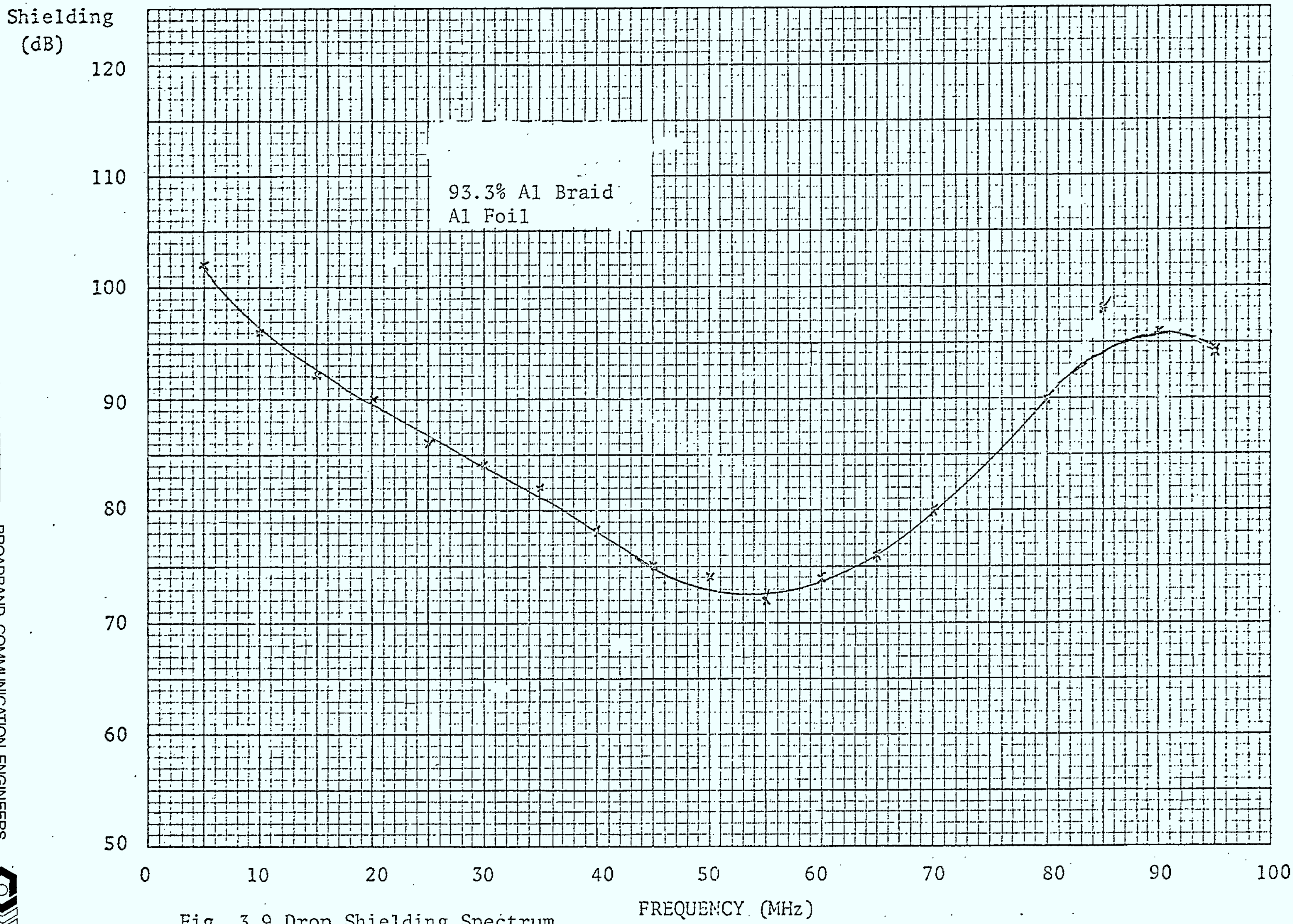


Fig. 3.9 Drop Shielding Spectrum

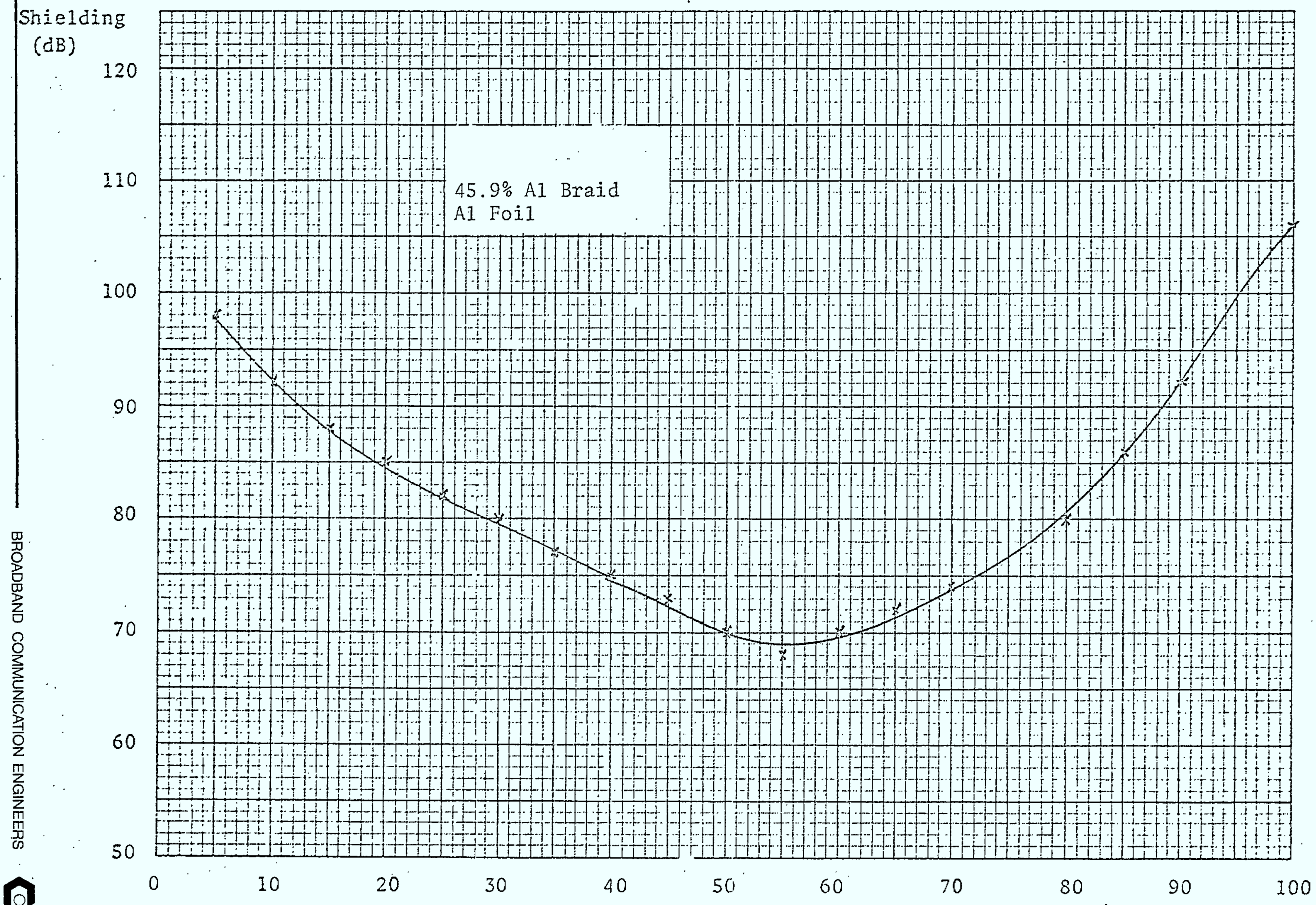


Fig. 3.10 Drop Shielding Spectrum

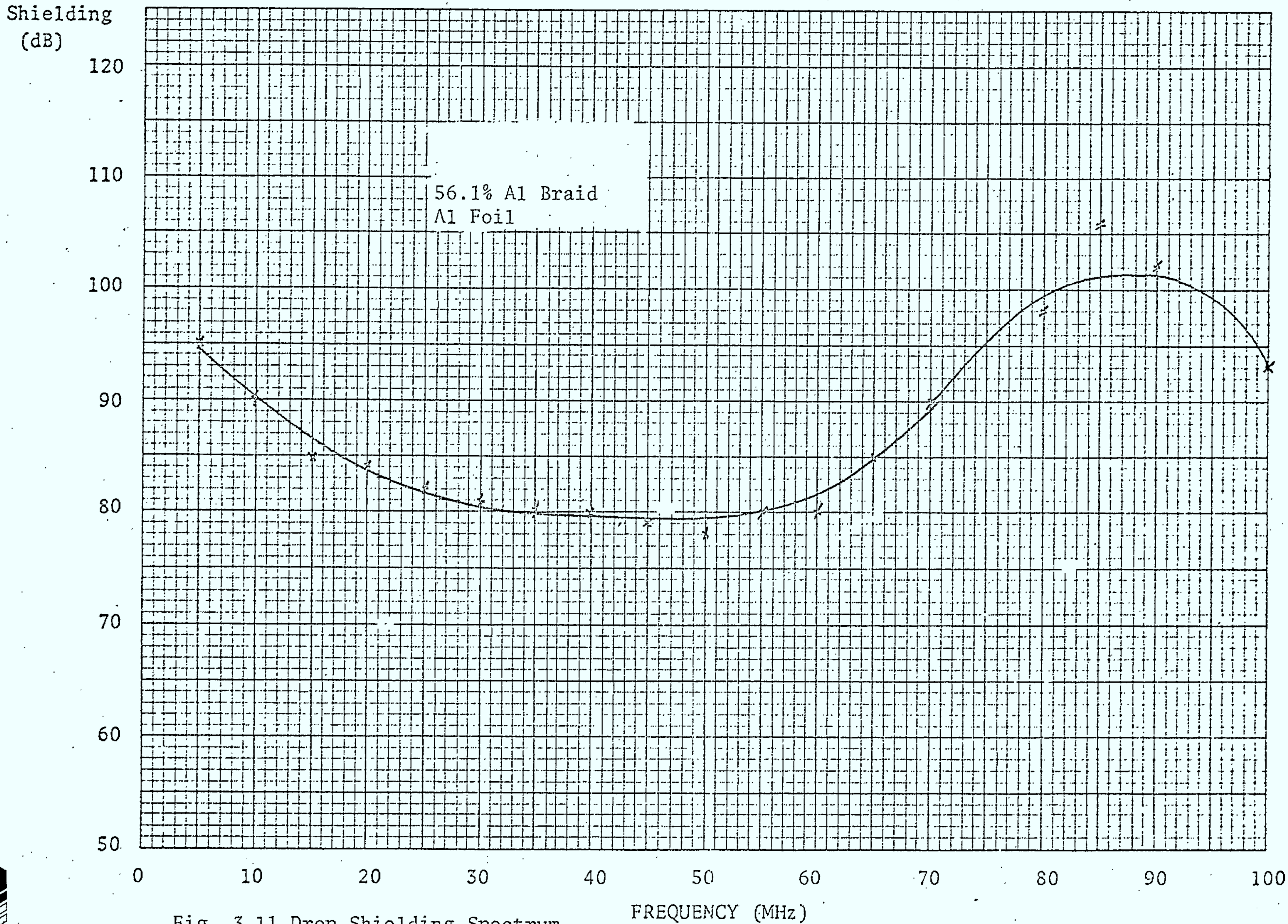


Fig. 3.11 Drop Shielding Spectrum

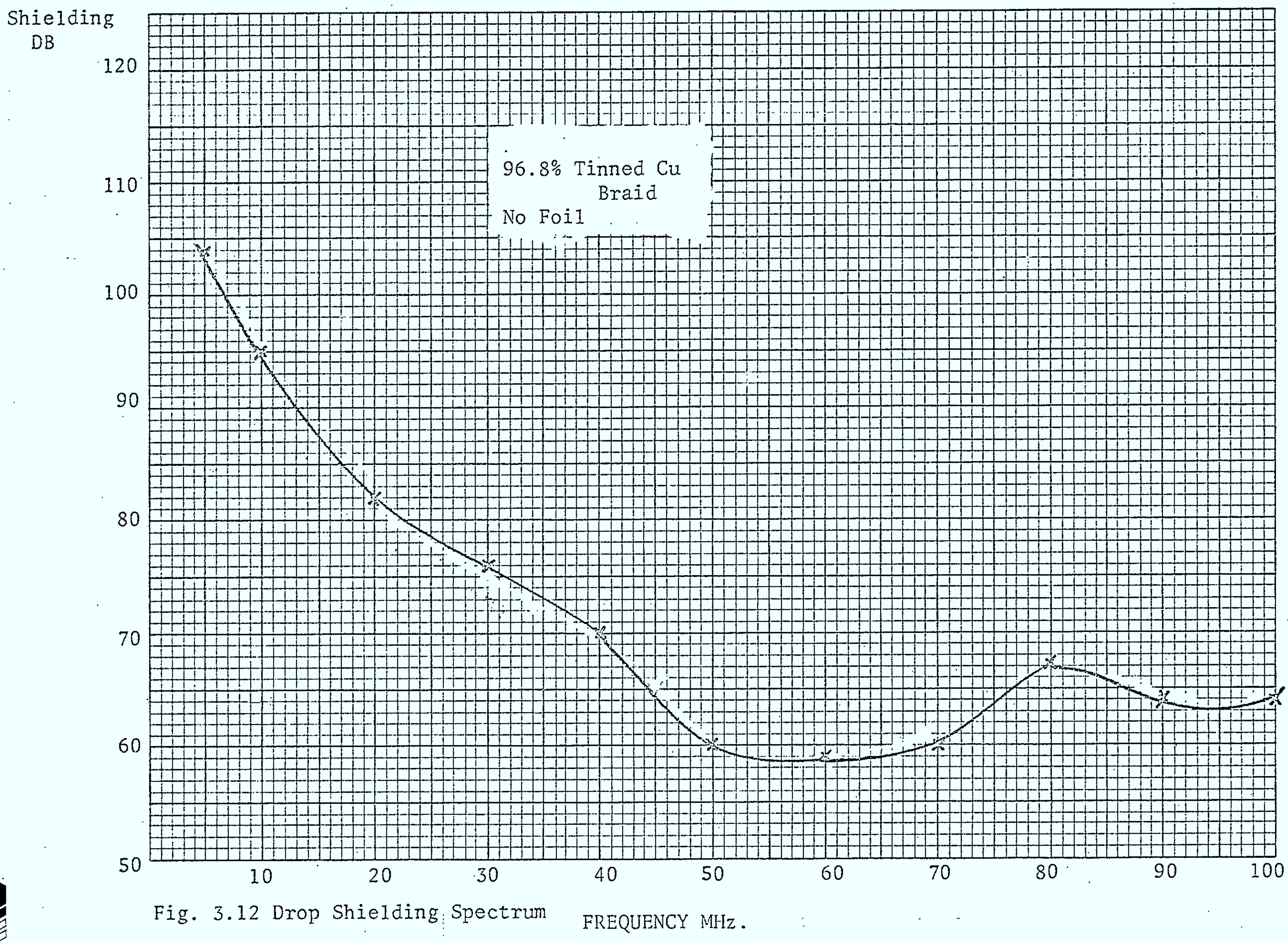


Fig. 3.12 Drop Shielding Spectrum

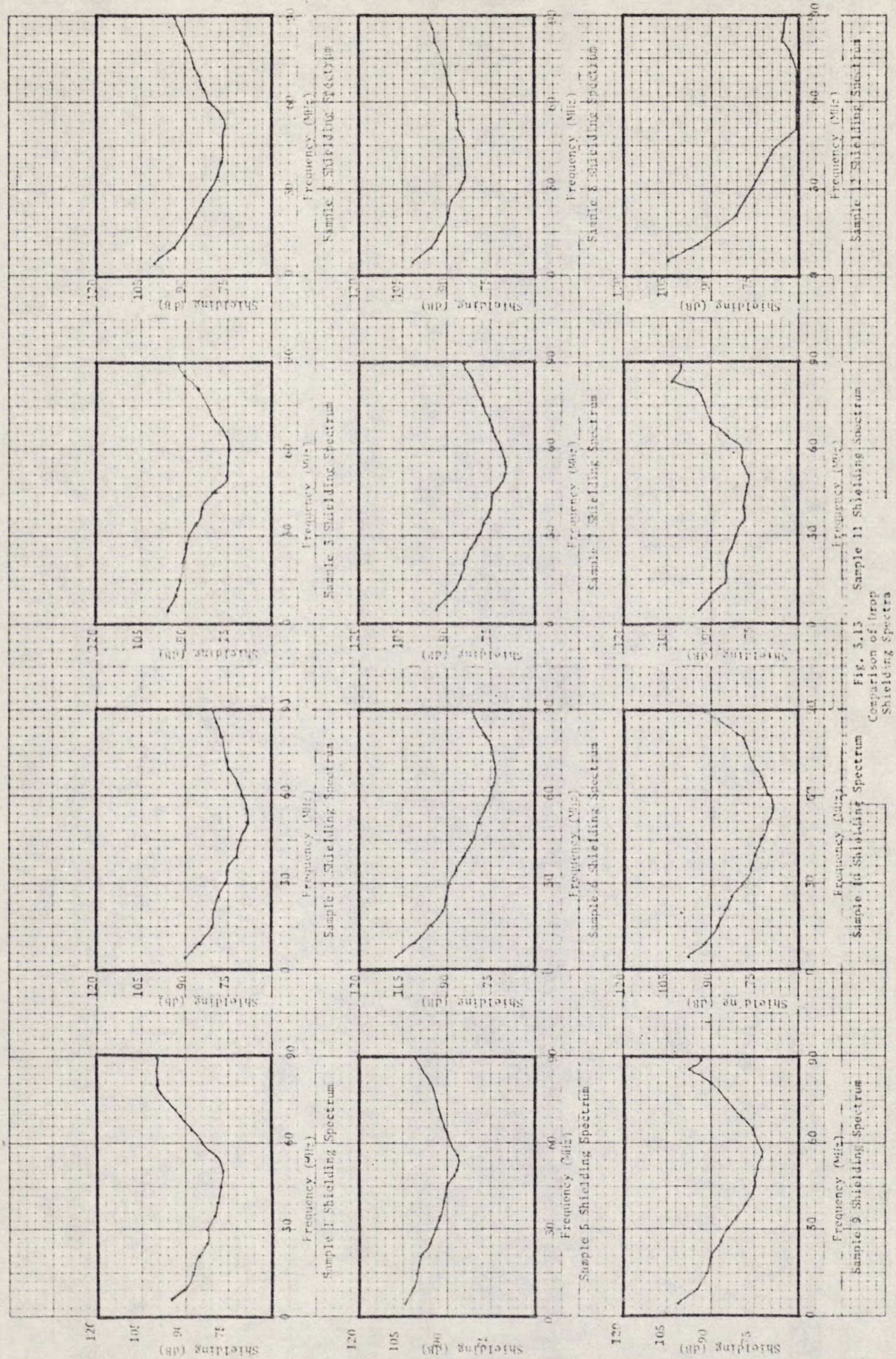


Fig. 3.13 Comparison of Drop Shielding Spectra

To demonstrate the correlation of braid percentage and shielding, the results of the shielding tests are plotted in Fig. 3.14 to Fig. 3.31.* Some of the results show over 15 dB variation in shielding for drops of almost identical braid percentage. It must be noted that there were several variations in the test samples other than braid percentage. Some of these variables are manufacturer, foil type (e.g. bonded vs. unbonded), braid material, and connector installation.

Due to the other variables and the ±5 dB accuracy of the test equipment, there is no clear correlation of braid coverage and shielding. These variables appear to be as significant as braid coverage. It is reasonable to assume that, all these things being equal, an increase in braid coverage does increase drop shielding.

*. Sample 12 was not compared as it has no foil.

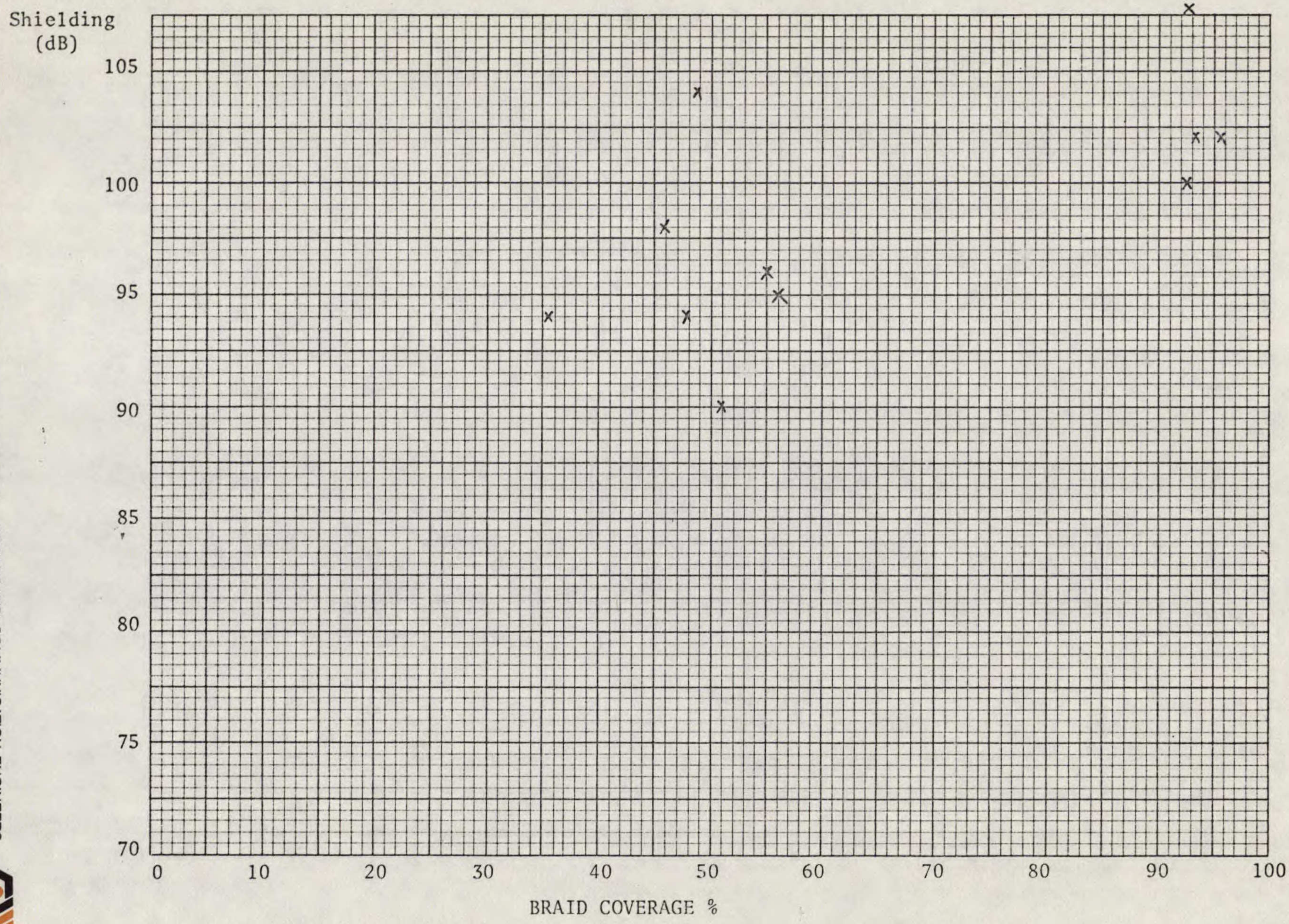


Fig. 3.14 Effective Shielding of Drop Samples at 5 MHz.

cablesystems engineering

BROADBAND COMMUNICATION ENGINEERS

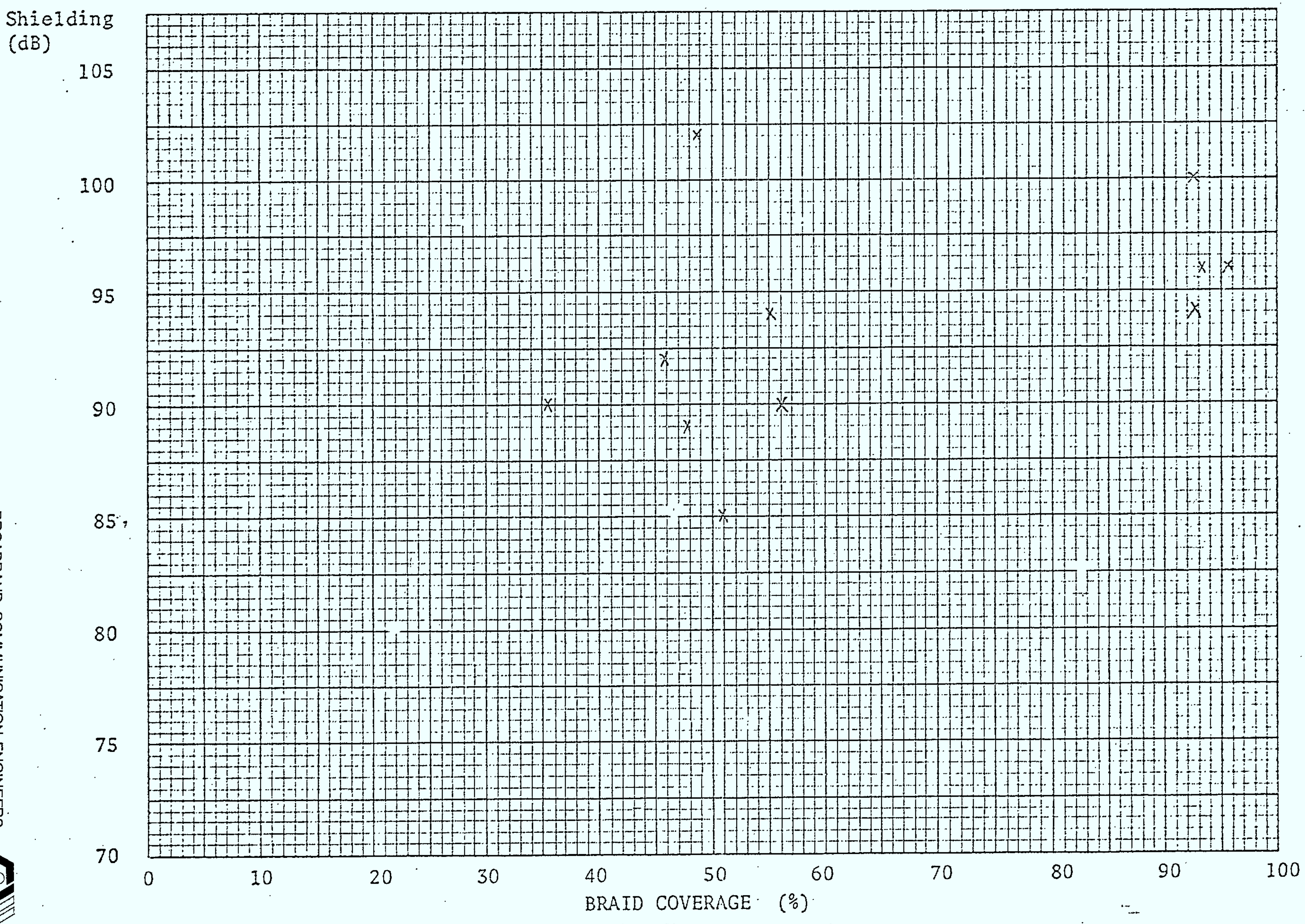


Fig. 3.15 Effective Shielding of Drop Samples at 10 MHz.

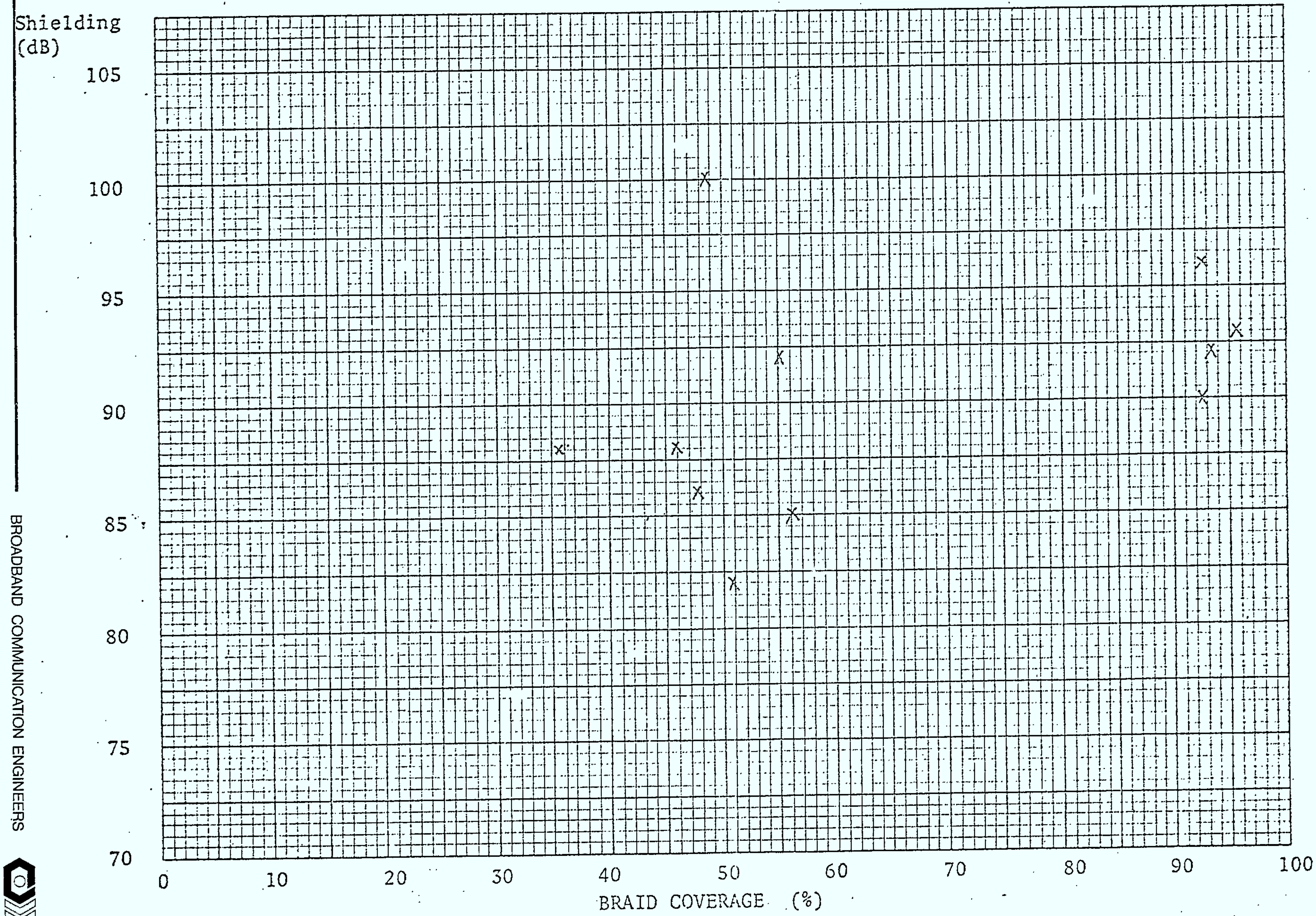


Fig. 3.16 Effective Shielding of Drop Samples at 15 MHz.

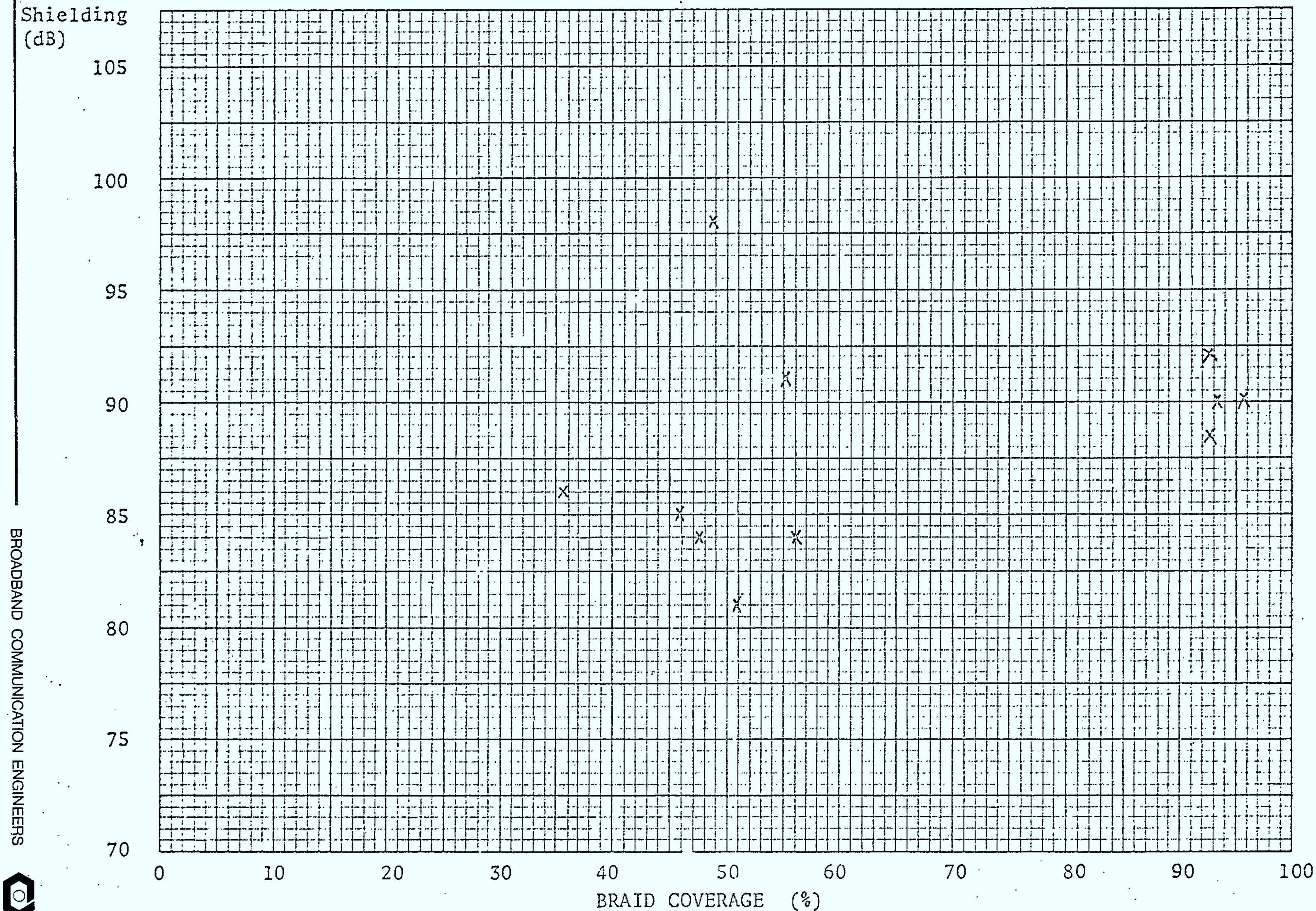


Fig. 3.17 Effective Shielding of Drop Samples at 20 MHz.

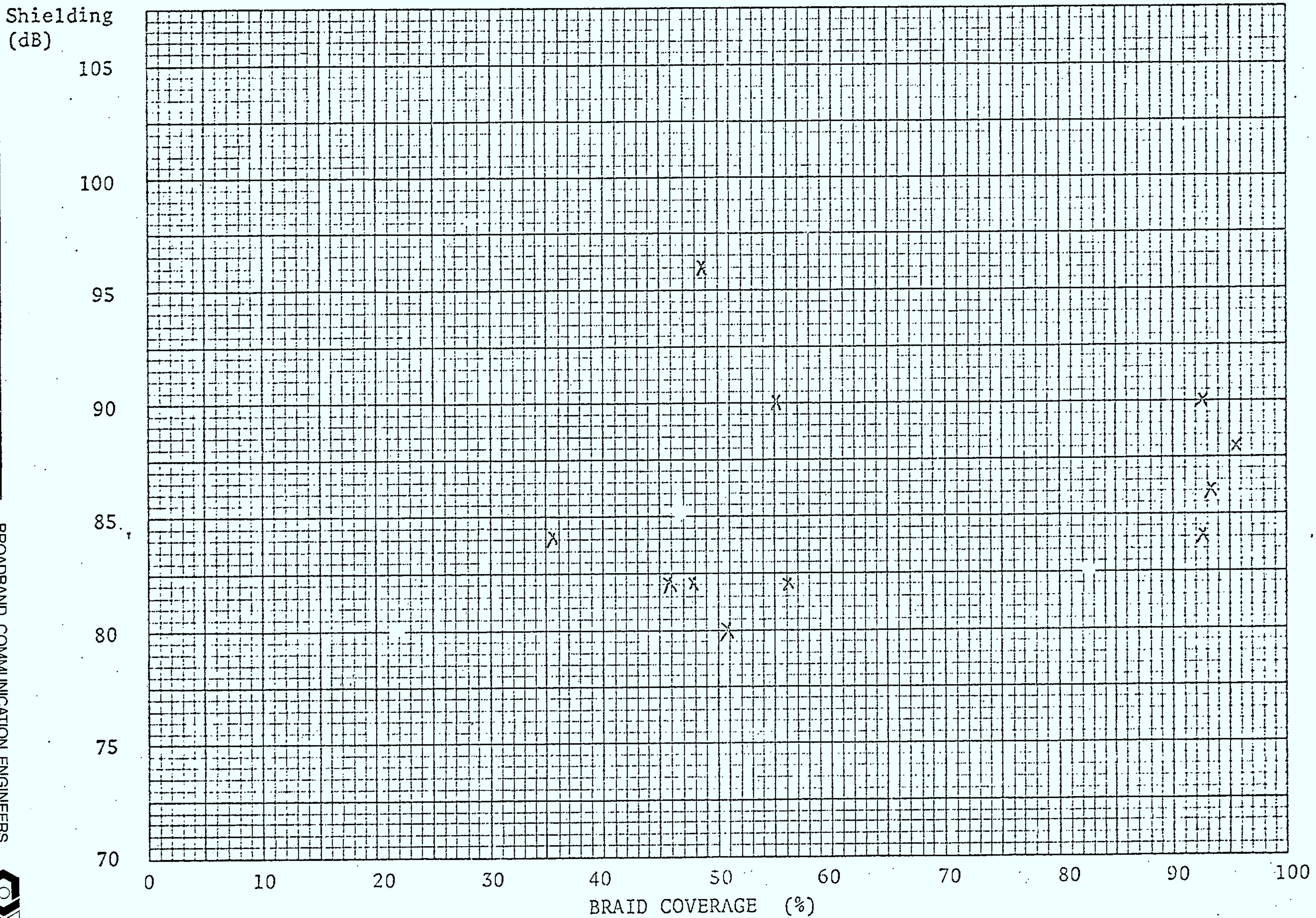


Fig. 3.18 Effective Shielding of Drop Samples at 25 MHz

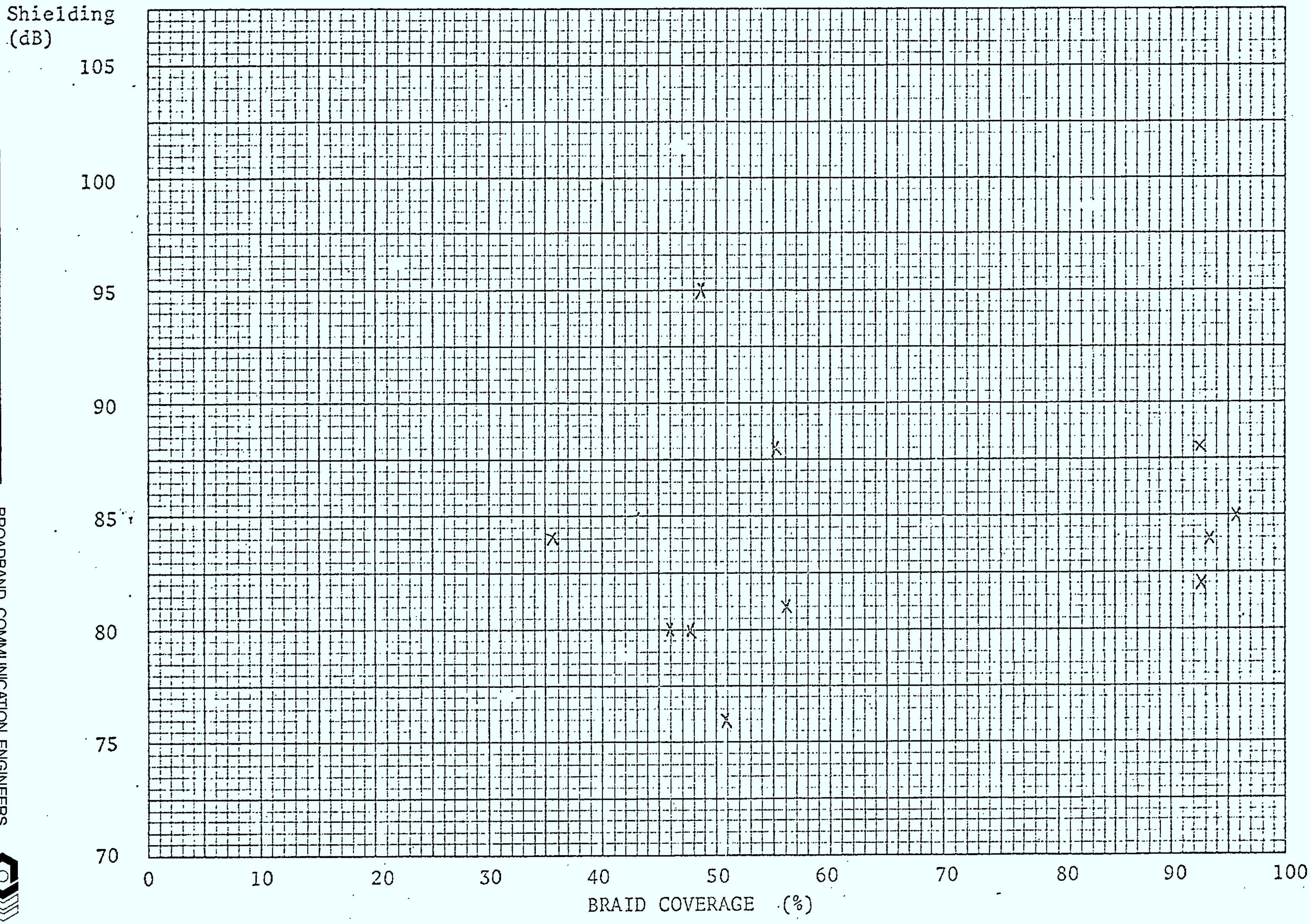


Fig. 3.19 Effective Shielding of Drop Samples at 30 MHz

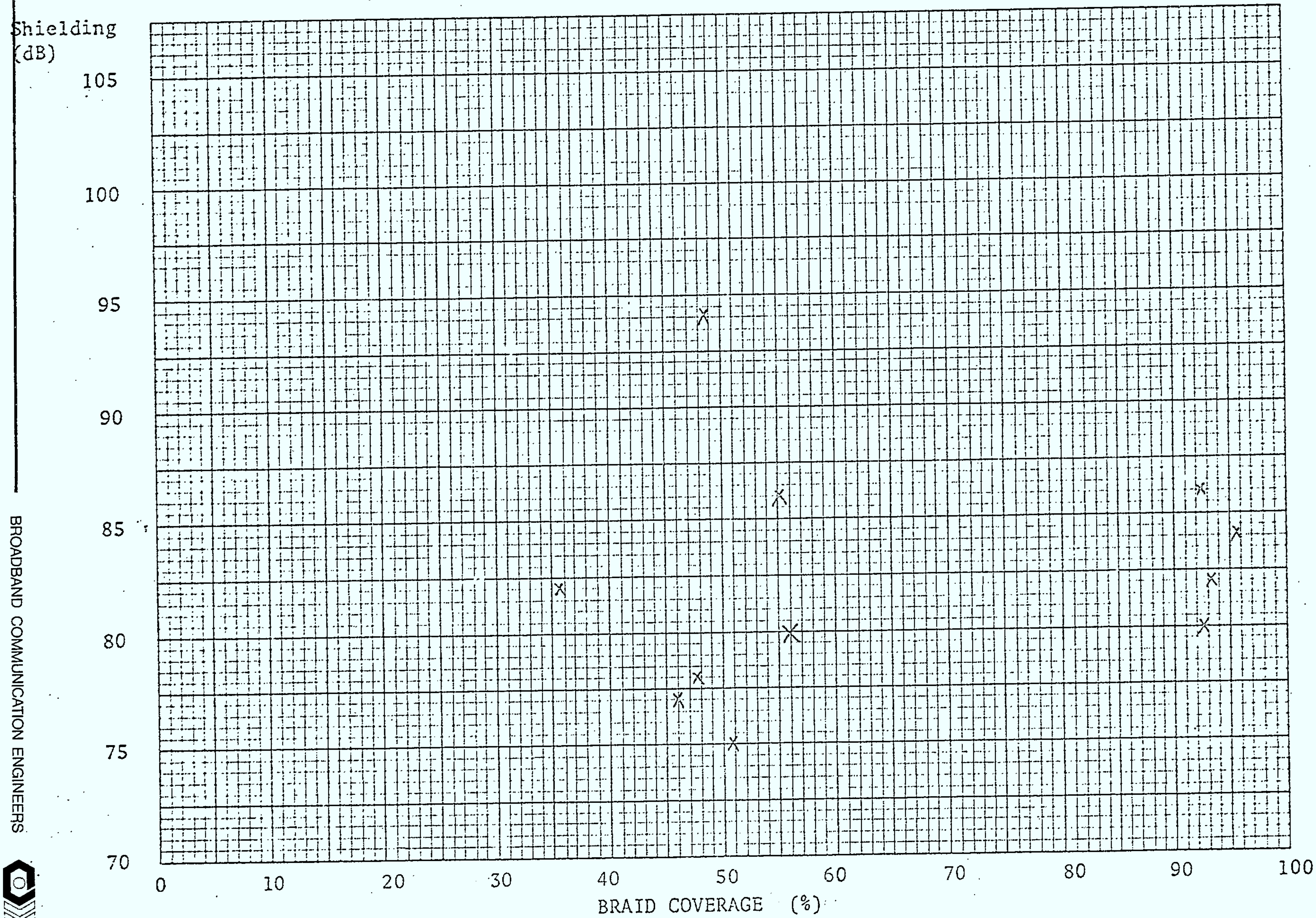


Fig. 3.20 Effective Shielding of Drop Samples at 35 MHz

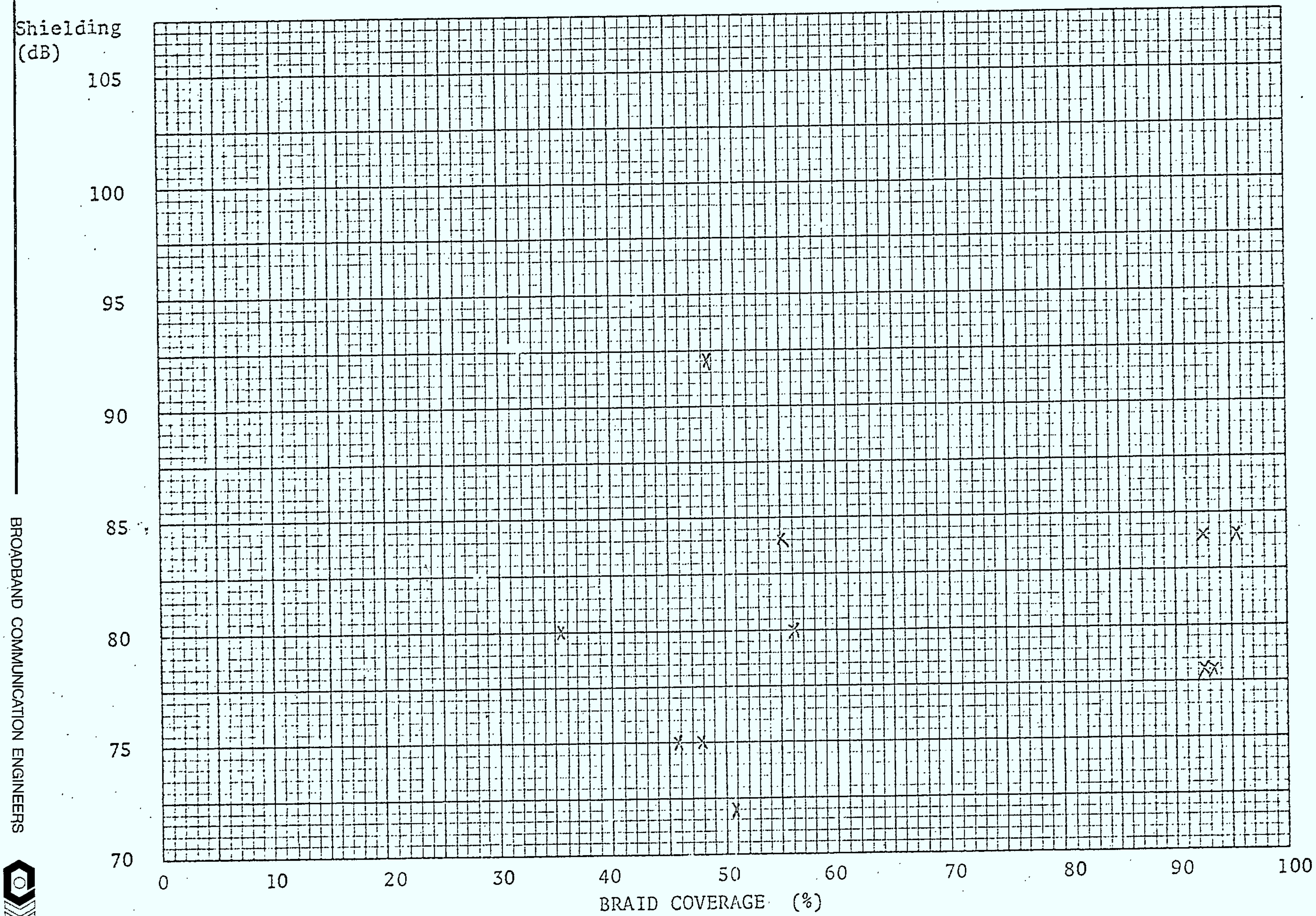


Fig. 3.21 Effective Shielding of Drop Samples at 40 MHz.

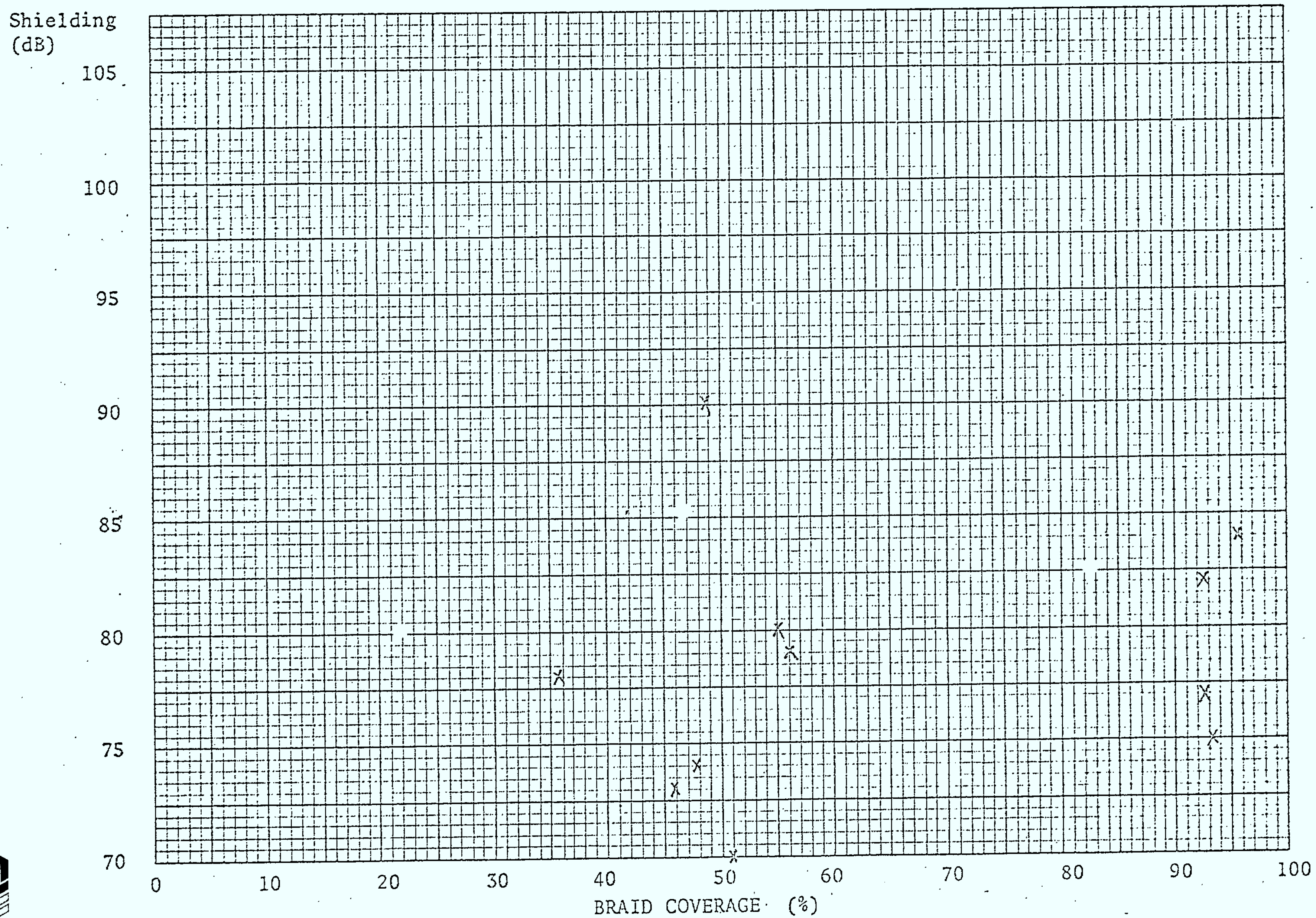


Fig. 3.22 Effective Shielding of Drop Samples at 45 MHz

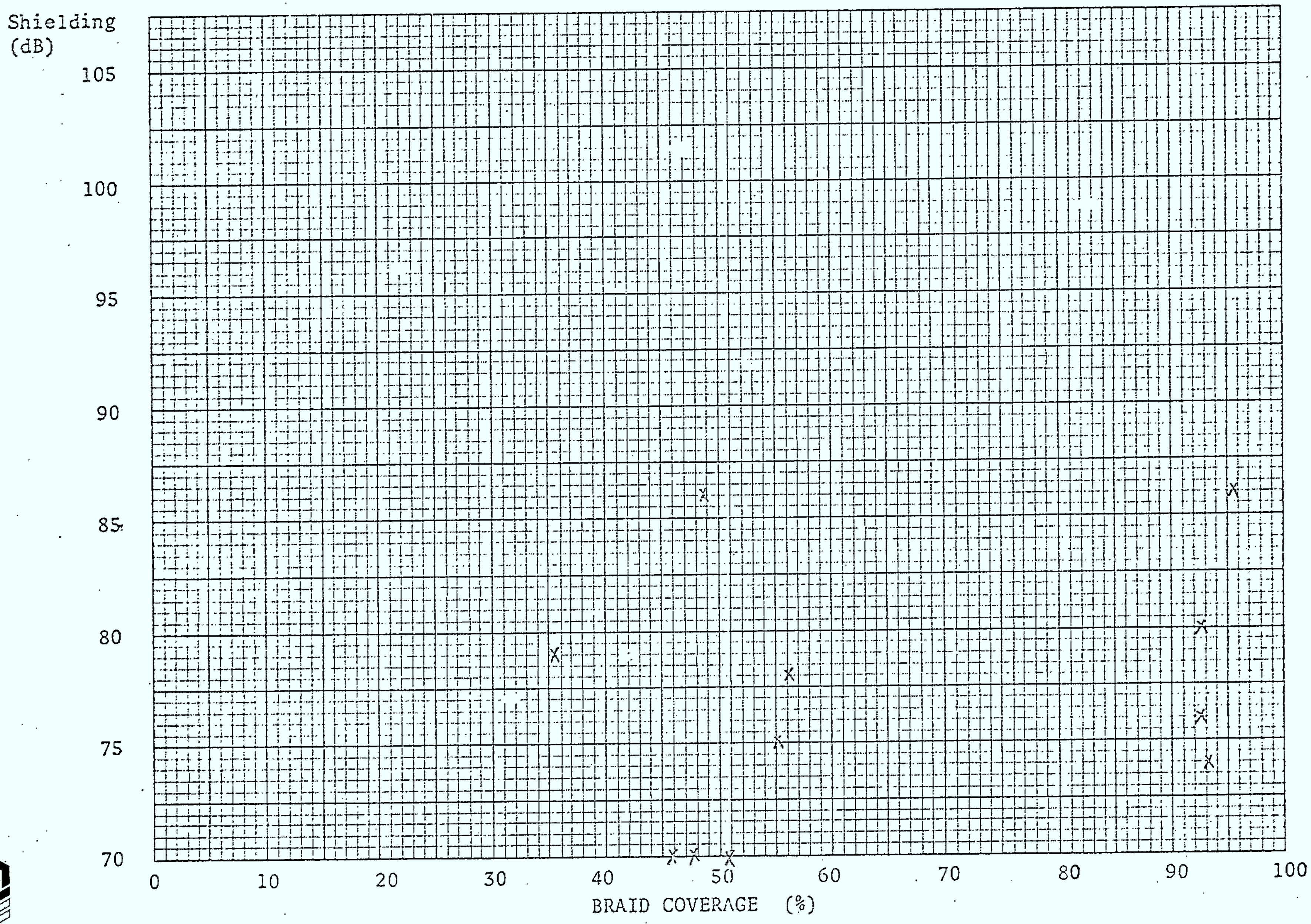


Fig. 3.23 Effective Shielding of Drop Samples at 50 MHz

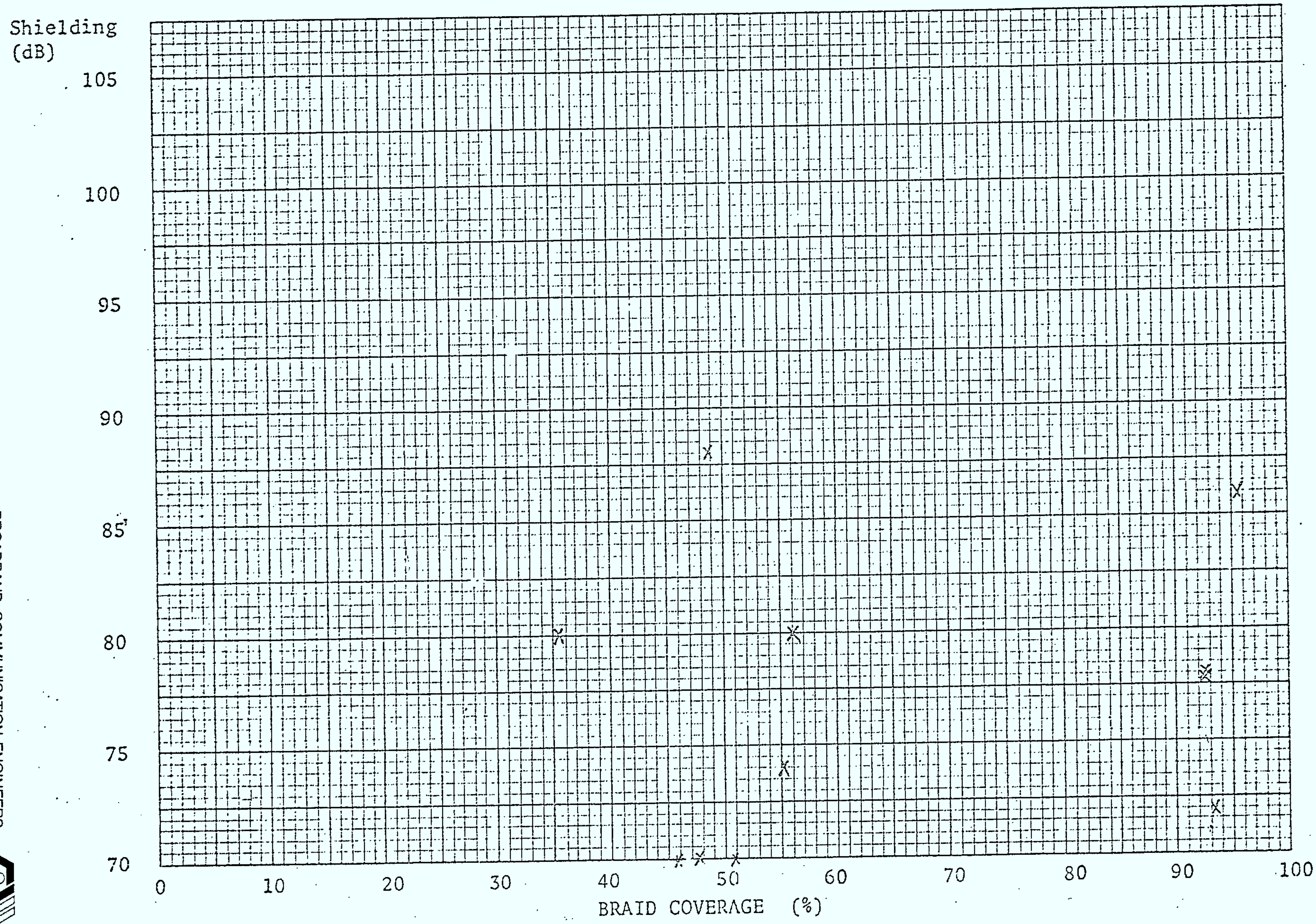


Fig. 3.24 Effective Shielding of Drop Samples at 55 MHz

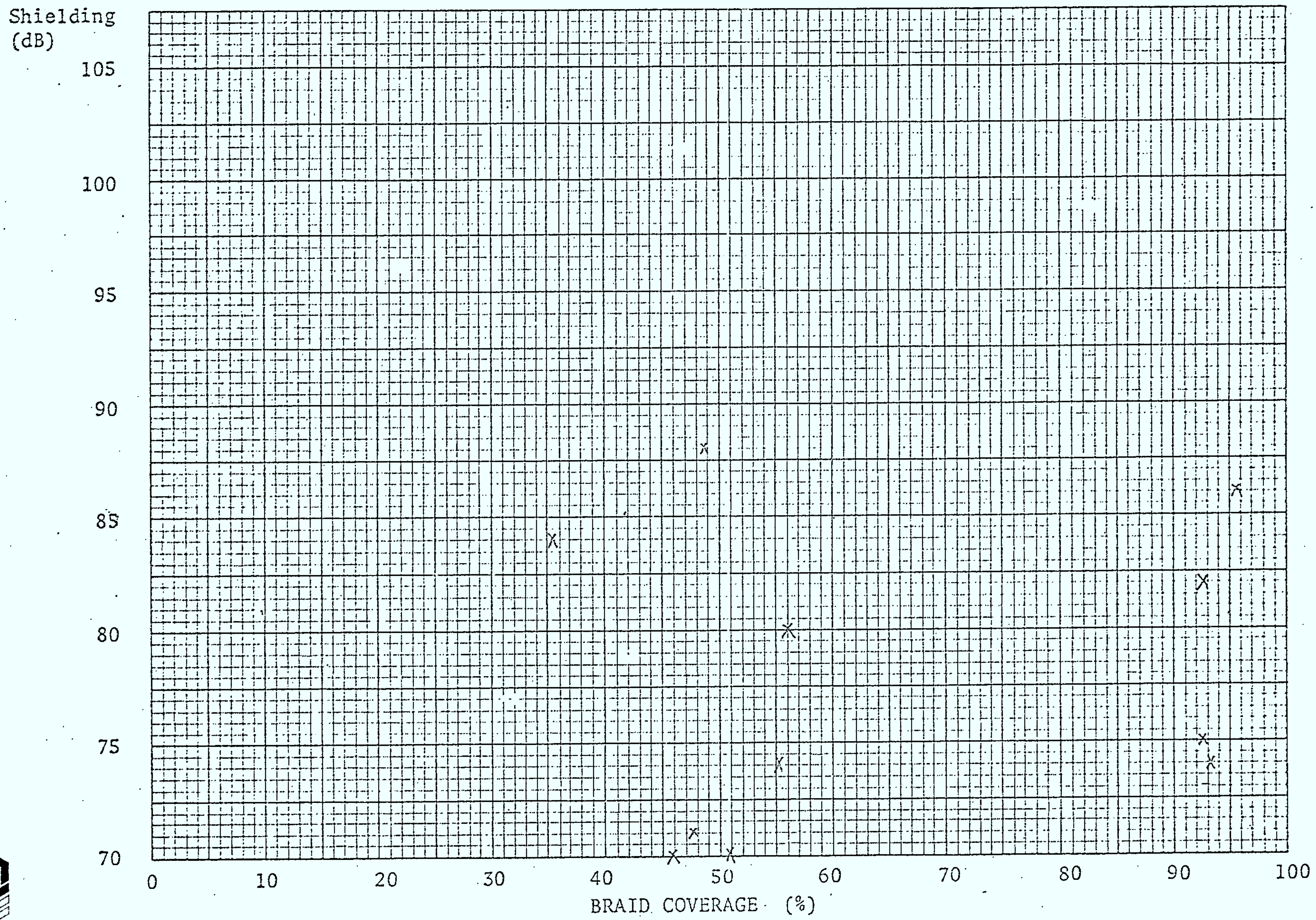


Fig. 3.25 Effective Shielding of Drop Samples at 60 MHz

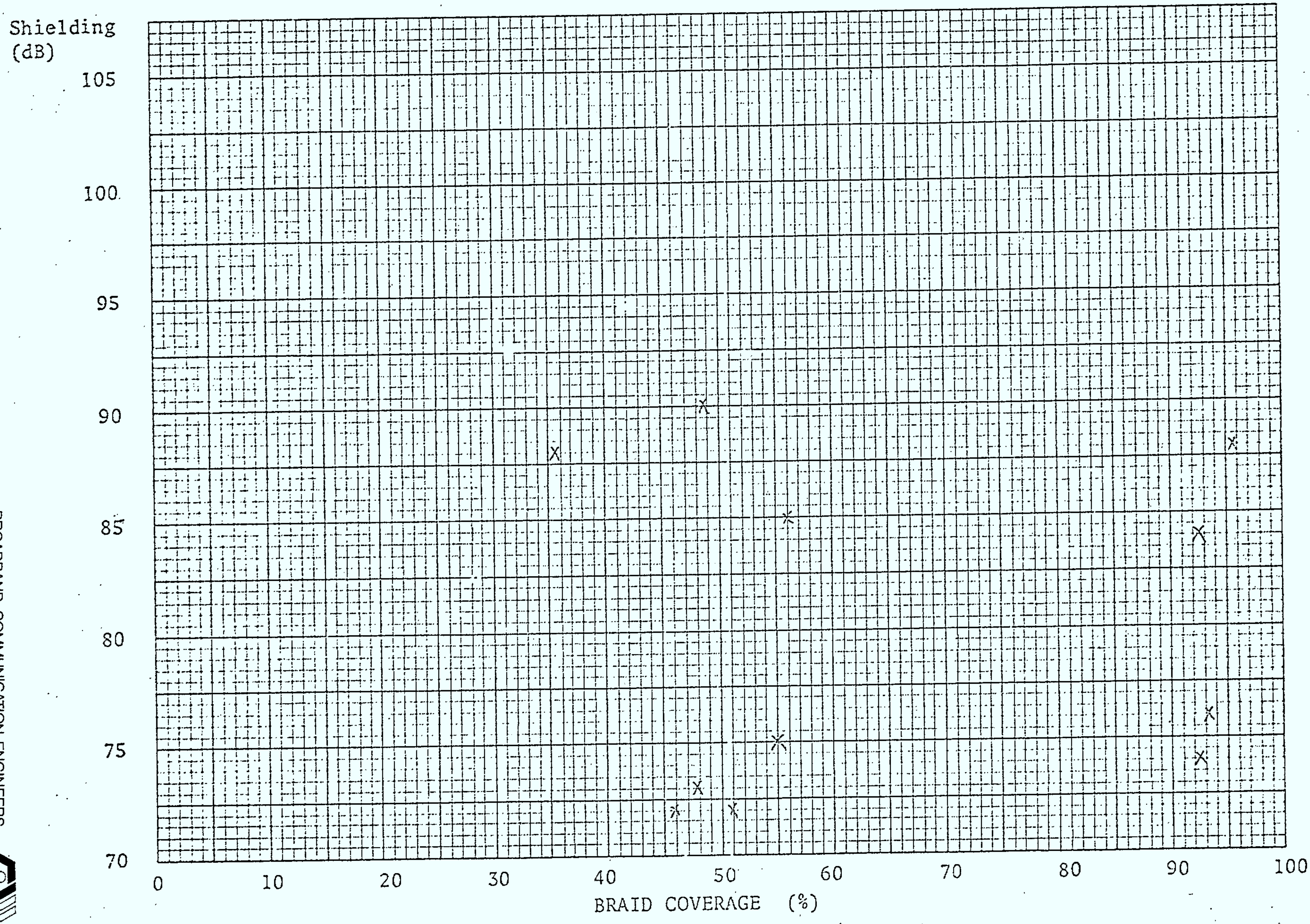


Fig. 3.26 Effective Shielding at 65 MHz.

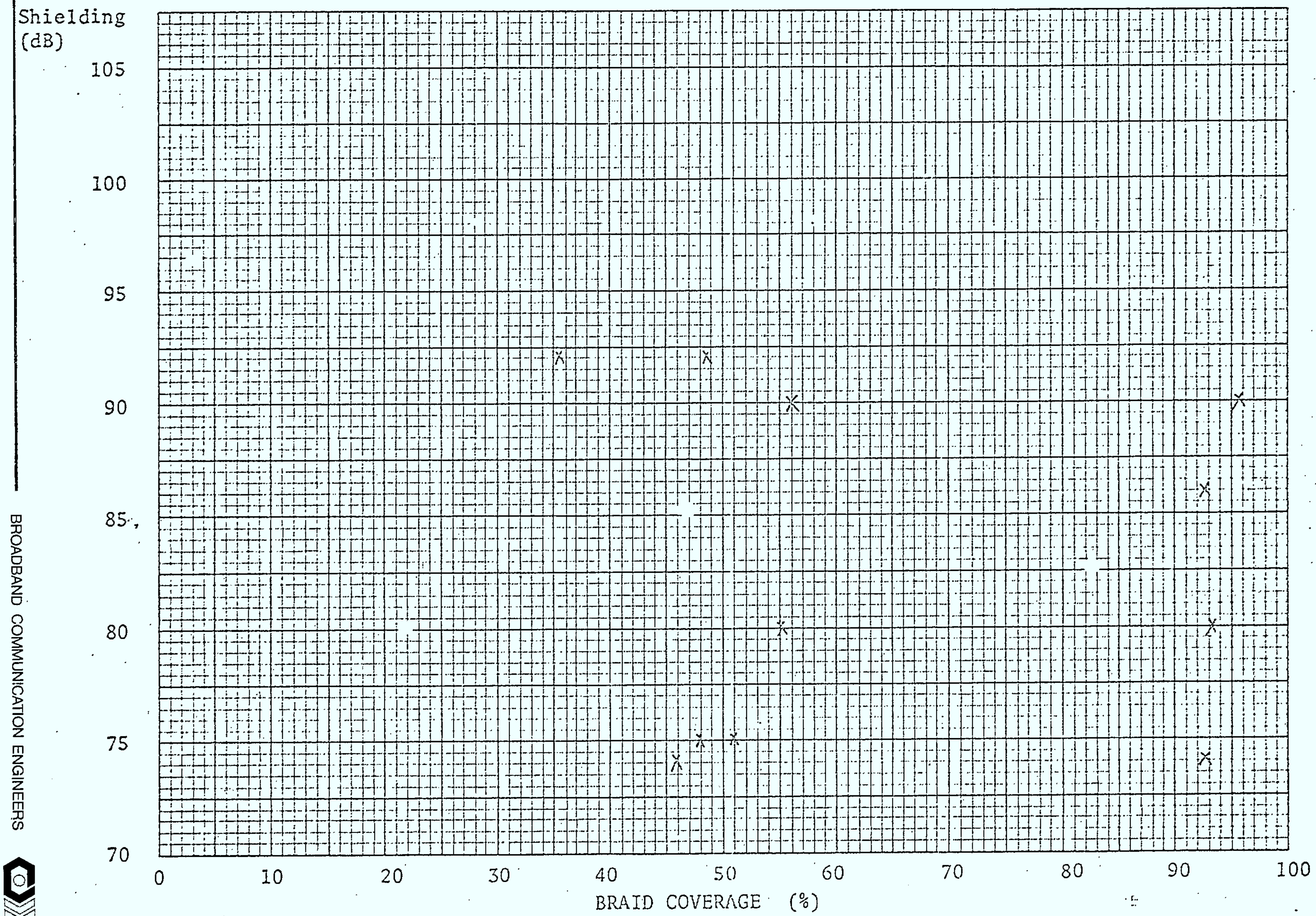


Fig. 3.27 Effective Shielding of Drop Samples at 70 MHz

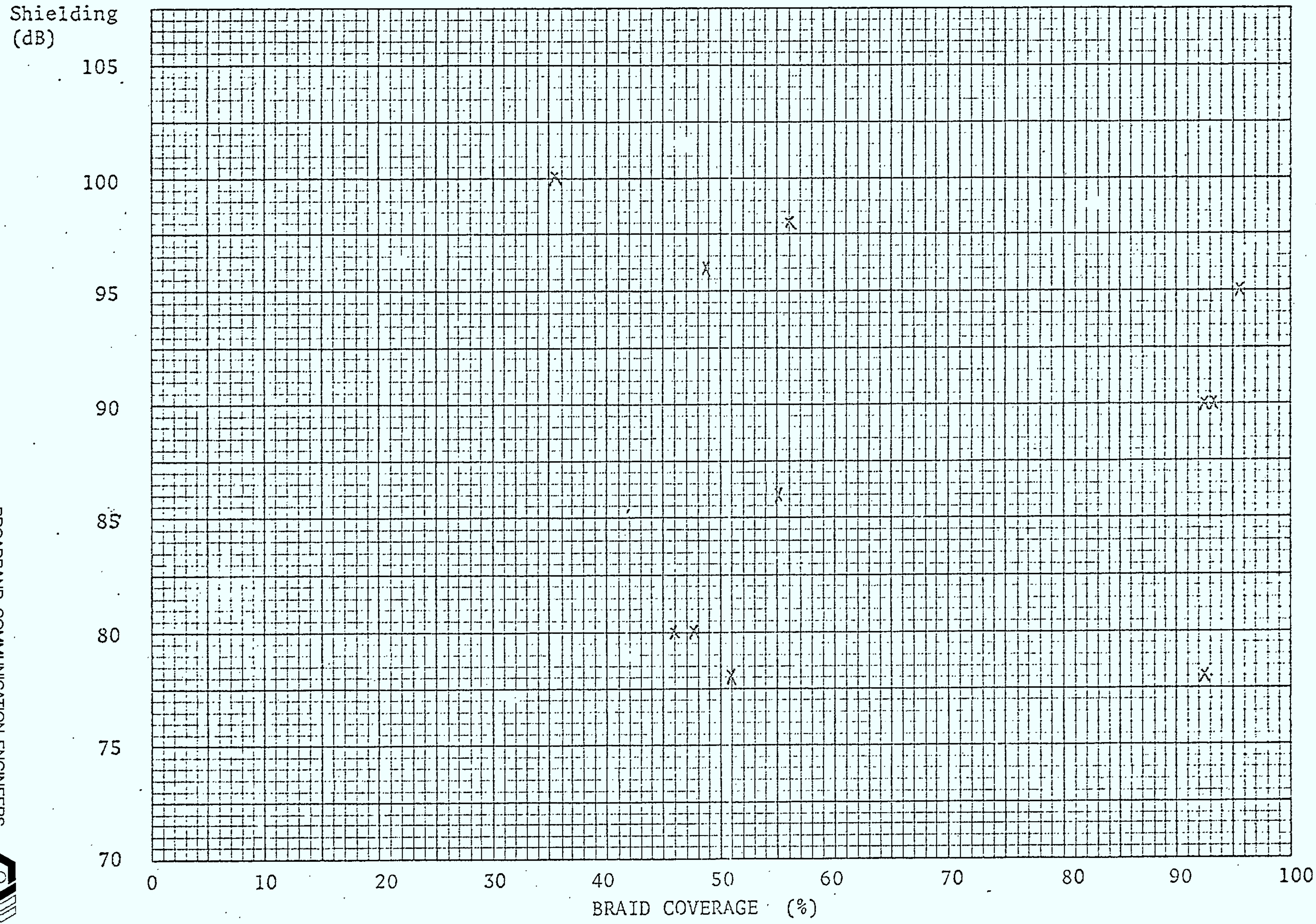


Fig. 3.28 Effective Shielding of Drop Samples at 80 MHz

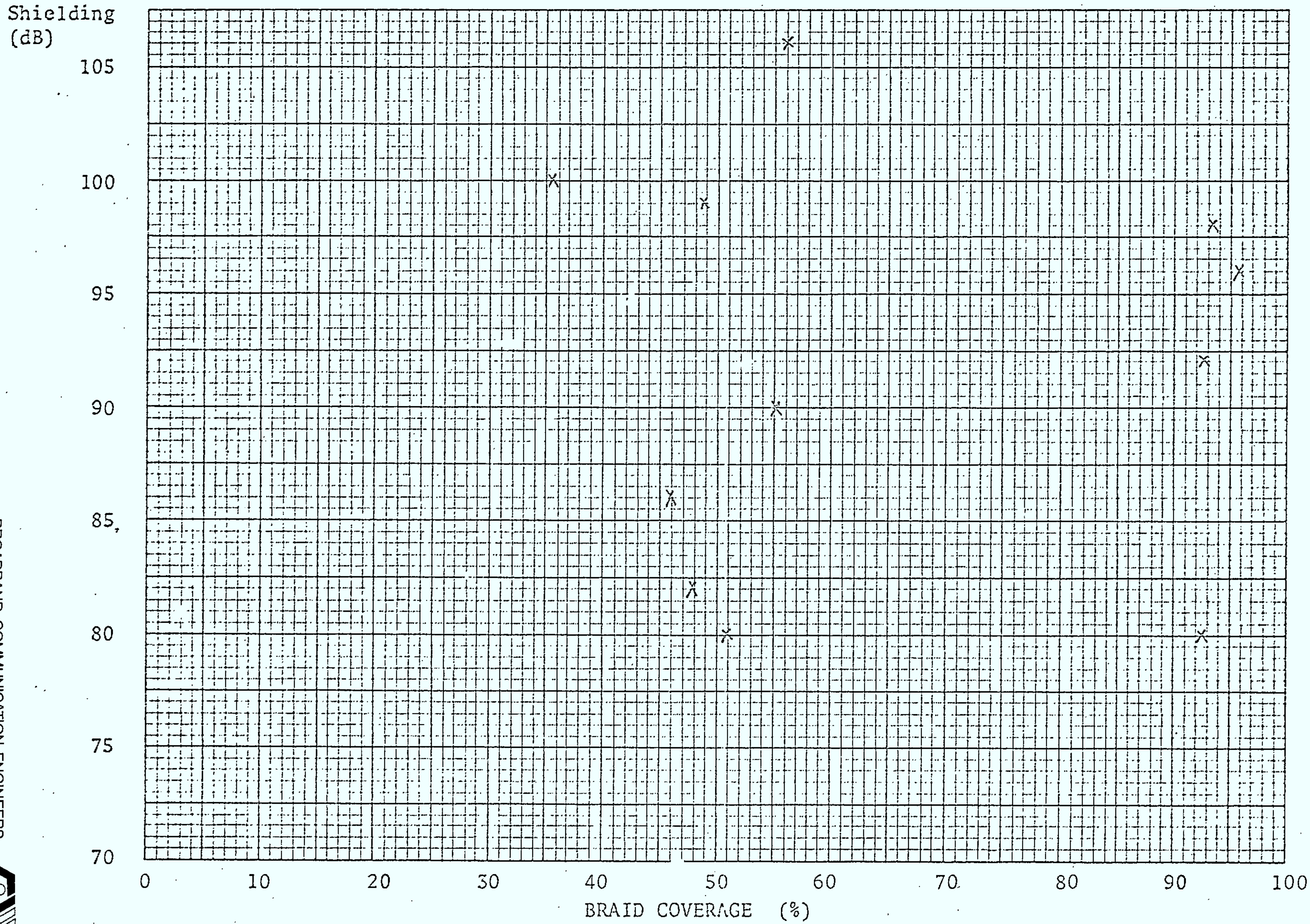


Fig. 3.29 Effective Shielding of Drop Samples at 85 MHz

cablesystems engineering

BROADBAND COMMUNICATION ENGINEERS

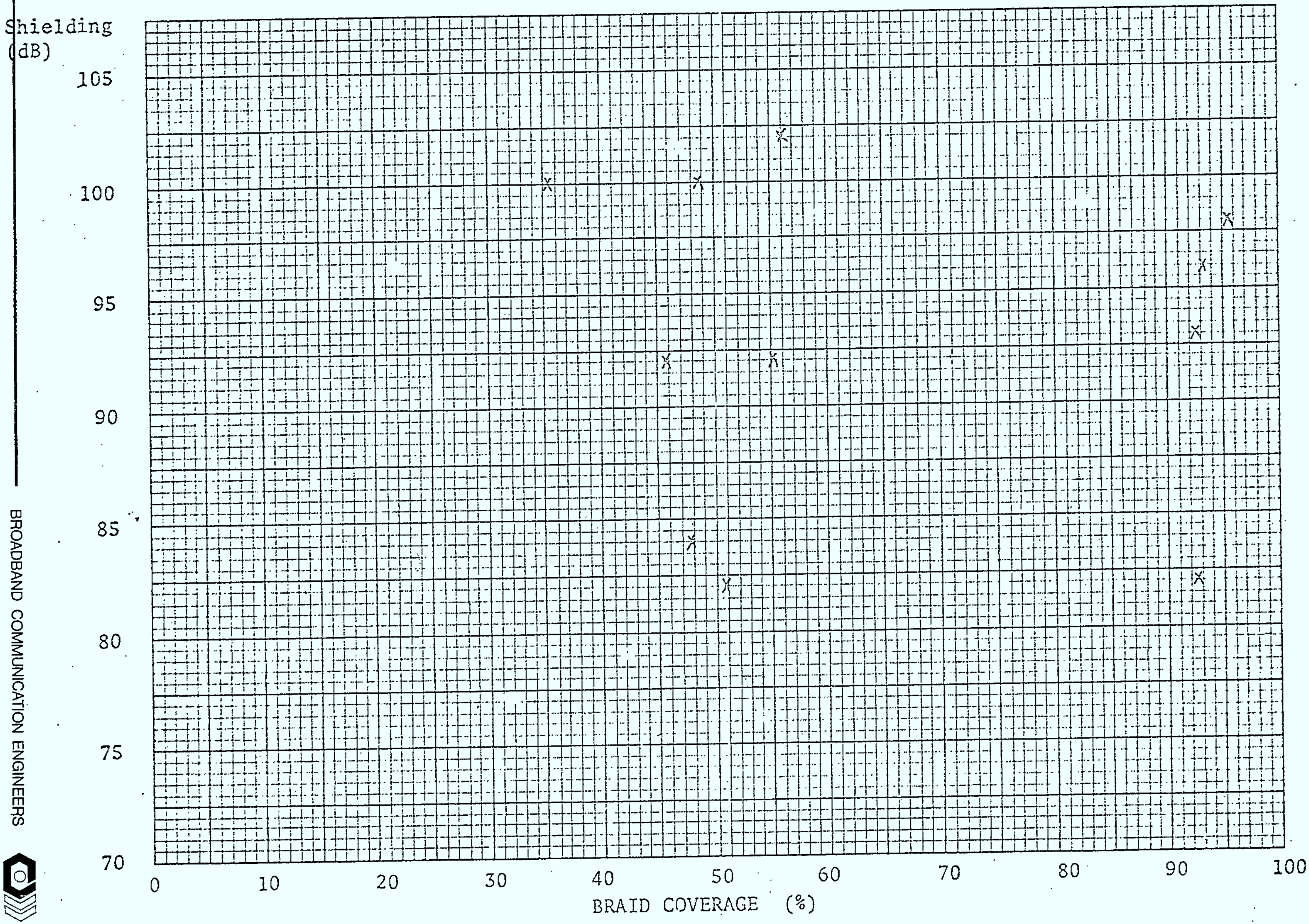


Fig. 3.30 Effective Shielding of Drop Samples at 90 MHz

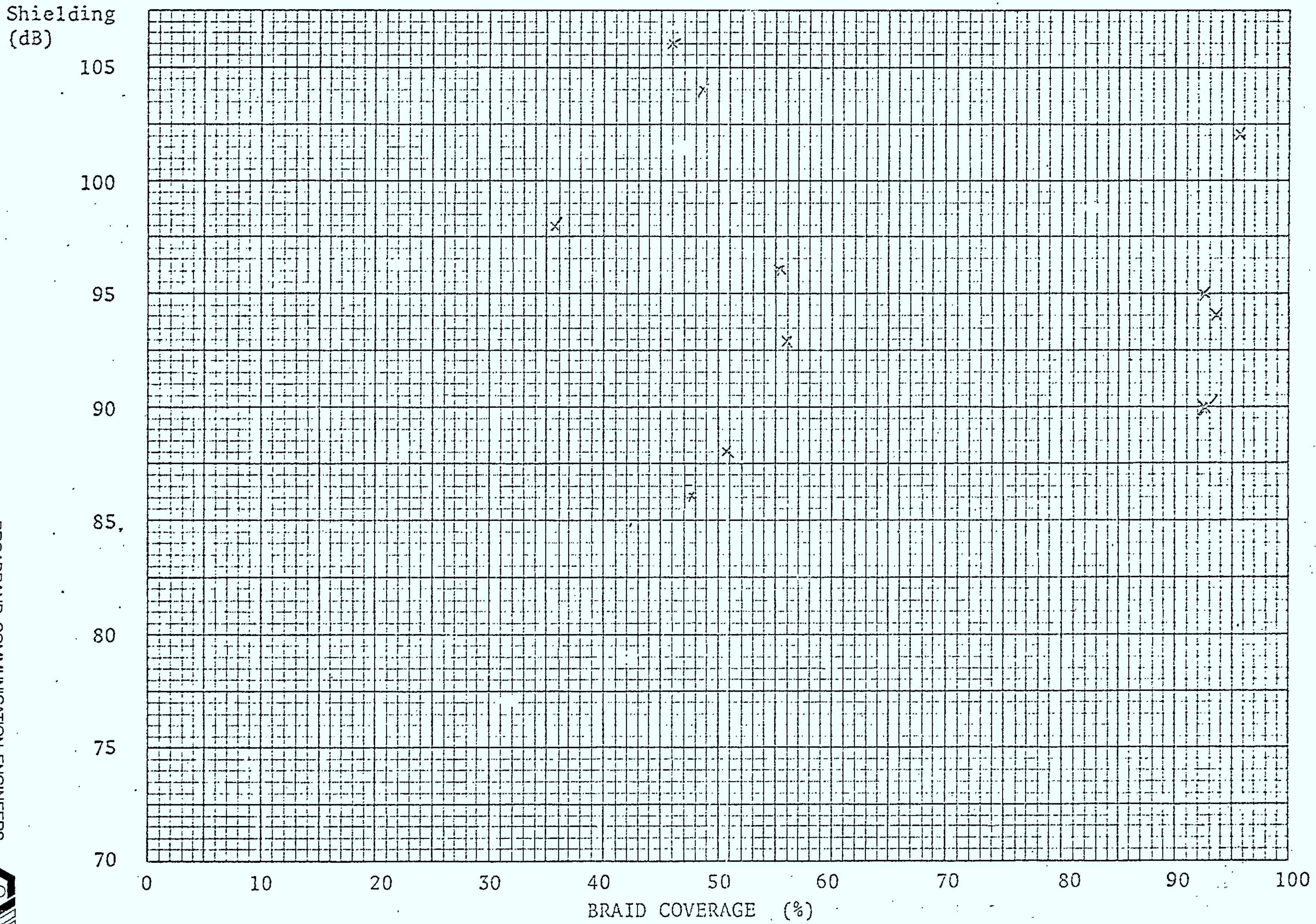


Fig. 3.31 Effective Shielding of Drop Samples at 100 MHz

3.2 DROP WIRE SHIELDING VARIABILITY

Five samples of drop wire were taken from one reel of cable and the shielding of each sample was measured as described previously. Identical connectors were used on each sample. The results of the shielding tests are compared in Fig. 3.32.

The shielding was relatively stable in the HF band (largest variance is 6dB at 30 MHz) but was less stable in the VHF band (greater than 25 dB variance at 70 MHz). This indicates that the variations in test samples (either connector installation or possible variances in shielding of samples taken from the same reel) are more critical at VHF than at HF.

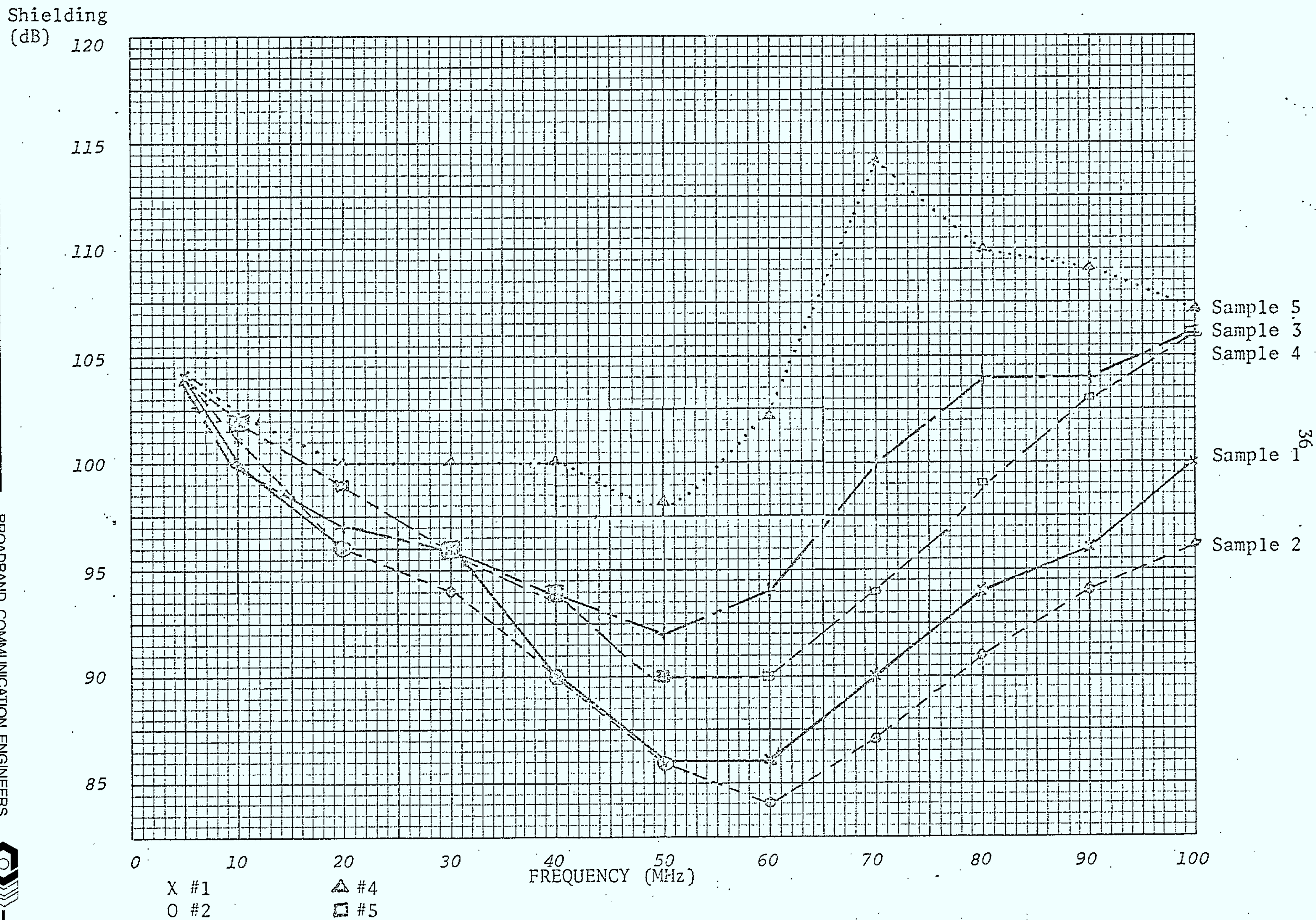


Fig. 3.32 Variability in Drop Shielding Spectrum

36

3.3 DROP WIRE SHIELDING - FIELD TESTS

Degradation in drop shielding may occur when the drop is installed in field conditions. Installation and maintenance practices, mechanical flexing of droplines, as well as connector corrosion and connector installation all effect shielding. These variations are difficult to simulate in the laboratory. A random sample of drops in existing systems was measured for shielding effectiveness, and the cummulative impairment of all these variables analyzed.

These drops were tested as described in Appendix 3.2 Shielding of the drop was calculated as described in Appendix 3.3

Results of the tests are shown in Table 3.2 and plotted in Fig. 3.33. These results indicate that the drops with a single copper braid have less shielding than those with a braid over aluminum foil.

The shielding of one drop which was tested was significantly worse than that of similar drops.

In general it appears that, of the drops tested, braid type is the critical element of drop shielding. However it must be noted that the single shielded drops were also in service longer than the double shielded drops. It is possible that temporal degradation accounts for this result.

TABLE 3. 2

SHIELDING OF SYSTEM DROPS

SHIELDING TEST

DROP #1A
SINGLE SHIELD COPPER BRAID DROP DISCONNECTED AT THE TAP

(from RG meter)

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	7.62	25	-56
2	18.288	15	-58
3	30.48	7	-62
4	45.72	3	-62

} WORSE AT CLOSE DIST. ONLY

DROP #1B
SAME DROP AS 1A DROP NOW HOOKED TO THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	9.144	16	-63
2	18.288	9	-64
3	30.48	7	-62
4	45.72	2	-63

DROP #2
DOUBLE SHIELD ALUMINIUM BRAID DROP TERMINATED AT THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	9.144	4	-75
2	15.24	0	-75
3	30.48	-8	-77
4	45.72	-8	-73

DROP #3
SINGLE SHIELD COPPER BRAID DROP TERMINATED AT THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	9.144	40	-39
2	18.288	35	-38
3	30.48	34	-35
4	45.72	29	-36

} CONSISTANTLY BAD!

DROP #4
SINGLE SHIELD DROP TERMINATED AT THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	9.144	13	-66
2	30.48	4	-65
3	45.72	2	-63
4	60.96	2	-61

TABLE 3.2 (cont'd.)

DROP #5
SINGLE SHIELD COPPER BRAID TERMINATED DROP AT THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	15.24	7	-68
2	30.48	-8	-77
3	45.72	3	-62
4	60.96	1	-62

DROP #6A
SINGLE SHIELD DROP WITH OLD F-81 SPLICE TERMINATED AT TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	7.62	22	-59
2	12.192	16	-61
3	30.48	8	-61
4	45.72	1	-64

DROP #6B
SAME DROP AS 6A WITH OLD F-81 REPLACED

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	7.62	18	-63
2	12.192	14	-63
3	30.48	8	-61
4	45.72	-1	-66

DROP #7
SINGLE SHIELD DROP DROP TERMINATED AT THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	7.62	20	-61
2	12.192	15	-62
3	30.48	12	-57
4	45.72	10	-55

DROP #8
DOUBLE SHIELD DROP ALUMINIUM FOIL DROP TERMINATED AT TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	7.62	4	-77
2	12.192	2	-75
3	30.48	-3	-72
4	45.72	-6	-71

TABLE 3.2 (cont'd.)

DROP #9
SINGLE SHIELD DROP WITH BAD F-81 SPLICE TERMINATED AT TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	7.62	22	-59
2	12.192	16	-61
3	30.48	8	-61
4	45.72	1	-64

DROP #9B
SAME AS 9A WITH NEW F-81 SPLICED CHANGED

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	7.62	20	-61
2	12.192	15	-62
3	30.48	8	-61
4	45.72	-4	-69

DROP #10
SINGLE SHIELD COPPER BRAID TERMINATED AT THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	7.62	20	-61
2	12.192	15	-62
3	30.48	12	-57
4	45.72	10	-55

DROP #11
DOUBLE SHIELD ALUMINIUM BRAID TERMINATED AT THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	7.62	4	-77
2	12.192	2	-75
3	30.48	-3	-72
4	45.72	-6	-71

DROP #12
RG-6U CABLE FROM SYRACUSE DROP TERMINATED AT THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	1.524	2	-93
2	15.24	-8	-83
3	30.48	-15	-84
4	60.96	-20	-83

TABLE 3. 2 (cont'd.)

DROP #13
DOUBLE SHIELD 59-U CABLE TERMINATED AT THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	15.24	-6	-81
2	30.48	-25	-94
3	60.96	-25	-88

DROP #14
DOUBLE SHIELD CABLE TERMINATED AT THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	15.24	-12	-87
2	30.48	-25	-94
3	60.96	-35	-98

DROP #15
DOUBLE SHIELD 59-U CABLE TERMINATED AT THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	15.24	0	-75
2	30.48	-5	-74
3	60.96	-15	-78

DROP #16
DOUBLE SHIELD CABLE 59-U TERMINATED AT THE TAP

TEST	DISTANCE(M)	INGRESS(DBMV)	SHIELDING EFFECT(DB)
1	15.24	-4	-79
2	30.48	-24	-93
3	60.96	-26	-89

AVERAGES

	SHIELDING (MEAN)	TOTAL (VARIANCE)
Double shield RG-59	90 dB	25 dB
" " Al. braid	75 dB	6 dB
Single shield	60	43 dB.

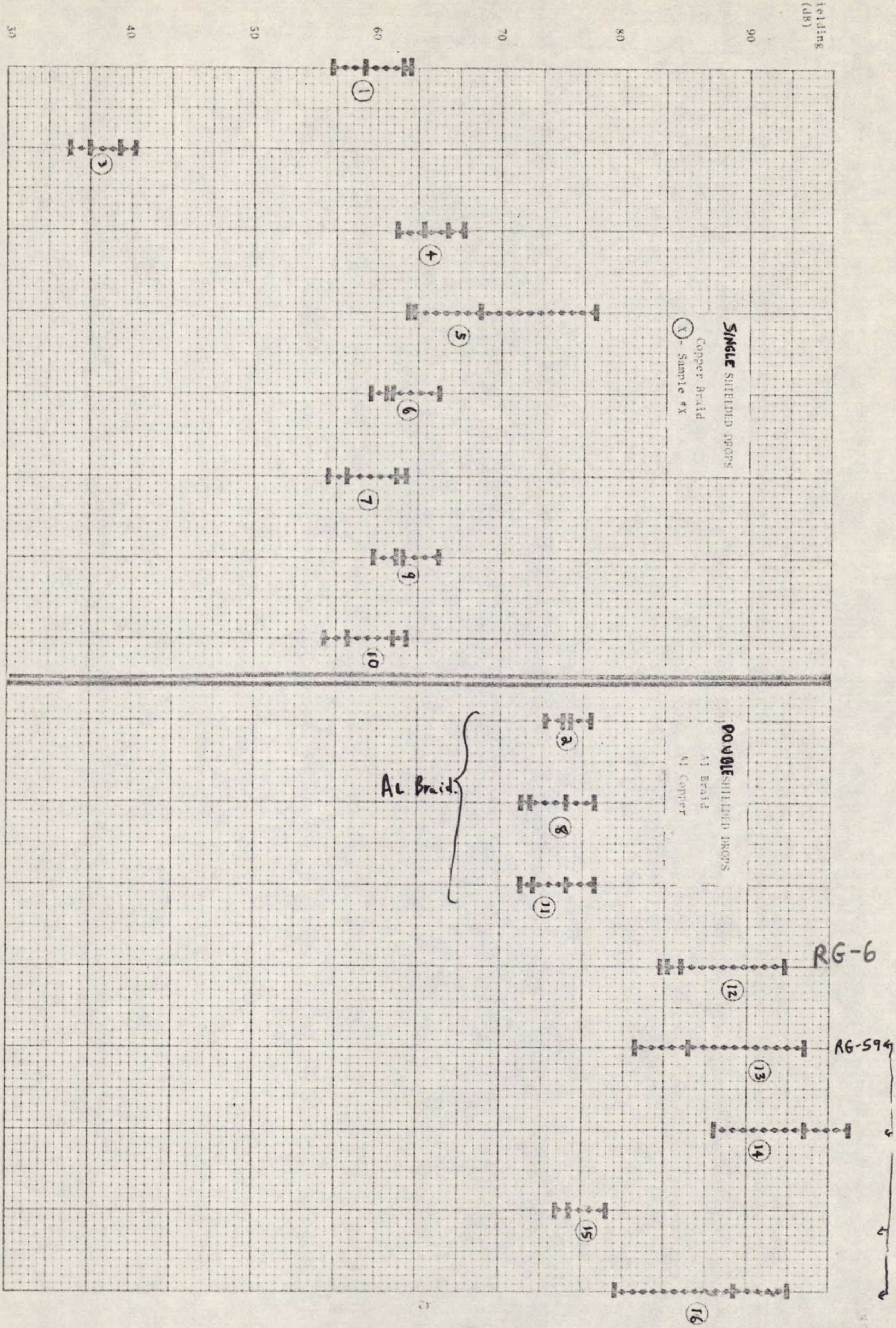


FIG. 3.33 MEASURED SHIELDING OF SYSTEM TEST DROPS

3.4 DROP VS. DISTRIBUTION SHIELDING

The relative shielding of drops and distribution lines was compared by measuring the input and output of distribution lines as shown in Fig. 3.34. Approximately 20 db output to spigot directivity of multi-taps isolate the output of the distribution line from the ingress received on the drop lines. If a higher signal level is received at the input of the distribution line, the drops would be at fault. If the level of ingress is the same at both input and output, the distribution is at fault.

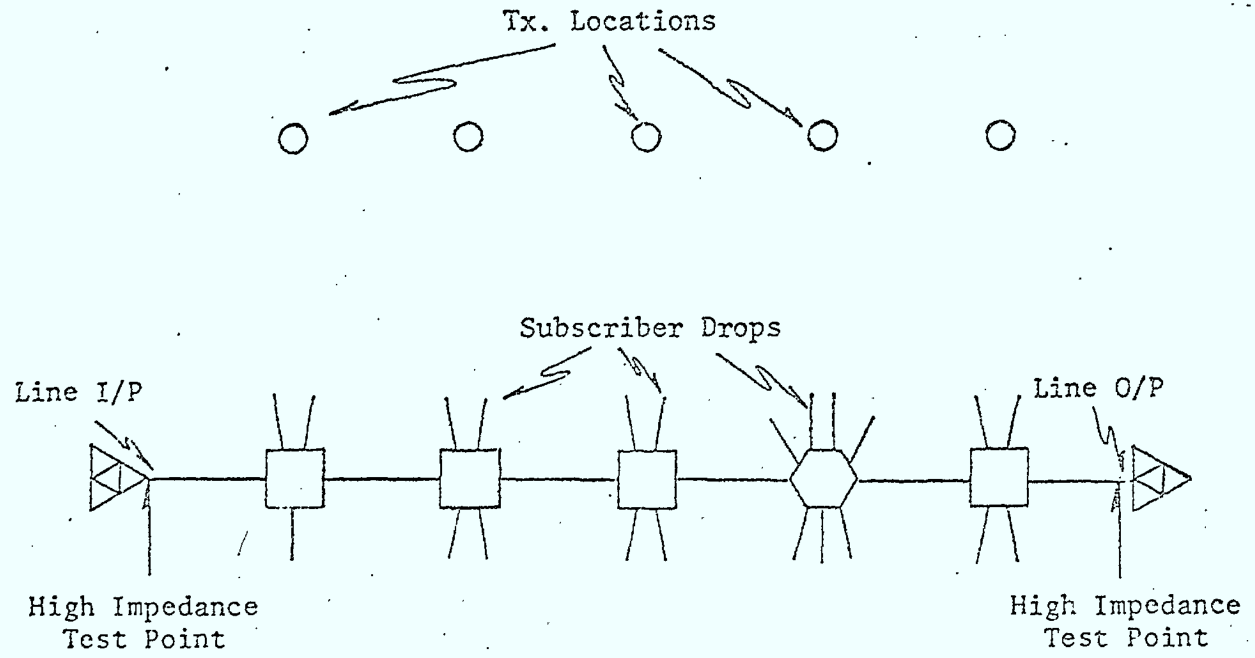
Two distribution lines in the London Cable TV system were tested. Plans for these lines are shown in Fig. 3.35. Test results are shown in Table 3.3 and Table 3.4

TABLE 3.3 LINE INPUT AND OUTPUT INGRESS LEVELS (Line J)

Transmitter Location	I/P Level (dBmV)	O/P Level (dBmV)
0	-35	-25
1	-20	-30
2	-15	-27
3	-27	-29
4	-5	-35
5	-10	-30

TABLE 3.4 LINE INPUT AND OUTPUT INGRESS LEVELS (Line H)

Transmitter Location	I/P Level (dBmV)	O/P Level (dBmV)
1	+5	-12
2	+3	-5
3	-7	-2
4	-1	-18
5	-3	+2



NOTE: Remove return amplifier at Line O/P and terminate.

FIGURE 3.34 Representative Distribution Line

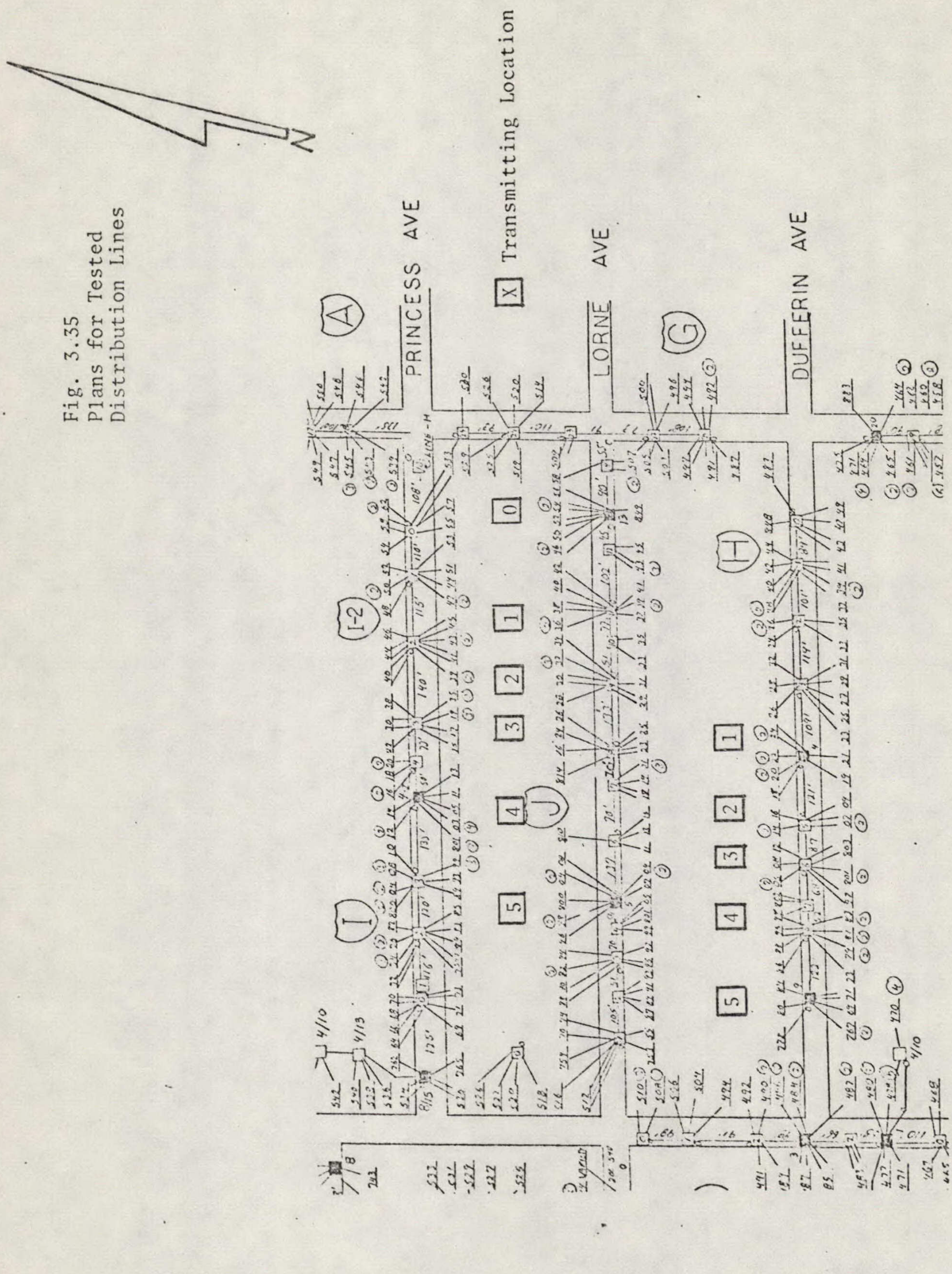


Fig. 3.35
Plans for Tested
Distribution Lines

On line "J" the ingress level received at the input was at least 10 dB higher than that received at the line output for transmitting locations 1,2,4, and 5. At these locations, then, the most significant shielding problems were on a drop line. For transmitting locations 0 and 3, the level received at the line input was not significantly higher. The most significant shielding problems were on the distribution line, not the drop, at these locations.

It is interesting to note that for locations 1,2,4, and 5 (i.e. where the drop is most critical) the signal levels at the line input ranged from -5 dBmV to -20 dBmV. For locations 0 and 3, levels were -27 dBmV and -35 dBmV.

Levels received at the line output varied from -25 dBmV to -35 dBmV (10 dB range) while at the line input they varied from -5 dBmV to -35dBmV (30 dB range).

On Line "H" the level received at the line input was at least 8 dB higher than at the line output for locations 1,2, and 4. For locations 3 and 5 the receiver levels were lower at the line input than at the output. For locations 1,2,4, input levels varied from -1 dBmV to +5 dBmV. For locations 3 and 5, levels were -3 dBmV and -7 dBmV.

Levels received at the line input varied from -7 dBmV to +5 dBmV (12 dB range) while those at the line output varied from -18 dBmV to +2 dBmV (20 dB range).

The minimum level received at the output of line H was -18 dBmV while the maximum level received at the output of line J was -25 dBmV. Also the variation in level received at the input of line H was 12 dB compared to a 30 variation for line J. One possible explanation for this is poor shielding on the H distribution line. This shielding problem is more difficult to isolate than the drop problems experienced at locations 1,2,4 and 5 on line J as smaller changes in signal level were experienced as the transmitter location was changed.

The two distribution lines seem to have a different "weak link" in their shielding. This has been experienced elsewhere in the same two-way system.

3.5 SUMMARY

There is a large number of types of drop wire available to C.A.T.V. systems. These wires have different shielding characteristics and, from the results of the shielding effectiveness tests, simple description of the characteristics (e.g. % braid coverage) does not necessarily correlate with effective shielding. Other variables such as type of foil, type of braid material, mechnaical stress, may have a more significant effect on drop shielding than % braid coverage.

Field tests indicated either that a double shielded drop wire has better shielding than single shielded or that shielding deteriorates with time. These tests indicated that the "weak link" in drop shielding is braid type if the drop is single shielded.

The comparison of the shielding of drops and distribution lines showed that drops not necessarily cause the most severe ingress problems on an HF C.A.T.V. system.

APPENDIX 3.1

Method for Braid Percentage Calculation

APPENDIX 3.1

BRAID PERCENTAGE CALCULATION

To calculate the percent braid coverage, the following formulae are used:

1) Tan a = 2π (D) + 2d) P/C

2) From 1) determine sin a in degrees

3) $F = \frac{NPd}{\sin a}$

4) $K = (2F - F^2) \times 100\%$

Where P = picks per inch

N = number of strands per carrier

C = number of carriers

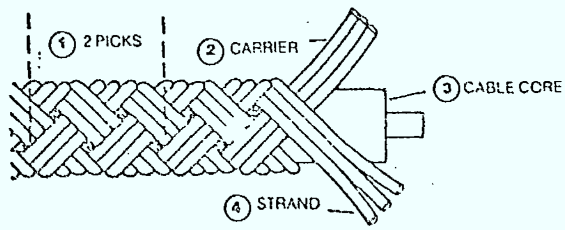
D = diameter under shield in inches

d = diameter of the strand in inches

a = angle (degrees) of braid with axis of the cable

K = shield coverage

NOTE: One inch = 2.54 cm



Example Braid

APPENDIX 3.2

Test Procedure for Shielding at Existing Drops

To measure shielding of existing drops the following equipment, adaptors and set-up is used. A truck equipped with safety cones, ladder and tools are required.

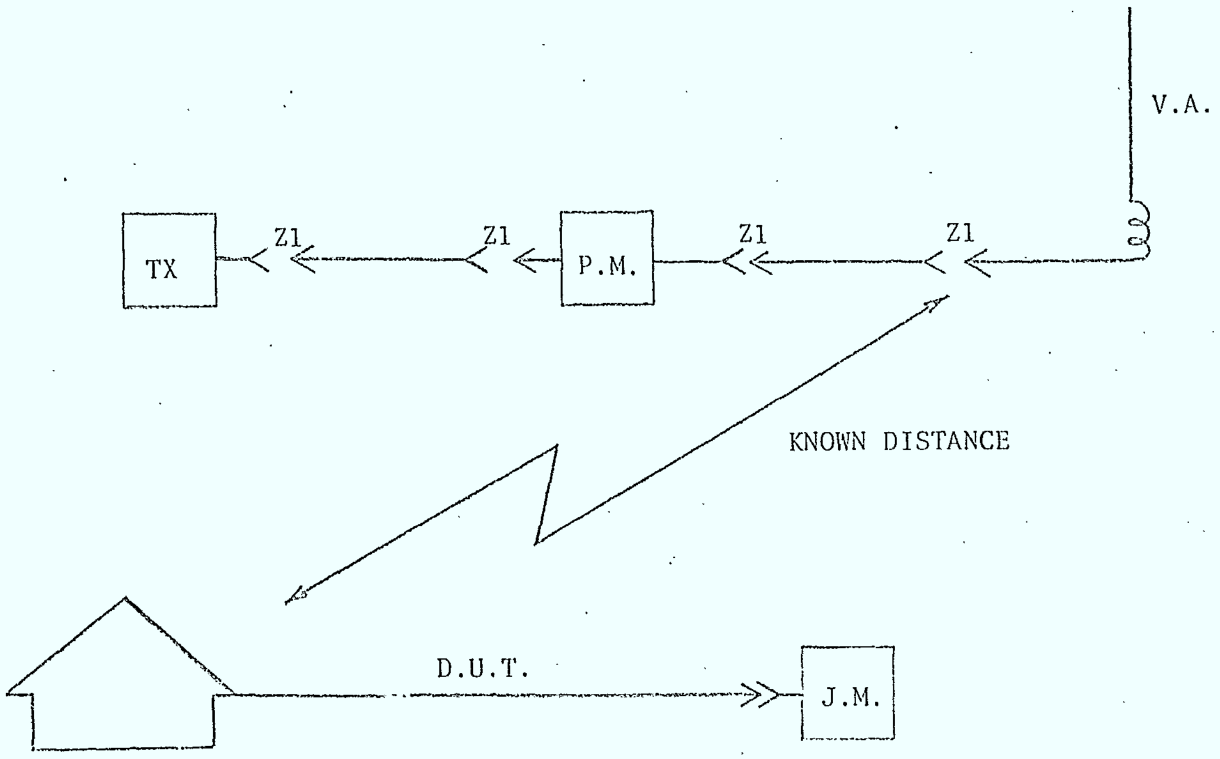
MEASUREMENT EQUIPMENT REQUIRED FOR SHIELDING OF EXISTING DROPS

Manufacturer	Model No.	Serial No.	Quantity	Description	Reference Designation
Cobra	77X		1	CB Transmitter	TX
Antenna Specialist	M-125		1	Antenna (27MHz)	V.A.
Heathkit	HM-102		1	Power Meter	P.M.
Jerrold	727		1	Tunable Field Strength Meter	J.M.

CONNECTOR AND CABLES REQUIRED

Amphenol	RG-58υ		15 FT.	52Ω Cable	W1
Amphenol	RG-58υ		3 FT.	52Ω Cable	W2
Amphenol	PL-259υ		4 FT.	50Ω Coaxial Con.	Z1

CONNECTION REQUIRED FOR SHIELDING OF EXISTING DROPS



VARIABLE SUBSCRIBER EQUIPMENT

PROCEDURE:

1. Move the transmitter to a measured distance from the drop line.
2. Measure the transmitter power output.
3. Tune the field strength meter.
4. Measure and record the level of transmitted signal being received by the dropline.
5. Repeat steps 1 and 4 at various distances.

APPENDIX 3.3

Drop Wire Shielding Calculations

The power received by an antenna can be expressed as

$$W_r = \frac{\lambda \quad g_1 \quad g_2 \quad W_t}{(4 \quad \pi \quad d)}$$

Where W_r = Power received (W)

λ = Wavelength of transmitted signal (m)

g_1 = Power gain of transmitting antenna

g_2 = Power gain of receiving antenna

W_t - Power transmitted (W)

d = Distance between antennae (m)

Since $\lambda = {}^{v}/_{f}$

Where v = Velocity of wave in free space (m/s)

f = Frequency (Hz)

Then $$g_2 = \frac{W_r \quad (4 \ \pi \ d)^2}{({}^{v}/_{f})^2 \quad g_1 \quad WT}$$

or

$$G_2 = 10 \log_{10} \left[\frac{W_r \quad (4 \ \pi \ d)^2}{({}^{v}/_{f})^2 \quad g_1 \quad W_t} \right] \text{ dBi}$$

If W_t = 10W

g_1 = 1

$f = 7.2 \times 10^6$ Hz

and $v = 3 \times 10^8$ m/s

Then $G_2 = 10 \log_{10} \left[9.096 \times 10^{-3} \ W_r \ d^2 \right]$ dBi

Antenna gain G_2 was calculated using computer program "GERRY"

LISTING OF GAIN CALCULATION PROGRAM

```
LIST
GERRY   11:24 AM        10-MAR-80
1  EXTEND
5  DIM I(4),T(4),G2(4)
10  OPEN"SHIELD.DAT" FOR OUTPUT AS FILE 1%
15  PRINT #1%, "SHIELDING TEST"
20  PRINT #1%
25  PRINT #1%
30  INPUT "DROP #" ;D1$
35  INPUT "COMMENTS";C$
40  PRINT "INPUT DISTANCE AND INGRESS LEVEL"
42  PRINT #1%,"DROP #";D1$
43       PRINT #1%,C$
44  PRINT #1%
45  PRINT #1%
46  PRINT #1%,"TEST","DISTANCE(M)","INGRESS(DBMV)", "SHIELDING EFFECT(DB)"
47  FOR I= 1 TO 4
50 INPUT T(I),I2(I)
60  T(I)=T(I)*.3048
70       I1(I)=10**((I2(I)-78.75)/10)
80  G2(I)=10*LOG10(I1(I)*(T(I)**2)*9.096*(10**(-3)))
85       PRINT #1%,I,T(I),I2(I),G2(I)
90       NEXT I
91       PRINT #1%
92       PRINT #1%
105      INPUT" MORE DROP Y/N";B1$
110      IF B1$="Y" GO TO 30
120      CLOSE 1%
130      END

READY
```