SENNHEISER UK LTD
3 Century Point
Halifax Road
High Wycombe
Bucks HP12 3SL

Tel: 01494 551 551
Fax: 01494 551 550

04 April 2002

Digital TV Switchover

In its consultation document *Digital Television: The Principles for Spectrum Planning*, the Government invited contributions on how best to use the spectrum released following the change to digital broadcasting. The consultation document barely acknowledges (para. 4.4) that this spectrum is also used within theatres, and by broadcasters and other programme makers for radio microphones and other sound links, and completely ignores the use of radio microphones for live music, corporate events, film and video production and many other purposes. There is no indication in the consultation document of the vital importance of this spectrum for these applications, and of the huge contribution to the British economy that this use of the spectrum makes.

The purpose of this contribution is to indicate how vital this "hidden", secondary use of the band IV & V "broadcast" spectrum is to many industries and, of course, to Sennheiser UK Ltd. in particular.

As the leading supplier of radio microphones and in ear monitoring (IEM) equipment in the UK we are in a position to give some indication of the volume of equipment likely to be affected by any decisions on the future of bands IV & V. During the period January to December 2001 alone, Sennheiser UK Ltd sold a combined total of over 13,000 radio microphone and in ear monitor transmitters, and a similar quantity of receivers. The typical, ex VAT, professional user cost of a single Sennheiser UHF radio microphone "system" (i.e. one transmitter & one receiver) ranges from £280.00 per system for the simplest up to £8,100.00 per system for the most sophisticated systems typically used by professional broadcast organisations and top musical theatre productions. We expect similar sales levels in this and future years. Whilst a proportion of the lower cost systems are sold with the expectation that they will be used in the de-regulated band from 863 – 865MHz, the vast majority are undoubtedly used on frequencies in channel 69 (854 – 862 MHz).

We believe that JFMG in their response to the consultation, entitled *Broadcast and Entertainment Production: Spectrum Requirements for Studio, Stage, Venue and Location,* have correctly identified the eventual "switchover" to digital terrestrial television and, more importantly, the ending of analogue television transmissions as "both a threat and an opportunity" for Programme Making and Special Events (PMSE). As the only organisation with access to the statistical information regarding licences issued in the UK for PMSE activities the importance of the input into this consultation process provided by JFMG must not be underestimated.

Given the level of radio microphones and IEM equipment sales that Sennheiser UK Ltd. has experienced in recent years we suspect that the licence statistics may not fully represent the true levels of actual usage of PMSE spectrum in the UK. While high profile

users such as major theatre productions and broadcast organisations are relatively assiduous with regard to radio licensing, the same can probably not be said for every user. We do include information regarding radio licensing in our radio product literature (contact information for JFMG in price lists and user manuals), and many of the telephone enquiries that we receive each day include questions about radio licensing, but we cannot ultimately force our customers to licence their equipment.

Threat

On the threat side it must be stressed, without wishing to sound melodramatic, that without suitable spectrum for PMSE there would eventually be no programmes for the Broadcasters to broadcast, on any technology platform, analogue or digital.

By "suitable spectrum" we mean spectrum which the currently available technology for PMSE activities can make use of. The technological development of professional equipment does move at a rapid pace, but not so rapid as the development of consumer technology where the customer base is potentially much larger. While the improvements in technology developed for consumer products do eventually (sometimes) permeate into professional equipment the effect is usually to improve the performance or reduce the size or cost, or a combination of the above, within the same parameters of spectrum usage. The equipment (radio microphones, radio talkback systems & In Ear Monitoring systems) which is being bought today, and much of that which is already in use, has a potential life span exceeding 10years[1] and represents a significant investment for the organisations (or individuals) which own and use them. They are unlikely to stop using them even if the radio spectrum which they utilise is no longer licensable for that purpose, at least that is, until the interference from the new user(s) of the spectrum renders the equipment useless, or some form of enforcement action is taken.

Radio microphones and In Ear Monitor systems have, on occasion, been accused by some outside the "entertainment" industry of being spectrally inefficient. It is a fact that the best of the current generation of equipment utilises the occupied bandwidth purely for the purpose of providing the levels of audio performance demanded by artists and producers, i.e. the end users. Most, if not all, development work in this field is aimed at improving the audio performance still further in order to keep pace with the improvements in other parts of the audio chain (i.e. mixing desks, loudspeakers, amplifiers, recording and editing equipment, etc.). Any equipment which was developed with the intention of being more spectrally efficient would have to satisfy the user base that there was no reduction, perceived or measurable, in the audio performance, as compared to the current technology, before standing even a ghost of a chance of achieving acceptance by the end users. Many technological so-called improvements actually turn out to be retrograde steps in their early manifestations when compared to the "mature" technologies they are intended to replace. The examples of digital radio microphones that have emerged so far follow this established pattern, being inferior to their analogue predecessors in operating range, signal to noise ratio and audio bandwidth. Even once market acceptance was achieved it would still take many years to effect a "changeover" because, as previously mentioned, the existing equipment base has plenty of life left in it and has cost it's owners a lot of money. Comparisons between radio microphones (or In Ear Monitors) and domestic radio

[1] We know of one major West End musical where a part of the radio microphone system includes some >15 year old Sennheiser equipment, of a type which has not been manufactured for the last ten years, yet is still used successfully for eight performances a week.

broadcast transmissions are inappropriate because the quality requirements for a contribution source are completely different from those required for a delivery system. For more detailed information on typical radio microphone system specifications, see Annexe A.

The economies of scale dictate that it is comparatively expensive to manufacture a product, or a variant of a product, which is only saleable in one relatively small market (e.g. the UK). Radio microphones are now manufactured for almost a “world market”, thanks to the fact that in most countries of the world one can use at least some part of the UHF spectrum known as bands IV & V. It is now possible for a live music tour to visit much of Europe with the same radio microphones thanks to the improvements in switching bandwidth of modern equipment. Similarly, outside broadcast units can travel to many (though by no means all!) parts of the world with the same equipment, without the need for costly re-engineering of radio equipment for every foreign trip.

Opportunity

The best option is for some of the spectrum cleared by the ending of analogue TV transmissions to be made available exclusively for PMSE. This would permit much greater mobility of equipment throughout the UK, reducing the number of variants of equipment required for touring theatre, outside broadcast units, film / video sound recordists, live music touring and corporate events users.

A change in the licensing regime towards the licensing of Access to spectrum rather than the licensing of transmitting apparatus also has many potential benefits. In particular allowing the development of new technologies without the necessity to adhere rigidly to specific technical parameters, so long as emissions are confined within a particular spectrum mask

Radio microphones and In Ear Monitors have proved to be highly capable of sharing spectrum with TV broadcasting. The relatively “static” nature of TV transmitters enables the geographic overlay method of frequency planning to be very successful. This method is unlikely to be of much use in enabling sharing with any other form of mobile service. One of the reasons for this is that many of the major users of PMSE are the broadcasters themselves and that they therefore have an interest in, and an appreciation of, the relationship between broadcasting and PMSE.

Similarly it is difficult to envisage any form of service involving mobile transmitters which could usefully share spectrum with broadcasting.

Independent users of PMSE spectrum have had to put up with many changes in frequency allocations over the last fifteen or so years. Previous consultations on spectrum planning have referred to the concept of "security of tenure" over frequency allocations. The digital switchover presents the opportunity to at last give PMSE spectrum users "security of tenure" over the frequency allocations they so badly need.

Interference

Professional users of radio microphones generally have a "zero tolerance" attitude to interference. Whereas patchy service and poor reception may be tolerated to some extent

by mobile communication service customers, any loss of reception within the "coverage area" of a radio microphone will not be tolerated by producers, performers or audience members. Even quite low level artefacts (typically described as "birdie noises") resulting from co-channel usage that might be deemed acceptable for domestic broadcast radio or television reception are regarded as unacceptable by professional radio microphone users. That it has been possible to meet these stringent operational requirements given the almost totally unprotected nature of PMSE licensing is testament to the high engineering standards which manufacturers and professional users of radio microphones have achieved.

Lessons from History

For those not familiar with the industry, a brief history of radio microphone usage in the UK in the last 20 years or so may be helpful.

Prior to the mid 1980's unless you were the BBC or an ITV franchisee there were only five radio microphone frequencies available to you in the UK. These were VHF frequencies between 173.8 MHz and 175.0 MHz and they are still available for radio microphones today. Of these five, only 3 or possibly 4 were capable of intermodulation free operation.

The broadcasters by comparison were relatively well served as they were permitted to use the vacated "band three" spectrum on spot frequencies administered by a self regulating group set up jointly by the BBC and IBA known as the Broadcasters Joint Frequencies Management Group.

Despite this restriction, many theatres, corporate events and live music events were using significantly more than three or four radio microphones on a regular basis.

A widely reported incident involving a new West End musical production[2] which suffered serious interference to its (rather more than five) radio microphones from a broadcasters high powered radio link at the opening performance started a gradual awakening at the DTI radio regulatory branch, and elsewhere, to the fact that the broadcasters were not the only people who needed to use radio microphones.

An organisation was formed, The Association of Service Providers (ASP), in an attempt to represent the non-broadcast users of radio microphones. This resulted eventually in the creation of a "Spectrum Management Organisation", ASP frequency Management Ltd., and the allocation of a number of spot frequencies in band three for use by independent "service providers" as well as various allocations in channels 22, 24 and 35 with various geographical restrictions. This enabled the major musical theatre productions in the West End and elsewhere, and many other users, to at last legalise their radio microphone usage. It also served to prove that users other than the broadcasters could be trusted to share spectrum with other users without causing interference to the primary users (i.e. broadcasters, radar, radio astronomy, MOD).

The cost to the various organisations involved in replacing the (largely illegal) VHF equipment that was the norm prior to this with the new UHF equipment was not insubstantial. Radio microphones were not a mass-market product and all were aimed at

[2] Starlight Express

professional users and priced accordingly. Some of the VHF equipment was capable of being re-tuned onto the newly available band three frequencies, but even this was not an inexpensive operation and also involved considerable upheaval for the owners and users, alternative equipment usually having to be found in order to maintain continuity of service while engineering work to re-tune equipment was being carried out. At this time almost all equipment was crystal controlled, and re-tuning was usually a lengthy process.

The relatively rapid transition to UHF was only possible because there were already in existence UHF radio microphone products manufactured for, and used in, other countries. Had the users all been required to wait until new product was developed to take advantage of this newly available resource, then it may never have been taken up, as the cost would have almost certainly been prohibitive.

The news that there was to be a fifth TV channel and that the relatively newly won UHF spectrum was to be "clawed back" for broadcasting some years later was therefore not terribly popular with the owners and users of radio microphones. However the industry had now become accustomed to almost entirely interference free multi-channel radio microphone usage, and so once again the not inconsiderable task of replacing or re-engineering the existing equipment on to frequencies in another part of the UHF band IV/V spectrum was undertaken. Thus a further sizeable expenditure was added to the investment already made by the industry in the existing equipment base. The birth of Digital Terrestrial Television a few years later has already caused many users significant expense and upheaval yet again.

We are fortunate that we now have a system that generally allows, with appropriate planning and forethought, most users of PMSE to have legal, legitimate, access to the spectrum they need in order to carry out their business in the UK. It would be a tragedy for many British businesses and the UK generally if these conditions were to be swept away.

DIGITAL TELEVISION: THE PRINCIPLES FOR SPECTRUM PLANNING – Questions

Q1. Our working assumption is that planning will continue for six multiplexes, as today. However we would also be interested in views on the costs and benefits of a more radical re-planning. This could be either reducing or increasing the number of multiplexes by one. Do you have views on this?

A1. Reducing or increasing the number of multiplexes by one has no direct effect on the useage of radio microphones and in ear monitors. However, a reduction in the number of multiplexes could reduce the opportunities for geographical sharing between DTT and PMSE. However, by enabling more spectrum to be cleared, there would be potential for a greater allocation to be made exclusively for PMSE use.
Conversely, an increase in the number of multiplexes could increase the opportunities for geographical sharing between DTT and PMSE.

Q2. What do you see as the costs and the benefits of maintaining the current basis for network configuration compared with those for adopting a configuration using fewer frequency channels?

A2. No Comment.

Q3. Do you agree that we should continue to plan on an interleaved basis to support regional services?

A3. An interleaved spectrum plan has greater potential for sharing by PMSE.

Q4: To what extent should the future planning of this spectrum take account of the provision of local services?

A4. No Comment.

Q5. What factors would have to be taken into account in order to plan to support mobile broadcasting services?

A5. No Comment.

Q6. Does this analysis of coverage potential and associated costs adequately inform those taking decisions about the level of coverage by terrestrial means that should be required for public service broadcasters?

A6. No Comment.

Q7. Our working assumption is that the public service broadcasters should be required to reach a certain minimum percentage of households by the terrestrial platform. However, we would like your views on whether it is right to require a minimum, what that might be and the associated costs and benefits?

A7. No Comment.

Q8. Do you agree that the level of coverage provided by the networks supporting the four multiplexes carrying predominantly pay-tv services should be left to the commercial judgement of the operators?

A8. No Comment.

Q9. Which channels are cleared will depend on the costs and benefits of different replanning options. For example clearing 5 channels at the top and bottom of the frequency range is less disruptive to consumers and has lower switching costs than clearing ten at the top end. The benefits, though, will depend on the use to which such freed up spectrum can be put. We would like your views on the costs and benefits of different options.

A9. Many (probably the majority) of the existing radio microphones and IEM's in use at present operate in channel 69. Many professional users make use of channels 66, 67 & 68 also. Much of the more recently produced radio microphone and IEM (i.e. that made within the last ten years) equipment is capable of operation over either a 24MHz or 32 MHz tuning range, with channel 69 towards the top of the tuning range. It would be extremely unacceptable to the existing users of such equipment if channel 69 in particular were no longer available to them. If the top 5 channels were cleared of analogue transmissions then this should only be for the purposes of making them available exclusively for PMSE. If only 5 channels are cleared at the top of the band then PMSE users will still need to depend heavily on geographical sharing to make up the shortfall in their spectrum requirements.

Large radio microphone systems, such as those used in musical theatre productions in London's West End, require extensive frequency planning to avoid mutual interference between the individual frequencies within the system due to intermodulation. With systems requiring 40 radio microphone channels (frequencies) or more being far from unusual, we are frequently presented with a dilema:

- In order to maximise the interchangeability of equipment within the system (and / or across the owners "fleet") it is desirable to use as many frequencies as possible within the same switching range.
- To minimise the total quantity of spectrum occupied by transmissions it is desirable to space the actual transmission frequencies out, usually arranged in groups of about 12 frequencies within blocks of approximately 8 MHz. In this way many of the intermodulation products from one group of transmitters can be arranged to fall in the "gaps" between the groups of frequencies in use.

It can be seen therefore that if only one contiguous block of frequencies is made available for radio microphones, or PMSE in general, this will not permit the most efficient use of the spectrum where large numbers of frequencies are required at one location.

Radio microphones and IEM's are unlikely to be able to share spectrum in any useful way with any form of mobile telecommunications service.

Clearing only the bottom 5 frequency channels and making them exclusively available for PMSE is unlikely to be as popular with existing radio microphone and IEM users as clearing the top channels. It would, at best, expose many users (owners) to significant re-engineering costs in order to be able to continue using their existing equipment, the majority of which operates at present on frequencies near the top of band V. For many existing users there would be no alternative to scrapping and replacing their existing equipment as it would not be viable, for either technical or economic reasons, to re-tune it.

Q10. Which frequency channels should we clear?

A10. See answer to Q9.

Sennheiser UK Ltd., 04 April 2002

Annex A

Typical Radio Microphone System Specifications:

Low cost system: Evolution WirelessÔ

Modulation: wideband FM
Available Frequency ranges:
A: 518–550, B: 630–662, C: 740–772, D: 790–822, E: 838–870 MHz
Tunable frequencies: 1,280
Switching bandwidth: 32 MHz
Nominal /Peak deviation ±24 kHz / ± 48 kHz
Noise reduction system "HDX"*
AF frequency response 60–18,000 Hz
Signal-to-noise ratio > 110 dB (A)
THD (1 kHz) < 0.9 %
Transmitter RF output power typ. 30 mW or 10 mW
In compliance with ETS 300422, ETS 300445,
CE, FCC

Top of the range system: 5000 series

Modulation: wideband FM
Available Frequency ranges: 450–960 MHz, 138–250 MHz
Tunable frequencies: 16 or 32
Switching bandwidth: UHF: 24 MHz, VHF: 7 MHz
Nominal/peak deviation: ± 40 kHz / ± 56 kHz
Noise reduction system: HiDyn *plus*™*
AF frequency response: 70 – 20,000 Hz, +1 / -1.5dB
Signal-to-noise ratio: >117 dB(A), (105dB CCIR)
THD (at nom. deviation): <1 % (typ. 0.5 %)
Transmitter RF output power: 50 mW (-3 dB) or 10 mW
(250mW version also available)

Receiver:
Frequency setting in 5kHz steps or a max. of 32 frequencies.
Min. channel spacing: 300kHz
Limiter threshold: (-3 dB) ≤1µV
RF sensitivity: ≤1.5µV / 52dB(A)S/N
Squelch, adjustable 0–100µV
Intermodulation spacing: ≥76dB
Selection of adjacent channels: ≥66dB
Adjacent channel rejection: ≥100dB
Image rejection: ≥100 dB

* HDX and HyDyn *plus*™ are Sennheiser proprietary companding systems employed to improve the overall system audio signal to noise performance and dynamic frequency response.