



Research Department Report

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IMPROVEMENTS TO A UHF REBROADCAST TELEVISION LINK SUFFERING TIDAL FADING:

Countisbury UHF relay station

J.H. Moore

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Research Department, Engineering Division
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**IMPROVEMENTS TO A UHF REBROADCAST TELEVISION LINK SUFFERING
TIDAL FADING: COUNTISBURY UHF RELAY STATION**

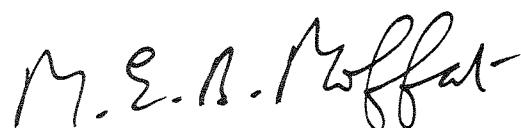
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Summary

The Countisbury UHF relay station serves the localities of Lynmouth and Lynton in North Devon. For some time, the problems of co-channel interference and tidal fading have on occasion been evident. The Report gives results obtained utilizing a new Rebroadcast Link (RBL) antenna array, which has improved very considerably the quality of the signals received at this relay station.

Details are also given of apparatus which enables sampled television picture sequences to be recorded on a VHS video cassette recorder. The channel identification, date and time are derived from the teletext signal and superimposed at the top of the picture.

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IMPROVEMENTS TO A UHF REBROADCAST TELEVISION LINK SUFFERING TIDAL FADING: COUNTISBURY UHF RELAY STATION

J.H. Moore

1. INTRODUCTION

The Countisbury UHF relay station, which serves the Lynmouth and Lynton locality of North Devon, has been in operation for several years. There have been reports that, at times, the pictures transmitted by the station were of poor quality and affected by interference.

The input signals to the transposer at Countisbury are derived from off-air reception of the main transmitter at Mendip. The impairment is likely to be caused by sea reflections.¹ These reflected signals result in partial cancellations and allow interference from co-channel stations to become apparent. In this case relay stations in South Wales are a likely source of interference.

To check the validity of the assumption and to assess the magnitude of the problem television picture and field strength monitoring equipment was installed at Countisbury. The results of the assessment are given in this Report.

Fig. 1. shows the relative position of the Countisbury relay transmitter, the main transmitter at

Mendip and the major sources of co-channel interference in South Wales.

2. INITIAL MEASUREMENTS TO DEDUCE THE SUBJECTIVE GRADE AND FREQUENCY OF OCCURRENCE OF PICTURE IMPAIRMENTS

Apparatus which had been built originally to monitor reception conditions in the Channel Islands was installed at Countisbury for this part of the investigation. Basically the apparatus consists of a 35 mm camera (having a large capacity film magazine) positioned so as to photograph a monochrome TV monitor. The television picture is received by a separate television tuner and additional electronic circuitry enables the adaptor to select preset TV channels and to activate the camera at preset times.

2.1 Photographic recording

The apparatus was set to record 'snapshots' of the received pictures from Mendip Channels 58 and 61*, the latter reputedly being the worst affected channel. Recording commenced each day at 0700 hours and a picture of each channel was taken hourly on the hour, up to 2400 hours. This period of 17

* Channel 58 (BBC-1), Channel 61 (ITV).

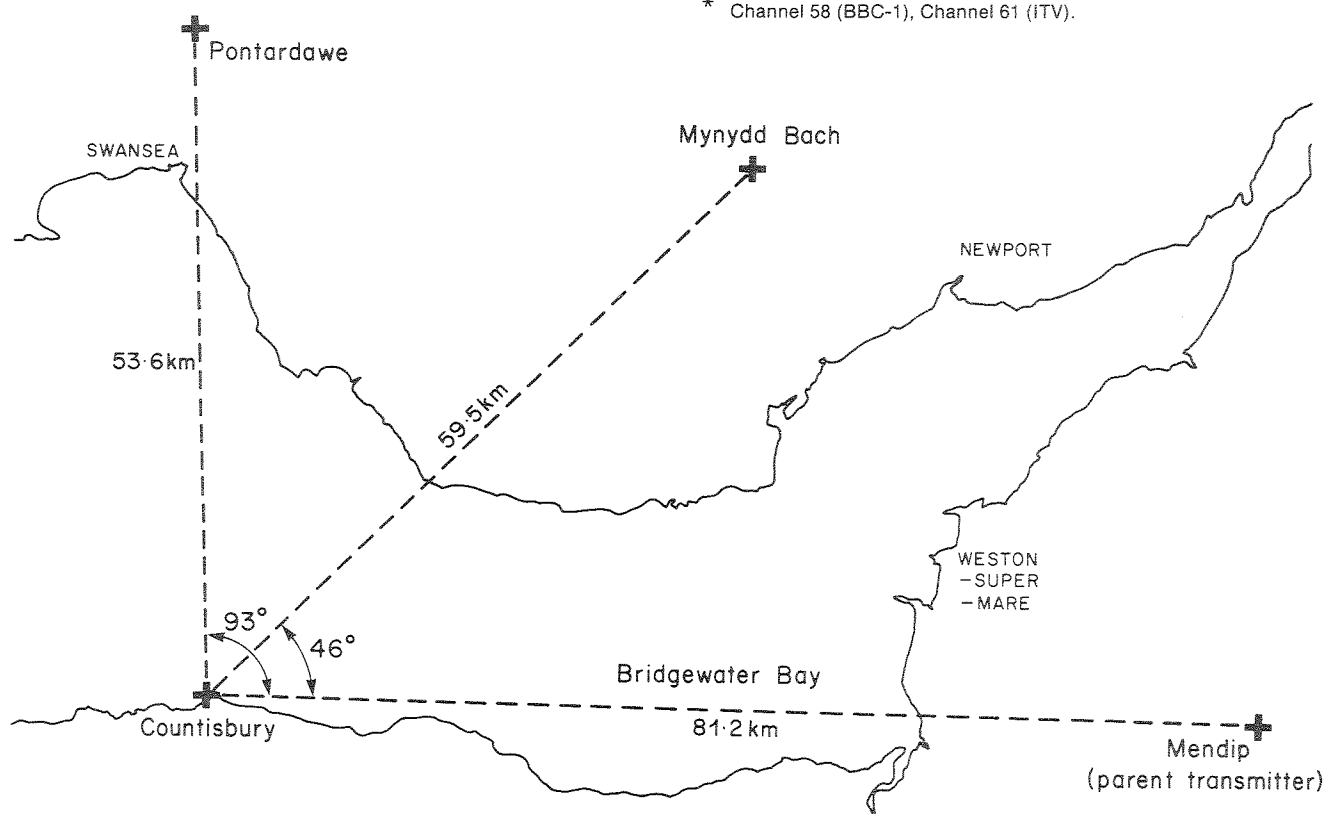


Fig. 1 - Geographical location of television transmitting stations.

hours daily recording was such that the effect on television reception of the tidal changes existing in this part of the Bristol Channel could be observed (see Fig. 2).

2.1.1 Picture analysis

The photographic recordings were processed so that the resulting pictures could be assessed by viewing them as projected images via a 35 mm film-strip projector.

The actual analysis of these pictures, utilizing the CCIR 5-point picture grading scale*, was carried out by trained/experienced observers who assessed each projected picture for various types of picture degradation, namely co-channel interference (CCI), delayed image interference (DII) and poor signal to noise ratio (S/N).

Table 1 shows the results of the picture analysis, as a percentage of the total number of snapshots for a given picture impairment grade on the CCIR scale. The results were obtained over a seven-week period, providing 845 snapshots per channel.

Table 1

Comparison of Picture Impairments of Channel 58 and Channel 61

CCI — Co-channel interference
DII — Delayed image interference
S/N — Signal to Noise ratio

CCIR Impairment Grade	Channel 58			Channel 61		
	%CCI	%DII	%S/N	%CCI	%DII	%S/N
5	75	99	72	29	100	82
4	20		26	33		15
3	3	1	1	24		2
2	1			10		1
1	1			4		

From this table, it will be seen that the reception of Channel 58 is subject to Grade 2 or worse co-channel interference for 2% of the time, whilst the reception of Channel 61 suffers considerable picture degradation due to CCI which is Grade 2 or worse for about 14% of the time.

* CCIR 5-Grade Impairment Scale (CCIR Rec. 500):
Grade
5 Imperceptible
4 Perceptible but not annoying
3 Slightly annoying
2 Annoying
1 Very annoying

Table 2 shows the results of further picture analysis, this time for Channel 64† and Channel 61. The results were obtained over a five-week period, providing 465 snapshots per channel.

Table 2

Comparison of Picture Impairment of Channel 64 and Channel 61

CCIR Impairment Grade	Channel 64			Channel 61		
	%CCI	%DII	%S/N	%CCI	%DII	%S/N
5	40.0	99.0	87	25.0	100	88
4	41.0		8	44.0		5
3	14.0		4	20.0		3
2	4.0	0.3	1	10.0		2
1	0.4			0.2		1

From this table, it will be seen that the reception of Channel 64 is subject to Grade 2 or worse CCI for 4.4% of the time whilst reception of Channel 61 is similarly degraded for 10.2% of the time.

It will also be seen in Tables 1 and 2 that Channel 64 and Channel 61 suffer to some extent picture degradation due to relatively poor S/N of Grade 2 or worse.

2.2 Field strength recording

To determine the variation in field strength with time, a Research Department digital field strength measuring receiver and a chart recorder were used to monitor the field strength of Mendip Channel 61; the receiver and recorder were allowed to run continuously so that the field strength could be monitored throughout the period the Mendip transmitter was actually broadcasting. These chart recordings gave a clear indication of signal level fluctuations due to anomalous propagation.

Fig. 2 shows the variation in the recorded vision carrier field strength of the Channel 61 signal on the 1st September 1984 which typifies poor reception conditions; close to the field strength minimum the picture was Grade 2 due to CCI and the signal level is attributed to the phase change of the sea- reflected signal.

From examination of the field strength charts, it became evident that these minima had a cyclic repetition whose rate was twice a day, although on some days the minima were not so clearly defined as in the example shown in Fig. 2.

† Channel 64 (BBC-2)

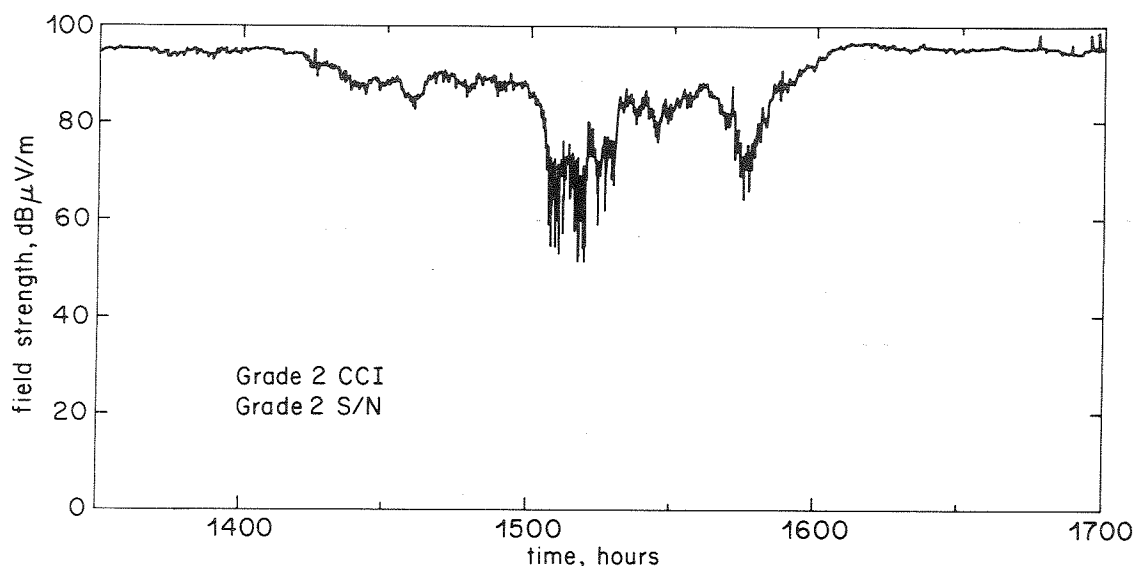


Fig. 2 - Vision field strength of Channel 61 on 1st September 1984.

Fig. 3 shows a picture taken at 3 p.m. (i.e. during the minima) and is typical of a television picture degraded by poor reception conditions; fairly severe co-channel interference, poor signal-to-noise ratio and delayed image interference are all very evident.

3. IMPROVING THE REBROADCAST LINK (RBL) SIGNALS

The analysis of results given in Section 2 shows that the principal cause of degraded pictures was that of CCI and, to a lesser extent, poor received signal levels. Examination of computer-predicted field strengths of co-channel stations indicated that the Mynydd Bach and Pontardawe relay stations were the

likely sources of CCI, although there were several other transmitters which could cause this form of picture degradation. Experiments on site confirmed that Mynydd Bach was the major source of interference.

The existing RBL receiving antenna at Countisbury consisted of four horizontally-polarised log-periodic antennas stacked vertically. These were mounted approximately 17 m a.g.l. (above ground level). It was apparent that an array having superior discrimination could be employed to minimise the interfering signal from Mynydd Bach and, to a lesser extent, the signal from Pontardawe. This latter signal, by virtue of its relative geographical bearing to Countisbury, should not prove to be troublesome since



Fig. 3 - Typical poor television reception during field strength minima.

a log-periodic array should provide good discrimination. The geographical bearing of Mynydd Bach, however, does not permit such good discrimination and therefore an antenna array was designed which provided sharp rejection on the bearing of Mynydd Bach (43° ETN). The theoretical rejection was calculated to be 43 dB, but is likely to be somewhat less in practice due to ground reflections and to amplitude and phase inaccuracies in the array itself.

The new phased array consisted of two horizontally polarised log-periodic aeri²als spaced horizontally. The directional pattern of this array³ is dependent on the spacing of the antennas, the relative amplitude and phase of the currents in the antennas, and the directional characteristics of the individual antennas.

In this instance, a directional coupler is used to combine the outputs of the two antennas. The required directivity is obtained by a combination of antenna spacing and the electrical lengths of feeders joining the antennas to the coupler.

This array was mounted on the Countisbury aerial mast at a height of approximately 5 m a.g.l. The height was selected to ensure that the foreground provided some screening from reflected signals.

The bearing of the array was adjusted such that the sharp rejection notch was precisely centred on Mynydd Bach, i.e. the array was aligned to minimise the received field strength from Mynydd Bach. To facilitate this alignment, the Mendip transmitter was temporarily switched off. Any subsequent maintenance of this array will require the above procedure to be repeated so as to obtain maximum rejection of the major source of interference.

4. EVALUATION OF THE NEW REBROADCAST LINK (RBL) PHASED ANTENNA ARRAY

To ascertain whether the new phased antenna array had the beneficial effect of rejecting or reducing co-channel interference, picture and field strength monitoring was resumed and comparative pictures were taken on Channel 61 as received both by the original antenna array and by the new array.

Table 3 shows the results of the picture analysis of this series of measurements in percentage time and subjective picture grade over a period of thirteen weeks. A total of 1575 snapshots per channel were recorded.

Table 3
Comparison of Picture Impairment - Channel 61

CCIR Impairment Grade	Original RBL Antenna Channel 61			New Phased Array Channel 61		
	%CCI	%DII	%S/N	%CCI	%DII	%S/N
5	48	100	94	71	100	95
4	38		3	24		5
3	10		2	4		
2	3			1		
1	1		1			

From this table, it can be seen that the new array gives significantly better reception, with a marked reduction in CCI. Pictures of Grade 2 or worse for 1% of the time compares very favourably with the 4% of time for the signals received by the original RBL antenna.

However, although the new array gave a marked improvement regarding CCI, there still existed occasionally a coarse CCI pattern unlike the patterning seen from Mynydd Bach which has a fine structure consistent with a frequency difference of five-thirds line offset. The source of this coarse CCI pattern was traced to a fault at Pontardawe, whose Channel 61 offset was found to be significantly out of tolerance. The fault condition was rectified and subsequent examination of pictures indicated the absence of the coarse CCI pattern.

5. ADDITIONAL PICTURE RECORDING APPARATUS

The efficacy of the new antenna array was assessed by examination of photographic pictures taken from a monochrome television monitor. However, another method of recording television pictures in colour has since been developed which utilizes a domestic video cassette recorder. This new method provides a facility for recording up to four separate channels at preselected time intervals throughout the day, with time, date and channel identifications displayed at the top of the television screen.

The apparatus consists of a VHS video cassette recorder and modified teletext adaptor which are both controlled by a BBC microcomputer. The microcomputer is also used, in conjunction with a digital field strength receiver, to disable the video recorder during periods when the field strength is below a pre-set value. A simplified block diagram of the apparatus is shown in Fig. 4.

The microcomputer is used to address the teletext adaptor tuner, so as to select the television channel and to allow the teletext page header to appear momentarily (about 5 seconds) each time the television channel is changed. This provides positive channel identification, since it shows the television programme as well as the date and time.

station, simultaneous field strength chart recordings of Channel 61 were also made. An analysis of these charts is given in Fig. 5. From this graph it will be seen that for 99% of the time, the field strength is greater than $83 \text{ dB}\mu\text{V/m}$ with the new phased antenna array. The corresponding value for reception on the original antenna system is $71 \text{ dB}\mu\text{V/m}$.

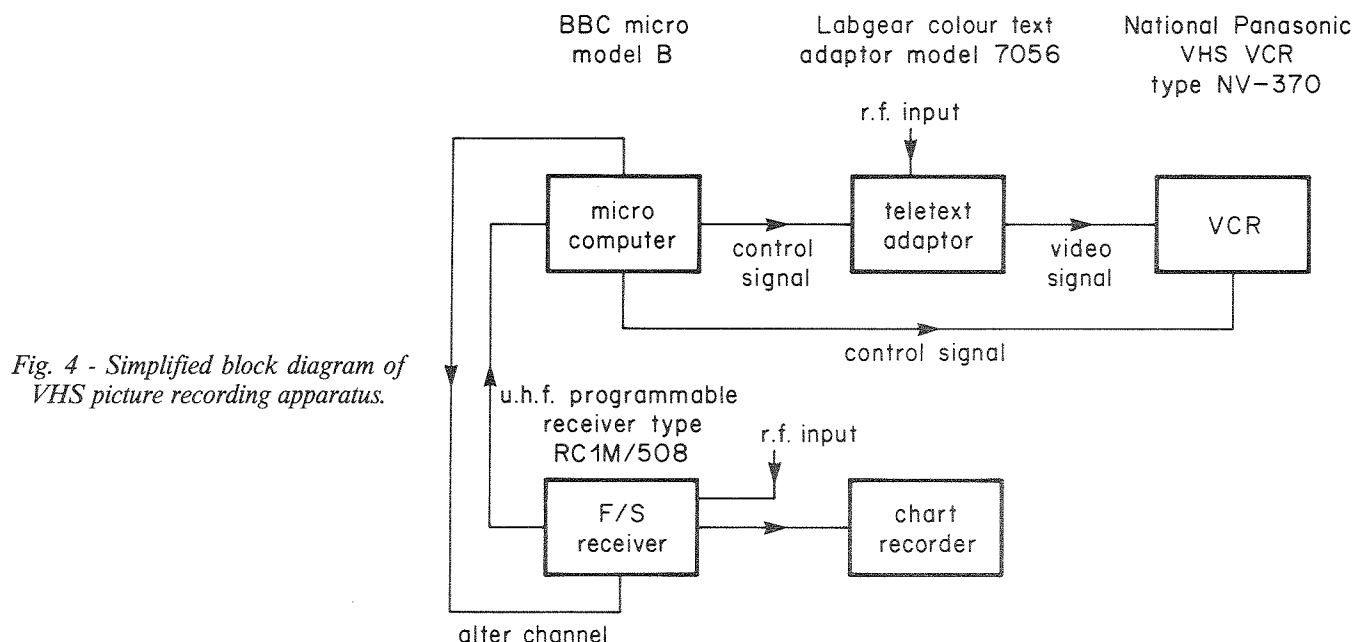


Fig. 4 - Simplified block diagram of VHS picture recording apparatus.

The equipment was used at Countisbury to monitor reception of all four channels (the fourth being Channel 54*) on the new RBL array.

The microcomputer was programmed to allow approximately 12 seconds' recording of each of the four channels, commencing at 0700 hours and subsequently every hour until 2400. A three-hour video cassette allowed up to 10 days of continual sampling.

Table 4 shows the results of this series of video recorded pictures of all four channels in percentage time and subjective picture grade over a period of six weeks. A total of 685 snapshots per channel were recorded.

From Table 4 it will be seen that the picture quality of all four channels received by the new antenna array is consistently better than that obtained from the original RBL vertically-stacked array.

6. FIELD STRENGTH RECORDINGS USING THE NEW RBL PHASED ANTENNA ARRAY

In addition to the photographic and video tape recordings of television reception at Countisbury relay

* Channel 54 ('Channel 4')

7. CONCLUSIONS

The outcome of the measurements at Countisbury is that the new RBL feed to the relay station, using a new phased array is considerably better than that using the original antenna system. Signal fading has been reduced by mounting the new RBL array so that it is partially screened by local terrain from signals reflected off the sea; co-channel interference has been reduced by the array which has been specifically designed to reject the major source of interference.

Any subsequent maintenance of the new phased array will necessitate careful alignment using the technique outlined in Section 3 so as to obtain maximum rejection of the co-channel signals transmitted from the relay station at Mynydd Bach.

The use of photographic techniques for recording picture degradations has been invaluable. However, a new video cassette recording system, with attendant microcomputer for control purposes, has now been successfully used to record sequences of colour television pictures, with channel identification, date and time coding in the form of a teletext page header displayed at the top of a television picture. Subsequent examination of such moving picture sequences is straightforward. In particular, any interference patterns

Table 4
Comparison of Picture Impairment: All Channels Received on New Antenna Array

CCIR Impairment Grade	Channel 58			Channel 64			Channel 61			Channel 54		
	%CCI	%DII	%S/N	%CCI	%DII	%S/N	%CCI	%DII	%S/N	%CCI	%DII	%S/N
5	98	100	99	99	100	99	85	100	98	99	100	99
4	2		1	1		1	13		2	1		1
3							2					
2												
1												

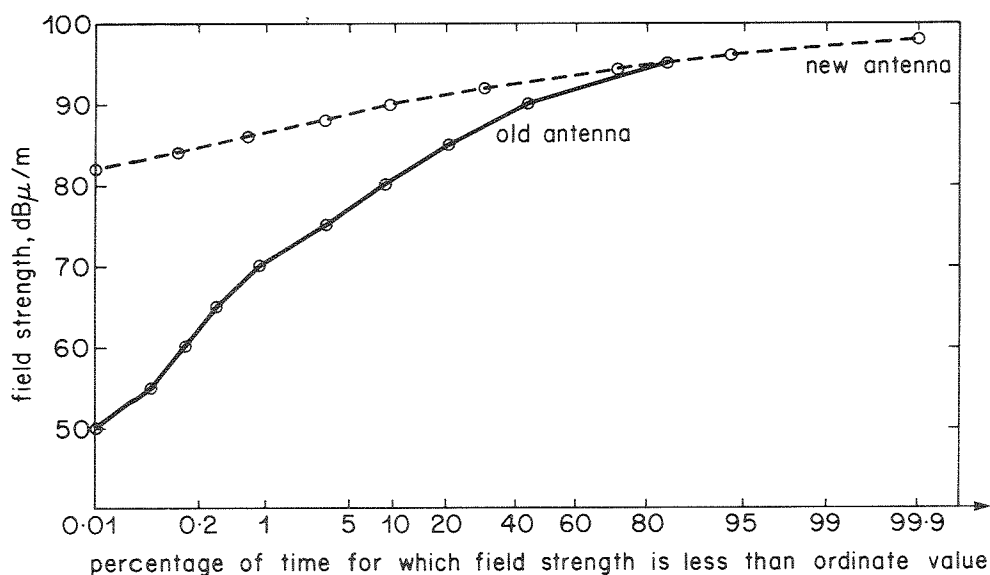


Fig. 5 - Statistical distribution of the field strength of Channel 61 received at Countisbury.

tend to be more easily discerned on moving pictures, whereas examination of photographically recorded 'snapshot' pictures necessitates lengthy chemical processing; and more careful interpretation of the still pictures is required since some interference patterns tend to be not so readily discernible.

The problems of co-channel interference on Re-Broadcast Link feeds to transmitters can on occasion be reduced by the use of a specially designed receiving antenna. The design of such an antenna, based on a phased array principle, enables a single interfering television transmission on a specific geographical bearing to be reduced very considerably. A simple phased array has been used to good advantage at the Countisbury relay station. Naturally, this array will provide rejection of signals on other bearings. It is considered that phased arrays should be more widely used in Rebroadcast Link feeds to transmitters troubled by single source co-channel interference.

8. ACKNOWLEDGEMENTS

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Transmitter Capital Projects Department.

The changing of the films, paper charts and latterly the video tapes was carried out by BBC staff at the Washford and Mendip Transmitters.

The processing of the recorded pictures was carried out by the Photographic Unit of Research Department Technical Services.

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