

Tricks of the Trade

Dave Porter G4OYX with Donald Scott GW4OWQ, John Spendlove G4DXY/EI4IM and Barry Collins G4ULA

We continue with the trials and tribulations of adding what became eventually the 1089 kHz full-power 150 kW fourth service at Brookmans Park starting in 1978. With the previous three high-power channels amounting already to 250 kW total RF output on site; the increase to 400 kW was not going to be without some problems. Indeed, certain intermodulation products had been identified internally in the BBC and also publicly reported upon in the technical press, namely *Wireless World*.

Much was written in the last issue of *Signal* [1] and, to aid understanding of the masts and tower layout at Brookmans Park, included below as **Figure 1** is an annotated map of the site as of 2016.

- Between A and B towers is the North Tee four-wire antenna carrying the 1089 kHz service at 150 kW.
- Between C and D towers is the South Tee four-wire antenna carrying the 1215 kHz and 1458 kHz services both at a nominal 50 kW each.
- Mast E is the 91 m Wincharger as a reflector for the 1215 kHz service and a powered reflector for the 1458 kHz service.
- Between Masts G and Mast H is the 'Mini-Tee', normally a reflector for the 1089 kHz service but able to be used as a reserve 75 kW omni-directional antenna for 1089 kHz.
- Mast F, more correctly annotated as Mast F1, is the 909 kHz 150 kW main radiator.
- The antenna tuning huts (ATHs) at the base of Towers A, B, C and D will most likely contain matching circuits to enable them to radiate various of the service frequencies in an emergency situation



Figure 1. The masts and towers layout at Brookmans Park courtesy of Mike Brown at <http://tx.mb21.co.uk/> facilitated by Martin Watkins

26 dB positive feedback!

With ToTT articles, it is always pleasing to receive reader feedback and, as such, the author was delighted when an email arrived from a fellow VMARS member, Don Scott GW4OWQ. It is reproduced below and has been only slightly edited to be in the regular format for *Signal*.

GW4OWQ writes:

The ToTT article in Signal issue 65 [1] brought a smile to my face and I have to stick my hand up and confess it was I who wrote that letter to Wireless World! Buster was a good friend of mine and my other half, Jean (who looked after Buster who was disabled), also helped in the production of his offshore radio magazine "Monitor".

You are quite correct that our concern was for 963 kHz, and, when it appeared that the BBC were going to ignore the problem, a letter to Wireless World seemed a good idea. I was employed by GEC Hirst Labs in Wembley at the time and, since we were co-working with BBC Research at Kingswood Warren, my letter could have been embarrassing so Buster offered to 'ghost' the letter for me.

Buster could not have written such a letter, at the time he was not even licenced. I coached both him and Jean through the RAE and we practiced Morse together, getting tested at North Foreland Radio and were issued consecutive callsigns: Jean G4OWO, Buster G4OWP (Offshore Wireless Person!) and myself G4OWQ.

As you noted, it took nearly a year for the problem to be sorted and I was already composing another letter for WW entitled "A Spurious Anniversary" but it was not needed in the end.

I was surprised by your comment that the team at Brookmans Park were unaware there was an on-going problem and it took the letter to bring it to their attention, I would have thought that the Engineering Information Department would have at least passed on the comments to engineering staff at Brookmans Park. We concentrated on the 729 kHz sprog because it was by far the stronger and most likely to get people's attention; we assumed (rightly I think) if one was cured so would the other be!

Thank you for a most interesting series of articles and a 'behind-the-scenes' look at the BBC's MF network at the time.

It was most illuminating to receive that note from Don and the author was able to clarify in a reply to him that we, in the Transmitter Operations Department, were aware locally right at the start of the new transmission that there were the 729 kHz and 963 kHz intermodulation products (IPs) as a field strength survey had been conducted using the trusty Potomac FIM-41 calibrated meter before and after the addition.

Spurious emission and fault reporting

It was usual in BBC Transmitter Operations that if there were site problems of concern, the BBC Monitoring Station at Tatsfield (until the mid-1970's) or Crowsley Park would contact the site engineers directly. It may have been that the then DTI Baldock site would have contacted BBC Crowsley Park for them check and internally alert us, but the author has no record of same. With Baldock being only a few miles away from Brookmans Park, there is no way that they would have not been aware of the IPs.

What probably happened was that there was indeed an official notification but it didn't filter down to Operations level but rather was passed to Transmitter Capital Projects Department who were actively working anyway on the further re-engineering of Brookmans Park and the rest of the BBC MF sites.

Officialdom, Legislation, Execution thereof, etc.

Readers may recall that comments of officialdom, etc. have been made previously in Signal [2] in a piece co-written by Dave Porter G4OYX and John Spendlove G4DXY/E14IM entitled *Amateur Radio Training in the late 1960s*.

Here, the authors examined the situation in Nottinghamshire and Derbyshire at that time where there was a knee-jerk reaction to the then recent loss of the offshore pirate stations with youngsters taking to the airwaves; these music transmissions were in addition to those that had been on for many years with pre-licensed amateurs having some unofficial practical experience...

The authorities were seemingly not impressed and stiff fines, up to the equivalent of about £400 today, were meted out for sometimes even first-time-offenders, together with confiscation of the audio and RF apparatus. G4OYX and G4DXY argued the case in the piece about this level of punishment and the execution thereof. The section is reproduced below:-

So, was it really so bad? Often, when evidence regarding pirate operations was being given in the Magistrates Courts, reference and suggestion was made to "possible interference to important safety-of-life services" and the like but significantly not proven. The interference aspect would have seemed very important to technically naïve members of The Bench when presented by RIS Officers of the Post Office but, looking back with the full technical knowledge we have now, it is fair to say that, for operations on medium wave and 2 MHz, it was highly unlikely that this would actually have been a problem. The output power of the transmitters in use was often c. 10–20 W; possibly slightly more in some cases but the redeeming factor was that the antennas in use, mainly end-fed long wires and their associated earth systems, were so poor that the actual radiated power was possibly only a watt or two and

hardly an issue across a town, though one must concede that near neighbours may have had breakthrough on record players, telephones and tape recorders. However, it must be said that possible interference was far more serious an issue for the HF pirates using dipoles and 10–20 W on 6.6 MHz "Echo Charlie". This part of the spectrum is for Aircraft Communications and there were instances of interference reported in RadCom.

Publicity

Much was made of such raids and fines in the technical and local press, though they rarely made the national papers.

Unsurprisingly, such publicity would be of interest to certain individuals, maybe those engaged professionally in RF broadcast, those having radio hobby interests, those who possibly had aspirations of employment in the legal profession or of course, all three!

For over forty years, the author has been in pen-friend contact with Barry Collins G4ULA of Coventry. In true pen-friend style we have neither met face-to-face nor spoken! Between the pair of us at least, much has been discussed. With similar interests and the chance to see and share details of RF problems and activities over the years, there must have been enough in our correspondence to write a book.

It is said that there is "a book in everybody" and after a three and a half year period of detailed research, Barry certainly delivered in 1991 with his book entitled *Danger Signals?* [3]. G4ULA has been most gracious in allowing publication of extracts. All the extracts have been only slightly edited to be in the regular format for *Signal*.

In his book, there are 118 pages on A4 size paper. It was a great shame that, after all the 42 months research and documentation, he could not find a publisher at the time willing to take it on for full-scale publication. One would guess that these days with social media and the ease by which specialist groups and individuals can be engaged, that such a tome would find a receptive audience. Alas, that was not to be and as such his considerable efforts remain a "Private Communication".

His *raison d'être* was well described in the Foreword to the book and it is reproduced below.

Danger Signals? : Foreword

During the period August to December 1985, the UK Department of Trade and Industry conducted a campaign of hitherto unequalled intensity against the then offshore broadcasters Radio Caroline and Laser 558. This was largely in response to the UK commercial radio lobby which, via the Association of Independent Radio Contractors and the IBA, made it clear to the authorities the disastrous effect on station audience figures and thus advertising revenue that the broadcasts of Laser in particular were having. The result was what rapidly became known as Euroseige '85, an exercise whereby the DTI chartered successively a number of ships to observe what UK vessels were illegally supplying the offshore stations from the UK, so as to discourage and make re-supply more difficult as well as gather evidence for prosecutions which subsequently followed.

Meanwhile, a complementary offensive was undertaken on land by The Radio Investigation Service Branch of the

DTI in the form of a war-of-words conducted via the mass media and press conferences. Prominent in this were the usual long-standing but hitherto unproved allegations that offshore broadcasters' interference was a potential threat to life. I, like many others working within the telecommunications industry, listened to several such claims with mounting amazement that accusations so obviously weak to the technically literate observer and therefore so easily disproved were, and never had been, challenged.

On the other hand my then existing knowledge told me that one claim, namely that Radio Caroline had interfered with reception of helicopter radio-navigation beacons, contained an element of truth. So what in fact was and is the real position?

It is out of the scope of this article to fully detail all that G4ULA discussed in 118 pages but examination of Chapter 8 (on page 89) will start to tie some ribbons...

G4ULA continues...

In the course of this book we have looked at the basic causes of interference and the forms it may take. This has enabled us to subsequently explore the accuracy of claims by the authorities that, in particular, interference from offshore broadcasters to emergency and navigation channels has over time posed a 'potential threat to life', a situation that it is said continues. However, what has emerged so far has shown that the fault for any interference, whether of the threat to life variety or not, lies almost entirely with the accuser rather than the accused. Specifically, a picture has emerged comprising a mixture of double standards in general and incompetence in frequency allocation matters in particular by the DTI (and its predecessors) this being all the more reprehensible in a UK regulatory body charged with, and supposedly expert in, matters of spectrum management. When allied to the shortcomings in design and performance of much professional radio equipment, which in turn has much to do with the poor official type approval specifications on which many items of hardware are based, is it little wonder so many problems exist? These factors of double standards, incompetence and deficient equipment standards along with the part played by the authorities all feature in these cases which could well be termed; *The BBC Interference that was* and *The BBC Interference that wasn't*.

The BBC Interference that was (1)

Brookmans Park near Hatfield just north of London has for many years been the home for several BBC transmitters

which up until 1978 radiated services on 908, 1214 and 1457 kHz. As a result of the Geneva Plan implemented on November 23rd that year, a number of slight frequency alterations took place at the site along with the adoption of a new transmitter on 1089 kHz, a channel formerly used by World Service for a number of years. The resulting spectrum occupancy was:-

909 kHz	Radio 2
1089 kHz	Radio 1
1215 kHz	Radio 3
1458 kHz	Radio London

All these changes also involved new aerial configurations that, combined with the use of high power, multi-channel transmitter operation within a relatively small physical area, made it inevitable to some extent that problems would arise. Sure enough, teething troubles did appear, taking amongst other things the form of IPs of various strengths being emitted from Brookmans Park on a number of frequencies, details of which are given in **Table 1**.

Frequency (kHz) of	Source	Field strength readings at			
		2.5km south-east of site on		2.3km north-west of site on	
		13.11.79	14.11.79	13.11.79	14.11.79
a) programme					
909	R2	0.78 V	1.52 V	1.10 V	1.68 V
1089	R1	1.10 V	1.05 V	0.58 V	0.90 V
1215	R3	1.02 V	0.98 V	0.41 V	0.38 V
1458	RL (London)	1.04 V	1.10 V	0.40 V	0.41 V
b) IP					
243	RL-R3				
306	R3-R2	4.50 mV	4.10 mV	1.70 mV	1.55 mV
360	2R2-RL				
369	RL-R1				
540	R2+R1-RL	4.40 mV	3.80 mV	1.90 mV	1.50 mV
549	RL-R2				
603	2R2-R3	1.00 mV			
720	2R1-RL				
729	2R2-R1	4.30 mV	0.40 mV	5.90 mV	0.55 mV
963	2R1-R3	2.05 mV	3.80 mV		2.80 mV
972	2R3-RL				
1269	2R1-R2				
1341	2R3-R1				
1521	2R3-R2				
1701	2RL-R3	90 µV	30 µV		1.05 µV
1818	2R2	1.18 mV	18 µV	0.55 mV	1.10 µV
1827	2RL-R1				
1998	R2+R1				
2007	2RL-R2	25 µV			
2124	R2+R3				
2178	2R1	<1 µV			
2304	R1+R3				
2367	R2+RL				
2430	2R3				
2547	R1+RL				
2673	R3+RL				
2727	3R2	60 µV	<1 µV		2.50 µV
2916	2RL	15 µV	15 µV		2.50 µV

Table 1. Intermodulation products (IPs) emitted from Brookmans Park

As far as the average listener was concerned the most 'visible' evidence of the IPs listed in **Table 1** was the appearance of spurious signals on 729 and 963 kHz, channels occupied by amongst others Radio Telefis Eireann and, ironically, Radio Caroline respectively. Now a point often made by the authorities is that all transmitters must ultimately come under official control so that any interference therefrom can be speedily dealt with, even to the extent that a 'guilty' unit can be closed down if necessary by the powers-that-be. Yet in the case being examined here this was not borne out. The interference which resulted from the Brookmans Park re-engineering

work undertaken in the run-up to the Geneva Plan implementation date of 23rd November 1978 was still present around a whole year later when the field strength readings in the list were re-taken on 13/14th November 1979. This was reflected by correspondence in the April 1979 edition of *Wireless World*, which elicited a reply from the BBC that:-

The changes we made on November 23, 1978 involved the commissioning of many new transmitters and aerial systems. At stations where several programmes are radiated it is not always easy to avoid combinations of this kind. We are now engaged in a tidying up and fine tuning operation at all our transmitting stations in the course of which these two spurious emissions will be eliminated or at least reduced to an acceptable level.

The 963 kHz intermodulation product arose because signals from the Radio One transmitter on 1089 kHz were apparently reaching the valve anodes of the 1215 kHz Radio Three counterpart via the latter's antenna wherefrom they were then re-radiated. This problem was cured during the summer of 1980 by the insertion of a 1089 kHz rejector type filter within the Radio Three installation. More difficult to resolve was the IP on 729 kHz for this was the result of the 1089 kHz signals directly entering the 909 kHz Radio Two transmitter, a 140 kW facility of second world war vintage and not very well 'screened' against the entry of external radio transmissions. Consequently the 1089 and 909 kHz signals mixed on the anodes of the Radio Two transmitter to produce a 729 kHz intermodulation product of relatively high strength, as can be seen from the earlier table. This was despite the use of appropriate filtering on the output feeder of the 909 kHz unit, and a cure was only finally effected when the wartime Radio Two installation was replaced from the 14th November 1979 onwards by a new arrangement using the 50 kW Marconi transmitters triplexed to give 150 kW output.

The BBC Interference that wasn't

Whilst the 729 and 963 kHz IPs were a matter of public debate, if only in the technical press, what was not publicly revealed and which is not evident from **Table 1** was the most interesting intermodulation product of all.

During Easter 1979, it came to the notice of the BBC that aircraft flying near the Brookmans Park site were experiencing problems with their reception of the Stansted navigation beacon 'SAN' on 369 kHz. This interference resulted from the signals of BBC Radio London and Radio One on 1458 kHz and 1089 kHz respectively, mixing to give an intermodulation product on 369 kHz, the same frequency as that used by the beacon. Measurements taken of the IP's signal strength, literally outside the front door of Brookmans Park, showed it to be only a few millionths of a volt (-90 dB) strong, much better than the -40 dB/50 mW level laid down for maximum spurious emissions in Appendix 8 of the International Telecommunication Union Radio Regulations. Filters were installed in the Radio London transmitter and fresh readings taken. These showed that the 369 kHz IP was now even fewer of a millionths of a volt in strength (-106 dB). Yet pilots still reported interference to their reception of SAN so meetings subsequently took place between the BBC, Civil Aviation Authority, Home Office and the (then) Radio Interference Service of the General Post Office. As a result, the BBC were able to prove that

the aircraft radio equipment and thus by implication the official type standards it was based on were deficient to the extent that a set could be driven into cross-modulation by a small signal thousands of times weaker than the one desired. So (once again) the authorities had to accept that shortcomings within receivers were responsible for the interference initially blamed on a transmitter, and in this case the cure was to change the Stansted beacon frequency from 369 to 339 kHz with effect from 15th May 1980.

The subsequent fallout

This incident raises a number of fundamental points. First the authorities, in this case the Home Office would, as the regulatory body at the time, have known the frequencies used by every United Kingdom transmitter including the fact that SAN had been using 369 kHz since 2nd July 1970. It is reasonable to expect therefore that such a body, when approving new frequencies in general and those for broadcasters in particular, should perform the relevant calculations so as to see whether any new IP could 'clash' with a frequency assigned to a navigation beacon likely to be used by any aircraft within the vicinity of the transmitter concerned. Second, past experience should have made the Home Office aware of the inadequate performance of much solid-state receiving equipment, especially when compared to its valve predecessors. And yet both these basic factors in whole or in part were either overlooked or ignored with the consequence that, as with the other IPs discussed earlier, this problem went on for over a year. Had it been an offshore broadcaster rather than licensed land-based one emitting the IPs in question, particularly the 369 kHz one, there seems little doubt that the authorities would have alleged a potential threat to life existed. All in all, this whole episode suggests that the incompetence and double standards displayed by the DTI, which have been referred to several times already, are merely a continuation of the practices employed by its forerunners.

There are some fairly pertinent observations in that piece from Barry.

With the author's help he did have one other observation of the correct way that some BBC interference was resolved. Resolution of same was rather in the author's interest as G4OYX was actually transferred temporarily for four months to Daventry in 1989 and was responsible for the HF Operations there!

G4ULA writes:-

The BBC Interference that was (2)

The BBC had a number of HF transmitter sites including Daventry where there were 100 kW and 300 kW senders in operation. One of the 100 kW senders was used for approximately 12 hours per day on 6195 kHz. During Autumn 1989 a transmitter fault allowed this sender to radiate a harmonic of significant strength on 2 x 6195 kHz, namely 12390 kHz.

The 12390 kHz area of the spectrum is allocated to the Maritime Mobile service i.e. ships. More specifically, frequencies between 12330.0 and 12426.1 kHz are allocated on a worldwide basis to 32 off, 3.1 kHz wide ship channels that are 'paired' with maritime radio channels used by land-based stations in the 13 MHz band. **Table 2** lists those channels around 12390 kHz,

Ship frequency (kHz)	Channel No.	Paired base frequency (kHz)
12385.8	1219	13156.6
12388.9	1220	13159.7
12392.0	1221	13162.8
12395.1	1222	13165.9

Table 2. Paired maritime-land based frequencies around 12390 kHz

So calls from ships on any of those channels could have suffered interference from the BBC harmonic especially on channels 1220 and 1221. The latter occupies 12392 kHz, the significance of which is described in radio regulation 2988D: "The carrier frequency 12392 kHz is used for distress and safety traffic by radio telephony".

Equally interesting is radio regulation 4375.3: "The carrier frequencies 4125 kHz, 6215.5 kHz, 8257 kHz, 12392 kHz and 16522 kHz are also authorised for common use by coast and ship stations for single-sideband radio telephony on a simplex basis for distress and safety traffic".

As if to reinforce the importance of the frequency, Volume 1 of *The Admiralty List of Radio Signals* notes that 12392 kHz is a working channel used by stations at Ostend (Belgium), Lyngby (Denmark), Rogaland (Norway) and Monaco. And so it was, that the Norwegian authorities complained to their British counterparts (most likely DTI Baldock) who in turn notified BBC Crowsley Park and thence to Daventry whose engineers investigated and corrected the fault.

Within Chapter 8 entitled "The Other Side of the Coin" Barry details what one can only view now as a most bizarre set of events. As can be seen previously G4ULA did lay bare some shortcomings of The Authorities in the courses of their actions and policies but, to be fair, a balancing argument was presented in this chapter. The first part detailed many of the channels used since the mid-1960s by the offshore stations and the various interference issues that resulted. The latter extract is best described as a perfect testament on how not to do it!

G4ULA continues:

The Radio Caroline Interference that was (heading by G4OYX)

All the foregoing incompetence in frequency selection matters reared its ugly head yet again when on Nov 30, 1985 the Caroline station engineers used the 1.5 kW maritime band transmitter on board to relay the 558 kHz English service on 6273 kHz. Unfortunately the band 6270 to 6281.4 kHz is allocated to 10 off 600 Hz-wide channels used for CW comms for shipping. The most commonly used of these channels, five and six, occupy 6272.4 to 6273 and 6273 to 6273.6 kHz respectively. By using 6273 kHz with programme material, Caroline at a stroke interfered with the two most-used channels. Not forgetting that 6273 kHz is also rather close to an emergency channel described in radio regulation 2986B as follows: "the frequency 6268 kHz is used exclusively for distress and safety traffic using narrow band printing telegraphy".

By some means. the station was informed of this foolhardiness and transmissions ceased after some two days.

In February 1988 the station returned to HF on 6210 kHz and then after a brief change to 6205 kHz, finally settled

on 6215 kHz for what turned out to be an 18-month period. Again all these frequencies officially were for maritime communications use.

Again the radio regulation exposes the folly of the 6215 kHz choice... "the carrier frequency 6215.5 kHz is used to supplement the carrier frequency 2182 kHz for distress and safety purposes and for call and reply in radio telephony".

With 5 kW or so on this channel, operation was very obviously not wise and in the summer of 1989, after a long-running official surveillance of the ship, a joint Anglo-Dutch boarding operation took place around midday on Saturday August 19, 1989. The 819 kHz and 6215 kHz transmitters were severely damaged by the raid. Some six weeks later the 558 kHz did return but 819 kHz and the HF never did.

Barry then examines the whys and wherefores of the HF operation and concludes that it was most foolhardy; his summing-up was as follows:-

Having suffered the expensive consequences of their own irresponsible interference, rather than other radio uses being the innocent victims of it, perhaps Radio Caroline's engineers will from now on, and at long last, take great care when choosing frequencies.

The BBC Interference that was (3)

This illustration of a local problem at Woofferton, details the sometimes unintended consequences of multi-sender, multi-antenna operation. With Daventry closing in March 1992, Woofferton was then a busy site, carrying in the mid-1990s, much Voice of America (VoA), Radio Free Europe, Radio Liberty, BBC World Service (WS) as well as Radio Canada International and Radio Japan.

The former USSR was still not politically stable and international broadcasters were continuing their transmissions to Russia and some of their former satellite states.

The map of the antenna field at Woofferton at that time is shown as **Figure 2**.

From Woofferton, c. 74° is the bearing for Moscow with the -12° slew on c. 58° for St Petersburg and the +12° slew for Kyiv on c. 86°. Check out arrays 901, 902, 903, 906, 907, 908 on the LHS and 915, 916, 917, 936, 954, 953 on the RHS. That entire suite of arrays cover the frequency range from 6 to 21 MHz on boresight 70° to 75° and with many having the -/+ slew capability.

Array 917 and its brother A936 are dual-band antennas for 6 and 7 MHz fixed on 74°. They were popular with the frequency managers as solid coverage of Moscow was just about guaranteed with 250 kW or 300 kW input power as antenna gains of around 20 dB were the norm!

The author was on night shift on one occasion and received a report from Crowsley Park around 0500 that a complaint had arrived via Baldock of a combination term

on a certain frequency being received in Denmark. The received audio on the designated frequency indicated that it was VoA Russian mixed with BBC WS. Crowsley Park suggested we might like to check locally. Its presence was confirmed.

Certain senders were tripped and when the one feeding A936 VoA on 6160 kHz was off, the term disappeared. Similarly when the sender feeding A931 BBC WS for southern Europe was tripped, it went also. A931 is a 7 MHz single band array and is located adjacent to A936. It was the 2 x 6160 kHz that was finding its way back into the 7 MHz sender and causing the 2f1-f2 combination term. Regrettably, the author can't recall the offending 7 MHz frequency but essentially the IP would be somewhere between 5050 and 5200 kHz. One can only guess that it must have been on an important channel for someone... maybe diplomatic point-to-point, or military, etc.

The antenna field layout shows A936 and A931 situated very close to each other next to S mast.

It's not hard to see how RF from A936 will 'fire-through' A931. In hindsight, when the field was designed, A931 and A932 should have been positionally swapped over, as A932 is a 15 MHz antenna and it would have been less likely for them to be in use simultaneously.

The fix in this instance would have been to transfer the BBC WS 7 MHz 140° transmission to another array on site or transfer it to say, Rampisham, with Woofferton taking the displaced Rampisham transmission if there was no spare capacity there.

This on-site generation of IPs was well-known and could be troublesome on older, legacy sites that had been added to in terms of antennas and senders over many years; Daventry was a prime example.

In 1988 the European Broadcasting Union (EBU) published a paper by BBC Antenna Specialist Tony Preedy G3LNP entitled "Intermodulation by transmitter interaction within an HF broadcasting complex" [4].

One can imagine that, by the late 1980's, the proliferation of HF broadcasts were about at their zenith not only with many broadcasters acquiring 500 kW senders but also employing them on an almost 24-hour basis. The paper documented what could be done or actually what was to be avoided in planning of such installations to prevent unwanted interactions.

Conclusion

The authors hope that this article has illustrated what could be considered to be a technical minefield when many

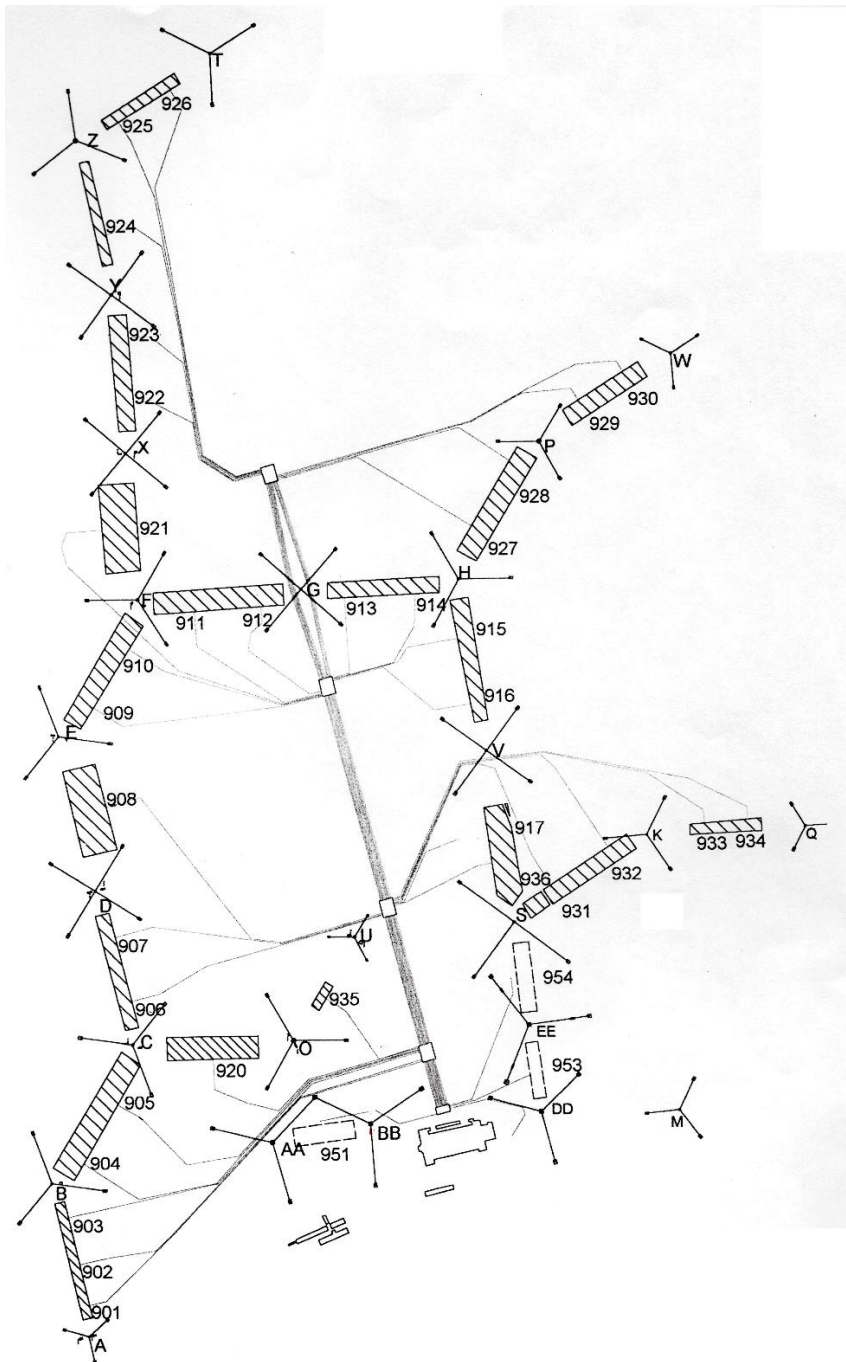


Figure 2. Antenna field at Woofferton

transmitters are operating together and that there can be challenging problems to overcome. Sadly some are not identified in the planning stage!

References

1. D Porter G4OYX Tricks of the Trade. *Signal* 2022, 65 (November), 17–22.
2. D Porter G4OYX and J Spendlove G4DXY/EI4IM. *Signal* 2016, 41 (November), 3–7.
3. B Collins G4ULA. Danger Signals? 1991 TP Graphics Ltd, Coventry.
4. AR Preedy, *EBU Review – Technical* 1988, No.232 (December), 1–16.