

## RECOMMENDATION ITU-R F.759\*

**USE OF FREQUENCIES IN THE BAND 500 TO 3 000 MHz  
FOR RADIO-RELAY SYSTEMS**

(Question 132/9)

(1992)

The ITU Radiocommunication Assembly,

*considering*

- a) that although in some cases it may be practical and spectrum efficient to employ frequencies above 3 000 MHz, there are technical and economic reasons for the fixed service to operate below 3 000 MHz;
- b) that radio-relay systems are widely employed throughout the world and make extensive and increasing use of the allocated spectrum below 3 000 MHz, ranging from high-capacity long haul to local circuits conveying TV, multiplex telephony or data signals using analogue or digital modulation;
- c) that the propagation characteristics in this band permit the design of economical radio-relay systems particularly suitable for long hop lengths;
- d) that it is not cost-effective to replace a single long hop with several shorter, higher frequency hops;
- e) that recent advances in communications technology such as TDMA, have enabled point-to-multipoint telephony systems to be developed for remote areas;
- f) that satisfactory operation on long paths over water (e.g. off-shore links) or paths that are obstructed is difficult or impossible to achieve in higher frequency bands;
- g) that for frequencies up to about 2 000 MHz it is possible to use Yagi type antennas enabling the use of lightweight supporting masts or towers, thereby permitting lower cost systems;
- h) that recent studies on sharing between the fixed service and other services on a co-channel basis have shown that reduced geographic separation may be possible due to development in new technology and consideration of terrain features to allow sharing at least in outer urban and rural areas;
- j) that current efforts in international standards fora in these frequency bands have resulted in an abundant supply of low cost equipment which has facilitated the rapid development of telecommunications infrastructures, especially in developing countries,

*recommends*

1. that since sharing is feasible between the fixed service and other services in the frequency spectrum below 3 000 MHz, sharing should be encouraged;
2. that there be continued access to spectrum in the band 500 to 3 000 MHz for the fixed service;
3. that Annex 1 should be referred to for information on the technical and operational characteristics of the fixed service in the frequency range below 3 000 MHz.

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\* Radiocommunication Study Group 9 made editorial amendments to this Recommendation in 2000 in accordance with Resolution ITU-R 44.

## **Technical and operational characteristics of the fixed service in the frequency range below 3 GHz**

### **1. Service objectives**

Applications of fixed radio systems in the frequency bands below 3 GHz include point-to-point links, ranging from high capacity, long-haul to local circuits conveying TV, multiplexed telephony or data signals using analogue or digital modulation. Fixed systems in these frequency bands offer the best communications alternative in many parts of the world for individuals, public telecommunications operators, police, fire and ambulance services, broadcasters, the energy industry (oil and electricity), a wide variety of transportation functions, offshore drilling applications, national security organizations and others.

On account of favourable propagation characteristics, fixed radio systems in bands below 3 GHz are particularly suitable for radio spans of up to about 80 km, and for longer hops and trans-horizon links. An attractive feature for network planners is that fixed radio systems can normally be deployed within short time-scales and also incur low maintenance costs.

Recent developments in radio technology, such as TDMA schemes, have paved the way for new modes of operation for point-to-multipoint transmission. These applications have shown a rapid increase in local circuits in many countries, mostly in rural areas. It should be noted that terrestrial radio systems often serve as the only available transmission means to subscribers in remote rural areas where a cable infrastructure is not economically feasible. Thus, in over 100 countries, radio systems in the fixed service are operating and will continue to provide an important role in their telecommunication networks.

### **2. System characteristics**

The fixed service system parameters listed in Table 1 are provided to assist in examining the feasibility of sharing between services. This table provides a small number of representative examples, but does not cover the full range of systems in current and future use. Note that the table does not contain all the information needed for full interference evaluation.

The continuing trend towards the use of higher modulation levels, which is dictated by the need for higher spectral efficiencies, should be taken into account. This may increase the susceptibility of fixed service systems to interference, which will require further sharing studies after the characteristics of these systems are defined. Increases in transmitter output power required to maintain the interference objectives shall remain within the limits specified in Article 27 of the Radio Regulations.

### **3. Frequency aspects**

The characteristics of radio systems operating in bands below 3 GHz make essential the continued availability of these bands to the fixed service, particularly for many low capacity analogue and digital applications. Satisfactory operation on long paths over water, or paths that are obstructed, is difficult or impossible to achieve in higher frequency bands. Multipath due to ducting is less severe at these frequencies in geographical areas where this is a problem. These bands also include most trans-horizon radio systems. Ability to use Yagi antennas up to about 2 GHz, and therefore lightweight supporting towers, permits lower cost systems where this is an important factor. The need to use pressurized waveguide above 3 GHz increases the cost and increases electricity consumption, which are often important factors in rural and remote applications.

TABLE 1

**Selected examples of fixed service system sharing  
parameters for bands below 3 GHz**

	Point-to-point					Point-to-multipoint				Trans-horizon
	Analogue		Digital			Digital		Analogue		Analogue
Capacity	8 ch	960 ch/ 1 TV	64 kbit/s	2 Mbit/s	45 Mbit/s	Central station	Out station	Central station	Out station	72-312 ch
Modulation	FM-FDM	FM-FDM	4-PSK	8-PSK	64-QAM	4-PSK		94 ch FM-FDM		FM-FDM
Antenna gain (dB)	17-33	34	17-33	33	33	10-17	17-27	10	19	49
Transmitter power (dBW)	7	7	7	7	1	7	7	4	4	28
e.i.r.p. (dBW)	19	36	19	19	34	24	34	12	21	75
Bandwidth (MHz)	0.3	40	0.032	0.7	10	3.5	3.5	2	2	6
Receiver noise figure (dB)	8	10	4	4.5	4	3.5	3.5	9	9	2
Normal signal level (dBW)	-93	-64	-112	-90	-65	-90	-90	-97	-97	-65
Receiver input level for BER of $10^{-3}$	N/A	N/A	-137	-120	-106	-122	-122	N/A	N/A	N/A
Maximum long-term interference <sup>(1)</sup>										
Total power (dBW)	-151	-129	-165	-151	-136	-141	-141	-142	-142	-138
Power spectral density (dB(W/4 kHz))	-170	-169	-174	-173	-170	-170	-170	-169	-169	-172

N/A: not applicable

<sup>(1)</sup> Interference values correspond to a degradation in receiver threshold of 1 dB or less.

Typically, the carrier level corresponding to the BER of  $10^{-3}$  is around 4 dB lower than that for BER of  $10^{-6}$ , the carrier level difference between  $10^{-6}$  and  $10^{-10}$  BER points is also about 4 dB.

In general, the cost of radio-relay systems tends to increase with frequency. ITU-R standards in these frequency bands have resulted in an abundant supply of low cost equipment which has facilitated the rapid development of the telecommunications infrastructure, especially in developing countries.

#### **4. Summary**

The fixed service has demonstrated its ability to efficiently use and share the radio spectrum, and the demand for this service continues to increase. The fixed service usage has evolved to a point where applications are supported in those bands whose characteristics best fit their need.

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