The UK wavelength changes

Long- and medium-wave broadcasting from November 23

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Many readers will have heard already of the impending changes to the frequencies used for BBC services in the l.f./m.f. sound broadcasting bands. This article gives the reasons for the changes, which stem mainly from increased demands for frequencies from other countries. A great many of these demands were written into the 1975 Geneva Plan (see January 1976 issue, p.42) which comes into effect this year on November 23rd. The author first gives the historical background and then explains in detail the BBC's reasons for its choice of the frequencies to be used for Radios 1, 2, 3 and 4 and the External Services and the effect on the transmitter network.

THE LOW FREQUENCY broadcast band extends from 155 to 285 kHz and the medium frequency band from 525 to 1605 kHz, although at present 255-285 kHz is not available for broadcasting in Western Europe. With 9kHz spacing between carriers, there is room for only 15 channels on l.f. and 120 on m.f. In the early days of radio broadcasting this would have been sufficient to assign exclusive channels to individual transmitters, but as the number of broadcasting stations in Europe increased in the 1920s an element of channel sharing became inevitable. Ever since then, periodic conferences have been necessary to regulate the use of frequencies for broadcasting by the various stations and countries. Thus we had a Geneva plan in 1926, a Prague plan in 1929, Lucerne in 1934, Copenhagen in 1948 and recently Geneva again in 1975. There was also a Montreux plan in 1939, but this was never implemented.

The latest Geneva Conference was by far the largest of its kind, because it embraced not only the European area, but the whole of Africa, Asia and Australasia as well. There are good reasons for having a single plan for the whole of this area. At present, for instance, Europe and Africa use mainly 9kHz channelling, but Asia and Australasia use 10kHz, so inevitably there are areas where heterodyne interference occurs between stations operating on the different channelling standards. This article will be concerned mainly with l.f./m.f. broadcasting in the 'European area', which in addition to Europe includes much of North Africa and the Middle East.

The recent Geneva Conference was long overdue. The Copenhagen plan made provision for 620 transmitters having a combined power of 20MW; by the end of 1976 the number of transmitters in the European area had grown to 1450 and the combined power had increased to 82MW. Mutual interference between stations has grown steadily worse and, due to the increased range of interfering signals after dark, the night-time service range obtained is in many cases only a fraction of that achieved in day-time. A crucial factor in l.f. and m.f. planning is, of course, this difference between day- and night-time propagation. Day-time reception depends almost entirely on the ground wave, which falls off in a predictable way and enables several high power stations to use the same channel without mutual interference. At night-time (and in some cases during the winter day), the signals are propagated over much greater distances by ionospheric reflection, giving rise to significant field strengths at distances up to a thousand or more miles. Although we use the terms day-time and night-time, the transition from one condition to the other is a gradual one, and in northern latitudes, night-time conditions apply during the mid-winter period to a substantial part of the working day, between about 1500 hours one day and 1000 hours the next (including the important period around breakfast time).

At earlier conferences the planners were most concerned with night-time conditions because it was during the evenings that audiences were at their largest. This situation has changed in the last 20 years, and television now claims the mass audience during the evenings, whilst radio's largest audiences normally occur in the day-time. Nevertheless, a significant number of people still listen to the radio during the evening hours, and in the United Kingdom this is typically around 1 million; there are also very large audiences during the morning and early evening periods.

November 23 — Principal new BBC frequencies

Radio 1	1053 kHz	285 metres
	1089 kHz	275 metres
Radio 2	693 kHz	433 metres
	909 kHz	330 metres
Radio 3	1215 kHz	247 metres
Radio 4	200 kHz	1500 metres

(With m.f. supplements in Aberdeen, Carlisle, Tyneside, Ulster and parts of South-West England).

The Geneva conference

This was held under the auspices of the International Telecommunication Union, in two sessions. The first session in 1974 was intended to settle the technical standards to be adopted; the second in 1975 prepared the frequency assignment plan. Some 100 countries were represented at the second session and the delegations were from governments, not broadcasting authorities. Thus the United Kingdom delegation was led by the Home Office, although senior engineers from both the BBC and IBA were included.

The consideration of technical standards was, of course, a long and detailed one, but the main decisions taken in the first part of the conference were these:

1. 9kHz channelling to be used throughout, with all carrier frequencies in the m.f. band to be multiples of 9. Some European countries, including the UK, and supported by the European Broadcasting Union, would have liked to change to 8kHz spacing, to provide more channels; but others, mainly in Asia, would have preferred to retain 10kHz. The adoption of 9kHz was, therefore, a compromise between these views.

Figures were also established for the minimum field strengths needed to provide a satisfactory service, depending on the geographical area and the frequency used.

2. The protection ratio adopted as providing a just acceptable standard of reception was taken as 30dB. This is the ratio between the strength of the (non-fading) wanted signal and the strength of interfering signals on the same frequency. A different figure is used for adjacent channel interference, but in considering the repercussions of the

Geneva conference, this is not a major factor.

Countries were asked to submit, in advance of the 1975 session, a list of their estimated needs to cover the period from 1978 to 1989, with details of frequencies, transmitter sites and powers.

In the early post-war years the UK already had a well developed broadcasting service, and at the time of the Copenhagen conference in 1948 enjoyed a rather privileged position in European broadcasting. The situation was quite different for many of the other states represented at the Geneva conference; in 1948 they were either not in existence or else had only a rudimentary broadcasting system. It was, therefore, to be expected that these countries would submit quite legitimate claims for increased frequency assignments. For the UK, however, the Home Office decided only to submit claims for those frequencies and power levels which are already available to the UK, together with a modest claim for additional low power assignments to allow for some future development of local radio.

At the 1975 session the proposals which had been submitted by the different countries were listed so that a study could be made of all the incompatibilities, that is to say, instances where one transmitter could be expected to create an unacceptable level of interference in the service area of another. A large computer programme was used to provide an estimate of the minimum usable night-time field strength, for every transmitter, i.e., the field strength which would be needed in order to provide a 30dB margin over the sum of the interfering co-channel signals. In the absence of interfering signals, a field strength of 1 or 2 mV/m may be quite adequate for satisfactory reception. In the presence of night-time interference, a much greater field-strength — say 20 or 30 mV/m — may be needed to provide the 30dB margin. Thus the effective coverage obtained from any transmitter is usually much less at night-time than during the day. Some, but by no means all, of the most obvious incompatibilities were resolved by direct negotiation between the two countries concerned. Nevertheless, it had to be accepted that, with the considerable increase in both the number and power of transmitters, there would inevitably be an increase in the usable field strength values in many cases, leading to a reduction in night-time coverage.

In the final outcome most of the original submissions were written into the plan, and many countries were therefore able to obtain a considerably increased number of frequencies; to what extent these will actually be taken up, time alone will show. In the European area, the plan includes some 2700 transmitters, with a total power of 214MW, an increase of almost 2:1 in the number of transmitters, and almost 3:1 in total power, over the 1976 situation.

So far as the United Kingdom is concerned, all of its existing frequencies, including 13 high power m.fs and one high power l.f. were retained, most of the m.fs with a change of just 1kHz, to conform to the new channelling plan. The United Kingdom also gained the right to use an additional l.f. channel – 227kHz – at medium power, although this is shared with a 2MW transmitter at Warsaw. Some additional low power assignments were also obtained, to provide for the future development of local radio. There are of course, no exclusive frequencies in the new plan, and many of the usable field strength figures for

Radio 2 distribution. The map shows which frequency is most likely to provide satisfactory reception in any particular area. Although a signal should normally be audible in the day-time, the areas of satisfactory reception at night-time will be much more limited than those shown.

night-time are appreciably higher than at present. They range from about 8mV/m at best to over 100mV/m in the worst case, the average being around 20mV/m. The inevitable result is that when the new plan is fully implemented, most transmitter service areas will shrink quite drastically at night-time, as compared to the day-time situation, and many listeners will suffer from increased interference to their m.f. reception.

The UK channels on which high power is permitted are shown below, together with the programme services for which they have been used until November 1978:

Frequency (kHz)*	Programme service
200 (200)	Radio 2
647 (648)	Radio 3
692 (693)	Radio 4
809 (810)	Radio Scotland
881 (882)	Radio Wales
908 (909)	Radio 4
1052 (1053)	Radio 4
1088 (1089)	External Services
1151 (1152)	Independent Local Radio
1214 (1215)	Radio 1
1295 (1296)	External Services
1340 (1341)	Radio Ulster
1457 (1458)	BBC Local Radio
1546 (1548)	BBC and Independent Local Radio

*Frequencies after Nov. 23, 1978 shown in brackets

For the BBC it was necessary to consider very carefully its future plans for l.f./m.f. broadcasting. It would have been possible to leave the main networks substantially as they were; but this could have led to a reduction in coverage at night-time, affecting most services, but especially serious in the case of Radio 3. It was therefore decided to study the possibility of devising a better way of using the frequencies available, in order to overcome the increased interference so far as possible, and also to take account of certain changes which the BBC had considered desirable for some years.

Firstly, Radio 4. In the last few years we have seen the development of local radio in England, and national services in Scotland, Wales and Northern Ireland, known as Radio Scotland, Radio Wales, and Radio Ulster respectively, each including an increasing proportion of locally produced programmes. At the same time Radio 4 has developed as the BBC's main channel for news and information, leading to the concept of a Radio 4 national UK service, which could provide an alternative both to local radio in England, and to Radio Scotland, Radio Wales and Radio Ulster in those countries. The most satisfactory way of realising this concept is to transfer Radio 4 to l.f., with additional transmitters in Scotland to extend the existing coverage on long-wave.

Secondly, it is hoped to improve the coverage of Radio 1. This is one of the most popular services, yet it has had since its inception only one m.f. channel and no v.h.f. — apart from the limited use of the Radio 2 v.h.f. network. It is not, unfortunately, possible to provide complete coverage with only one medium frequency, even in the day-time. As an additional v.h.f. network is not practicable at present, two medium frequencies will be used for Radio 1, which will enable a substantial improvement to be made to both the day- and the night-time coverage.

The night-time interference level on 648kHz can be expected to increase very considerably in the new plan, and the value of this frequency for Radio 3 would, therefore, be much reduced. It is, however, a valuable frequency, which can be used more effectively by the External Services, using high power and a directional aerial system, to provide a mainly day-time service to much of northern Europe. This frequency was therefore exchanged for 1089kHz, which will be used for Radio 1.

The existing frequencies for Radio Scotland, Radio Wales and Radio Ulster will remain unchanged, although if all the Geneva plan assignments are taken up it may be necessary to increase the power of some of the transmitters concerned to maintain the night-time coverage. Similarly, the frequencies used for local radio — 1458kHz (BBC), 1152kHz (ILR) and 1548kHz — are not affected by the proposed rearrangements. This leaves five frequencies — 693, 909, 1053, 1089 and 1215 kHz — to provide the coverage required for Radios 1, 2 and 3. Two will be used for Radio 2 (693 and 909), two for Radio 1 (1053 and 1089) and one for Radio 3 (1215). The final list of BBC high power channels from Nov. 23 therefore, works out as follows:

Frequency (kHz)	Programme service
200	*Radio 4*
648	*External Services*
693	*Radio 2*
810	Radio Scotland
882	Radio Wales
909	*Radio 2*
1053	*Radio 1*
1089	*Radio 1*
1215	*Radio 3*
1341	Radio Ulster
1296	External Services
1458	Local Radio (BBC)

Programme services in italics represent a change of use.

The only major change which has been found necessary to the original plan concerns the use of 227kHz. It was intended to use this frequency for Radio 4 in Central Scotland, as well as 200kHz at Droitwich in the Midlands and Burghead in the North of Scotland. It was always recognised that interference from Warsaw, also on 227kHz, would be a problem under night-time conditions, and small m.f. transmitters were, therefore, proposed for Edinburgh, Glasgow, Dundee and Aberdeen. To check the interference situation, a series of measurements were made during 1976/77, and these showed that the CCIR propagation curves which had been used in planning the use of 227kHz were not valid for this particular path, particularly for day-time conditions in winter. It was found that the Warsaw signals were appreciably stronger than expected, and as a result the service area achieved with 227kHz would have been extremely restricted, except during the day-time in the summer. This would not be an acceptable situation and further studies showed that much better overall coverage could be achieved by synchronising all three transmitters (Droitwich, Westerglen and Burghead) on 200kHz. On this channel much lower field-strengths can be used, so a greater night-time coverage is possible; but, of course, the advantage of using two different frequencies is lost. With a single frequency, an area of unsatisfactory reception is created between adjacent transmitters in those areas where the field strengths from two transmitters are similar.

In the case of 200kHz, these areas will fall across the border country and the central Highlands of Scotland. The main population centres which could be affected are Aberdeen, Carlisle and Newcastle, and low power m.f. transmitters will be provided for those places. To reduce the effect of interaction between geographically adjacent transmissions, the 200kHz carriers will be phase locked and the timing of the audio modulation will be adjusted so that the total delay over the two paths will be as nearly equal as possible. In many places within these so called 'mush' areas, it will be possible to use the directional properties of ferrite rod aerials to favour one transmission relative to the other, and therefore improve the standard of reception. With the use of 200kHz at Westerglen, the provision of m.f. transmitters at Glasgow, Edinburgh and Dundee became unnecessary.

It should be noted that each of the networks to be used is a completley new one, except for that of 1214/1215kHz, which will be transferred almost unchanged form Radio 1 to Radio 3. The total numbers of transmitters and the total powers are as follows:

Service	No. of trans.	No. of freq.	Total output power (kW)
Radio 1	24	2	759
Radio 2	24	2	625
Radio 3	18	1*	271
Radio 4	13	1 l.f. + 8 low power m.f.	522

*Plus one or two very low-power transmitters on 1197kHz.

Local radio

Most of the m.f. channels used by the 20 BBC local radio stations will only be changed by 1 or 2kHz. In three cases, however, larger changes are involved, and these are: Radio Leicester moves from 1594 to 1584kHz. Radio Solent (Bournemouth area transmitter) changes from 1594 to 1359kHz. Radio Leeds moves from 1106 to 774kHz. This last change is necessary because the original frequency is only two channels away from 1089kHz, which is to be used for Radio 1 in the same area.

Re-engineering the network

The BBC's existing m.f./l.f. network has been built up over many years, and there are a number of old installations — dating in some cases from the 1930s — which are inefficient in terms of both power consumption and maintenance effort. A programme of modernisation was clearly overdue, but was deferred until the results of the Geneva conference were known.

The plan described above requires a complete re-organisation both of the sound distribution network and the transmitter system. To implement the changes which are needed by November 23rd, 38 new transmitters have to be installed, in addition to 24 new masts and 28 multi-frequency aerial systems; 70 more transmitters will be replaced during the next few years. It has been decided to standardise all transmitters, with output powers of 1, 10 or 50kW, and these can be used singly or in groups to provide powers of 1, 2, 10, 20, 50, 100 or 150kW. Nearly all the transmitters will be operating in synchronised groups, and the power levels and aerial directivities have been carefully planned to provide the maximum coverage.

Several stations will be carrying 3, 4 or even 5 services, and an interesting example is Burghead in the North of Scotland, which will be carrying Radio 1 on 1053kHz, Radio 2 on 693kHz, Radio 3 on 1215kHz, Radio Scotland on 810kHz and Radio 4 (UK) on 200kHz, with powers ranging from 20 to 100kW. The l.f. service will be transmitted from a T aerial suspended from two 500-ft masts, and each of these masts, in addition to supporting the T aerial, will act as a mast radiator for two of the m.f. services. For maintenance or in an emergency all four m.f. services can be combined into one mast.

Effect of the changes

The effect of the changes will, of course, vary between the four services and also from one area to another. Taken overall, however, they should provide some improvements in coverage, and a very considerable improvement over the night-time coverage which would have been achieved if the changes had been confined to those required under the Geneva plan. Taking the coverage as the percentage of the population who should be able to obtain a satisfactory standard of reception (provided that a suitable receiver is used), the situation before and after the changes is summarised in the accompanying table.

Service	Before November 23, 1978			After November 23, 1978		
	Frequencies (kHz)	Coverage % Day	Night	Frequencies (kHz)	Coverage % Day	Night
Radio 1	1214	87	38	1053 & 1089	96	55
Radio 2	200	98	83	693 & 909	98	65
Radio 3	647	92	71	1215	87	38
Radio 4	692, 908 & 1052	99[1]	75[1]	200*	98[2]	91[2]

*Plus 9 low-power m.f.

[1] England only
[2] United Kingdom

It will be seen that Radio 1's coverage is increased appreciably both by day and by night, as well as that of Radio 4. The day-time coverage for both Radio 2 and Radio 3 is maintained at a nearly identical level. Night-time coverage for these networks will be less than at present, but these are in the main music services, and a high proportion of listeners can be expected to use the high-quality stereo (or mono) version which is available on v.h.f.

There are, of course, considerable problems in introducing such wholesale changes, and a concerted publicity campaign is being mounted to help and guide listeners in finding the new frequencies. Problems will undoubtedly arise, not least the number of receivers without the long wave band (about 10% of the total number of sets in use) and the fact that after the changes the markings on many tuning scales will show the wrong programmes. This situation will correct itself gradually as new sets come into use; many imported receivers already have scales marked in kHz without any station names. Those who for some reason do not hear of the changes, and tune to their accustomed place on November 23rd, will in all probability still find a BBC programme, though it may not be the one they expect to hear — who knows, some new horizons may be opened.

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Transmitters to be used for Radio 1

1053kHz (285m)

Station	Power (kW)
Barnstaple	1
Barrow	1
Bexhill	2
Brighton	2
Burghead	20
Droitwich*	150*
Dundee	1
Folkestone	1
Hull	1
Londonderry	1
Postwick*	10
Stagshaw	50
Start Point	100*

1089kHz (275m)

Station	Power (kW)
Brookmans	150*
Fareham	1
Lisnagarvey	10
Moorside Edge	150*
Redmoss	2
Redruth	2
Tywyn	1
Washford	50
Westerglen	50*
Whitehaven	1

1485kHz (202m)

Bournemouth	2

*Directional aerial

Transmitters to be used for Radio 2

693kHz (433 metres)

Station	Power (kW)
Barrow	1
Bexhill	1
Brighton	1
Burghead	50
Droitwich	150
Exeter	1
Folkestone	1
Plymouth	1
†Postwick	10*
Redmoss	1
Stagshaw	50

909kHz (330 metres)

Station	Power (kW)
Bournemouth	1
Brookmans Park	140
†Clevedon	50*
Fareham	1
Guernsey	0.5
Jersey	1
Lisnagarvey	10
Londonderry	1
Moorside Edge	100
Redruth	2
Torquay	1
Westerglen	50
Whitehaven	1

†Initially Clevedon and Postwick will be restricted to 20 and 2 kW respectively.
*Directional aerial

Transmitters to be used for Radio 3

1215kHz (247m)

Station	Power (kW)
Brighton	1
Brookmans Park	50*
Burghead	20
Droitwich	30*
Fareham	1
Hull	0.15
Lisnagarvey	10
Londonderry	0.25
Moorside Edge	50*
Newcastle	2
Plymouth	1
Postwick	1
Redmoss	2
Redruth	2
Tywyn	0.5
Washford	60
Westerglen	40*

1197kHz (251m)

Station	Power (kW)
Cambridge	0.2

*Directional aerial

Transmitters to be used for Radio 4 (UK)

Station	Power (kW)
200kHz (1500m)	
Burghead	50
Droitwich	400
Westerglen	50
720kHz (417 metres)	
Lisnagarvey	10
Londonderry	0.25
603kHz (498 metres)	
Newcastle	2
1449kHz (207m)	
Redmoss	2
1485kHz (202m)	
Carlisle	1