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TECHNICAL SERVICES DIVISION

Report No. 21

Title: Television field intensity measurements at a distance of 160 miles in southern Australia.

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Title: Television field intensity measurements at a distance of 160 miles in southern Australia.

Report prepared by N.J. Medlin
for the Director of Technical Services, July 1960.

Summary: Measurements of the field-intensity of each of the Sydney and Melbourne television transmitters were made at Taree and Warrnambool, respectively, during the summer of 1959-60. The distances involved are of the order of 160 miles. Results are given in terms of the field-intensity exceeded for 1%, 10% and 50% of the time.

D McDonald

(D. McDonald)
Director
Technical Services Division

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Television field-intensity measurements at a distance of 160 miles in southern Australia

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Television field-intensity measurements at a distance of 160 miles in southern Australia

1. General

Measurements of the field-intensity from each of the Melbourne television transmitters were made at Warrnambool, Victoria, during the winter months of 1958 (Ref. 1), and were continued during the summer of 1960. From October, 1959, until March, 1960, similar measurements of the Sydney television stations were made at Taree, N.S.W..

Recording was confined generally to the evening hours but fairly comprehensive observations were made at other times so that, as far as was practicable, all periods of high field intensity occurring during the hours of television transmission, were observed. A total of 70 hours per transmitter was recorded at Warrnambool and 65 hours per transmitter at Taree but, as was explained earlier, these periods were effectively extended by observations at other times.

The prime object of the Taree measurements was to compare an essentially inland path (Melbourne-Warrnambool) Fig. 5, with one along a coastline (Sydney-Taree) Fig. 6, and to attempt to assess the effect of the additional atmospheric ducting likely to occur along such a coastline. In both cases the radio paths are approximately 160 miles long and measurements were made at 64.25 Mc/s, 182.25 Mc/s and 196.25 Mc/s, the vision carrier frequencies of the television transmitters.

During the period of the summer recordings at Warrnambool, there were several occasions when signals were received on 64.25 Mc/s, from the Brisbane television transmitter 990 miles away. These signals were recorded and an analysis of the results is given in Fig. 1. The signals were recorded with the receiving aerial directed towards Melbourne. The aerial would normally discriminate against reception from the Brisbane direction by about 2-3 db. The field strengths have been determined from this aerial output, neglecting this correction and the actual field strengths may be some 2-3 db higher. Later observations have shown that there is a similar period of 'Sporadic E' activity during the winter months but none in the autumn and spring.

2. Equipment

2.1 General

Receiving sites were selected so as to give a reasonably unobstructed path for the first few miles in the direction of the transmitters. Portable masts were erected and the aerials raised to 30 ft. above ground level. Both receiving sites could be considered as a representative example of the average type of domestic installation within the service area of a television station. All measurements were made using commercial type aerials, which are basically Yagis, making use of 3 elements at 60 Mc/s and 5 elements at 200 Mc/s. The aerial was connected through 6 to 8 feet of 300 ohm flat twin cable to a "balun" and thence through a length of 50 ohm co-axial cable to an R.C.A. BW7 field-intensity receiver. The receiver operated a pen-recorder. The nominal gain of the receiving aerial is 6 db at 64.25 Mc/s and 9 db at 182.25 and 196.25 Mc/s, while the back-to-front ratios are given as -40 db and -25 db respectively. Within the service area of a transmitter, at unobstructed sites, these figures have been substantially confirmed.

During the course of the measurements, however, it was suspected that these gains and back-to-front ratios were not being realised in the types of fields encountered beyond the horizon. Simple checks were made by rotating the aerial while continuously recording a signal; back to front ratios of -6 db at 64.25 Mc/s and 0 db at 182.25 Mc/s were observed. These checks prompted more careful examination of the forward gain of the aerial by comparing it directly with an appropriate dipole, positioned co-linearly with the dipole of the array, at a spacing, of approximately $\frac{\lambda}{2}$ and at the same height. At such a spacing, the coupling between the two aerials is of the order of -40 db (Ref. 2) and there is little mutual effect. Switching between the aerials was accomplished by a relay at the top of the mast. The relay connected either aerial through a short length of 300 ohm cable to the "balun" and, from there on, the equipment arrangement was the same as that used to make the field-intensity recordings. The arrangements for aerial comparison and field intensity recording were thus, for all practical purposes, identical.

2.2 Aerial Gain Measurements

A series of back-to-front ratio recordings of the Yagi aerial, made at Warrnambool and Taree are shown in Figure 2. The apparent ratio on 64.25 Mc/s is about -19db, the normal ratio being -40 db. At 182.25 Mc/s, the back-to-front ratio appears to be about -6 db but on one of the transitions it is 0 db, the normal ratio is given as -25 db.

To check the forward gain of the array, dipoles resonated at 64.25 Mc/s and 182.25 Mc/s were compared directly with it. The relay switching permitted a rapid change of aerials while continuous recordings were being made. This was essential because of the rapidly varying signals.

At 64.25 Mc/s the forward gain of the array appeared to vary continuously, the limits of the variation being + 6 db and 0 db. The normal forward gain of 6 db was apparent on approximately the same number of occasions as was zero gain. On more than 50% of comparisons the array gain was approximately 3 db.

At 182.25 Mc/s the situation was very much worse. The limits of the measured forward gain were + 6 db and -6 db, the nominal forward gain being 9 db. On more than 50% of the comparisons the signal level from the array was approximately the same as that from the dipole, an effective gain of 0 db.

Because of limited time, it was not possible to gather sufficient data to evaluate the array gain on a statistical basis but on the majority of occasions it appeared that the maximum forward gain coincided with high signals and the minimum with low.

2.3 Conversion of received signal to field intensity

The variation of the effective forward gain of the receiving aerial in situations such as these, posed the problem of how to convert the recorded signal levels to field intensity values. At the lower frequency this was not so difficult, as adopting an average effective gain of 3 db would not introduce appreciable errors, but at 182.25 and 196.25 Mc/s a different approach had to be made. It was mentioned in paragraph 2.2 that the maximum forward gain appeared to coincide with high signals and vice versa. Although not true all the time, this variation was used in the following manner in the conversion of the higher frequency signal recordings to field-intensity. For 50% of the time the aerial gain was considered as being 0 db, for 10% of the time as 3 db and for 1% of the time 6 db. The results are plotted in Fig. 4 and when compared with field intensities from similar circuits overseas, the comparison seems favourable.

3. Comparison with meteorological data

Meteorological data from Williamtown, the approximate mid-point of the Sydney-Taree path, have been compared with the measured results in order to try and determine whether the period of the measurements was a representative sample of propagation conditions.

By a direct comparison of meteorological temperature - pressure-height graphs with signal-level recordings, it was found that an approximate "rule-of-thumb" could be used as a measure of the probability that high signal levels would be recorded in Taree. This rule was, that where there was a rapid increase in temperature, with height, of greater than 3°C, occurring at a height of 2000-3000 ft. above the surface, high signal levels were certain. When such temperature inversions were found at greater heights, the increase in signal level was less until, at 10,000 ft., the increase was only just apparent as an increase of a few db in the basic, back-ground signal level. The few recorded temperature inversions of this amplitude below 1000 ft., had no apparent effect. Summer periods of 1959-60, 1958-59 and 1957-58 were then compared on this basis. Table 1 gives details.

Table 1

	Number of occasions of high signals (a)	Number of occasions of medium level signals (b)
1957-1958	9	10
1958-1959	10	8
1959-1960	7	9

Note (a) The number of days on which temperature inversions of greater than 3°C were recorded in the 2000-3000 ft. region.

(b) The number of days on which similar temperature inversions were recorded in the 5000-6000 ft. region.

The total number of significant temperature inversions during the 1959-60 summer was slightly fewer than for the two previous summers. It is to be expected, as a consequence, that the data recorded at Taree are slightly lower in percentage of time than for an "average" year.

4. Results

The results are plotted in terms of the field-intensity exceeded for a particular percentage of the recorded time, in Fig. 3 and 4. The field intensity - percentage time curves for both Warrnambool and Taree are compared at 64.25 Mc/s and 182.25 Mc/s while additional overseas measured values for similar circuits have been included as a basis for further comparison. As the results at 196.25 Mc/s closely followed those for 182.25 Mc/s, only the latter have been plotted.

It is of interest to compare the Warrnambool and Taree statistical observations with the latest C.C.I.R. data (Ref. 3) averaged for a large number of paths, long periods of recording and frequencies between 40 Mc/s and 600 Mc/s. This has been done in Table 2.

Table 2

Comparison of recorded field strengths for Warrnambool and Taree with C.C.I.R. data

Percentage of time for which signal is exceeded	Field strength dbu 100 kw e.r.p.					
	Warrnambool		Taree		C.C.I.R.	
	64.25Mc/s	182.25Mc/s	64.25Mc/s	182.25Mc/s	Mean	Spread
50%	+ 27	+ 14	+ 25	+ 16	+ 20	+ 10 dB - 13 dB
10%	+ 36	+ 31	+ 39	+ 30	+ 30	+ 15 dB - 14 dB
1%	+ 43	+ 43	+ 51	+ 45	+ 39	+ 18 dB - 13 dB

Conclusions

5.1 The measured values for both circuits agree substantially with those from similar circuits overseas, at the frequencies considered.

5.2 It is difficult to determine, from the data obtained, whether the additional atmospheric ducting to be expected along the coast of N.S.W., does result in higher signal levels for significantly longer periods of time, during the summer months. Fig. 3, which compares the two paths at 64.25 Mc/s, does indicate higher fields for small percentages of the time but the difference at 182.25 and 196.25 Mc/s is negligible. (Fig. 4). There may be

..6/.

some relation between the field intensity and frequency but the slope of the Taree 64.25 Mc/s curve and the two curves at 182.25 Mc/s are similar and it would appear that the Warrnambool 64.25 Mc/s curve is the "odd man out". More data would be necessary to positively answer the question.

5.3 Dipole aerials should be used for any future measurements of this type, probably with the addition of a low noise-factor amplifier at the mast-head.

5.4 The number of significant temperature inversions recorded at Williamtown during the 1959-60 summer was fewer than during the previous two summers. This would seem to indicate that the Taree data may be a little lower in percentage of time than for an "average" year.

6. References

1. A.B.C.B. Report No. 17 - Tropospheric propagation at 64.25 Mc/s, 182.25 Mc/s and 196.25 Mc/s.

2. P.M.G. Radio Report No. 42 - 160 Mc/s Radiotelephone Systems: Site Engineering.

3. Tropospheric Wave Propagation curves for Distances well beyond the Horizon. C.C.I.R. Report No. 145. Documents of the Los Angeles Assembly 1959 Vol. 3, p. 293.

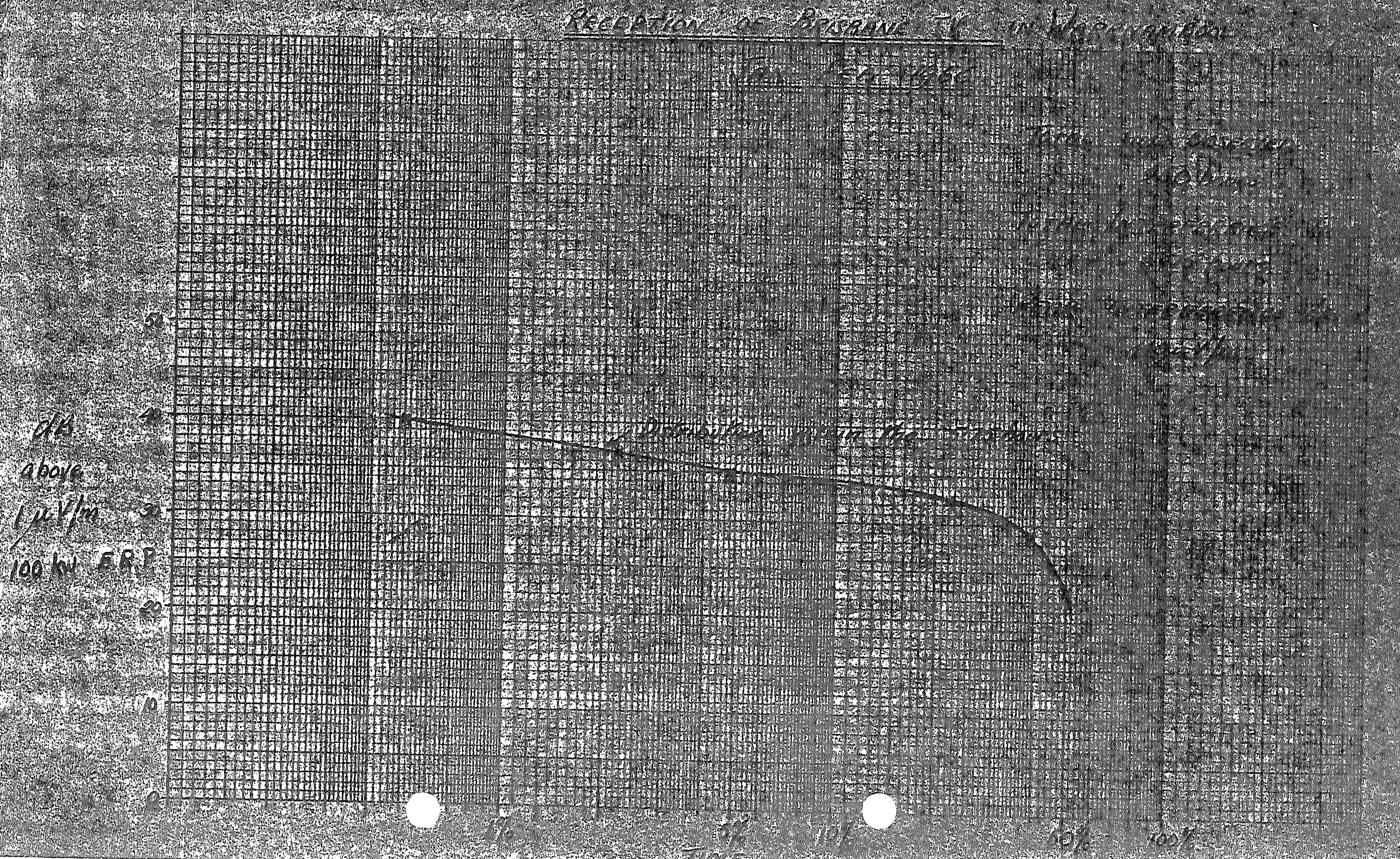
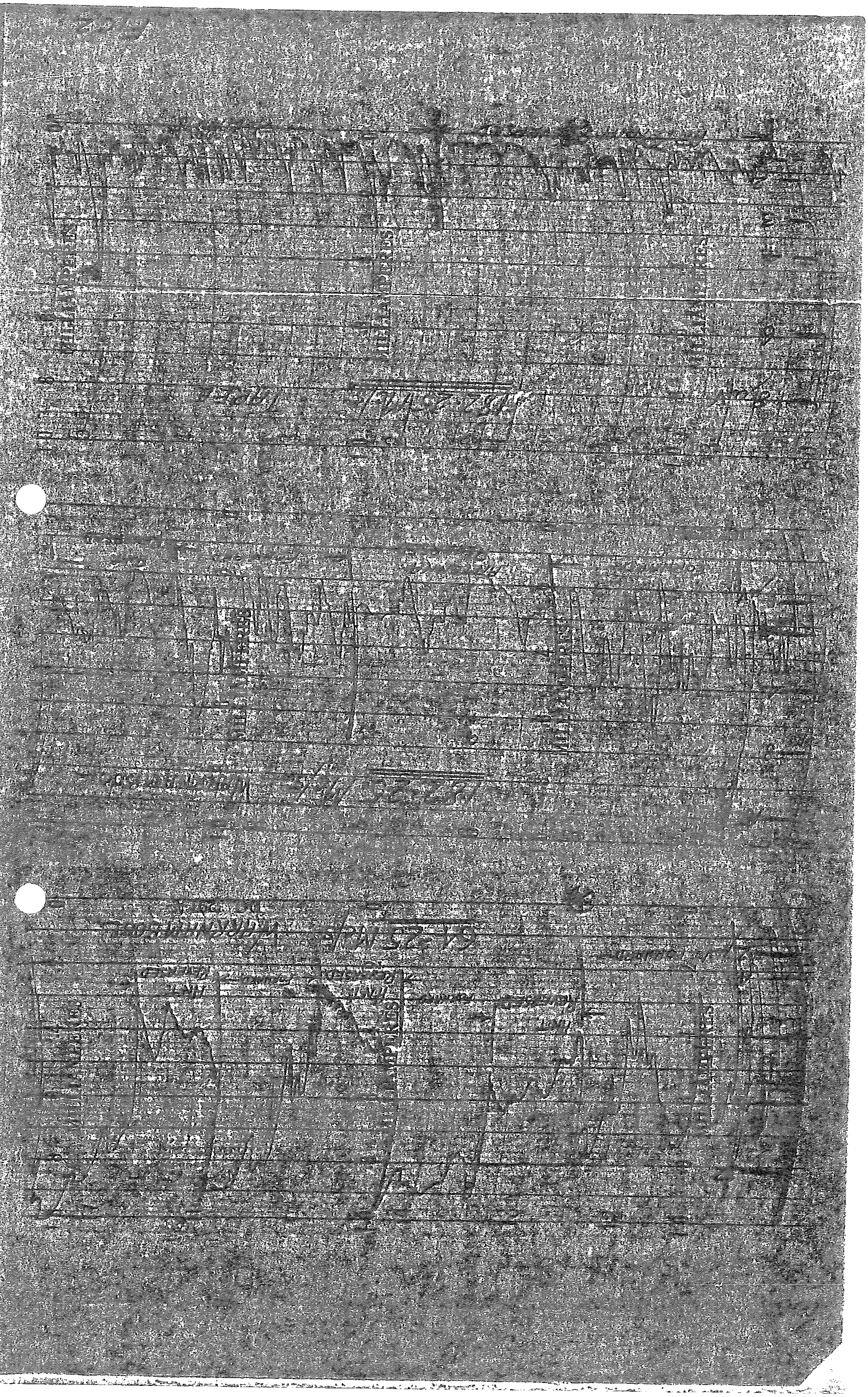
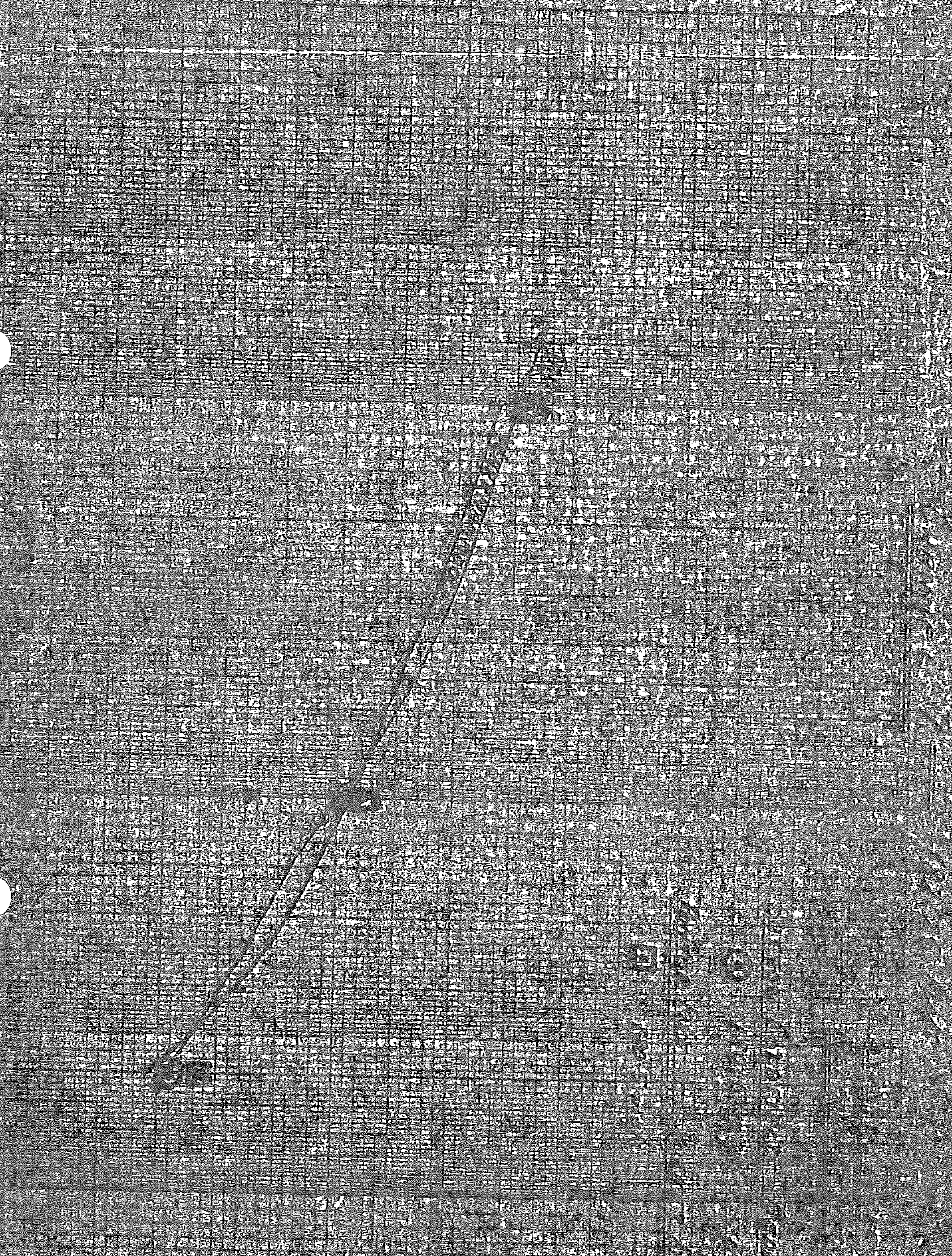

Reception of Brisbane TV
dB
above
1 µV/m
100 kW E.R.P
50
40
30
20
10

Fig 1





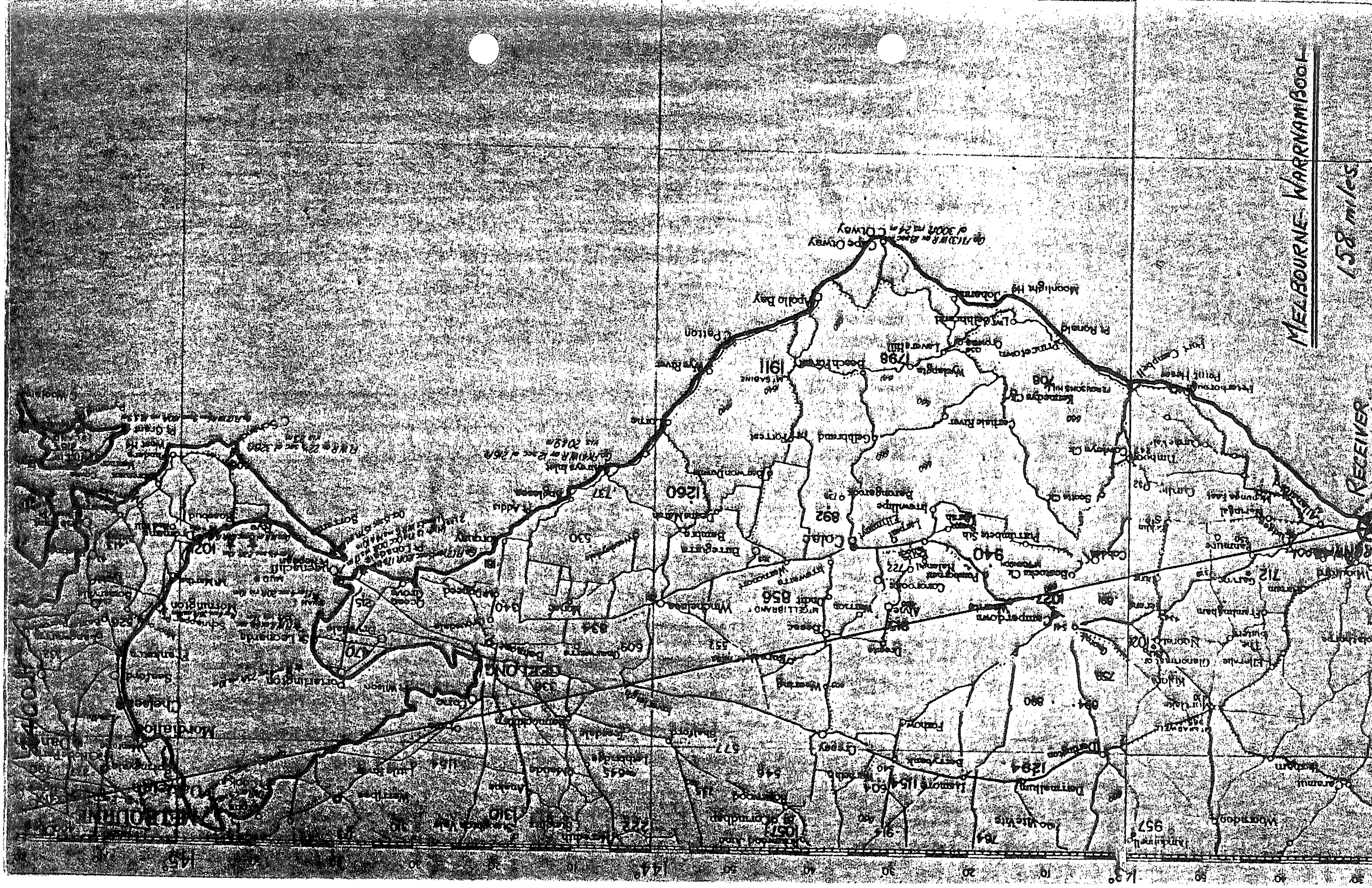
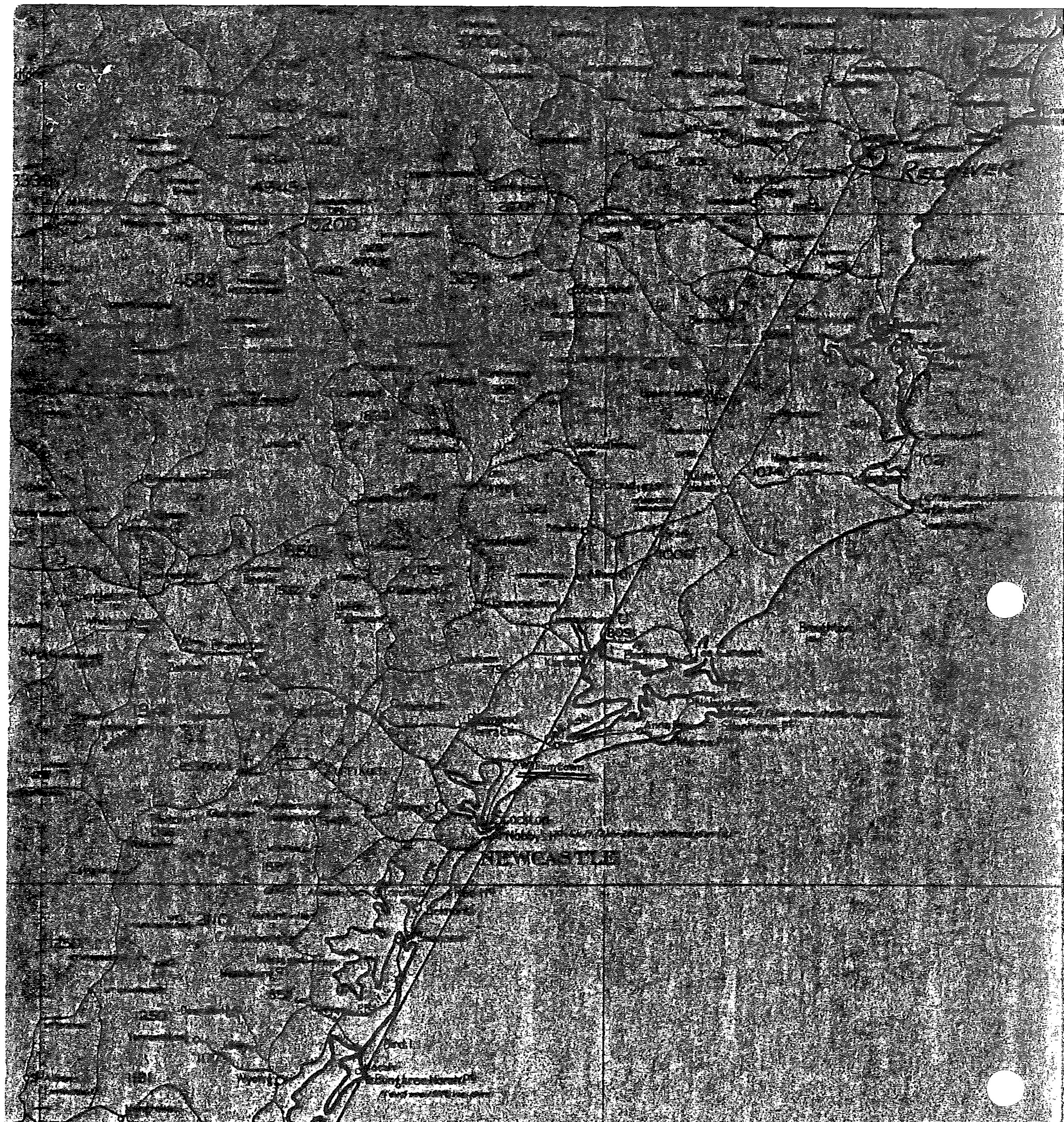


Fig. 5



SYDNEY – TAREE

153 miles.

FIG. 6