RADCOM TECHNICAL FEATURE

LF Mobile Antenna Design

by R Bearne, G4DUA

TOP BAND IS A GOOD BAND for mobile working, offering reliable SSB communications over 50 miles during the day and providing capable coverage of the British Isles and beyond at night.

The reason why 160m is not a popular mobile band may lie in the fact that antenna performance is crucial to the success of a Top Band mobile installation.

This article attempts to cover the important factors when venturing into the design of a low frequency antenna.

ANTENNA EQUIVALENT CIRCUIT

A SIMPLIFIED EQUIVALENT circuit of the antenna is given in **Fig 1** and can be used as a model to analyse each component part in detail. The circuit elements are listed as follows:

Tx represents the transmitter with a source impedance of 50Ω.

L is the inductance of the loading coil

R_1 is the resistive loss of the loading coil

R_r is the radiation resistance of the antenna

C_a is the capacitance of the antenna

R_e is the resistive earth return via the car body and back to the transmitter

C_m is the shunt capacitance required to match the antenna to 50Ω

ANTENNA EFFICIENCY

WHEN THE ANTENNA is at resonance the circuit simplifies to purely resistive components, these being R_1, R_r and R_e. As they are in series the current flowing through each is equal.

The power radiated by the antenna is I^2R_r because R_r is the resistance to which transmit power must be delivered for the antenna to radiate.

The power dissipated in R_e and R_1 is power wasted as heat developed in the loading coil and through the ground return.

Thus the antenna efficiency=

$$\frac{\text{Power Radiated}}{\text{Total Power}} = \frac{I^2R_r}{I^2(R_1+R_r+R_e)}$$

$$\text{which simplifies to: } \frac{R_r}{R_1+R_r+R_e}$$

Thus in order to obtain the best possible antenna efficiency we need to maximise the radiation resistance (R_r) and minimise the coil and earth losses (R_1 and R_e)

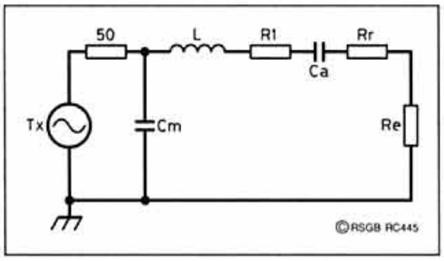


Fig 1: Antenna Equivalent Circuit.

MAXIMISING RADIATION RESISTANCE

RADIATION RESISTANCE R_r depends solely on the length of the antenna and is given by:

$$R_r = 40\tan^2(\pi h/\lambda)\Omega$$

where h = antenna length and λ is the wavelength.

A 2m long whip has a radiation resistance of 0.13Ω whereas a 3m whip has a radiation resistance of 0.28Ω which is more than double. Clearly the antenna needs to be as long as you are able to make it.

ANTENNA CAPACITANCE

IN ORDER TO HELP minimise the losses from the coil (R_1) it would help if the required load inductance could be made as small as possible. To achieve this it is necessary to make the antenna capacitance as large as possible. The capacitance of a whip is given by the formula:

Radius a	Turns n	Length 1	Wire Length	Inductance L, µH
1.00	10.00	0.39	31.42	7.73
1.00	50.00	1.97	157.10	87.26
1.00	75.00	2.95	235.65	146.20
1.00	100.00	3.93	314.20	207.04
1.00	150.00	5.90	471.30	331.13
1.00	*170.00*	*6.68*	*534.14*	*381.22*
1.50	10.00	0.39	47.13	12.91
1.50	50.00	1.97	235.65	169.68
1.50	75.00	2.95	353.48	294.50
1.50	92.00	3.62	433.60	383.52
2.00	10.00	0.39	62.84	18.24
2,00	50.00	1.97	314.20	265.60
2.00	65.00	2.55	408.46	388.10
2.50	10.00	0.39	78.55	23.65
2.50	51.00	2.00	400.61	382.11

Table 1: Coil Winding Characteristics.

$$Ca = 2\pi\varepsilon_o\,[\,\ln(h/a) - 1]$$

Where h = antenna length
a = radius of whip in metres
ln = natural logarithm
ε_o = 8.85 E-12 F/metre (Permittivity of Free Space)

This capacitance increases with antenna length and diameter and so once again the antenna should be made as long as possible with the largest diameter practical. For example a 2m long whip of 4mm diameter would have a capacitance to earth of 21pF.

SERIES INDUCTOR L1

TO GET THE MAXIMUM efficiency out of the antenna we must ensure the coil has the maximum possible Q (minimum RF losses). The Q of a coil is defined by :

$$Q = \frac{2\pi fL}{R_1}$$

Where f = frequency
π = 3.142
L = Inductance
R_1 = Coil resistance at frequency f

To increase Q, we need to minimise the coil resistance. The coil resistance is made up of two factors, RF loss and DC loss and each must be considered in the coil design. DC resistance is proportional to the diameter and length of wire used. Therefore to obtain minimum DC resistance the largest practical wire size should be used on a coil with the minimum winding length. The inductance of a coil is given by the following equation:

$$L = \frac{a^2n^2}{9a+10l}$$

Where a = radius in (in)
n = no.of turns
l = overall length of coil (in)

Table 1 gives winding characteristics in a table of results which determine winding lengths for various inductance values on a given radius. As the radius is increased the winding length decreases and hence DC resistance will be reduced.

RF resistance is made up of two phenomena and these are known as Skin Effect and Proximity Effect. Consider a solid wire carrying an RF current. This current generates a magnetic field which tends to force the RF current to the outer surface of the wire. This is known as **skin effect** and is proportional to the square root of frequency. The skin effect for a material is defined by its skin depth, which gives a measure of how far the RF

* 30 Bouvirie Avenue, Salisbury, Wiltshire SP2 8DT

current penetrates the material at a given wavelength. At VHF and above almost all the current flows on the outer surface and hence the use of silver plated wire at these frequencies.

This phenomena is still very relevant at low frequencies and an example of this is given in **Table 2**. Impedances are shown for straight circular copper wires of three diameters of a given length at a frequency of 2MHz. The results demonstrate how the impedance increase of the wire is not directly proportional to diameter, this being due to skin effect. Two 22AWG wires used in place of one 2AWG would present a smaller impedance, ie 129Ω against 200Ω respectively.

This idea was taken further with the development of Litz wire which consists of many strands of enamelled copper wire twisted together. Because the wires are insulated from each other the wire surface area is increased and the RF losses are reduced correspondingly.

Conductor resistance of a coil is given by:

$$R_c(\omega) = Rdc[1 + (\omega\, \mu\, \sigma\, r^2)^{1/2}]$$

where ω = frequency in radians
μ = permeability of the wire
σ = conductivity of the wire
r = wire radius

This shows how DC and RF resistance play a part in the overall coil loss. The equation also shows how care must be taken in choosing the characteristics of Litz wire. If the DC loss of the wire is too high then any improvement in RF resistance will be negated.

The proximity effect represents itself as the distortion of the magnetic field in an RF current carrying coil due to proximity of adjacent wires in the coil. Butterworth stated that this effect could be minimised by use of a specific coil shape, ie its length to diameter ratio which he stated to be:

$$\text{Coil diameter} = \frac{8}{15} \times \text{Coil Length}$$

ie about a 2:1 diameter to length ratio.

Butterworth also stated that for a given inductance and a given coil diameter there is an optimum wire size such that the turns would always be spaced apart to reduce this effect.

Wire diameter mm	Impedance (ohms)
6.5mm	200
2.6mm	223
0.64mm	258

Table 2: Impedance of a Copper Wire at 2MHz.

OVERALL ANTENNA DESIGN

TAKING ALL THE theoretical factors into account the design of the whip can now be pursued. The whip was designed to operate at 1933kHz which is the mobile channel used on Top Band. Using a spreadsheet program an analysis was performed on antenna efficiency for various whip lengths and loading coil Qs.

The results of this analysis are given in **Table 3** and the resultant efficiencies are related to a 0.5m whip having a loading coil with a Q of 200. **Fig 2** gives the results in graphical form and clearly shows the how the efficiency is enhanced by greater whip lengths and larger coil Qs. For example increasing the whip length from 1.5m to 3m gives an 8dB improvement in efficiency (which is 1.5 'S' points). In addition a coil Q improvement to 600 gives another 4dB which gives a 2 'S' point advantage over the shorter and less efficient antenna. In linear terms this means 15 times more power radiated!

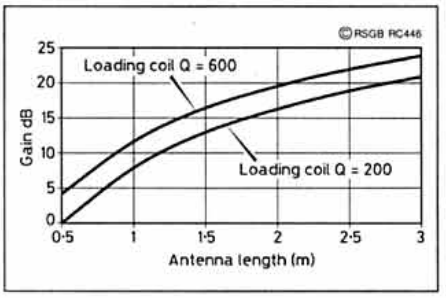


Fig 2: Antenna gain relative to a 0.5m whip.

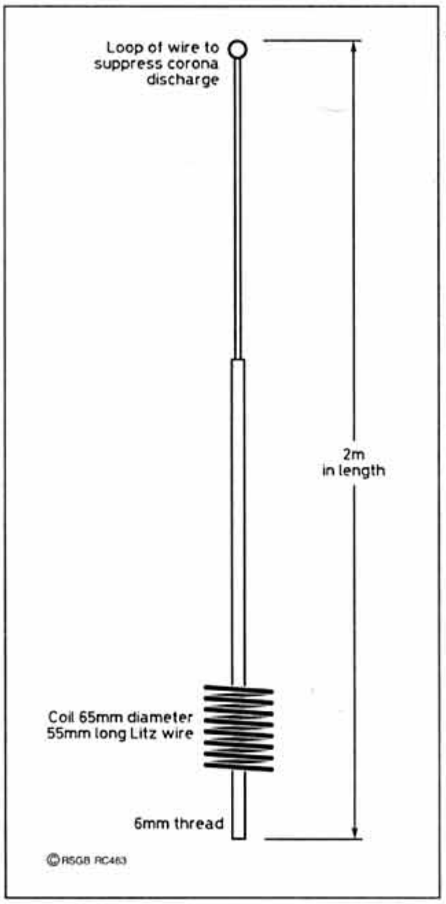


Fig 3: 160m whip antenna construction.

PRACTICAL COIL DESIGN

THE FIRST COIL was wound with 1mm diameter enamelled copper wire with each turn spaced 0.5mm apart on 50mm plastic pipe with approximately 200 turns. The inductance and Q were measured on a Network Analyser, the resultant Q was 210 with an inductance of 400μH, so nowhere near the target Q of 600.

The next stage was to obtain some Litz wire and fortunately some was snapped up at a junk sale. The wire was approximately 50 strands of 0.03 mm diameter with an overall diameter equivalent to 0.65mm. A coil was closewound on a 75mm former with an overall length of 40mm (close to the 2:1 ratio) resulting in some 70 turns. The coil Q increased to a remarkable 640.

PRACTICAL ANTENNA DESIGN

ONCE A COIL WINDING technique and wire type had been established a mechanical structure had to be made. The overall structure had to be strong and light enough for possible fitting on a simple gutter mount. A fairly discrete antenna was in mind so an overall length of 2m was decided upon and is shown in **Fig 3**.

ANTENNA SET UP & TESTING

THE ANTENNA WAS MOUNTED on the roof the car and the resonant frequency measured. Once this was found it was necessary to match the antenna to 50Ω by use of a shunt capacitance (C_m in the equivelent circuit).

Now if the antenna will match without any shunt capacitance then the antenna losses are in the region of 50Ω which means the antenna efficiency is well below par. Listed in **Table 4** are some approximate values of antenna loss and how they relate to shunt capacitance .

ANTENNA Q

IN ORDER TO MATCH the antenna on the car 2.2nF was required which gives an overall loss of 18Ω. To confirm this the antenna Q

Antenna Length	Radiation Resistance	Capacitance	Series L	Coil Loss (Q=200)	Coil Loss (Q=600)	Ant Effic'y % Coil Q=200	Ant Effic'y % Coil Q=600	Gain dB, re 0.5m Ant with Coil Q=200	Gain dB, re 0.5m Ant with Coil Q=600
0.54.11	E-03	7.26E-12	9.33E-04	56.67	18.89	0.01	0.02	0.00	4.12
1 1.64	E-02	1.23E-11	5.51E-04	33.47	11.16	0.04	0.10	8.07	11.84
1.53.70	E-02	1.69E-11	4.00E-04	24.31	8.10	0.13	0.28	12.77	16.26
2 6.58	E-02	2.13E-11	3.18E-04	19.30	6.43	0.27	0.57	16.08	19.34
2.51.03	E-01	2.56E-11	2.65E-04	16.10	5.37	0.49	0.98	18.62	21.69
3 1.48	E-01	2.97E-11	2.28E-04	13.87	4.62	0.78	1.52	20.68	23.58

Table 3: Antenna efficiencies for specific whip lengths and coil Qs.

Overall Antenna Loss	Required Shunt Capacitance
10Ω	4nF
20Ω	2nF
30Ω	1.3nF
50Ω	0nf

Table 4: Antenna loss and shunt capacitance.

was calculated by measuring the antenna bandwidth (bandwidth is related to Q by measuring the frequency span between the 2.6:1 SWR points of the antenna).

The bandwidth was found to be 7kHz and hence Q was calculated by using the following formula:

$$Q = f_0/(f_{u\,2.6:1} - f_{l\,2.6:1})$$

where f_0 = resonant frequency

$f_{l\,2.6:1}$ = lower frequency where SWR is 2.6:1

$f_{u\,2.6:1}$ = upper frequency where SWR is 2.6:1

Hence Q = 276

Now $Q = 2\pi fL/R$ for the antenna, where L is the coil inductance and R is the antenna overall loss. The inductance was measured as 380mH and so R can be calculated. The antenna loss was 18Ω which corresponds to the theoretical value of 22Ω. Now this suggests an earth loss in the region of 11Ω.

ON AIR TESTING

THE ANTENNA RADIATES well and has been given good reports throughout the UK. Due to the high Q and hence narrow bandwidth the antenna is difficult to keep on tune under all weather conditions. A capacity hat was tried but did not provide a large enough increase in antenna capacitance to reduce the antenna Q and hence widen the bandwidth. The best route would seem to be to improve the overall weather protection of the loading coil. ♦

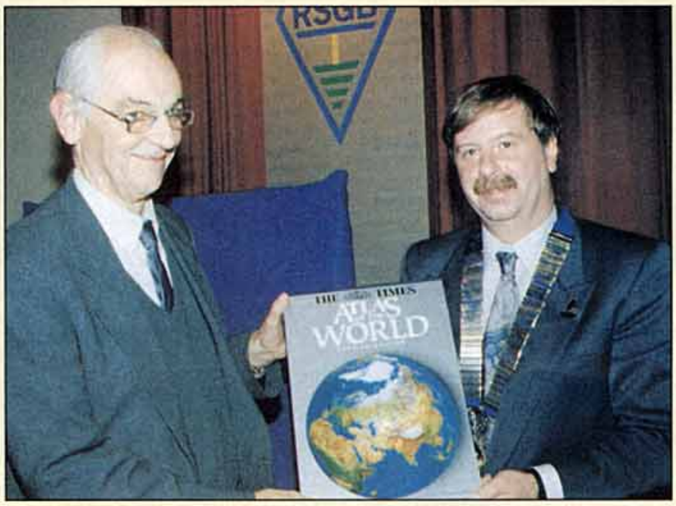
Annual Meeting Awards

SEVERAL TROPHIES were presented during the Informal Session of the 1994 RSGB Annual Meeting, held in London last December:

The Ostermeyer Trophy for the best article about home constructed equipment in *RadCom* went to John Hey, G3TDZ, for 'The Multiband Phasing Transceiver' (June, July, August 93).

Receiving the Fraser-Shepherd Award for research into Microwave communication: A Horsfall (left) and D B Hall.

Professor R C Jennison with the Pilot Officer Norman Keith Adams prize.



Pat Hawker, G3VA, accepted the Benet trophy on behalf of C W Horrabin, G3SBI.

The Wortley-Talbot Trophy for outstanding experimental work in amateur radio was presented to Ian Keyser, G3ROO, for his *RadCom* article: 'An easy-to-set-up Amateur Band Synthesiser' (December 93).

The Fraser Shepherd Award for research into microwave radio communication was awarded to A Horsfall, G4CBW and D B Hall, G8VZT.

The Pilot Officer Norman Keith Adams Prize for the most original article published in *RadCom* went to Professor R C Jennison, G2AJV, for his article 'The G2AJV Toroidal Antenna' (April, May 94).

The Courtney-Price Trophy for the most outstanding published technical contribution to amateur radio in published in *RadCom* was awarded to Mr J Hollingworth, ZF1HJ, for 'The new HF data mode - Clover 2'.

The Bennett Trophy for significant contribution or innovation which furthers the art of radio communication was awarded to Mr C W Horrabin, G3SBI for his work on receiver mixers, crystal filters and low noise oscillators (reported in *Technical Topics*).

The Calcutta Key for outstanding service to international friendship was awarded to Tim Hughes, G3GVV. ♦

Technical Update

HF/VHF VEE BEAM DESIGN AND PERFORMANCE, MAR 95

WE HAVE RECEIVED the following letter from P L Stride, G2BUY, regarding the article on HF/VHF Vee Beam Design and Performance by Richard A Formato, K1POO.

"The HF Link Geometry section of this article contains a number of obvious misconceptions.

"Fig 6 shows all the ionospheric layers at a common altitude rather than at the correct levels of about 60km for D, 120km for E, 250km for F1 and 300/500km for F2. It is also inferred that the D layer contributes to the returning signal whereas it only introduces attenuation. In practice, only the F2 layer is important in long distance paths above about 2000km.

"The text and Fig 7 refer to the use of the '4/3 radius earth'. This concept was introduced to account for the increased ground range resulting from *atmospheric* refraction of higher frequency HF, VHF and microwave signals. It is not applicable to paths above about 1km and has no relevance whatever to ionospheric propagation. Amended figures for Chicago and New York are:-

Layer Height 500km		
Distance, km	Hops	Take-off Angle
6146	2	10.4°
5381	2	13.6°

Layer Height 300 km		
Distance, km	Hops	Take-off Angle
6146	2	3.8°
	3	11.3°
5381	2	6.2°
	3	14.0°

"The errors are only significant at low take-off angles.

"It would also have been interesting to know something of the origins of the computer programme on which the article is based and of any experimental verification."

The author replied:

"The purpose of Fig 6 is to illustrate the concept of virtual height and its importance in determining the range of take-off angles needed to support a particular link. Fig 6 is not intended to imply that the usual ionospheric layer model places all the layers at one height. Quite to the contrary, the virtual reflection height typically varies between 100 and 500km, which is why Fig 7 plots curves for virtual heights in this range. A good discussion of this topic is available in [1], Section 17.04.

"The 4/3 earth correction applies only to groundwave propagation, not to ionospheric paths. The communicated range plot in Fig 7. should therefore be replaced with the enclosed plot [shown on the right - *Ed*] which is computed for an actual mean spherical earth radius of 6371km. Reference [1] Section 16.07 is a good source of information for readers interested in atmospheric refraction effects.

"The antenna patterns were computed on a PC using a program that implements Dr M T Ma's sloping vee model described in [2], Section 6.1. Impedance bandwidth was experimentally verified on several antennas, and the measured VSWR results in Fig 11 are typical. Detailed pattern measurements have not been made. Several antennas were built and operated very successfully on links in Greenland, between Greenland and the USA, and between Christchurch, NZ, and Antarctica.

"[1] *Electromagnetic Waves and Radiating Systems*, Second Edition, Edward C Jordan and Keith G Balmain, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968.

"[2] *Theory and Application of Antenna Arrays*, M T Ma, Wiley-Interscience, John Wiley & Sons, New York, 1974."

LF MOBILE ANTENNA DESIGN, FEB 95

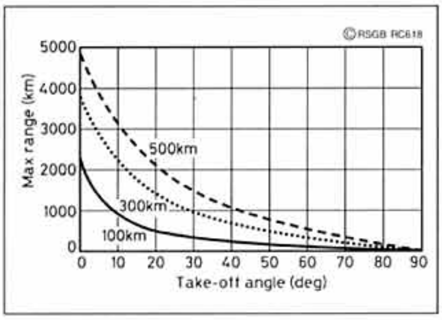
WE HAVE ALSO received a letter from P L Stride, G2BUY, regarding the article on LF mobile antenna design, R Bearne, G4DUA

"On the first page in discussing radiation resistance, the author first quotes a formula then continues with two examples which are incorrect. The correct figures are 0.0658 and 0.148 respectively. However, the correct values do subsequently appear in Table 3.

"In discussing antenna capacitance the author quotes a formula which is plainly incorrect as it fails to pass the simple test of Dimensional Analysis. It is clear that the numerator should contain the variable h representing the antenna length. Comparison with similar formulae in related fields indicates that the expression in square brackets should appear as a denominator not as a numerator. With these changes the expression comes close to the right answers but still does not reproduce the figures given in Table 3. A minor adjustment to the numerical constant does reproduce the Table 3 figures. The corrected formula then reads:

$$"C_a = 2 \pi E_o h / (\ln(h/a)-1.7)$$

"This is in reasonable agreement with the formula given in Terman's *Radio Engineers Handbook* which I believe to be essentially correct.



"In the discussion on skin effect the variable omega is said to represent frequency in radians, this is incorrect it should read radians per second.

"In the discussion on maximising coil Q the author correctly quotes Butterworth's criterion of. Coil Diameter = 8/15 x coil length.

"The author then misinterprets this as '2:1 diameter to length ratio' whereas it should be interpreted as 2:1 length to diameter ratio! ie Butterworth is telling us that the coil should ideally be longer than it is wide - a fact which is generally recognised by those who have experience in this field. This is plainly not a simple slip as the subsequent coil design is based on this incorrect premise where the coil diameter is 75mm and the length is 40mm.

"There is a presentational error in Table 3 in that the first two columns have become conjoined and therefore read as nonsense. The correct presentation is as follows:

Antenna Length	Radiation Resistance
0.5	4.11E-03
1	1.64E-02
1.5	3.70E-02
2	6.58E-02
2.5	1.03E-01
3	1.48E-01

"In this table in order to calculate the antenna efficiency a figure has been assumed for earth loss resistance but its value to has not been declared. Investigation reveals this assumed figure to be 5 ohms - about half the figure which the author ascribes to his system later. The remaining figures in Table 3 appear to be correct with the exception of the relative gain figures which I am unable to reconcile with the associated efficiencies. For example taking the reference as 0.5m with a coil Q of 200 for which the efficiency is 0.01 compared with a 1m antenna of efficiency of 0.04 implies a power gain of 4 times corresponding to 6dB, yet the table gives a figure 8.07dB! Maybe there is a hidden rounding up error in the reference figure in the spreadsheet program which accounts for this discrepancy. This also impacts upon the graph shown in Fig 2.

"In the penultimate paragraph the author claims his coil measured 380mH (millihenries) but this should be 380 microhenries. This is significantly greater than the calculated value which appears in Table 3 as 318 microhenries. [This was not the author's fault, see note below-*Ed*]

"On a philosophical note, although the realisation of high Q is an important parameter in antenna efficiency which cannot be denied I believe another important parameter is low self capacitance associated with the loading coil since this acts to divert current from the whip radiator. This may account for why the very long coils favoured by the commercial manufacturers have proved to be so successful.

"The author makes a case for the use of Litz wire (or bunched conductors as it is now called) to obtain high Q and this reminds me

CONTINUED ON PAGE 80

CONTEST CLASSIFIED

All rules should be read in conjunction with the General Rules published in *Contest Classified*

DIRECTION FINDING RESULTS

SOUTHGATE VHF FOXHUNT

This year's 2m DF Hunt, held as ever on August Bank Holiday Monday, attracted teams from five clubs (Southgate, Verulam, Silverthorn, Cambridge and Swansea), which set a new record.

Two double DF Hunts were arranged (1400 - 1600 and 1700 - 1900), with G7HJA as the 'easy' fox, and G4KZD as the 'difficult' fox on each hunt.

In the first hunting period G7HJA was seated at the edge of a field in Whitewebbs Park and was found with relative ease by just about everyone. The opposite was true of G4KZD, who was extremely well buried somewhere between the water tower and Cockfosters Road in Trent Park. Only three teams managed to find him, and it took each of them a long time to do so.

After the break, the second hunt commenced. This time G7HJA was found sitting by one of the lakes in the grounds of Forty Hall, while G3KZD was once again in thick undergrowth, this time alongside the edge of Whitewebbs golf course.

As soon as the final hunt ended, everyone QSYed as quickly as possible to The Spinney for the announcement of the results and the post DF Hunt barbecue. Predictably our Welsh friends won again, but this time not by a very large margin. Unfortunately neither novice team had the confidence to hand in their entry form, so no winner can be declared for this section.

Post	Team member(s)	Transmitters				Total
1	GW1XBG/GW1DTA	14.26	15.32	17.34	18.20	248
2	G4DFB	14.26	-	17.33	18.14	227
3	G3UUT & Family	14.31	-	18.20	17.38	211
4	G3JKS, G0ODS, G0SNO, J Lauder	14.44	-	17.39	18.20	197
5	G3ZVW, G0NMC, B Neal	14.44	-15.55	18.35	18.20	146
6	2E1BFL, C Wood G0MEE, A Evans	14.19	15.58	18.54	18.30	139
7	G0ULI	14.28	-	18.15	18.59	138
8	G7COQ, G Raxworthy	16.00	-	-	18.59	1

ARDF RULES

FOREST OF DEAN VHF ARDF WEEKEND

An informal weekend of direction finding is once again being organised by the Swansea DF Group under the auspices of the RSGB. The aim is to promote interest in 2m 'foxhunting' and encourage inter-club and national competition. It will take place in the Forest of Dean. A local camp site is available: details from GW1BXG.

Dates: 8 and 9 July 1995.

Times: Saturday 1030 - 1400 and 1600 - 1930, Sunday 0930 - 1300BST - all double foxes.

Maps: Outdoor Leisure 14 - 1:25000 Wye Valley and Forest of Dean; or Landranger 162 - 1:50000, Gloucester and Forest of Dean.

Anyone requiring directions on Friday should give a call on 144.725MHz. On Saturday night it is intended to have a BBQ and a few drinks and maybe a portable hunt around the campsite.

Details from Phil Smith, GW1XBG, tel: 01792 642001.

WALSALL AMATEUR RADIO CLUB NATIONAL VHF EVENT (2 METRES)

Please note that the start location for this event (on 4 June 1995) as given in May 1995 *Contest Classified* should read: the Greyhound public house car park, on A50 in the village of Boundary.

SOUTH MANCHESTER QUALIFYING EVENT (TOPBAND)

Date: 11 June 1995

Map: 118 (Stoke on Trent)

Assembly: 1300 for start at 1320.

Location: Picnic area on B5082, 5 miles SE of Northwich, NGR 732709.

Competitors requiring tea should notify Chris Plummer, tel: 01782 514630 no later than 3 June.

HF RULES

RSGB SSB FIELD DAY 1995

1. The **General Rules** for RSGB HF Contests, published in the January 1995 issue of *Radio Communication* will apply. This is a 'Portable' contest.

2. **When:** 1500UTC 2 September to 1500UTC 3 September 1995.

3. Sections:

(1) Open: Maximum licensed power. Equipment: one transmitter and one receiver or one transceiver, PLUS an additional receiver if desired. No antenna restrictions.

(2) Restricted: Maximum of 200W pep **input power**. Equipment: one transmitter and one receiver, or one transceiver - no additional receiver. Antenna: Only one antenna may be used, which must be a single element (eg dipole, longwire, W3DZZ, trapped vertical) having not more than two elevated support points. No part of the antenna may be more than 15m above ground level.

Entrants in both sections may keep standby equipment on site, but it may not be connected to a power source or antenna at the same time as the main equipment.

4. Contacts: SSB only in the 3.5, 7, 14, 21 and 28MHz bands. Please note that the 10-minute QSY rule has been deleted.

5. Exchange: RS plus serial number starting from 001.

6. Scoring: For each complete QSO with:

(a) a fixed station in IARU Region 1 2 points

(b) a station outside IARU Region 1 3 points

(c) a /P or /M station in IARU Region 1 5 points.

IARU Region 1 countries include those in Europe, Africa, USSR, ITU Zone 39 and Mongolia. For a more precise definition refer to the RSGB Amateur Radio Operating Manual.

7. Multiplier: ONE for each DXCC Country worked on each band.

8. Final Score: The final score is given by the total number of QSO points earned on all bands added together, multiplied by the total number of multipliers worked on all bands added together.

9. Logs must be addressed as per General Rules, and postmarked not later than the Monday **22 days** after the end of the contest. Please don't forget (i) Separate logs for each band, (ii) the list of Multipliers worked for each band and (iii) Alphabetically sorted dupe sheet of callsigns worked.

10. Awards: The leading station in the open section will receive the Northumbria Trophy. The leading station in the restricted section and the second- and third-placed entrants in both sections will receive certificates of merit. A certificate will also the awarded to the station in each continent submitting the highest-scoring checklog.

21 / 28MHZ SSB CONTEST 1995

1. **The General Rules** for RSGB HF Contests *(RadCom Jan 95)* apply. ***Entrants are reminded that stations using packet or other spotting facilities must enter as multi-operator stations.***

2. Eligible entrants: Overseas (inc EI), UK.

3. When: 0700 - 1900UTC, Sunday 1 October 1995.

4 Sections: (a) UK **(b)** Overseas **(c)** UK Receiving **(d)** Overseas Receiving.

Single operator and Multi-operator entries accepted in transmitting sections.

5. Frequencies / Mode: 21150 - 21350kHz and 28450 - 29000kHz, SSB only.

6. Contest Exchange: RST and serial number, commencing with with 001. UK stations must also send their County Code.

7. Scoring:

(a) UK stations work only Overseas stations, 3 points per QSO. Multipliers as per General Rules.

(b) Overseas stations work only UK stations, 3 points per QSO. Multipliers: 1 for each UK County worked on each band. **NOTE:** *The same station may be contacted on both bands for QSO points and Multipliers.* **Total Score:** The number of QSO points on each band are added together. The total number of multipliers on each band are added together. The final score is the total QSO points multiplied by the total multipliers.

8. Logs: Separate logs are required for each band. Overseas entrants may use the stationery provided by their National Society. UK entrants see General Rules.

9. Address for logs: RSGB HF Contests Committee, c/o G3UFY, 77 Bensham Manor Road, Thornton Heath, Surrey CR7 7AF, England.

10. Closing date for logs: UK entrants, postmarked by 1 November 1995. Overseas entrants, delivered by 1 December 1995.

11. Awards:

Section a: The Whitworth Trophy to the UK single-op winner. The Powditch Transmitting Trophy to the leading single-op entry on 28MHz. Certificates of Merit to the 2nd and 3rd placed entrants overall and on each band.

Section b: Certificates of merit to the three leading entrants. Subject to the decision of the RSGB HF Contests Committee, additional certificates may be awarded to the leading entrants from each continent / country.

Multi-operator entries: Certificates of Merit to the leading groups in each section.

RECEIVING SECTION

Rules as for the transmitting sections except where specified below. Holders of transmitting licences for frequencies only above 30MHz may enter the receiving section.

7. Scoring: UK SWLs log only Overseas stations in contact with UK stations participating in the contest. Overseas SWLs log only UK stations in contact with Overseas stations participating in the contest. Scoring and multipliers as for the transmitting sections.

8. Logs: Columns to be headed: time UTC; callsign of station heard; report / serial number sent by that station; County Code sent by that station (if applicable); callsign of station being worked; multiplier (if new); points claimed.

NOTE. In the column headed 'station being worked' the same callsign may only appear once in every three contacts except when the logged station counts as a new multiplier.

11. Awards (At the discretion of HFCC, dependant upon the level of support.) The Metcalf Trophy to the leading UK entrant. The Powditch Receiving Trophy to the leading UK entrant on 28MHz. Certificates of Merit to the leading 3 entrants in each section, and the leader from each overseas country.

21 / 28MHZ CW CONTEST 1995

1. The **General Rules** for RSGB HF Contests (*RadCom* Jan 95) apply. **Entrants are reminded that stations using packet or other spotting facilities must enter as Multi-operator stations.**

2. Eligible entrants: (a) UK, (b) Overseas, (c) UK Receiving, (d) Overseas Receiving. Single or Multi-operator entries accepted in the transmitting sections.

3. When: 0700 - 1900UTC, Sunday 15 October 1995.

4. Sections: (a) UK **(b)** Overseas **(c)** UK QRP **(d)** Overseas QRP **(e)** UK Receiving

(f) Overseas Receiving. QRP stations may use 10W RF OUTPUT or less.

5. Frequency / Mode: 21 and 28MHz bands, CW only. Entrants are requested not to operate in the sub-band 21.075 - 21.125MHz.

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of the time many years ago when I was required to investigate this technique as part of my commercial activities. I recall that after obtaining some very anomalous results I discovered that the Q could be doubled by prebaking the winding at 150°c. This drives out the moisture reducing dielectric loss associated with the insulation and confirms that the capacitive current plays an important part in the overall loss. It follows also that keeping the coil protected from moisture is also very important and may militate against the use of this type of wire for the mobile application."

The author replied:

"Paragraph 2. Agreed that the radiation resistance figures in the text are typos, the correct values are in Table 3.

"Paragraph 3. The antenna capacitance formula in the text is a typo as observed.

"Paragraph 4. Obviously omega is frequency in radians per second.

"Paragraph 5. Although there is a typo 'diameter to length ratio' best results were obtained with a short coil of large diameter, which I believe to be due to the reduced winding loss because less wire is necessary.

"Table 3. Agreed there is a typo on the first two columns of the table. The gain figures are different because of the truncation of some figures to simplify the table.

"Paragraph 12. The values of inductance used in Table 3 were just examples and were not related directly to the values used in the real antenna.

"In response to the philosophical comments, I believe that short coils are more effective because of the reduced winding length required to meet the required inductance. Self capacitance is covered in my article by explanation of proximity effect and the use of Litz wire obviously requires the coil to be kept dry because of the cotton covering used on this type of wire.

"In general there were a few useful comments in this letter but most of the content was over critical in extreme."

[Note: We have had some minor teething problems with Greek symbols and our new typesetting software. This has resulted in µ (micro) changing to m (milli) and Ω (ohm) changing to W (watts). We are aware of the problem and are taking steps to prevent these errors appearing in print - *Ed*]. ♦