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HIGH FREQUENCY RADIO NOISE SURVEY AT THREE COMMUNICATION SITES IN THE OTTAWA AREA

by

W.R. LAUBER, L.R. BODE AND J.M. BERTRAND

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ABSTRACT

Radio noise measurements have been carried out over two week periods during each of the four seasons to establish existing day-time noise levels at three high frequency communication sites in the Ottawa area. The parameters used were the average available noise power spectral density (F_a), and the ratio of the rms to the average voltage of the noise envelope (V_d). By comparing the results to those expected at a "quiet receiving site" as defined in CCIR Report 322 it has been possible to rate quantitatively the site effectiveness or degree of degradation of each site. As well, noise measurements have been made in the evenings (2000-2400 hours LST) at one site. The results were found to compare favourably with the predictions of CCIR Report 322. By using these night-time values as representative of the Ottawa area, the day-night difference in noise levels at 2.5 MHz was computed. These differences were also used to rate quantitatively the degree of degradation of each site.

1. INTRODUCTION

In 1973 the Communications Research Centre (CRC) carried out a High Frequency (HF) radio noise survey at a Canadian Forces receiving site on the East coast of Canada [1]. The results of this survey showed that the day-time ambient noise levels compared favourably with those predicted for a "quiet receiving location" as defined in CCIR Reports 322[2] and 258[3]. From this survey two quantitative criteria for evaluating the effectiveness of an HF receiving site at mid-latitudes have been proposed [4]. These are: first, a low rms difference (≈ 3 dB) between the measured day-time ambient noise levels and the expected values of man-made noise at a quiet receiving location as defined by the quiet receiving site line (QRSL), and second, a 20 dB difference between day and night noise levels at 2.5 MHz for the spring, summer and autumn seasons. In the winter season this latter difference is about 10 dB.

In order to determine the ambient noise levels at other communication sites in Canada and to test the above two criteria for assessing effectiveness of a communications site, measurements have been made over a one year period at three communications sites in the Ottawa area: CRC Quiet Site, CRC High Frequency Direction Finding (HFDF) Site and Canadian Forces Station (CFS) Leitrim, Figure 1.1 shows the relative locations of the three sites. Measurements of night-time noise have been made to assess the reliability of the CCIR atmospheric noise predictions for this area.

The results of this survey are reported herein and compared with those obtained from the Mill Cove Survey [1].

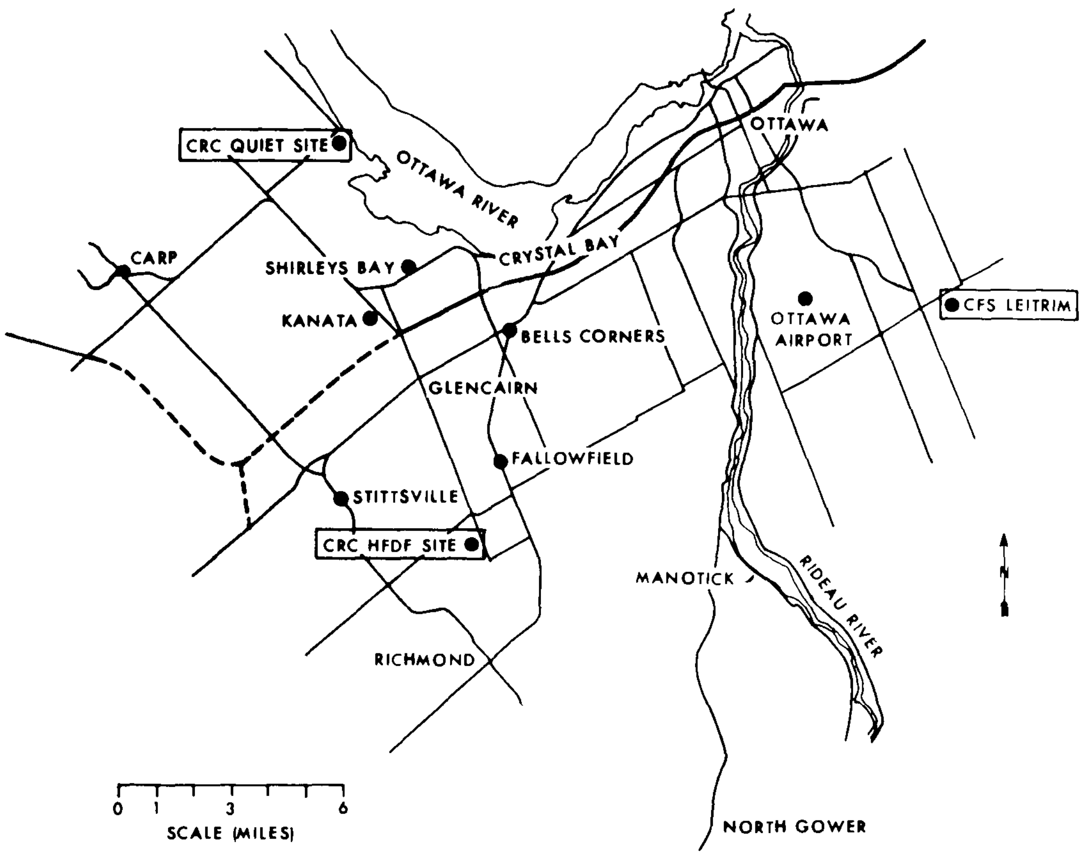

Figure 1.1. Map of the Ottawa Area Showing the Locations of the Three Noise Measurement Sites.

2. SCOPE OF OPERATIONS

2.1 NOISE PARAMETERS

The two noise parameters measured in this study were: (1) F_a, the effective antenna noise factor which results from the external noise power available from a loss free antenna; and (2) V_d, the voltage deviation, defined as the dB difference between the root mean square (rms) and average noise envelope voltages. Both of these parameters have been used extensively in CCIR Reports 322[2] and 258[3] and are thus internationally accepted units.

F_a is related to the rms noise-field strength as measured by a receiver with an effective noise bandwidth b connected to a short vertical monopole over a perfectly conducting ground plane by the formula:

$$F_a = E_N - 20 \log F + 95.5 - 10 \log b \qquad (1)$$

where: F_a is the effective antenna noise factor or the average power above thermal noise per unit bandwidth (dB above kT);

k is Boltzmann's constant (1.38×10^{-23} joules/K);

T is the reference temperature (K);

E_N is the rms noise field strength in a bandwidth b (dB above 1 μv/m);

F is the frequency (MHz); and

b is the effective receiver noise bandwidth (Hz).

The V_d parameter has been used as the shape factor in predicting the Amplitude Probability Distribution (APD) of atmospheric noise [5]. A family of idealized APD curves for atmospheric noise is presented in CCIR Report 322 with V_d as the main parameter. Spaulding and Disney[6] have pointed out the importance of knowing both the noise characteristic as well as its level when predicting the performance of a communication system. For example Montgomery [7] has shown theoretically and Omura and Shaft [8] have verified with performance data that the probability of a bit error occurring in a non-coherent frequency-shift-keying (NCFSK) system is equal to one-half the probability that the noise exceeds the signal.

2.2 EQUIPMENT

For this study a Singer NM-26T receiver connected to a nine-foot vertical rod antenna was used. The antenna and its associated coupler were attached to a 0.6 x 0.6 metre ground plane strapped to the roof of a station wagon. This receiver was identical to the modified NM-25T receivers used in the previous study [1]. For this receiver F_a is computed from the following equation:

$$F_a = MR + K - G$$

where MR is the NM-26T receiver meter reading (dB above 1 μv);

G is the gain of the low noise preamplifier, and was 9 dB for the Comdel HDR-102 used here; and

K is a combined constant having a different value for each frequency.

K is calculated using the formula:

$$K = 95.5 - 10 \log b - 20 \log F + AF + CL - EH$$

where b is the effective receiver noise bandwidth (Hz), and was 4 kHz for the NM-26T receiver;

F is the receiver frequency (MHz);

AF is the antenna factor or coupler insertion loss (dB), and was determined from the calibration curves supplied with the antenna coupler;

CL is the cable loss (dB), and was calculated for the 20-foot length of RG58 used to connect the antenna coupler to the receiver; and

EH is the antenna effective height (dB above one metre).

Since the effective height of a short vertical monopole (< λ/10 on physical height) above an infinite, perfectly conducting ground plane is equal to one half the physical height, an effective height factor of EH = 20 log (9/2 ft. x 0.3048 m/ft.) = 2.8 dB above one metre was used for the nine-foot rod. This theoretical result has been confirmed within ±2 dB by ourselves [1] and previous workers [9].

2.3 SCHEDULE

To obtain data for each of the four CCIR defined seasons (Spring - March, April, May; Summer - June, July, August; Autumn - September, October, November; Winter - December, January, February) and to observe any seasonal patterns in the HF radio noise environment, measurements were taken at the three sites according to the schedule shown in Table 2.1.

The day-time measurements were taken during the time of strongest ionospheric attenuation and thus of lowest levels of ionospherically-propagated atmospheric noise, i.e., during the 0800-1200 hours, Local Standard Time (LST) period. This was to ensure that the measured levels were predominantly due to man-made noise. During the evening hours the level of ionospherically propagated atmospheric noise exceeds the day-time levels by significant amounts, especially at the lower frequencies. Since at night the noise should be essentially common to the three sites, noise measurements during the evenings

(2000-2400 hours LST) were made only at the CRC Quiet Site. These measurements were obtained for comparison with the atmospheric noise predictions of CCIR Report 322.

TABLE 2.1

Schedule of Ottawa Noise Measurements

Season	Dates	Site CRC Quiet Site	 CRC HFDF Site	 CFS Leitrim
Winter	22 January – 10 February 1974	x	x	-
Spring	18 April – 1 May 1974	x	x	x
Summer	8–21 July 1974	x	x	x
Autumn	30 September – 18 October 1974	x	x	x
Winter	7–21 January 1975	-	-	x

The parameters F_a and V_d were measured on signal-free frequencies as close as possible to the nominal frequencies of 2.5, 5, 10, 15, 20, and 25 MHz. A data run for each frequency consisted of 11 samples of F_a and V_d taken at 15 second intervals.

The results of the measurements taken at the CRC Quiet Site, the CRC HFDF Site and CFS Leitrim are discussed in detail in Appendices A, B and C respectively.

3. RESULTS AND CONCLUSIONS

3.1 RESULTS

Table 3.1 summarizes the results of the day-time measurements at the three sites by showing the median values of F_a and V_d, defined as F_{am} and V_{dm}, for each season. From this it can be seen that there are significant differences in the radio noise environments at the three sites, especially at frequencies below 10 MHz. The values of F_{am} and V_{dm} from the CRC Quiet Site are generally the lowest of the three, which means that both the noise level and the degree of impulsiveness of the noise are the lowest for this site. A V_{dm} value of 1.05 indicates a gaussian noise environment; higher values of the V_d parameter indicate a more impulsive noise environment. The highest values of F_{am} and V_{dm} were usually found at the CRC HFDF site; however, the V_{dm} values observed here were significantly lower than those obtained at the Halifax dockyard [1] where V_{dm} values of 6 dB were quite common.

TABLE 3-1A

Summary of Day-Time F_{am} Values Measured at the Three Sites (dB above kT)

SEASON	SITE	FREQUENCY MHz 2.5	5	10	15	20	25
Spring	CRC Quiet	42	35	23	24	15	10
	CRC HFDF	60	51	37	30	22	10
	CFS Leitrim	53	38	28	26	17	11
Summer	CRC Quiet	42	37	30	24	14	13
	CRC HFDF	51	46	31	28	16	13
	CFS Leitrim	53	41	35	28	15	12
Autumn	CRC Quiet	41	34	24	23	16	11
	CRC HFDF	59	54	35	29	18	9
	CFS Leitrim	44	36	27	26	16	9
Winter	CRC Quiet	43	38	26	25	16	11
	CRC HFDF	57	52	32	28	17	9
	CFS Leitrim	47	37	29	28	20	14

TABLE 3-1B

Summary of Day-Time V_{dm} Values Measured at the Three Sites (dB)

SEASON	SITE	FREQUENCY (MHz) 2.5	5	10	15	20	25
Spring	CRC Quiet	1.1	1.0	1.6	1.0	1.0	1.0
	CRC HFDF	3.2	2.9	2.0	1.7	1.5	1.2
	CFS Leitrim	2.1	1.1	1.7	1.0	1.0	1.0
Summer	CRC Quiet	1.2	1.7	3.1	1.9	1.1	1.0
	CRC HFDF	2.2	2.1	3.0	2.2	1.8	1.2
	CFS Leitrim	4.2	2.6	3.1	2.1	1.1	1.0
Autumn	CRC Quiet	1.1	1.0	1.1	1.1	1.0	1.0
	CRC HFDF	1.9	2.1	1.9	1.2	1.4	1.0
	CFS Leitrim	1.6	1.3	1.5	1.3	1.1	1.0
Winter	CRC Quiet	2.0	1.4	2.0	1.2	1.0	1.1
	CRC HFDF	2.4	2.2	2.4	1.3	1.1	1.1
	CFS Leitrim	1.6	1.5	2.0	1.7	1.0	1.0

Tables 3.2 and 3.3 show the results of applying the two site effectiveness criteria, discussed in section one, to these sites. From Table 3.2 it can be seen that the values of the rms difference between the F_a measurements and the levels predicted by the quiet receiving site line (QRSL) are essentially the same, whether all the F_a measured data are used to compute the difference or just the F_{am} values. Table 3.3 shows the increase in noise level (dB) at night over that of the day at 2.5 MHz using the night-time results at the CRC Quiet Site as representative for the Ottawa area. The results presented in these tables tend to show that the CRC Quiet Site is

quite comparable to the ideal "quiet receiving location", i.e. it had a low rms difference (≈3 dB) between the measured day-time ambient noise levels and the expected values of man-made noise at a quiet receiving location, and about a 20 dB difference between day and night noise levels at 2.5 MHz for the spring, summer and autumn seasons. In the winter season this latter difference was about 10 dB. However, the results in these tables show that the CRC HFDF site was significantly degraded, i.e. a large rms difference (≈10 dB) between the measured day-time ambient noise levels and the expected values of man-made noise at a quiet receiving location, and a negligible difference between day and night noise levels at 2.5 MHz. From aural monitoring of the noise, the high day-time levels at frequencies below 10 MHz (see Table 3.1) were found to be caused by powerline noise. This was the major source of the degradation.

TABLE 3–2

Comparison of the Day-Time Measured Noise Levels of the Three Sites with the Predicted Levels at the Quiet Receiving Location

SEASON	SITE	RMS DIFFERENCE (dB) USING ALL DATA	USING F_{am}s ONLY
Spring	CRC Quiet	3.0	2.5
	CRC HFDF	12.6	13.5
	CFS Leitrim	6.9	6.1
Summer	CRC Quiet	6.3	3.1
	CRC HFDF	8.0	8.1
	CFS Leitrim	8.1	8.3
Autumn	CRC Quiet	2.5	1.8
	CRC HFDF	12.3	12.3
	CFS Leitrim	4.2	3.4
Winter	CRC Quiet	3.8	3.0
	CRC HFDF	11.1	10.4
	CFS Leitrim	6.8	4.6

TABLE 3–3

Comparison of the Day and Night Noise Levels of the Three Sites at 2.5 MHz

SEASON	SITE	INCREASE IN NIGHTTIME OVER DAYTIME NOISE LEVEL (dB)
Spring	CRC Quiet	18
	CRC HFDF	0
	CFS Leitrim	7
Summer	CRC Quiet	17
	CRC HFDF	8
	CFS Leitrim	6
Autumn	CRC Quiet	18
	CRC HFDF	0
	CFS Leitrim	15
Winter	CRC Quiet	13
	CRC HFDF	–1
	CFS Leitrim	9

CFS Leitrim was found to be somewhat degraded but not as much as the CRC HFDF site, i.e. it had about a 7 dB rms difference between the measured day-time ambient noise levels and the expected values of man-made noise at a quiet receiving location, and about a 10 dB difference between day and night noise levels at 2.5 MHz. As was shown in Appendix C, from our measurements over 49 days this site was relatively quiet for approximately 63% of the time. However, for the remaining 37% of the time, the radio environment of the site was dominated by a strong source of man-made noise at frequencies below 10 MHz(see Table 3.1). From aural monitoring these high levels were found to be caused by powerline noise.

3.2 CONCLUSIONS

From the program of measurements at these three sites and the experience gained in the previous study it is concluded that:

1. The execution of a receiving site survey requires at least two weeks of data to ensure that local atmospheric activity does not bias the results;

2. There is very little seasonal difference in the day-time radio-noise levels at mid-latitudes, so that measurements for only one season can be extrapolated over the entire year;

3. Powerline noise is a serious problem especially at frequencies below 10 MHz, and further it is often intermittent and thus not easily found;

4. An otherwise good site may be degraded intermittently, and so checking should be done often and carefully if low radio-noise levels are to be maintained;

5. Of the two criteria proposed to measure receiver site effectiveness the first (comparing the site to a "quiet receiving location") seems to give a better overall measure of effectiveness. The second (the existence of a 20 dB difference between the day and night noise levels at 2.5 MHz), however, is a good measure of site effectiveness if powerline interference is predominant at the lower frequencies, but not if a site is degraded by ignition noise, which has been found to be the dominant noise source at frequencies above 20 MHz [3];

6. The CCIR atmospheric noise predictions as reported in CCIR Report 322 are quite accurate (within ±6 dB) for the evening (2000-2400 hour LST period for communication sites in the mid-latitudes (43-49°N) of Canada. For the day-time periods (0800-1200 hours and 1200-1600 hours) noise levels much below the QRSL have not been observed even at the "quietest" sites, even though the CCIR predictions predict levels some 5 to 10 dB below the QRSL for frequencies 2-10 MHz for this time period.

4. REFERENCES

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9. Hagn, G.H., *MF and HF Man-Made Radio Noise and Interference Survey - Keflavik, Iceland*, Stanford Research Institute Technical Memorandum, February, 1972.

APPENDIX A

Noise Measurements at the CRC Quiet Site

A.1 INTRODUCTION

The noise measurements at the CRC Quiet Site were taken near building 21 at a location approximately 580 metres from the road and a small 7-kV power-line. Figure A-1 shows a layout of the area. In the winter season 14 days of measurements were taken; these showed the site to be relatively quiet. Because of this, measurements for the other three seasons were made for only seven days during the two week seasonal measurements periods. This arrangement proved sufficient for the spring and autumn seasons, but because of local atmospheric activity, in the summer season, seven days did not provide a large enough sample. Also, for each season atmospheric noise measurements were taken on seven nights.

A.2 CRC QUIET SITE, DAY-TIME MEASUREMENTS

Table A-1 summarizes the results of the day-time measurements for the four seasons. These results are also plotted as a function of frequency in Figures A-2 to A-5. The figures show F_{am}, the median value of F_a for each season and the range of values of F_a measured in the two week measurement period. Finally, the figures contain a line that represents the expected values of man-made noise at a quiet receiving location as reported in CCIR Report 322[2]. The equation for this line is:

$$F_a = -28.6 \log F + 53.6$$

where F is the received frequency in MHz.

The plotted results show that the measured data fit the predicted line quite closely. This close fit is further indicated in Table A-1, which lists the rms differences between the measured data and the predicted line, referred to in the table as the Quiet Receiving Site Line (QRSL). The rms difference for each season was computed both with all the measured data and also with only the median value of F_a. There is very little difference between the two values except in the summer, where because of the wide variation in the measured data caused by local atmospheric activity, the rms difference using all the measured data is significantly larger than that computed using the median values. From the above it can be concluded that the CRC quiet site is nearly ideal. This is further proven by the results of the V_d measurements summarized in Table A-2. The low values of V_{dm}, the median values of V_d for each season, show the site to be relatively free of impulsive man-made noise.

Finally from Table A-1 it can be seen that very little seasonal difference exists between the F_{am} values. All the differences are within 4 dB, with the exception of the 10 MHz values which have a difference of 7 dB. These are quite consistent with the results from the Mill Cove Study [1] which showed differences of less than 5 dB.

A.3 CRC QUIET SITE, NIGHT-TIME MEASUREMENTS

The night-time atmospheric noise measurements were taken at the same location as the day-time measurements and in the 2000-2400 hour LST period. Table A-3 summarizes the results for the four seasons. By comparing the V_{dm} measurements between day and night it can be seen that the noise is more impulsive at night than during the day. Figures A-6 to A-9 show plots of the median values and the range of values of F_a obtained during the measurement periods. As expected, these figures show that the atmospheric noise level was much higher at night than during the day, especially at the low frequencies. Comparison of the observed day and night-time levels of F_{am} at 2.5 MHz shows that the night-time level exceeds the day-time level by 18 dB in the Spring, 17 dB in the Summer, 18 dB in the Autumn and 13 dB in the Winter. The measured levels compare favorably with the CCIR predicted levels which are also plotted on the figures. Table A-4 shows a comparison of the CCIR prediction and measured F_{am} values for each season. Of the 20 values quoted, 70% agree within ± 3 dB and 90% within ± 6 dB. This limited comparison tends to show the good reliability of the CCIR predictions for this area of Eastern Canada.

TABLE A-1

Summary of CRC Quiet Site Day-Time Noise Measurements

SEASON	PARAMETER	FREQUENCY (MHz)						RMS DIFFERENCE (dB) BETWEEN MEASUREMENT AND QRSL	
		2.5	5	10	15	20	25	USING ALL DATA	USING F_{am}s ONLY
Spring	F_{am}	42	35	23	24	15	10	3.0	2.5
	σ	2.0	1.7	3.1	1.0	1.4	0.8		
	N	7	7	7	7	7	7		
Summer	F_{am}	42	37	30	24	14	13	6.3	3.1
	σ	8.1	6.5	4.7	2.5	2.8	1.5		
	N	7	7	7	6	7	7		
Autumn	F_{am}	41	34	24	23	16	11	2.5	1.8
	σ	0.8	0.9	2.0	2.6	2.1	1.6		
	N	7	7	7	7	7	7		
Winter	F_{am}	43	38	26	25	16	11	3.8	3.0
	σ	2.4	1.9	3.4	1.9	1.0	1.9		
	N	14	14	14	14	14	14		

where F_{am} is the median value of F_a measured in the two week period (dB above kT)

σ is the standard deviation (dB) of the F_a measurements

N is the number of days on which data were collected

TABLE A-2

Summary of CRC Quiet Site Day-Time Noise Characteristics (V_d)

SEASON	PARAMETER	FREQUENCY (MHz) 2.5	5	10	15	20	25
Spring	V_{dm}	1.1	1.0	1.6	1.0	1.0	1.0
	σ	0.2	0.3	0.8	0.2	0.4	0.1
	N	7	7	7	7	7	7
Summer	V_{dm}	1.2	1.7	3.1	1.9	1.1	1.0
	σ	2.7	2.2	0.8	0.5	0.3	0.2
	N	7	7	7	6	7	7
Autumn	V_{dm}	1.1	1.0	1.1	1.1	1.0	1.0
	σ	0.2	0.1	0.5	0.2	0.1	0.1
	N	7	7	7	7	7	7
Winter	V_{dm}	2.0	1.4	2.0	1.2	1.0	1.1
	σ	0.7	0.6	1.6	0.6	0.1	1.2
	N	14	14	14	14	14	14

where V_{dm} is the median value of V_d (dB) measured in the two week measurement period.

σ is the standard deviation (dB) of the V_d measurements.

N is the number of days on which data were collected.

TABLE A-3

Summary of CRC Quiet Site Night-Time Atmospheric Noise Measurements

SEASON	PARAMETER	FREQUENCY (MHz) 2.5	5	10	15	20
Spring	F_{am}	60	52	39	27	16
	σ	8.4	6.8	4.8	2.3	1.3
	V_{dm}	4.5	3.4	2.7	1.2	1.0
	N	8	8	8	7	7
Summer	F_{am}	59	58	44	28	16
	σ	8.8	4.3	2.4	1.5	0.5
	V_{dm}	3.6	3.4	3.2	2.2	1.1
	N	7	7	7	7	5
Autumn	F_{am}	59	52	30	23	18
	σ	6.5	3.7	4.7	1.2	0.5
	V_{dm}	2.9	3.0	2.4	1.0	1.0
	N	9	9	9	9	9
Winter	F_{am}	56	45	27	23	15
	σ	4.3	4.1	2.6	0.4	0.5
	V_{dm}	4.5	2.5	1.2	1.0	1.0
	N	7	7	7	7	6

TABLE A-4

Comparison of CCIR Predictions with the Night-Time Atmospheric Noise Measurements

SEASON	FREQUENCY (MHz)	CCIR PREDICTED F_{am}	MEASURED F_{am}	DIFFERENCE (MEASURED-PREDICTION) (dB)
Spring	2.5	58	60	+2
	5	52	52	0
	10	40	39	-1
	15	28	27	-1
	20	22	16	-6
Summer	2.5	63	59	-4
	5	56	58	+2
	10	44	44	0
	15	31	28	-3
	20	19	16	-3
Autumn	2.5	56	59	+3
	5	48	52	+4
	10	29	30	+1
	15	24	23	-1
	20	22	18	-4
Winter	2.5	53	56	+3
	5	48	45	-3
	10	36	27	-11
	15	24	23	-1
	20	22	15	-7

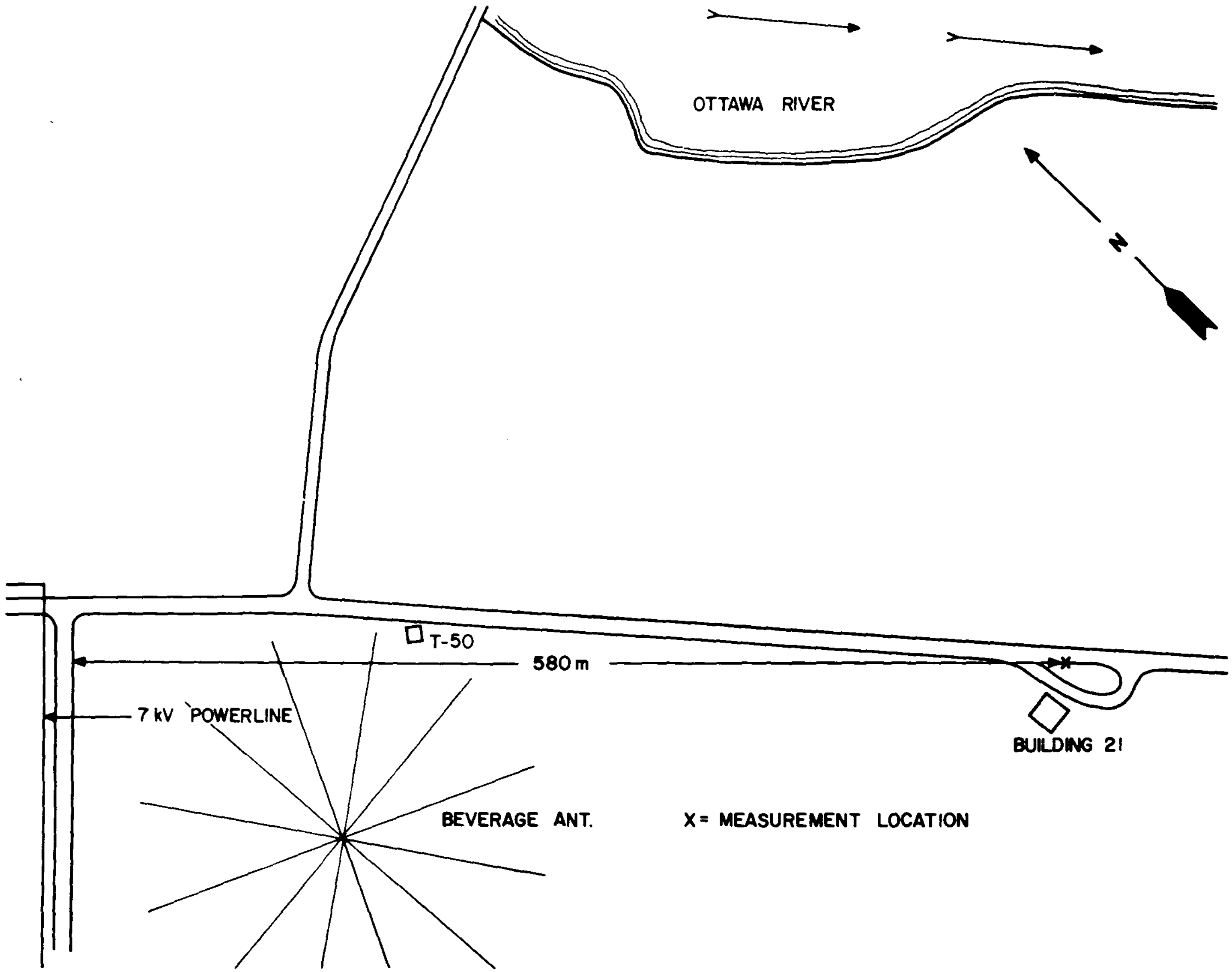


Figure A-1. Site Plan of the CRC Quiet Site.

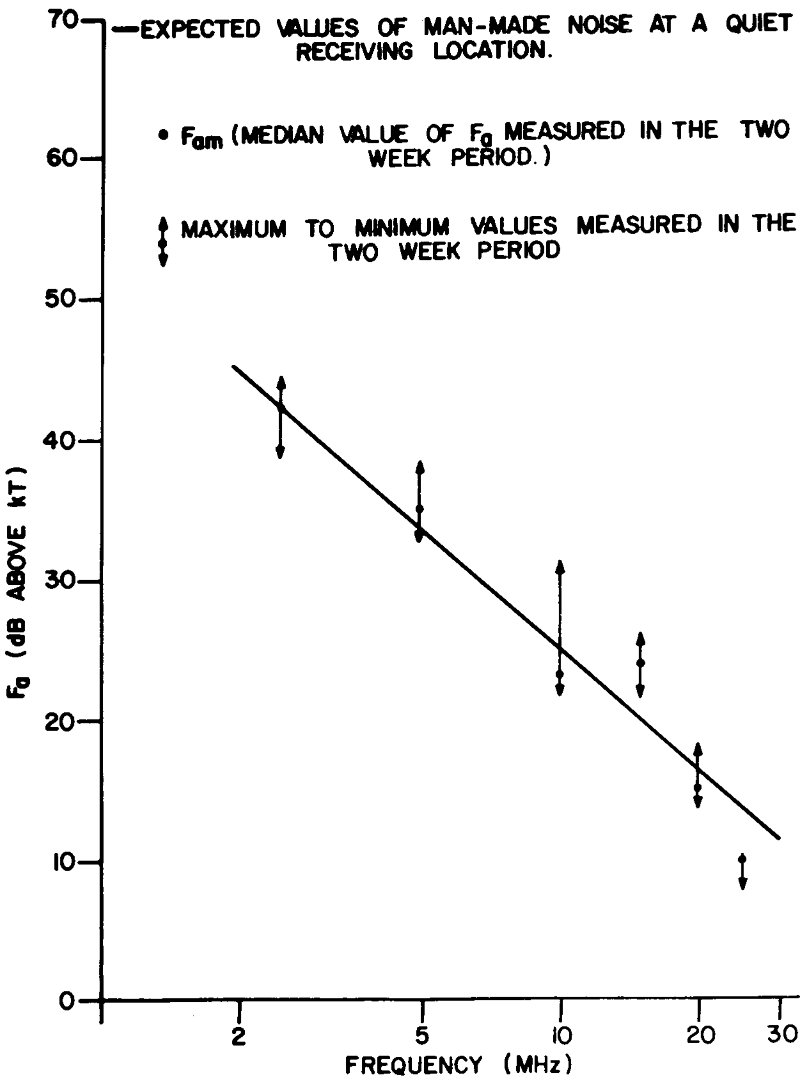


Figure A-2. Measured Noise Levels at the CRC Quiet Site, Spring, 0800–1200 hours..

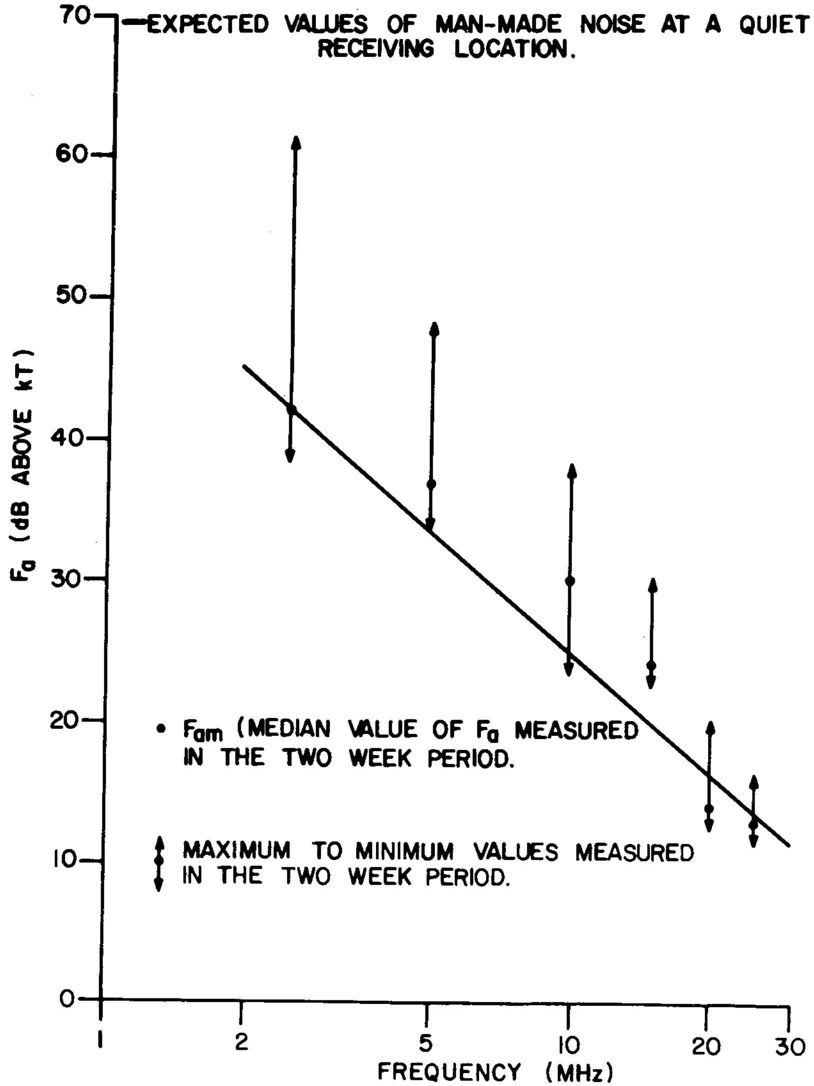


Figure A-3. Measured Noise Levels at the CRC Quiet Site, Summer, 0800–1200 hours.

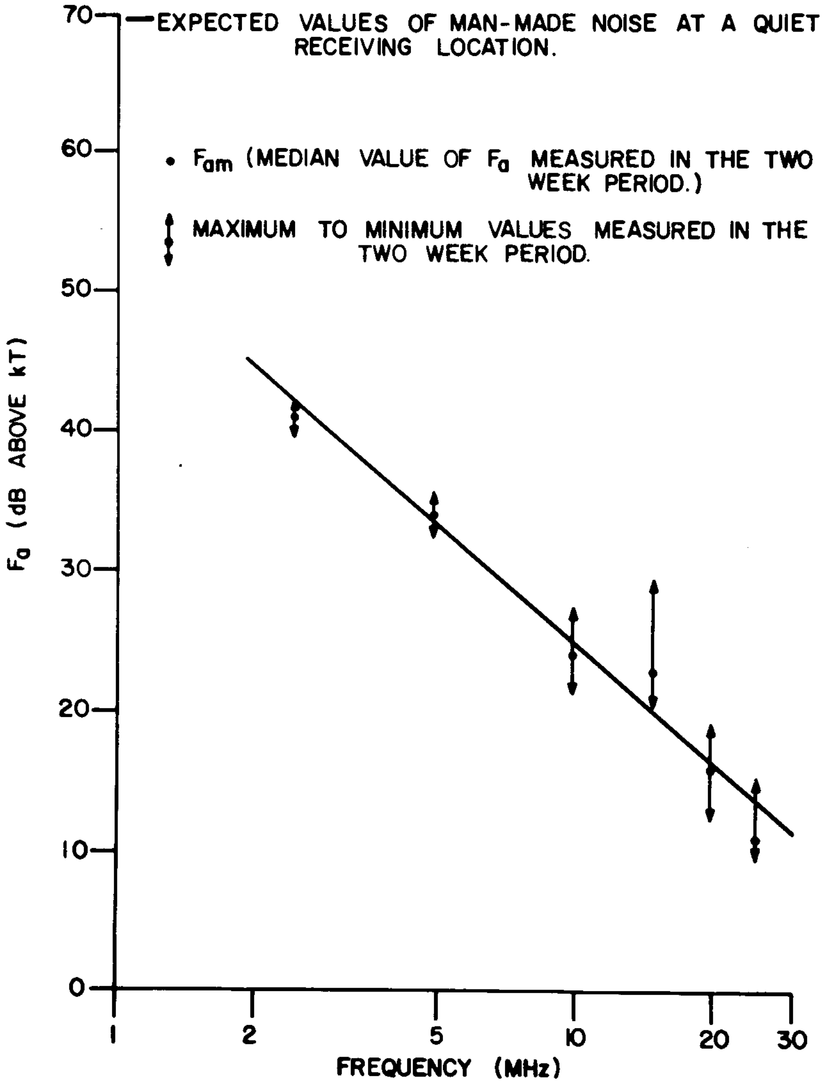


Figure A-4. Measured Noise Levels at the CRC Quiet Site, Autumn, 0800–1200 hours.

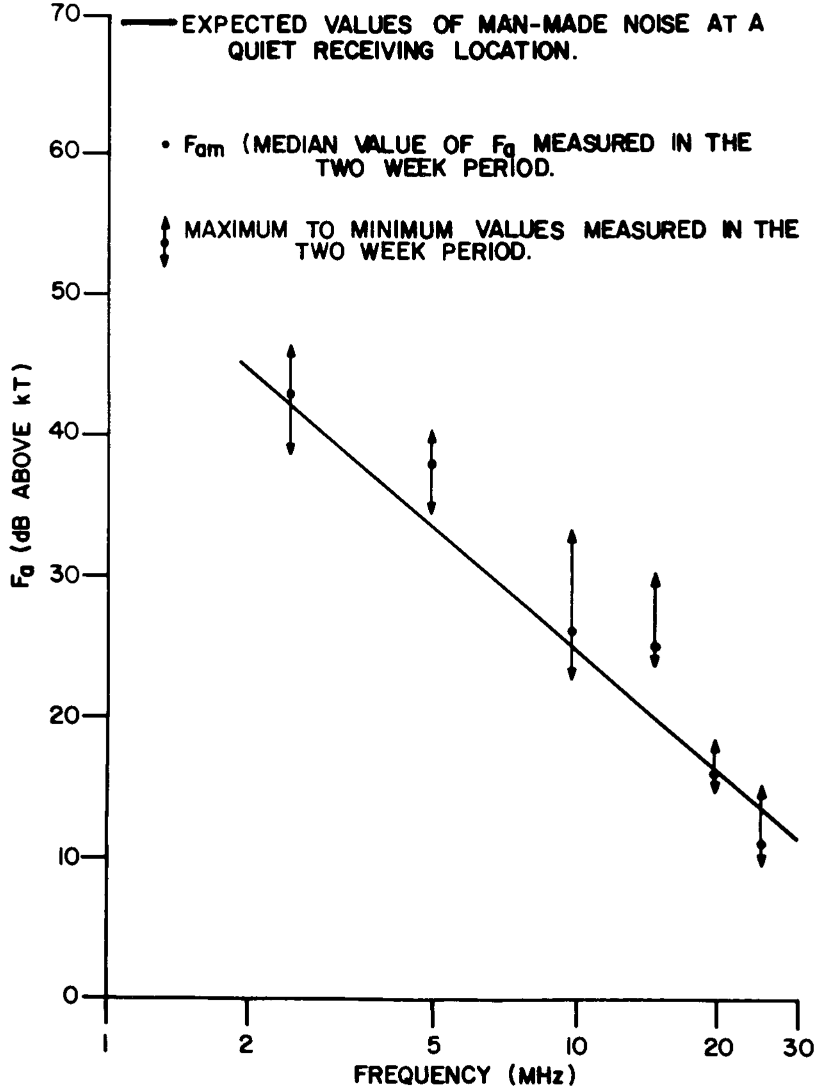


Figure A-5. Measured Noise Levels at the CRC Quiet Site, Winter, 0800–1200 hours.

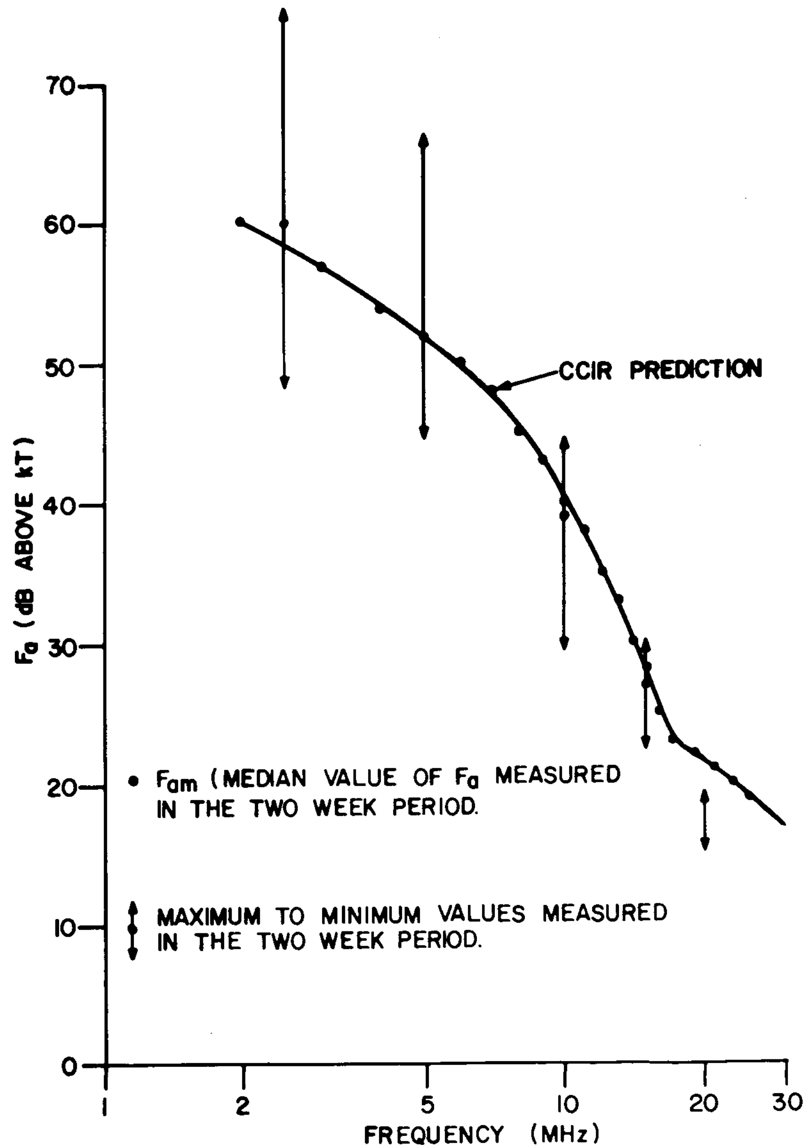


Figure A-6. Measured Noise Levels at the CRC Quiet Site, Spring, 2000–2400 hours.

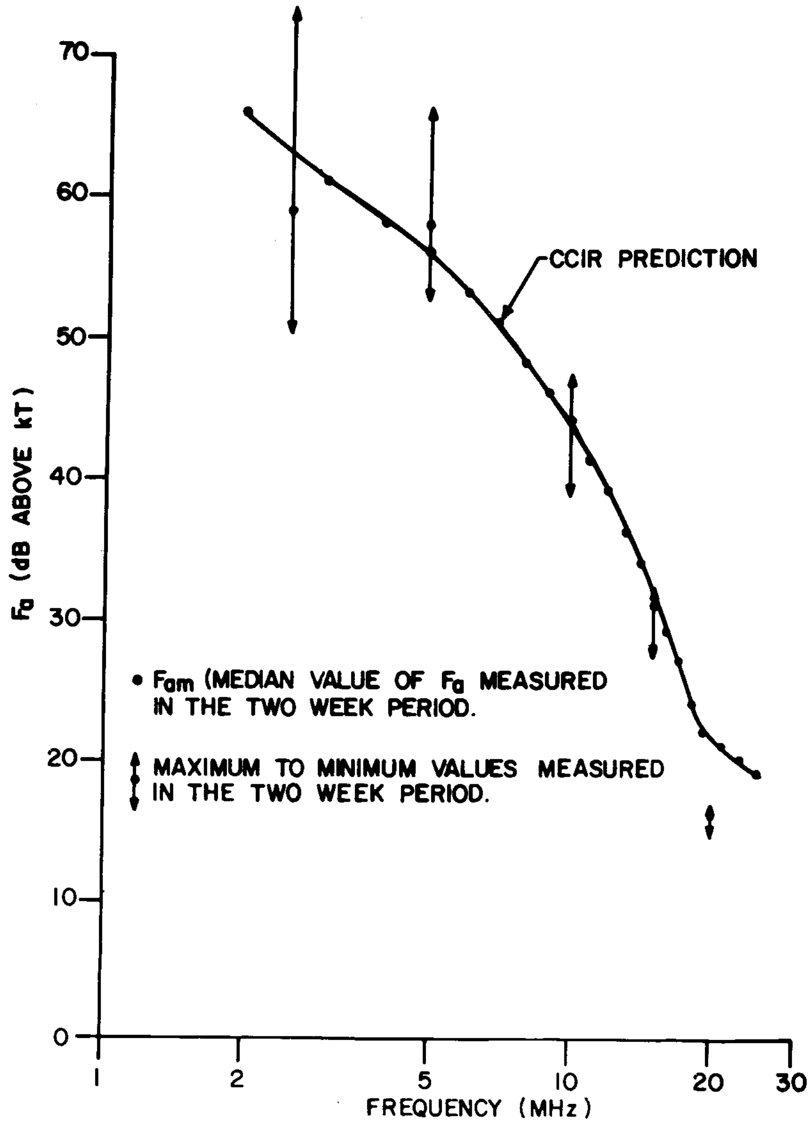


Figure A-7. Measured Noise Levels at the CRC Quiet Site, Summer, 2000–2400 hours.

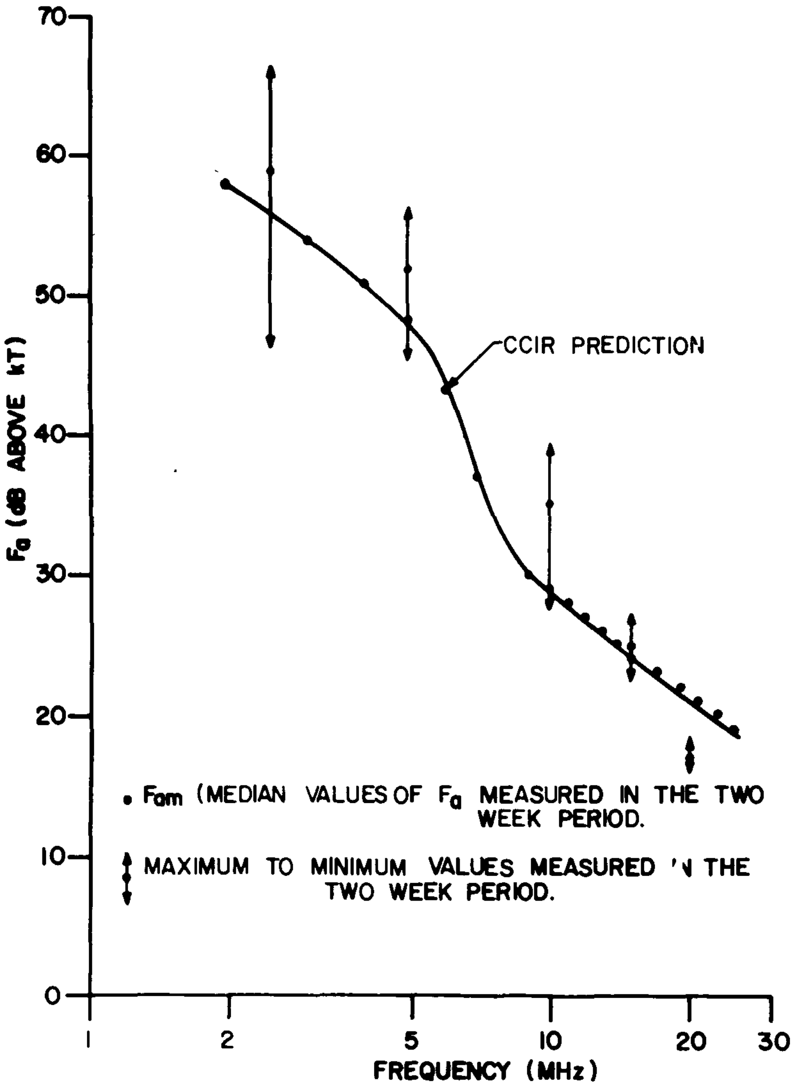
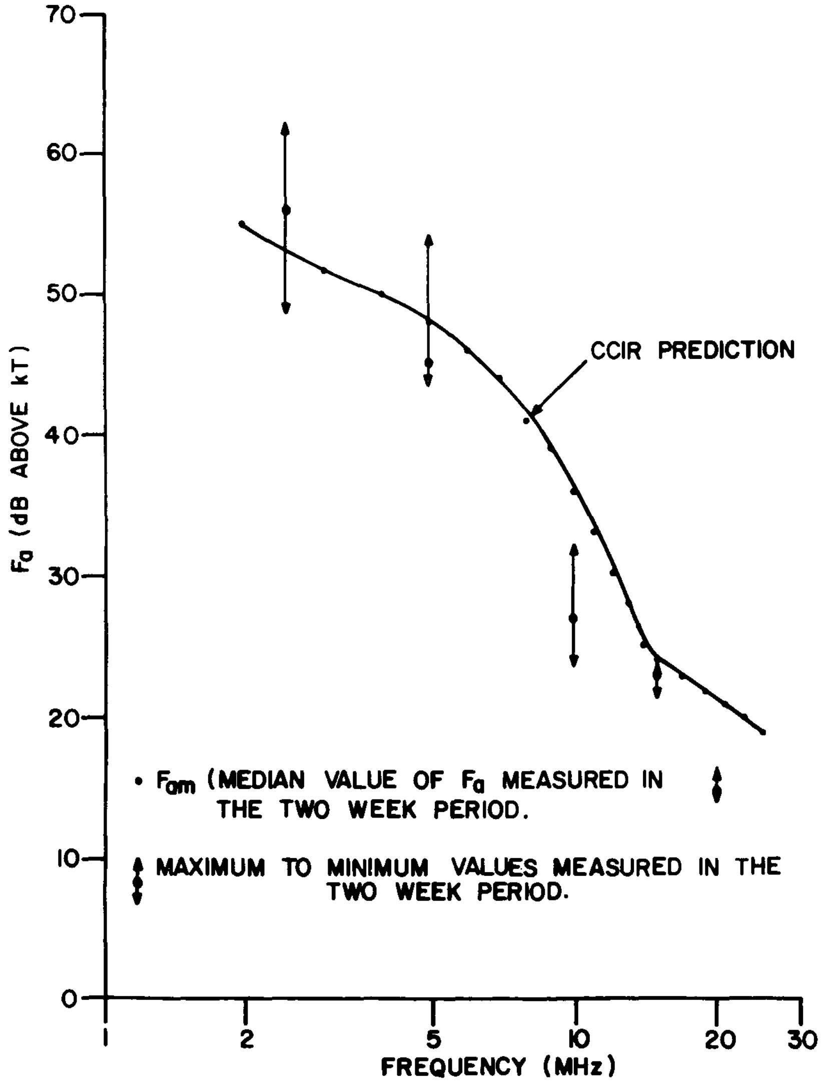


Figure A-8. Measured Noise Levels at the CRC Quiet Site, Autumn, 2000–2400 hours.



A-9. Measured Noise Levels at the CRC Quiet Site, Winter, 2000–2400 hours.

APPENDIX B

Noise Measurements at the CRC HFDF Site

B.1 INTRODUCTION

The primary measurements at the CRC HFDF site were taken near the underground laboratory at the Centre of the Array at a location approximately 730 metres from the road and an 8 kV powerline. Figure B-1 shows a layout of the area. In the winter 14 days of measurements were taken. These showed the site to be significantly degraded from a quiet site, especially at frequencies below 10 MHz. Seven days of measurements in the spring season confirmed this conclusion. Thus, in the summer measurement period, seven days of data were collected at two other locations; one near the gate, approximately 120 metres from the powerline, and a second about 1.3 km east of the HFDF site (corner). Because of the local atmospheric activity in the summer, as mentioned previously in Appendix A, seven days of data were insufficient to give an unbiased measure of the noise environment of the site. Therefore in the autumn season twelve days of data were collected both at the laboratory site and at the corner site. These showed the corner site to be somewhat the quieter, but the whole area seems to be significantly degraded from a quiet site by powerline noise.

B.2 CRC HFDF SITE, DAY-TIME MEASUREMENTS

Table B-1 summarizes the day-time results obtained for the four seasons. These results are also plotted as a function of frequency in Figures B-2 to B-8. The graphs show the median values, the range of values of F_a measured in the two week period, and the quiet receiving site line (QRSL) as defined in Appendix A. The results show that the measured values are a poor fit to the QRSL for frequencies below 10 MHz. By aural monitoring, these high noise levels were found to be caused by powerline noise. Table B-1 lists the rms difference between the measured data and the QRSL both for all the measured values of F_a and for the F_{am} values only. The values of the differences are quite similar. The large value of the difference shows that the HFDF site is degraded significantly from a quiet receiving location at frequencies below 10 MHz, especially when compared to the CRC Quiet Site. This conclusion is further substantiated by the results of the V_d measurements as shown in Table B-2. The higher values of V_{dm} compared with those reported in Appendix A show that the radio-noise background is more impulsive* at this site.

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* Audibly it sounded like regular impulsive noise (gap-type spark discharge), apparently coming from a power line.

Finally, by using the night-time atmospheric noise levels measured at the CRC Quiet Site in Appendix A as references, the day-night differences in noise levels at 2.5 MHz were computed. It can be seen that for this site the night-time noise levels exceeded the day-time levels by 0 dB in the Spring, 8 dB in the Summer, 0 dB in the Autumn and -1 dB in the Winter seasons, compared to values of nearly 20 dB for the Quiet Site. This small change in the day-night noise levels confirms the conclusion that this is significantly degraded by powerline noise, especially at frequencies below 10 MHz.

TABLE B-1

Summary of the CRC HFDF Site Day-Time Noise Measurements

SEASON	LOCATION	PARAMETER	FREQUENCY (MHz)						RMS DIFFERENCE (dB) BETWEEN MEASUREMENT AND QRSL	
			2.5	5	10	15	20	25	USING ALL DATA	USING F_{am}s ONLY
Spring	Lab.	F_{am}	60	51	37	30	22	10	12.6	13.5
		σ	1.4	2.7	3.2	3.3	2.0	0.5		
		N	7	7	7	7	7	6		
Summer	Lab.	F_{am}	51	46	31	28	16	13	8.0	8.1
		σ	6.3	4.4	5.9	2.5	1.6	1.5		
		N	7	7	7	7	7	7		
	Gate	F_{am}	59	48	31	32	26	15	10.9	12.3
		σ	7.0	2.8	6.6	2.8	4.4	4.2		
		N	7	7	7	7	7	7		
	Corner	F_{am}	48	46	31	29	16	12	7.5	7.8
		σ	3.2	3.7	6.1	2.4	1.7	1.5		
		N	7	7	7	7	7	7		
Autumn	Lab.	F_{am}	59	54	35	29	18	9	12.3	12.3
		σ	6.0	7.7	6.3	3.8	3.5	1.0		
		N	12	12	12	12	12	12		
	Corner	F_{am}	52	45	35	29	20	12	10.0	8.4
		σ	8.7	6.8	6.2	3.0	4.4	5.8		
		N	12	12	12	12	12	12		
Winter	Lab.	F_{am}	57	52	32	28	17	9	11.1	10.7
		σ	7.7	5.9	4.4	2.5	2.4	3.6		
		N	14	14	14	14	14	14		

TABLE B-2

Summary of CRC HFDF Site Day-Time Noise Characteristics (V_d)

SEASON	LOCATION	PARAMETER	FREQUENCY (MHz)					
			2.5	5	10	15	20	25
Spring	Lab.	V_{dm}	3.2	2.9	2.0	1.7	1.5	1.2
		σ	1.3	1.3	0.5	0.7	0.4	0.2
		N	7	7	7	7	7	6
Summer	Lab.	V_{dm}	2.2	2.1	3.0	2.2	1.8	1.2
		σ	0.3	0.5	0.7	0.3	0.6	0.4
		N	7	7	7	7	7	7
	Gate	V_{dm}	2.5	2.8	2.7	2.0	2.0	1.5
		σ	0.9	0.8	0.7	0.4	0.6	0.6
		N	7	7	7	7	7	7
	Corner	V_{dm}	1.8	2.1	2.6	1.9	1.2	1.1
		σ	1.2	1.1	0.9	0.4	0.5	0.2
		N	7	7	7	7	7	7
Autumn	Lab.	V_{dm}	1.9	2.1	1.9	1.2	1.4	1.0
		σ	0.4	0.6	0.5	0.5	0.3	0.1
		N	12	12	12	12	12	12
	Corner	V_{dm}	2.0	1.9	1.6	1.3	1.6	1.1
		σ	0.6	0.6	0.4	0.2	0.3	0.4
		N	12	12	12	12	12	12
Winter	Lab.	V_{dm}	2.4	2.2	2.4	1.3	1.1	1.1
		σ	1.5	1.5	1.2	0.7	0.3	0.2
		N	14	14	14	14	14	14

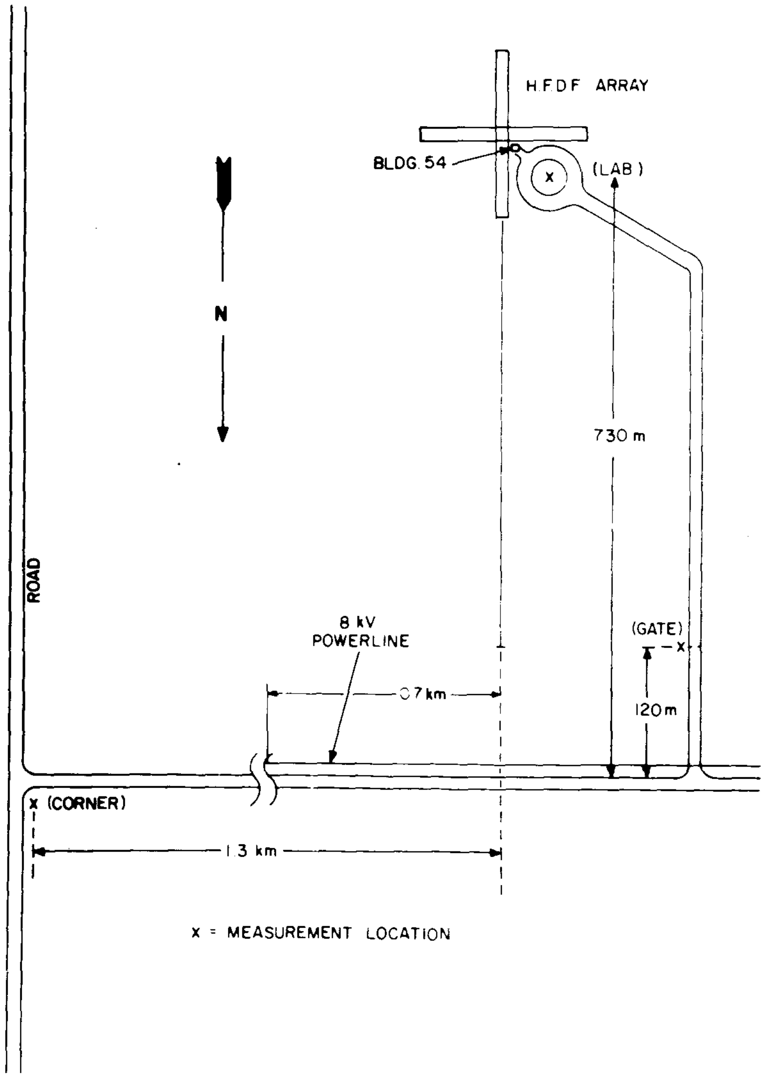

Figure B-1. Site Plan of the CRC HFDF Site.

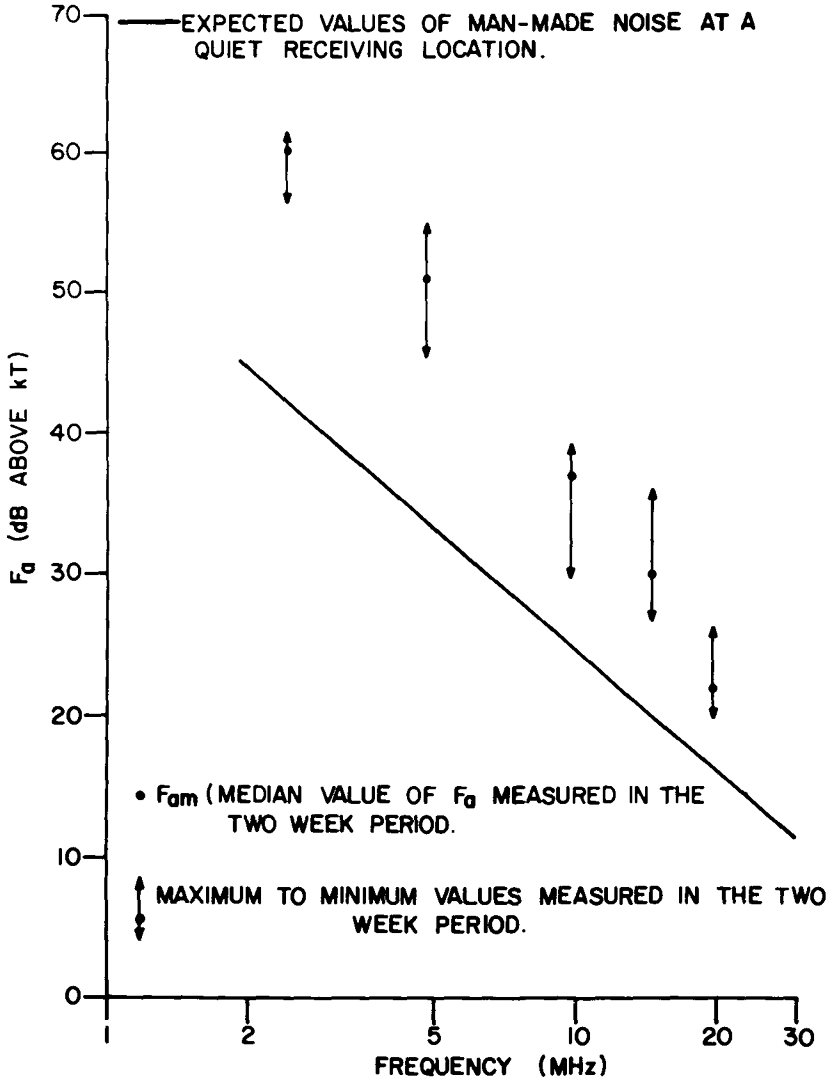

Figure B-2. Measured Noise Levels at the CRC HFDF Site, Spring, 0800–1200 hours.

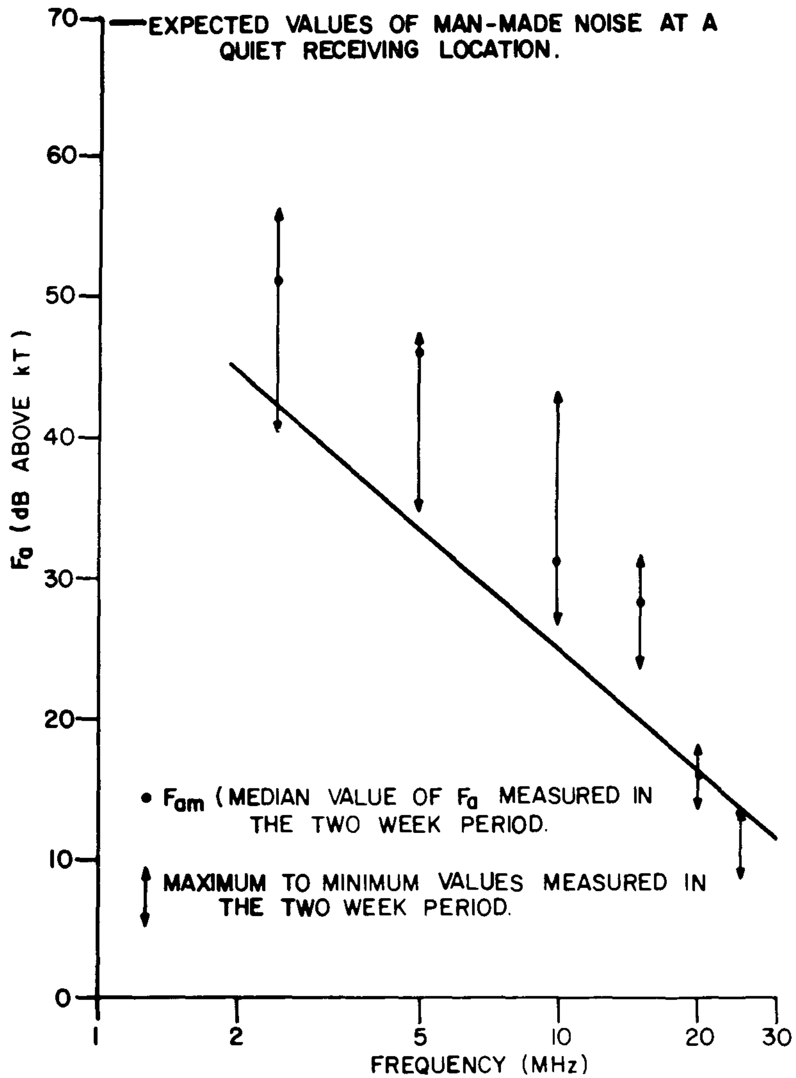

Figure B-3. Measured Noise Levels at the CRC HFDF Site, Summer, 0800–1200 hours.

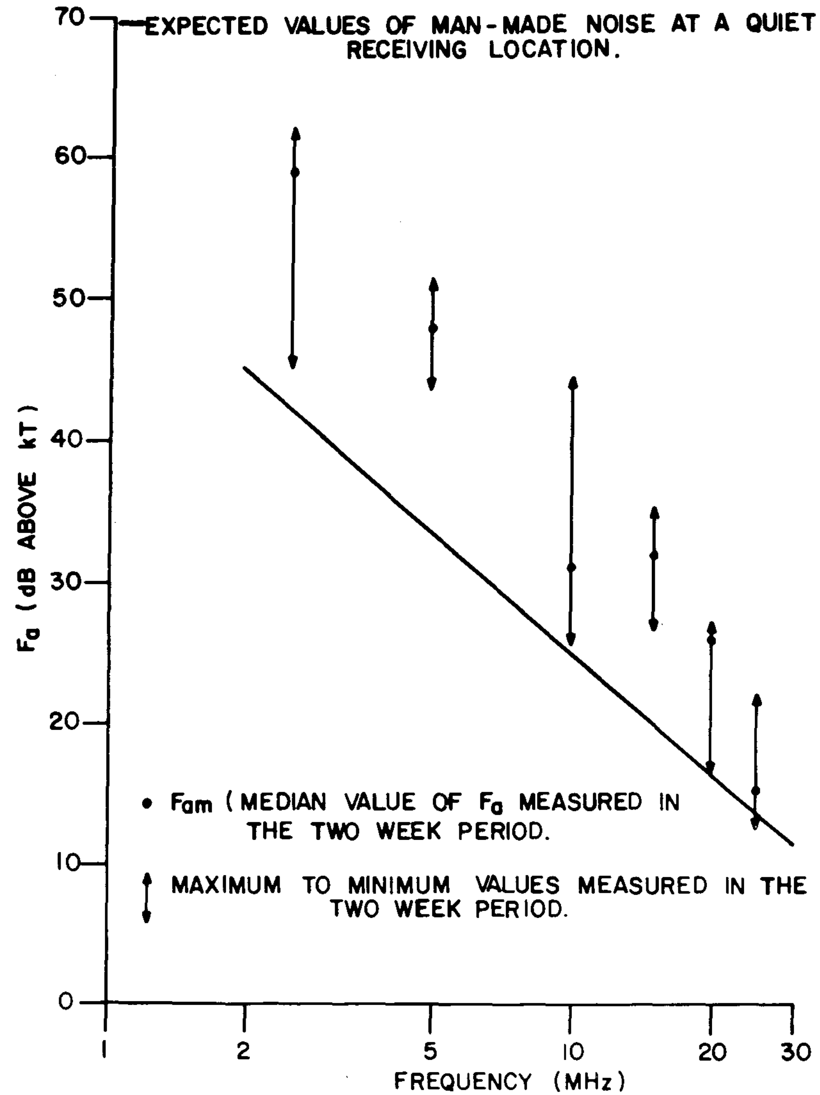

Figure B-4. Measured Noise Levels at the CRC HFDF Gate, Summer, 0800–1200 hours.

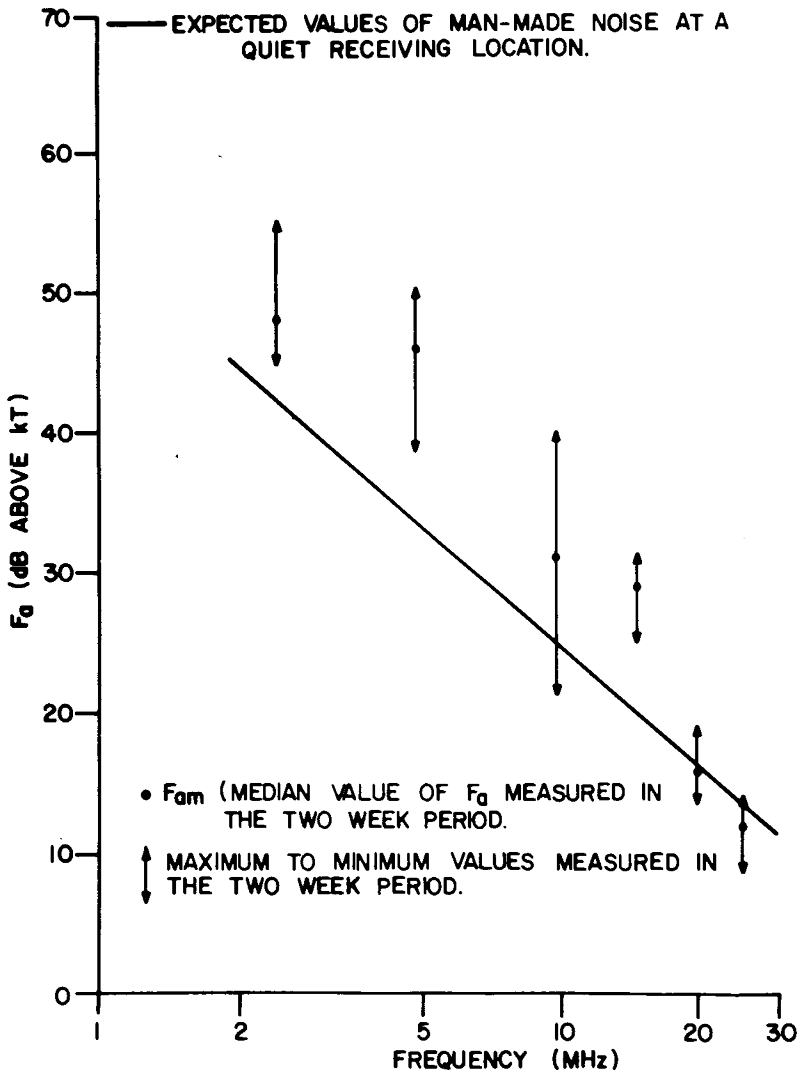

Figure B-5. Measured Noise Levels at the CRC HFDF Corner, Summer, 0800–1200 hours.

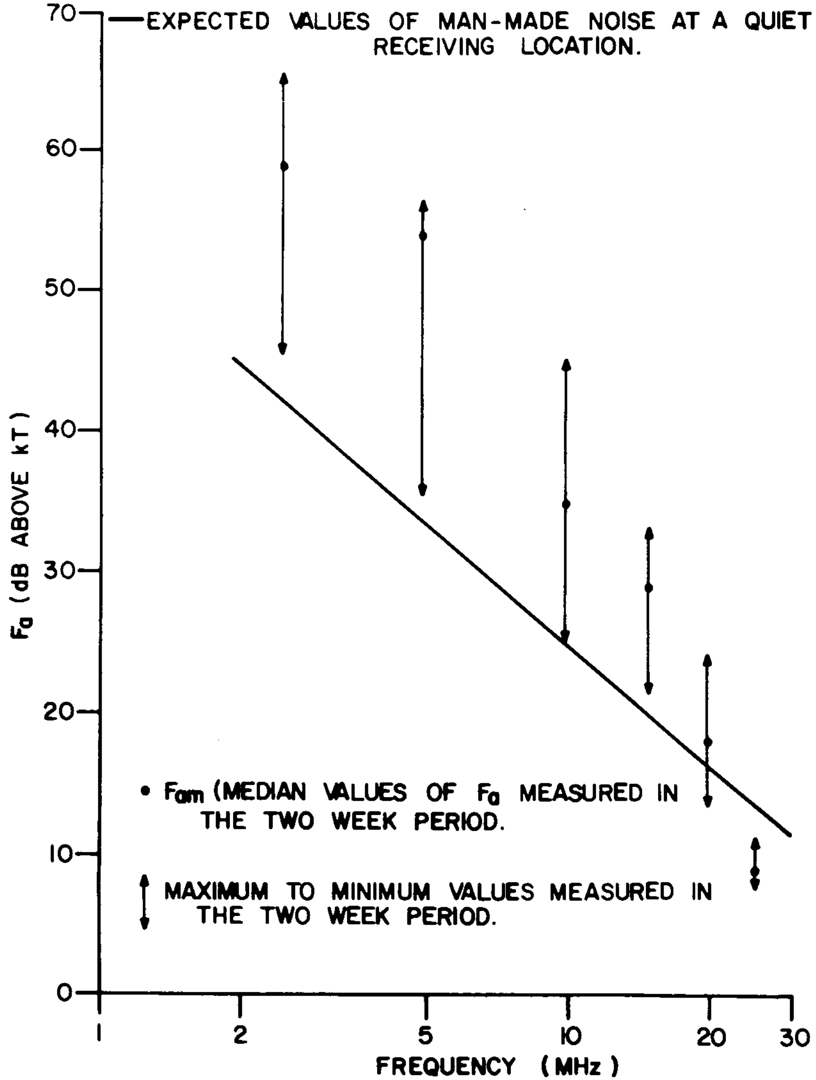

Figure B-6. Measured Noise Levels at the CRC HFDF Site, Autumn, 0800–1200 hours.

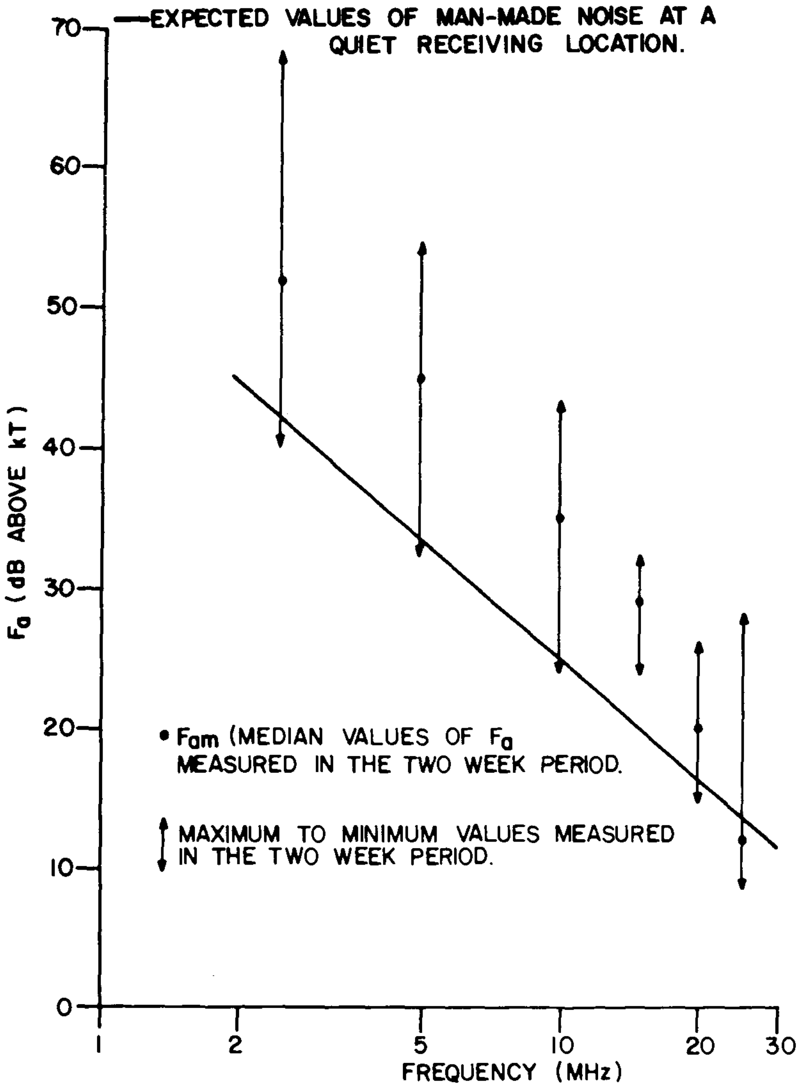

Figure B-7. Measured Noise Levels at the CRC HFDF Corner, Autumn, 0800–1200 hours.

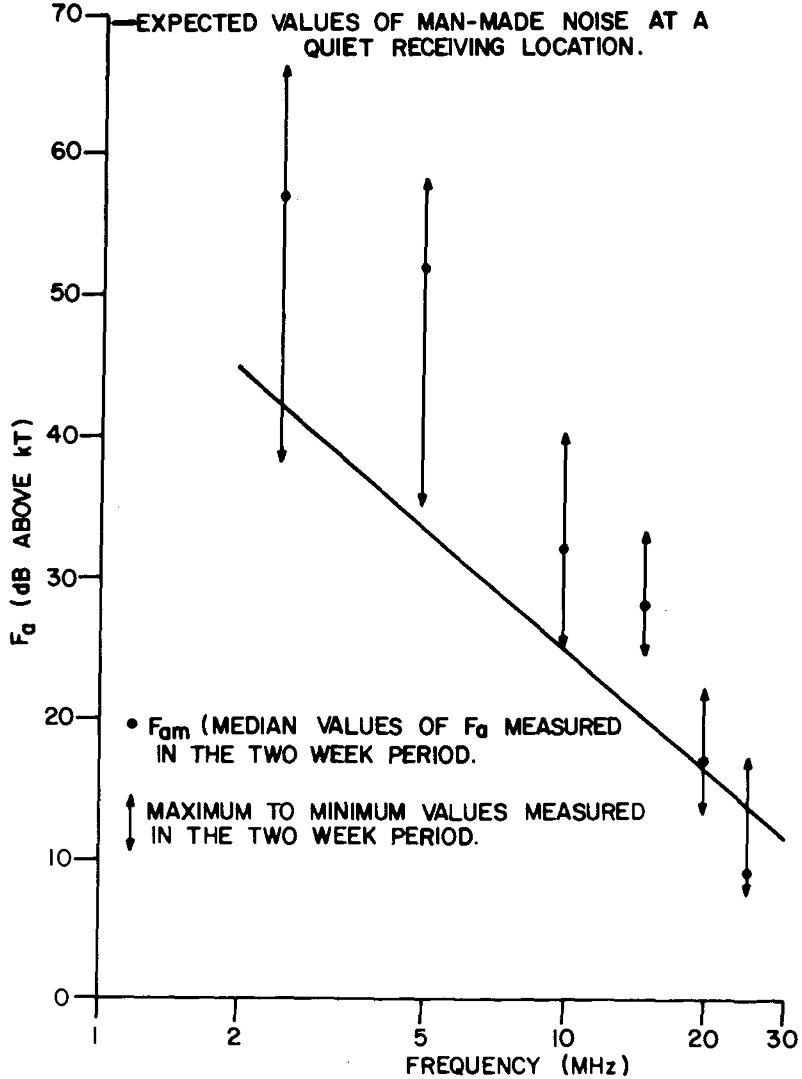

Figure B-8. Measured Noise Levels at the CRC HFDF Site, Winter, 0800–1200 hours.

A P P E N D I X C

Noise Measurements at CFS Leitrim

C.1 INTRODUCTION

The noise measurements at CFS Leitrim were taken near a large circular array approximately 490 metres from the road and a 44 kV powerline. Figure C-1 shows the layout of the area. In the spring season the results of 14 days of measurements showed that a strong powerline noise source dominated the radio environment on seven days, and this noise showed a very distinct weekly pattern. Four of the seven days of noise measurements in the summer again showed a similar weekly pattern in spite of local atmospheric activity. Fourteen days of measurements in the autumn period showed this source to dominate on only two days, and fourteen days of measurements in the winter season showed this source to be dominant on five days. These results indicate that this site is significantly degraded below 10 MHz by a randomly occurring source of powerline noise.

C.2 CFS LEITRIM, DAY-TIME MEASUREMENTS

Table C-1 summarizes the results obtained for the four seasons. These results are also plotted as a function of frequency in Figures C-2 to C-5. The graphs show the median values and the range of values of F_a measured in the two week period as well as the quiet receiving site line (QRSL) as defined in Appendix A. The results show that the measured values are a poor fit to the QRSL for frequencies below 10 MHz for the Spring, Summer and Winter seasons. By aural monitoring, these high noise levels were found to be caused by powerline noise. Because of the random nature of the source the autumn measurements were almost unaffected. Table C-1 lists the rms difference between the measured data and the QRSL both for all the measured values of F_a and for the F_{am} values only. Both differences are quite similar, but the large values of the differences for all except the autumn season show the site is degraded significantly from a quiet receiving location at frequencies below 10 MHz. The results of the V_d measurements shown in Table C-2 are slightly higher than those from the CRC Quiet Site but not as high as those from the CRC HFDF site. The effect of the powerline noise source is not as noticeable in the V_d measurements as it was in the F_a measurements.

By using the night-time atmospheric noise levels reported in Appendix A as references, the day-night difference in noise levels at 2.5 MHz were computed. It can be seen that the night-time noise levels exceeded the day-time levels by 7 dB in the Spring, 6 dB in the Summer, 15 dB in the Autumn and 9 dB in the Winter season.

Finally, it was very easy to determine on which days the powerline noise source was dominant. The data from 49 days of monitoring during the four seasons were able to be divided into two groups: the first group consisted of 18 days on which the noise source dominated the radio environment ("noisy" case) and the second group consisted of 31 days without the noise source ("quiet" case). Table C-3 shows that for frequencies below 10 MHz the "noisy" days had higher noise levels than the "quiet" days. The "noisy" days also had a higher rms difference between the measured F_{am} values and the QRSL. The rms differences for F_{am} from the "quiet" days are quite comparable to those obtained from the CRC Quiet Site in Appendix A. Thus it is concluded that this site is quite good, except for a strong local powerline noise source that degraded the site significantly for 37% of the time.

TABLE C-1

Summary of CFS Leitrim Day-Time Noise Measurements

SEASON	PARAMETER	FREQUENCY (MHz)						RMS DIFFERENCE (dB) BETWEEN MEASUREMENTS AND QRSL	
		2.5	5	10	15	20	25	USING ALL DATA	USING F_{am}s ONLY
Spring	F_{am}	53	38	28	26	17	11	6.9	6.1
	σ	8.9	2.1	2.6	1.0	0.8	0.5		
	N	14	14	14	14	14	12		
Summer	F_{am}	53	41	35	28	15	12	8.1	8.3
	σ	4.9	4.4	5.6	3.9	2.7	1.6		
	N	7	7	7	6	7	7		
Autumn	F_{am}	44	36	27	26	16	9	4.2	3.4
	σ	4.1	1.6	3.3	2.1	1.2	0.9		
	N	14	14	14	14	14	14		
Winter	F_{am}	47	37	29	28	20	14	6.8	4.6
	σ	8.4	3.1	4.6	2.9	1.6	0.8		
	N	14	14	14	14	14	14		

TABLE C-2

Summary of CFS Leitrim Day-Time Noise Characteristics (V_d)

SEASON	PARAMETER	FREQUENCY (MHz)					
		2.5	5	10	15	20	25
Spring	V_{dm}	2.1	1.1	1.7	1.0	1.0	1.0
	σ	0.8	0.4	0.9	0.1	0.0	0.0
	N	14	14	14	14	14	12
Summer	V_{dm}	4.2	2.6	3.1	2.1	1.1	1.0
	σ	1.1	1.2	0.7	0.7	0.5	0.3
	N	7	7	7	6	7	7
Autumn	V_{dm}	1.6	1.3	1.5	1.3	1.1	1.0
	σ	0.8	0.4	0.6	0.3	0.2	0.1
	N	14	14	14	14	14	14
Winter	V_{dm}	1.6	1.5	2.0	1.7	1.0	1.0
	σ	1.5	0.6	1.6	0.7	0.4	0.1
	N	14	14	14	14	14	14

TABLE C-3

Comparison of the Day-Time Noise Measurements of the "Noisy" and "Quiet" Cases

CASE	PARAMETER	FREQUENCY (MHz)						RMS DIFFERENCE BETWEEN MEASUREMENTS AND THE QRSL USING THE F_{am}s ONLY
		2.5	5	10	15	20	25	
Noisy	F_{am}	58	39	30	27	17	11	7.7
	σ	5.1	2.3	3.4	3.2	2.1	1.9	
	N	18	18	18	18	18	17	
Quiet	F_{am}	45	37	27	27	17	11	3.7
	σ	2.6	3.3	4.6	2.7	2.3	2.1	
	N	31	31	31	30	31	30	

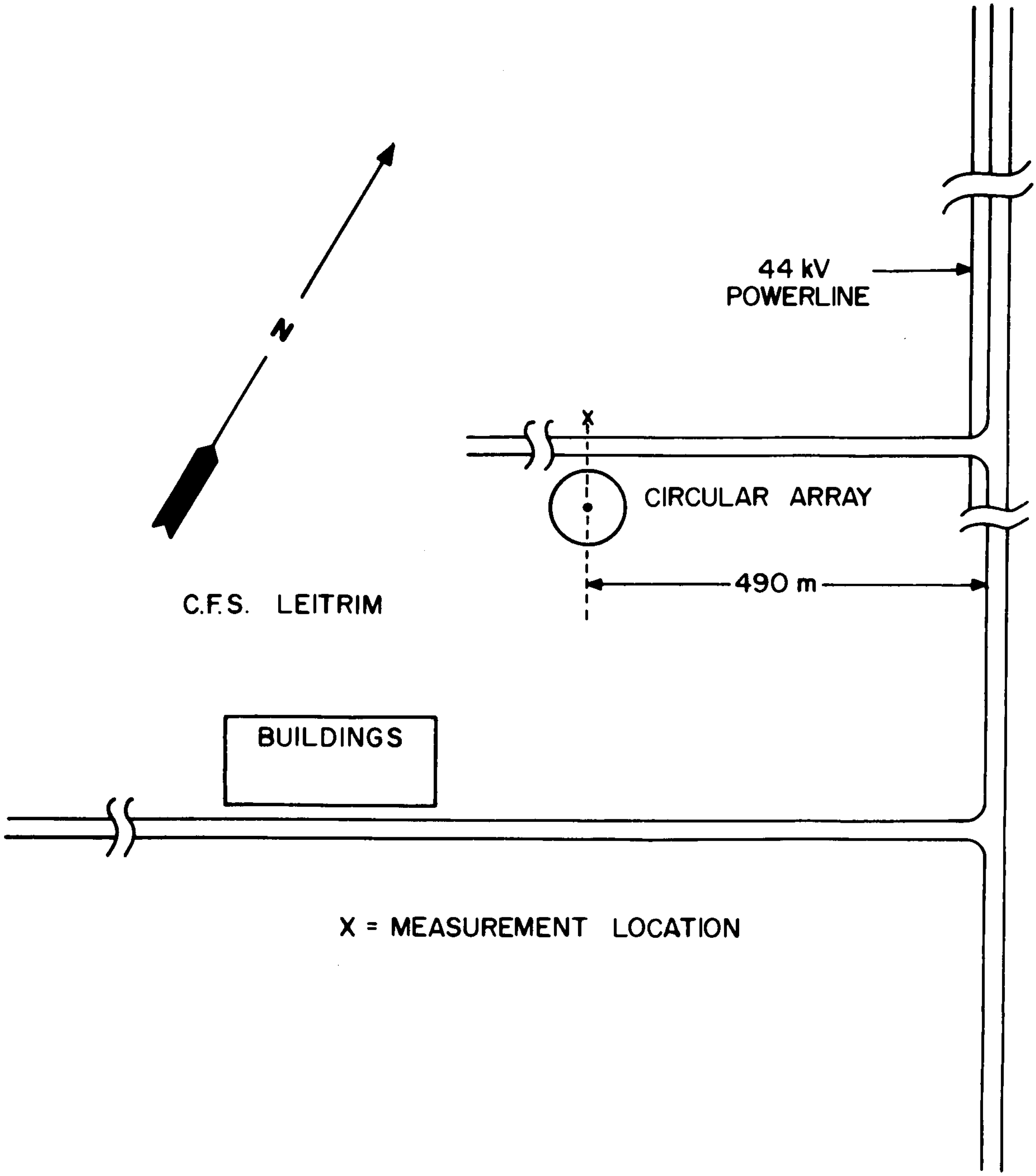

Figure C-1. Site Plan of CFS Leitrim.

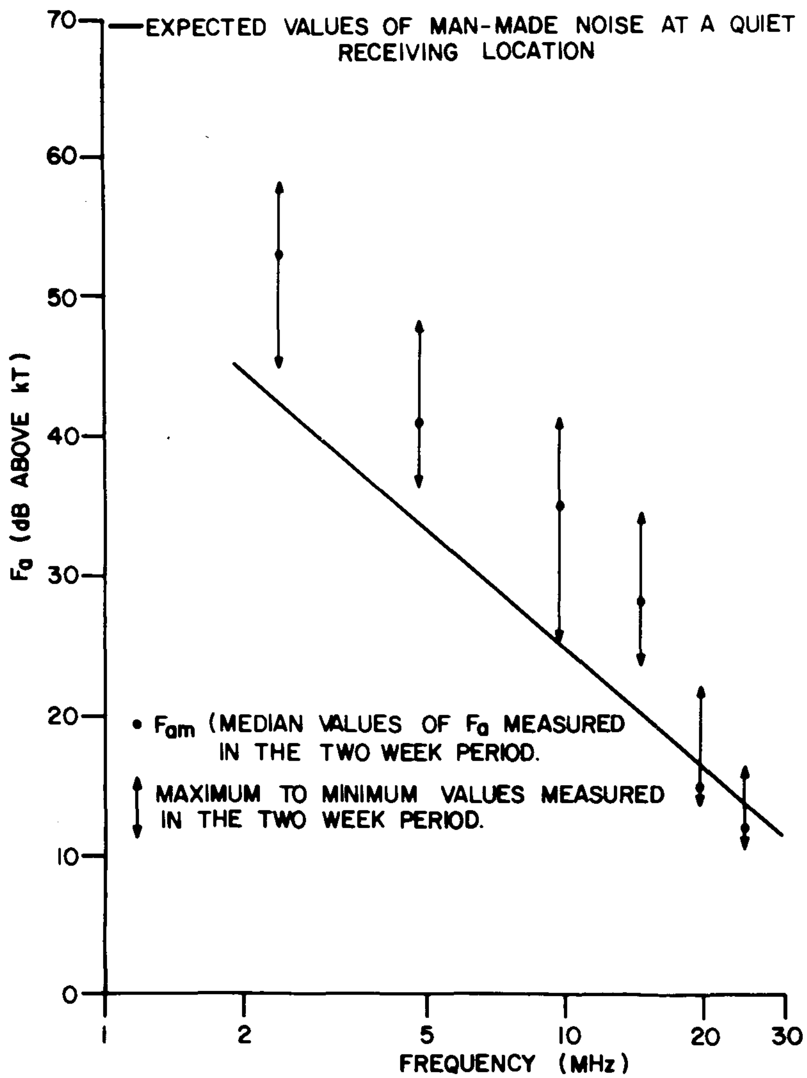

Figure C-2. Measured Noise Levels at CFS Leitrim, Spring, 0800–1200 hours.

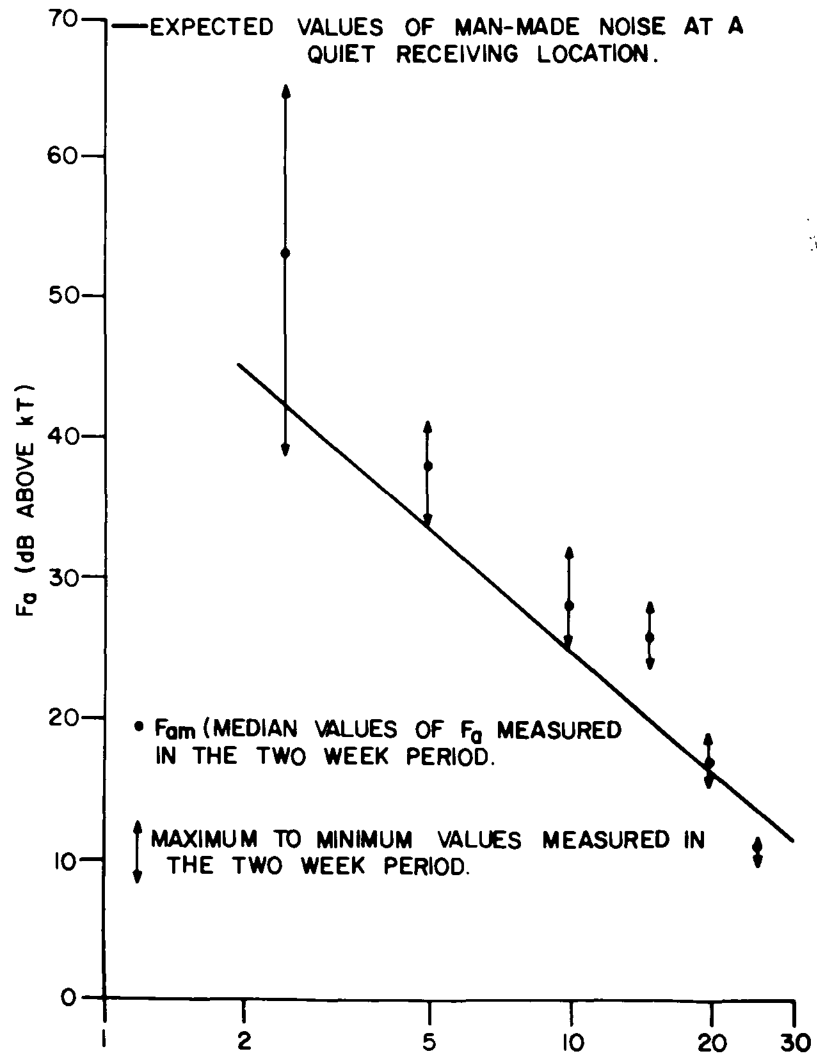

Figure C-3. Measured Noise Levels at CFS Leitrim, Summer, 0800–1200 hours.

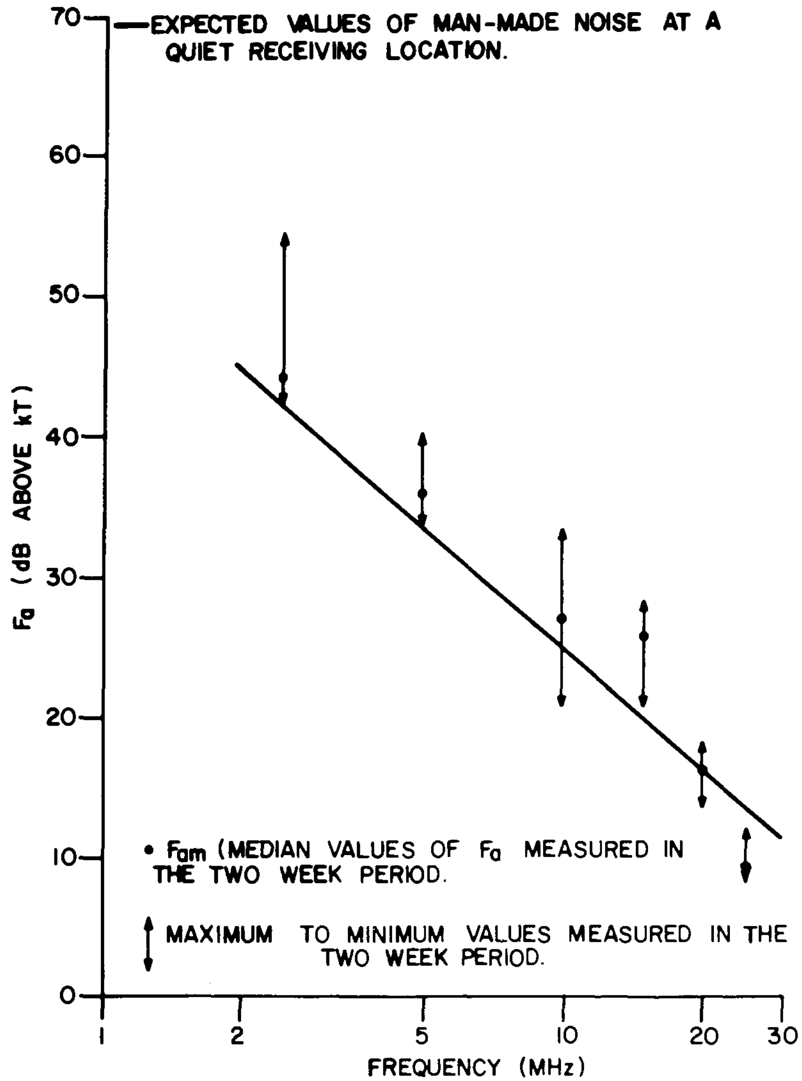

Figure C-4. Measured Noise Levels at CFS Leitrim, Autumn, 0800—1200 hours.

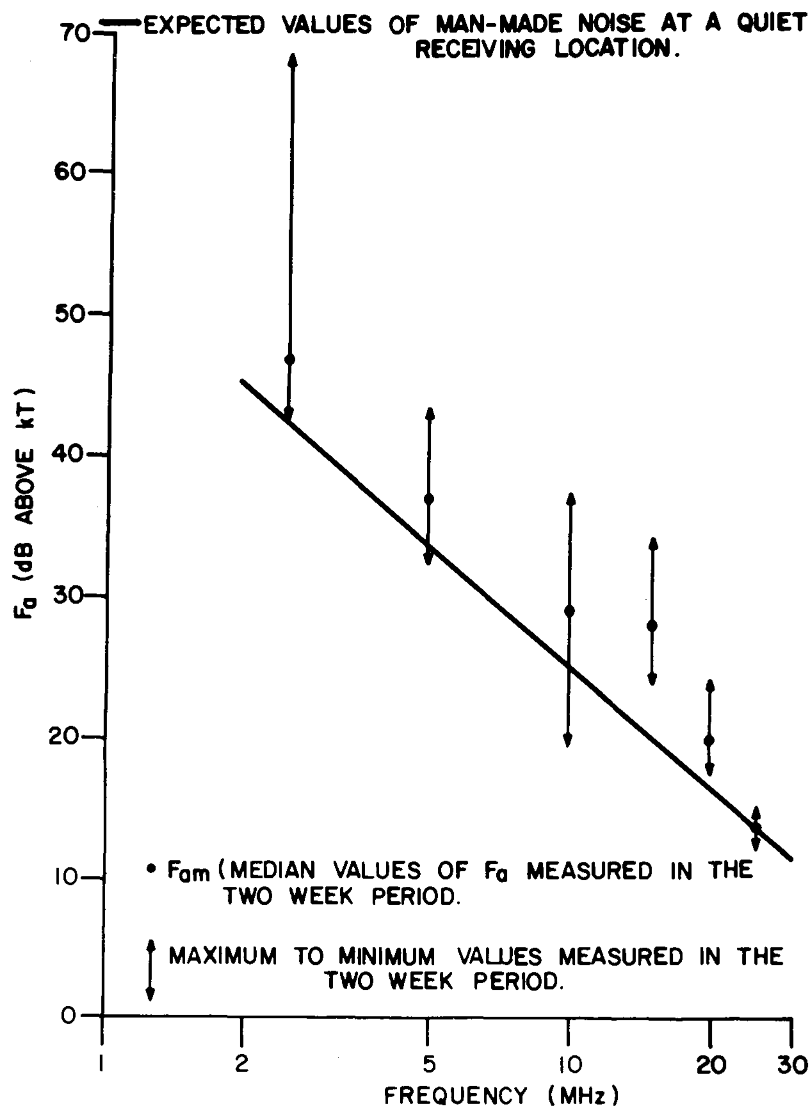

Figure C-5. Measured Noise Levels at CFS Leitrim, Winter, 0800—1200 hours.

CRC DOCUMENT CONTROL DATA

1. ORIGINATOR: Department of Communications/Communications Research Centre

2. DOCUMENT NO: CRC Report No. 1294

3. DOCUMENT DATE: August 1976

4. DOCUMENT TITLE: High Frequency Radio Noise Survey at Three Communication Sites in the Ottawa Area

5. AUTHOR(s): W.R. Lauber, L.R. Bodé and J.M. Bertrand

6. KEYWORDS: (1) High Frequency
(2) Radio Noise
(3) Survey

7. SUBJECT CATEGORY (FIELD & GROUP: COSATI)

17 Navigation, Communications, Detection, and Countermeasures

17 02 Communications

8. ABSTRACT:

Radio noise measurements have been carried out over two week periods during each of the four seasons to establish existing day-time noise levels at three high frequency communication sites in the Ottawa area. The parameters used were the average available noise power spectral density (F_a), and the ratio of the rms to the average voltage of the noise envelope (V_d). By comparing the results to those expected at a "quiet receiving site" as defined in CCIR Report 322 it has been possible to rate quantitatively the site effectiveness or degree of degradation of each site. As well, noise measurements have been made in the evenings (2000–2400 hours LST) at one site. The results were found to compare favourably with the predictions of CCIR Report 322. By using these night-time values as representative of the Ottawa area, the day-night difference in noise levels at 2.5 MHz was computed. These differences were also used to rate quantitatively the degree of degradation of each site.

9. CITATION:

RP&DS Rev. 1973