THE USE OF THE RADIO FREQUENCY SPECTRUM ABOVE 30 GHz

A CONSULTATIVE DOCUMENT

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CHAPTER 1: INTRODUCTION

1 This Consultative Document has a dual objective:

i) to draw attention to the millimetre wavebands ('mm wavebands') — the largely unexploited bands above 30 GHz — and the potential they offer for future communications users and to summarise the relevant information (which, as regards possible future uses, is only fragmentary) held by DTI Radiocommunications Division ('RD');

ii) to invite readers — notably users and potential users of radio and manufacturing industry — to contribute to DTI's preliminary thinking by giving their views on the possibilities discussed here and by supplementing our information by drawing attention to other applications which may be foreseen or technical developments which may be in hand.

(NB. It is quite separate from the feasibility study into Microwave Video Distribution Systems ('MVDS') commissioned jointly by DTI and the Home Office in October 1987 and which will be published shortly.)

2 The history of radio is the history of the exploitation of ever higher frequency bands. If the result of this exploitation is to provide the greatest benefit to users and UK manufacturing industry, it should not happen in a random fashion but should be the result of close collaboration between these interests and RD as the spectrum management authority. This Consultative Document is a part of that process. It is also intended to help with one of RD's wider objectives: to achieve European harmonisation in frequency allocations within this range. This is being pursued within the Conference of European Post and Telecommunications Authorities ('CEPT'), with a view to achieving Europe-wide markets for equipment (as far as possible) and thus to help us in setting the stage for future exploitation of these bands. By thinking about and discussing these issues at an early stage, the opportunity is there for the UK to take a lead in the development of equipment and applications for the millimetre wavebands, in order to exploit these Europe-wide and world-wide markets.

3 The frequency range under consideration is very wide. The lower limit of 30 GHz is determined by the fact that it is the limit above which firm national frequency allocations have either not been made or not been fully developed. No precise upper limit has been specified, simply because any such limit would be arbitrary. Obviously the higher the frequency band under consideration, the longer the timescale before its use is likely to be a practical possibility; and the less there is that can be usefully said about it to date.

4 The status of the frequency bands within this range varies. The broad allocation to services (ie fixed, mobile, etc) up to 275 GHz is laid down internationally by the International Telecommunication Union ('ITU') in Article 8 of the Radio Regulations. Apart from certain allocations to the amateur service, there are no UK national allocations above 150 GHz; below 150 GHz draft UK allocations have been proposed and in some cases have been formally made.

5 In the Microwave Fixed Links Committee ('MFLC') RD's consultative forum on Fixed Radio Services a provisional table of fixed service allocations between 30 and 60 GHz was drawn up in 1985. This is reproduced at Annex 1. Subsequently, in 1986, RD invited the consultants Ewbank Preece Consulting Ltd ('EPCL') to take a more detailed look at this range (with the upper limit extended to 70 GHz to cover both sides of the oxygen absorption peak), in order to gather evidence more widely on possible user applications and the availability of equipment — again, with a view primarily to fixed service applications.

EPCL were also asked to suggest which applications would most appropriately be accommodated in which bands and their suggestions are incorporated in the Table which comprises Annex 2 to this Document. EPCL's Report* was completed in April 1987; it has not been formally published, but is available for consultation in DTI Libraries and elsewhere.

6 Within CEPT work has just begun on a study of the possibility of harmonising national frequency allocation tables in the bands up to 275 GHz. The UK is already taking an active part in this work and any feedback to this Consultative Document will clearly be of benefit in achieving a harmonised European pattern which benefits UK consumers and manufacturers.

7 The development of radiocommunications applications is inevitably influenced by other areas of Government policy. On telecommunications, for example, the Government's policy of bringing about a managed process of liberalisation means that at any particular time there may be restrictions on certain radiocommunications systems being operated by private users as opposed to public telecommunications operators. To take another example, some uses of radio might be in conflict with the objectives of the Government's policy as a whole. These linkages cannot be overlooked, particularly as regards the immediate future; but this Document is considering frequencies some of which will not be exploited for many years to come, when the impact of cable, telecommunications and broadcasting policies may be quite different. Therefore, in suggesting future uses or commenting upon the ideas discussed here, respondents should be aware of, but not necessarily constrained by, the nature of current policies.

8 This Document is necessarily couched in terms of the present framework for managing the radio spectrum. However, this framework itself is open to change and several changes have recently been under consideration; this has a number of implications for the ideas discussed in this Document. The use which is made of the radio spectrum can both influence and be influenced by the nature of the regulatory framework; and it is possible that some of the questions which are raised for discussion in this Document could cease to be for Government to decide (at the detailed level) if the private sector were given a greater role in spectrum management. These issues are discussed briefly in Chapter 4.

9 The intention of this Document, then, is to set out the background to the preliminary discussion of the way these frequencies may be used. In Chapter 2, a brief account is given of the implications for users of the physics of radiowave propagation; the framework of existing international and national frequency allocations is described; and a number of possible types of use which have been suggested to RD are discussed. Chapter 3 looks at equipment availability and the state of development of technology; Chapter 4 is a reminder of the present regulatory structure and possible changes to it; Chapter 5 looks at the environmental and safety aspects; and Chapter 6 gives a summary and poses some questions for consideration.

* Entitled 'Study of Frequency Spectrum Planning Issues in the 30-70 GHz Frequency Range', Ewbank Preece Consulting Ltd 1987. Requests for an executive summary of this report should be addressed to DTI, Radiocommunications Division [illegible] Room 605, Waterloo Bridge House, Waterloo Road, London SE1 8UA (telephone 01-215 2072 - 24 hour ansaphone [illegible]

CHAPTER 2: CHARACTERISTICS AND POSSIBLE USES OF THE FREQUENCIES ABOVE 30 GHz

1 The radio frequency spectrum in the millimetre wavebands is very largely unoccupied at present — thus plenty of bandwidth is potentially available for high-capacity transmissions. However, there are constraints — the range is limited by the physics of radiowave propagation and the type of use of any particular band is constrained by international and national frequency planning.

Propagation Factors

2 The transmission of radio waves above 10 GHz is subject to basic attenuation due to range but superimposed on this are the effects of gases and those of hydrometeors (mist, fog, rain, hail or snow). The gases and water vapour are always present whereas the hydrometeors come and go.

3 Figure 1 shows these effects between 10 and 350 GHz as specific attenuation* at sea level in dB/km for each of the components of attenuation. Two of the curves show the attenuation due to gases present in the atmosphere; oxygen and water vapour. The attenuation shows pronounced **absorption peaks** at various frequencies in the range.

4 The remaining curve shows the effects of average rainfall (25 mm/hr). It is clear that, away from the gaseous attenuation peaks, rain attenuation dominates. The areas outside these peaks are the so-called radio transmission windows to space and are of interest to space services

5 In the regions around the absorption peaks, the high attenuation means that radiocommunication distance ranges on the earth's surface will be very short, but this attenuation also means that the distance over which radio systems interfere with each other will be small.

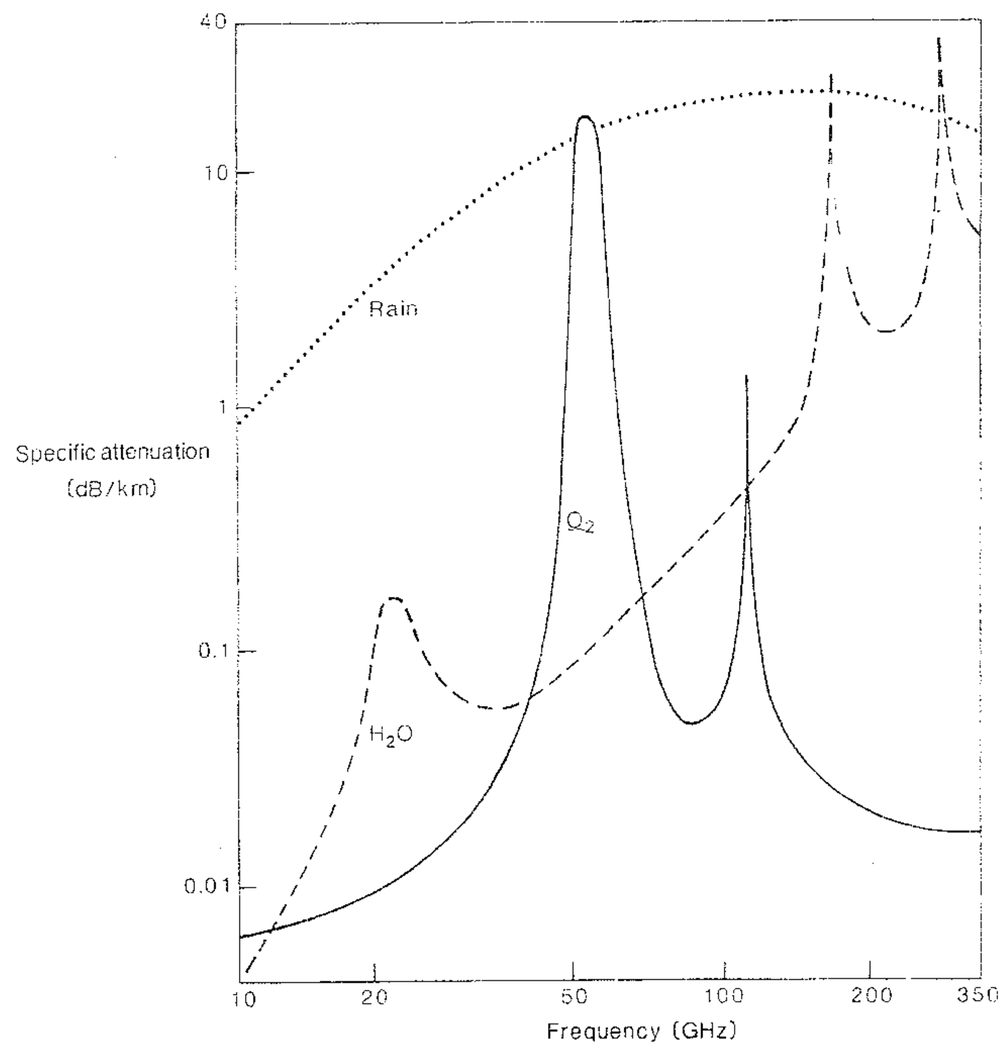
6 Hence, the distance at which a frequency can be used successfully again, the frequency re-use distance, is also relatively small. An example of this is shown in Figure 2 for the frequency range 30 to 70 GHz which includes the first oxygen absorption peak at 60 GHz. The figure shows, for a typical digital communication system (a low capacity digital system of 8 Mbit/s using 4 PSK modulation) the potential working range at each frequency and the distance at which the frequency could be re-used. A similar pattern could be observed about other absorption peaks.

7 Intra-building propagation experiments at 60 GHz have shown that propagation is significantly dependent on the materials used in the construction of the building. Concrete construction contains the signal, whereas plasterboard is virtually transparent. Rooms with metal walls maintain a high signal level but also suffer from severe multipath effects, which results in large variations in signal level.

8 The rest of this Chapter discusses briefly the types of application for which this frequency range might be used. It does not purport to be comprehensive — one of the objectives of this Document is to invite views and suggestions from potential users and manufacturers.

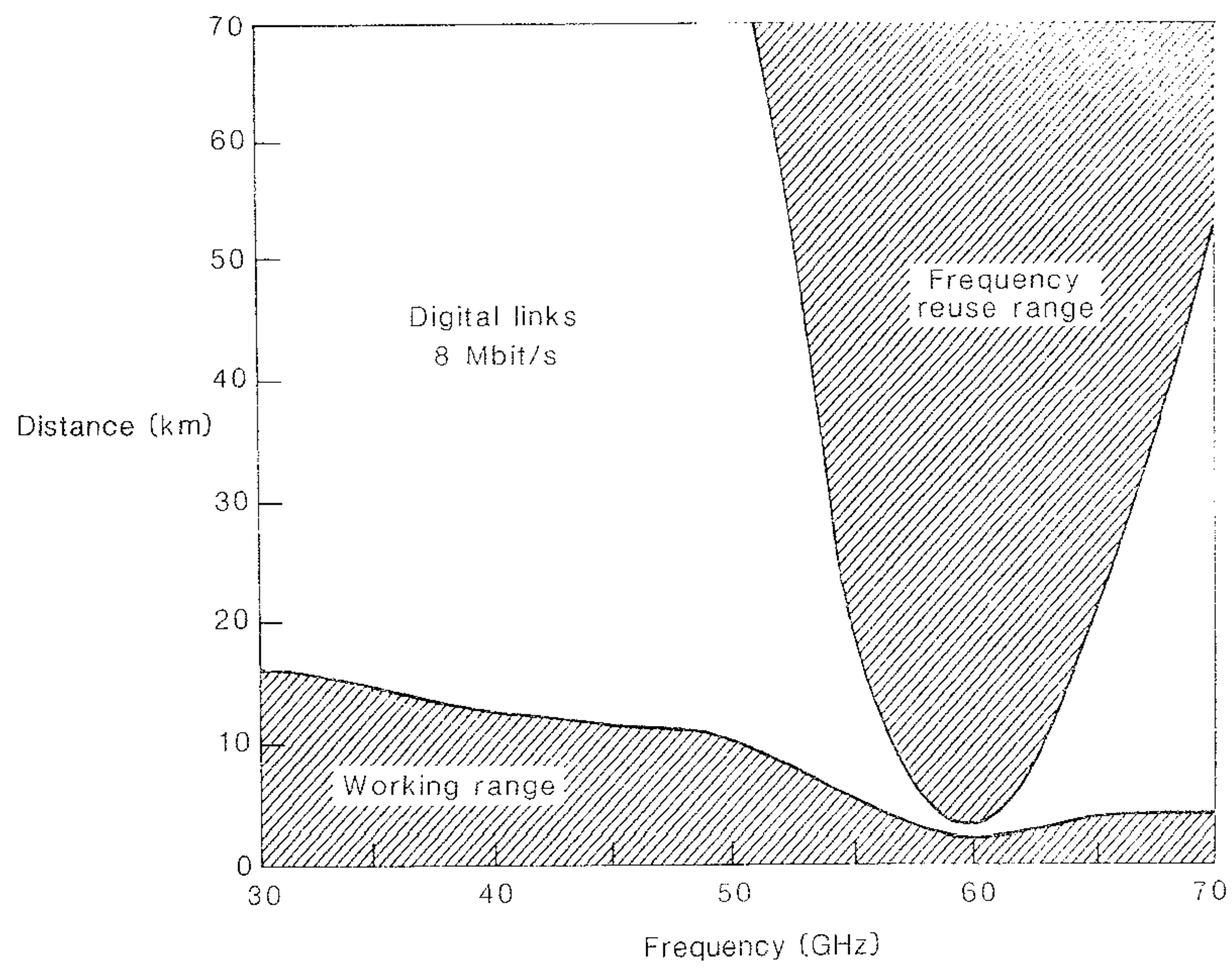
* Specific attenuation of a radio signal is the rate at which it is attenuated (diminished) by the presence in the atmosphere of gases, water vapour and hyrdometeors. It is normally expressed in dB/km.

FIGURE 1 Attenuation by atmospheric gases and rain



Note: The intensity of radio waves decreases naturally as they spread out from the transmitter. Additionally, rain and atmospheric gases such as oxygen (O_2) and water vapour (H_2O) cause further loss at millimetric frequencies. This is expressed as 'specific attenuation' in decibels ('dB') per km. The attenuation due to gases is particularly frequency selective, eg the oxygen attenuation has a sharp peak at frequencies around 60 GHz, cutting the intensity of the radio waves by 95% for each kilometre of travel. The effect of the various attenuations is cumulative.

FIGURE 2 Potential working and frequency re-usage range of millimetric fixed links



Note: The potential working range is the average maximum distance over which a typical fixed link can operate. The range is influenced by the attenuation of the radio waves in the intervening space, being shorter in cases of high attenuation. Where two links employ the same frequency (ie frequency re-use), if they are separated by a distance greater than the frequency re-use range, it will be certain that mutual interference will be below an acceptable level. The frequency re-use range is thus always larger than the working range. If the two links are separated by less than the re-use distance, detailed calculations are necessary to determine whether other factors, eg the directionality of the antennas, will provide sufficient protection from mutual interference.

Frequency Allocations

3 The starting point is the type of use allowed in any given band under the International Frequency Allocation Table. This is set out in detail in Annex 2. The bands above 30 GHz are allocated variously to a number of services, often with several services sharing the same band. These are listed below, with explanatory notes where necessary:

Fixed	(A communication service between specified fixed points. An example of a system within the fixed service would be the point-to-point radio relay links forming part of a national trunk telephone distribution network.)
Fixed-Satellite	(A communication service between earth stations at specified fixed points via a satellite or between a fixed earth station and a satellite.)
Mobile	(A communication service between radio stations at least one of which is intended to be used while in motion or during halts at unspecified points. The mobile service may be qualified by one of the following prefixes: land, maritime or aeronautical. NB — each type of mobile service includes base stations as well as mobile stations, eg the maritime service includes land based coast stations which communicate with ships.)
Mobile-Satellite	
Broadcasting	
Broadcasting-Satellite	
Amateur	
Amateur-Satellite	
Radiolocation/ Radionavigation	(A service in which the determination of position or the obtaining of information relating to position is achieved by means of the propagation of radio waves. This general service includes most radar applications.)
Radionavigation-Satellite	
Radio Astronomy	
Meteorological Aids	
Inter-Satellite	
Space Research	
Earth Exploration Satellite	
Standard Frequency and Time Signal Service	

Although these categories are tightly defined, there is in practice a degree of convergence between some of them in respect of the frequency bands used, eg between fixed (point-to multipoint) and broadcasting; and between uncoordinated links in the fixed and mobile services.

10 Within this framework, each national administration has, or will develop, its own national allocation table. In the UK actual or draft allocations have been made for part of the frequency range. Annex 2 sets out in tabular form the relevant information on frequency allocations, together with other information of interest. It includes the international frequency allocations; actual allocations, or draft proposed allocations for the UK; and proposals for the use of bands made in the study of 30-70 GHz commissioned by DTI from EPCL. The table also draws attention to the existence of research and development work on particular applications in certain bands (as indicated by the existence of 'testing and development' licences on issue) and it notes propagation factors of interest. It also notes the two bands recently identified by RD for early release to users as soon as specifications have been drawn up. These are 37-39.5 GHz and a band at around 60 GHz. The bands will be open to both PTOs and private users. The emphasis will be on achieving a relatively relaxed 'low-cost' specification and imposing as few restrictions as possible on the type of application to be allowed.

Possible Uses

11 A wide range of uses is possible within this pattern of national allocations. This Document addresses civil applications which might be of commercial interest. It emphasises the fixed and mobile services, because most of RD's current information relates to these services; but responses drawing attention to applications in other services would be particularly welcome. Few radio systems currently operate in this range (one of the few being the use of 49.2-50.2 GHz by Mercury Communications Ltd ('MCL') — for customer links) and there have been relatively few expressions of interest from potential users. This has been the experience both in RD's own consultative fora and in EPCL's study of fixed applications in the 30-70 GHz frequency range.

12 However, a number of specific uses can be foreseen as possibilities if equipment can be made available at reasonable prices. (This in turn depends in part — and for the applications we know of, at least — upon manufacturers perceiving the possibility of a volume market among users, in order to justify their investment in developing the equipment; potentially a chicken and egg situation.) These applications include the following:

i) *Point-to-Point Terrestrial Links* for either public telecommunications operators or private use. Certain telecommunications systems are exempt from licensing under Section 6 of the Telecommunications Act 1984 and hence are not subject to the Government's fixed link duopoly policy — see footnote* for the exemption criteria. If

*To be exempt a system (ie all the apparatus at each end of a link together with any wires, repeater stations, etc, in between) must meet all of the following conditions:

(a) it must consist entirely of apparatus controlled exclusively by the operator of the system;

(b) it may not be run to convey signals and/or messages by way of rendering a service to third parties;

(c) it may not be connected to any system operated by a third party (eg the PSTN, private circuits leased from BT or MCL or any circuit or apparatus run by another organisation);

(d) it may not be used by anyone other than the operator (and the operator's employees); and

(e) it must be used exclusively for the purposes of the operator's business by the operator's employees.

these criteria are met, telecommunications can be privately provided betweeen establishments in the same organisation; this is already exploited by a number of users and could prove attractive to a wider range of users in the future, eg the financial and retailing sectors. If at some future date the Government's policy of a managed progress of liberalisation of telecommunications means that some of the current restrictions are eased, this could well increase the attractiveness of self-provided radio links. Applications in the millimetric wavebands could include short-haul links within a conurbation (but not restricted to one district) for both large volume high speed data and slower speed data communications; and very short inter-building links. EPCL's Report estimated that for the former, the market size could run at 1,000 units per year over a 10 year period. Links at frequencies around 60 GHz might be particularly attractive to organisations with a requirement for privacy: the high absorption attenuation gives the possibility of relatively secure, very short range links. This is likely to be of interest to the military and the police and may also have civil applications.

A further application for point-to-point links is in linking two parts of a private telephone system. Under the licence entitled 'Class Licence for the running of Branch Telecommunication Systems issued under the Telecommunications Act 1984' apparatus situated in different premises occupied solely by the same organisation or a member of its group can be connected by private link provided none of the premises is more than 200 metres from any other. In many cases, such a link — which might for example have to cross a road — can be provided more conveniently by radio.

ii) *Point-to-Multipoint Terrestrial Links* for eg data or television material. Such networks might be two-way or unidirectional. The most obvious two-way application is for the customer links in the telephone services provided by BT and MCL; a possible omnidirectional application is MVDS which is already the subject of some development work.

iii) *Electronic Funds Transfer at Point of Sale ('EFTPOS').* Predictions have been made that some 14,000 establishments in the UK will have EFTPOS by the early 1990s. A plastic card wiped through a card reader at the retailers and authenticated by a PIN will be validated immediately by the card-issuing bank and the necessary transfer initiated between the accounts of the customer and the retailer. Millimetre microwave transmissions could be an appropriate medium for the data communications between retailers and nodes in the bank's networks. If transceivers are required for each pairing of retailer and each banking outlet, the projected growth of EFTPOS by the early 1990s would support some 50-60,000 links. Such links would need to be run by a PTO.

iv) *Intra-Building Communications.* The use of millimetre wave transmissions within buildings would provide flexibility in allowing for changes in the use of space within buildings without costly rewiring on each occasion. The building could be divided into a number of areas covered by a low power radio system. The size of each area would depend on the operational requirement, the frequency used and the type of construction of the building. The area could be as small as a single room or as large as a complete floor. The type of communications system could be the equivalent of a Local Area Network ('LAN') for computer to computer communication, a cordless PABX for voice and data or the collation of data from electronic point of sales terminals in a retail store. EPCL's Report estimated that the number of cordless PABXs in operation by 1999 would not exceed 5% of the present PABX base, ie 17,500. However, the market for transceivers would depend on the number of extensions served by each PABX and this could easily be in the region of 100 since the interest is likely to come, initially at least, from larger organisations. There might thus be a market for 1.2 million small transceivers for PABXs alone.

v) *Non-Regulated Point-to-Point Links* ie systems not requiring coordination. The short interference distance in some of the bands under consideration should make it possible to allow equipment to be used with the minimum of regulatory control under the Wireless Telegraphy Act, as with Citizens Band mobile radio.

vi) *Mobile Systems.* A number of mobile applications for use of the frequency bands above 30 GHz have been identified. Micro-cellular mobile radio systems combine the advantages to be gained from such services as pagers, cordless telephones and cellular mobile radio. Use could be made of the atmospheric attenuation effects, particularly at 60 GHz and 120 GHz to provide cell size of considerably less than 1km. Another possible application is two-way data communications between moving vehicles and roadside units, eg route guidance, automatic tolling, vehicle identification and fleet control. The cordless LANs and wireless PABX systems mentioned above provide point-to-point and point-to-multipoint communications and also allow mobility within the coverage area of each transmitter. If the building were to be configured as a microcellular system this would also allow roaming throughout the building. Cordless telephones could gain access to the PSTN via a telepoint replacing the public telephone box and providing limited mobility. A universal portable telephone could have several modes of operation which combine functions of a cordless telephone for use at home and at the office and a cellular telephone for use on the move.

13 The above paragraphs have concentrated on applications in the fixed and mobile services, but there will be requirements also in the other services listed at the start of this Chapter. We are aware of possible requirements in the radiolocation/radionavigation services for eg vehicle guidance systems and civil marine radar for the leisurecraft market.

14 Comments will be welcomed on the possible uses mentioned above and any others not covered. The extent to which all these uses will develop will depend upon equipment availability, which is discussed in the next Chapter.

CHAPTER 3: EQUIPMENT AVAILABILITY AND TECHNOLOGY DEVELOPMENTS

Currently available equipment

1 There are two link equipments available in the UK which operate above 30 GHz. The first is a 40 GHz portable Electronic News Gathering ('ENG') system. It is a one-way video link operating in the 38.6-40 GHz band. The nominal range of the unit is 2.5 km. The second is a point-to-point system operating in the 50.4-50.65 GHz or 50.9-51.15 GHz bands.

UK developments above 30 GHz

2 UK manufacturers are developing equipments for civil applications operating at up to 29 GHz and are investigating the possibilities of producing units for use between 30-60 GHz and higher. Some are also engaged on research and development work on military units. This research may offer the spin-off of lower-cost parts for civil applications.

The need for technology development

3 The heavy exploitation of the mm-wavebands must await the development of low cost solid state microcircuits. This is particularly true for those applications intended for mass markets. The semiconductor device manufacturers need the spur of large orders to stimulate investment in development of suitable low-cost devices. The equipment manufacturers are disinclined to commit development funds to mm-waveband products before low-cost semiconductor devices become available.

4 Until this circle is broken, equipment manufacturers are obliged to use existing technology which cannot achieve the cost breakthrough essential to the uptake of the market. It is estimated that it may be 10 years before technology developments and production capabilities have advanced to the point where yields of usable devices are high enough to bring down prices to attractive levels.

5 Development of two types of component is essential for the large-scale exploitation of mm-wave communications systems:

i) sources of mm-wave power;

ii) monolithic mm-wave integrated circuits ('M^3ICs').

Both have essential parts to play both for short and long term applications for the exploitation of mm-wave communications systems.

6 Following DTI's launch of the Enterprise Initiative in January 1988, Government support is, in general, no longer available for individual company projects, but is still available for some collaborative ventures. Under DTI's Research and Technology Initiative collaborative research under the following headings may be eligible for DTI grants:

EUREKA

LINK

Advanced Technology Programmes

General Industrial Collaborative Projects

The UK EUREKA Office at DTI will advise on how a project might qualify for EUREKA and provide general information on EUREKA and on existing EUREKA projects and proposals. Telephone 01-215 6612 for further information.

The LINK Secretariat at DTI will provide specific advice on prospective LINK programmes. Telephone 01-215 6671 for details.

General advice on General Industrial Collaborative Projects and on collaborative research under Advanced Technology Programmes may be obtained from your nearest DTI Regional Office, Scottish Office or Welsh Office (addresses and telephone numbers are given at Annex 4).

Power sources

7 The exploitation of frequencies above 30 GHz depends on the development of suitable power sources at progressively higher frequencies as new bands are opened. The only currently available source of power for mm-wave systems that is small, lightweight and operates at low voltage is the semiconductor diode. The most successful power source to date is the impatt (Impact ionisation avalanche transit-time) diode. This device can be manufactured from Silicon, Gallium Arsenide ('GaAs') and Indium Phosphide.

8 Silicon impatt diodes are currently produced in quantity for frequencies up to about 30 GHz. Their prices are moderate. Above 30 GHz the output efficiency falls rapidly with increasing frequency. GaAs technology is in its infancy, but single units operate up to a little over 40 GHz.

Monolithic Millimetre Microwave Integrated Circuits ('M^3ICs')

9 The technology of these devices is based on that of monolithic microwave integrated circuits ('MMICs') which have been demonstrated successfully already in the 1-30 GHz frequency range. M^3ICs are suitable for use at frequencies above 30 GHz. Once the development and manufacturing difficulties have been overcome, the technique promises to offer complete transmitters and receivers plus signal processors on a microchip at low cost. The long-term future of mm-wave radio systems, therefore, is seen to be critically dependent on the development of these circuits, just as low-cost computing power has been dependent on the development of the digital microchip.

10 In both MMICs and M^3ICs, the circuits are manufactured on a 'chip' (substrate) of semiconductor material, generally GaAs for M^3ICs, and GaAs or Silicon-on-Sapphire ('SOS') for MMICs. Passive components — inductors, capacitors and resistors — are formed on the substrate as well as the active devices (Field-Effect transistors and diodes) and interconnection. This is all carried out as part of the chip-making process and is potentially much cheaper than the present technology in which individual active and passive components are assembled into waveguide, or hybrid microcircuit techniques are used.

11 The essential difference between MMICs and M^3ICs is that the active device geometry of the latter is smaller. Further research is required to enable smaller structures to be fabricated and manufacturing yields to be boosted.

CHAPTER 4: FREQUENCY ASSIGNMENT PROCEDURES

Current System

1 For the civil bands which are the responsibility of DTI, frequency management is largely centralised on RD. While major users such as the telecommunications operators who have blocks of spectrum allocated to them on a delegated basis have a large measure of freedom in the way they use their allocation, the fixed and mobile bands used by the private users are managed centrally by RD through the licensing system. The Division, in consultation with users and manufacturers, draws up equipment specifications, and users are licensed only if their equipment is approved as meeting the appropriate specification. RD maintains databases of users and assigned frequencies which are co-ordinated as necessary with existing users in the UK and overseas.

2 Conventionally, users of fixed and mobile radio need individual frequency assignments if they are to operate without causing interference.(An exception to this is the increasing use of trunked mobile radio systems such as those being developed in Band III.) Frequencies are assigned by RD's engineers, employing either manual methods or computer systems and making use of databases of existing users, of geographical terrain and a mathematical model of radiowave propagation. Once a suitable frequency has been found, its use must be co-ordinated as necessary with existing users in the UK and overseas. Users are required to keep to their assigned frequency by the terms of their licence under the Wireless Telegraphy Act, which may also specify other parameters, eg power, antenna type.

3 A number of departures from this pattern are possible:

i) in some bands and/or for some applications, the scope for mutual interference may be small or non-existent. An unregulated or self-regulated regime might thus be allowed without the risk of chaos. In the currently-used bands, some very low power applications are exempted from licensing control but with regulations governing equipment specifications. There are plans for further exemption;

ii) the increased use of trunked mobile radio systems would avoid the need for individual assignment to users and reduce the overall frequency assignment workload on RD;

iii) another possibility is that, where there is still a need for coordination between users, it may be possible for RD to shed some of the work, eg to a group representing the users (ie delegation) or to a body acting as an agent for the users (considerable use is made of delegation already);

iv) more radical suggestions include auctioning blocks of spectrum to users or allowing private sector organisations to manage blocks of spectrum within the terms of a licence from Government.

Frequency Planning Organisations

4 A report commissioned by DTI from the consultants CSP International ('CSPI')* and published 2 April 1987 recommended that many of the frequency management functions carried out by RD should be handed over to competing private sector 'frequency planning organisations' ('FPOs'). Each FPO would have the exclusive right to manage a particular band or bands of spectrum. The recommendations did not explicitly cover the frequency range above 30 GHz, but the basic philosophy of the recommendations was that as the need arose to exploit new bands, they should in general be offered to FPOs to manage on a commercial basis. The Government is now considering CSPI's proposals together with other possible options for the future management of the spectrum.

5 EPCL's Report put forward a somewhat different conception of the FPO which they saw as more appropriate for the millimetre microwave bands. In these bands, there is a requirement for considerable investment in research and development plus production facilities to meet the cost requirements of volume markets. EPCL did not consider it likely that such investment strategies would be undertaken in the absence of a clearly defined applications policy. Therefore they saw the FPO as a group with technical expertise which could act as an interface between the requirements of the user community and the supplier industry. It would vet the systems supplied to users to ensure that they were within operational constraints and might act as frequency co-ordinators. In this concept, the FPO is in some sense an agent of the user and/or supplier communities. EPCL envisaged an FPO having a rôle in approving equipment for MVDS and, as a last resort, resolving frequency allocation problems in any bands set aside specifically to cater for MVDS; carrying out coordination in point-to-point fixed link bands; and, for EFTPOS applications, providing technical guidance to banks and retailers who would form a largely self-regulating group.

Unregulated/Self-regulated System

6 This appears to be most feasible in the oxygen absorption band around 60 GHz. Individual licensing of users and equipment might be dispensed with in favour of simple requirements imposed on the equipment. Alternatively, a simple over-the-counter licensing system might be adopted, as with Citizens Band radio. EPCL's Report noted that the development of the market for intra-building communications — cordless PABXs and LANs — would create an almost unmanageable situation if individual frequency coordination were attempted. They recommended, therefore that operational frequencies would be selected by the users (within a defined range) on a 'first come first served' basis.

* Deregulation of the Radio Spectrum in the UK, HMSO, April 1987, ISBN 0 11 511979 6, £9.50.

CHAPTER 5: ENVIRONMENTAL AND SAFETY ISSUES

Planning Questions

1 Since the size of antenna needed for a specific application is inversely proportional to the frequency, the types of antenna used at 30 GHz and over will in general be small and unobtrusive — 150mm or less in diameter would be typical. Moreover, existing technology allows flat plate-type antennas to be used, which are less obtrusive than dishes. Many antennas will thus be 'de minimis' in planning terms but a few may come within the definition of 'development' and so require planning permission. The first part of this Chapter therefore draws attention to the main features of current planning legislation as it affects telecommunications antennas. For more detailed information, please consult in the first instance DOE/Welsh Office Planning Policy Guidance Note No. 8, published January 1988 (HMSO £3.10). Alternatively, enquiries may be addressed to:

Department of the Environment
Development Control Policy Division
2 Marsham Street (Room C13/20)
London SW1P 3EB
Tel: 01 276 3901

2 The erection or installation of radio masts and antennas may require specific planning permission. However, **the General Development Order ('GDO') 1977***, as amended in 1985, grants general planning permission for the installation, alteration and replacement of a wide range of telecommunications apparatus, so that planning applications are often not required. A Special Development Order ('SDO') modifies the scope of the GDO permissions in a number of important respects in the special areas to which it applies — ie National Parks, Areas of Outstanding Natural Beauty, Conservation Areas and the Broads.

3 Planning applications are not normally required for any development which falls within the limits set out in the various 'permitted development' classes in Schedule 1 of the GDO. Only if a direction has been made under Article 4 of the Order and where necessary confirmed by the Secretary of State, or if the effect of the GDO has been modified in relation to specified land by an SDO, or if the permission given by the GDO has been withdrawn by a condition imposed on the previous grant of planning permission, or if the development is proposed within a site designated under the Wild Life and Countryside Act 1981, will a planning application be required for development included in the classes in the GDO.

4 For the types of application discussed in this Document, the most relevant 'permitted development' class in the GDO is Class XXV. This includes the erection of satellite antennas and microwave antennas for private or business use on buildings and structures of more than 15 metres in height, other than private dwelling houses. This would include a block of flats, factory or other commercial premises. The permission does not apply in areas covered by the SDO. There are several other limits:

i) an antenna must be so sited as to minimise its effect of the building's external appearance;

ii) it must not exceed 900 mm in any dimension if it is a satellite antenna, or 1.3 metres if it is a terrestrial microwave antenna. Supporting structures for the latter type are permitted, but the combination must not add more than 3 metres to the overall height of the building etc, on which it is placed;

* On 4 February 1988 DOE issued a Consultation Paper on the consolidation and amendment of the GDO, although no significant changes to the provisions outlined in this Chapter are proposed.

iii) only two microwave antennas of either type per building may be installed without specific planning permission.

5 Class I of the GDO allows one satellite antenna to be erected anywhere on a dwelling house or within the curtilage, subject to various limits. These limits include a 900 mm overall size limit and a restriction on installing antennas on the dwelling house in a way which projects above the roofline of the house. Class XXIV allows the installation of telecommunications apparatus by licensed telecommunications code operators, subject to a series of limits and exceptions which mainly affect structures such as antennas and masts. Code operators include BT, MCL and Kingston Communications (Hull) plc; the two national cellular radio operators; and operators of cable systems. Both Classes are modified in their application to areas covered by a SDO.

6 None of the GDO provisions override the need for developers to obtain consent under Section 55 of the Town and County Planning Act 1971 before executing works affecting a listed building.

Biological Effects of Electro-Magnetic Waves

7 Concern is sometimes expressed over the biological effects of exposure to non-ionising electro-magnetic radiation, particularly in circumstances where workers or members of the public may be in close proximity to transmitting antennas. General responsibility for this issue rests with the Health and Safety and Executive (HSE) although, as part of the present licensing process, RD issues with every fixed link licence application form a Memorandum of Guidance on Safety Precautions Relating to Intense Radio-Frequency Radiation . This Memorandum contains the latest official standards available, published by the Medical Research Council ('MRC') in January 1971.

8 The existing guidance covers only the frequency range up to 30 GHz. Moreover, understanding of the possible hazards of non-ionising radiation is constantly developing. The National Radiological Protection Board, therefore, has been considering for some time preparing revised guidelines and in May 1986 it published, at the request of the HSE, a Consultative Document covering the frequency range up to 300 GHz*. The Board expects to report further on this topic in due course, taking account of the comments made on that Consultative Document and recent consultation with the MRC on the biological effects of radio frequency and microwave radiation.

9 As and when new standards are issued, RD will incorporate them in the Memorandum of Guidance it issues with licence applications.

10 Many of the applications discussed in this Document would use only very low powers and absorption of energy in tissue at frequencies above 30 GHz is essentially a surface phenomenon. However, since our knowledge of the effects of exposure at these high frequencies is limited, it is clearly desirable for well-founded advice to be available by the time the use of these frequencies becomes widespread. It is clearly in the interests of the equipment manufacturing industry itself to take a lead in ensuring that potential customers are assured that operation of the equipment does not present an exposure hazard. It can do this by publicising the extent to which its products fall within various norms, proposed or accepted nationally or internationally and by carrying out or sponsoring further research.

* Advice on the protection of workers and members of the public from the possible hazards of electric and magnetic fields with frequencies below 300 GHz: a consultative document (NRPB, May 1986)

CHAPTER 6: SUMMARY AND QUESTIONS FOR CONSIDERATION

Summary

The frequencies above 30 GHz constitute an enormous reserve of radio frequency spectrum, as yet scarcely used. We are only just beginning to think about how it should be used and this Document is intended to set the scene for further discussions. It has:

i) outlined briefly the propagation characteristics of these frequencies (Chapter 2);

ii) described the actual or planned international and national frequency allocations (Chapter 2 and Annex 2);

iii) discussed a number of possible uses which have been suggested to RD (Chapter 2);

iv) indicated the sort of equipment currently available (Chapter 3);

v) noted that the exploitation of these frequencies depends on the development of low-cost solid state micro-circuits, which requires both time for technology to develop — perhaps 10 years — and a prospect of a volume market (Chapter 3);

vi) described the existing regulatory structure and noted a number of changes which have been suggested (Chapter 4);

vii) drawn attention briefly to the relevant planning and radiation safety considerations (Chapter 5).

Questions for Consideration

1 Can you provide further information on:

- equipment/technology developments;
- research into propagation at these frequencies;
- initiatives in other countries?

2 Are you aware of potential uses besides the ones discussed in this Document?

3 Of the possible uses discussed, do you have any views on those which are/are not likely to be developed?

4 Given that the development of the right technology at the right price may depend upon identifying volume markets for equipment, in which application areas are those volume markets most likely to be found?

Comments on any other aspects of this Document will, of course, be equally welcome. Responses should be sent to:

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