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Radiocommunication Sector of ITU

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Technical and operational characteristics of land mobile MF/HF systems

M Series

Mobile, radiodetermination, amateur and related satellite services

International Telecommunication Union

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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R M.1795

Technical and operational characteristics of land mobile MF/HF systems

(Questions ITU-R 1-3/8, ITU-R 7-5/8)

(2007)

Scope

This text provides land mobile service characteristics information for use in sharing studies.

The ITU Radiocommunication Assembly,

considering

a) that land mobile links using frequencies above 30 MHz have a limited range, dependent on varying degrees of topography, vegetation, man-made structures, ground constants, the troposphere and the ionosphere;

b) that mobile stations may operate in sparsely populated, remote and difficult-to-access areas beyond distance ranges possible using VHF or UHF;

c) that frequencies between 2 and 30 MHz can provide distance ranges greater than those possible above 30 MHz using ground-wave or sky-wave propagation as appropriate;

d) that mobile stations have practical antenna limitations dependent on whether operating in motion or at halt;

e) that base stations in the land mobile service may also be used in mixed land mobile/fixed networks if the allocation allows it,

noting

a) that Recommendation ITU-R P.368 provides ground-wave propagation curves according to ground characteristics;

b) that Recommendation ITU-R P.533 may be used to predict HF sky-wave propagation at frequencies between 2 and 30 MHz,

recommends

1 that for interservice and intraservice frequency sharing studies in the MF/HF bands representative technical and operational characteristics of land mobile systems given in Annex 1 should be used.

Annex 1

Specific characteristics of the MF/HF range

1 Introduction

Most land mobile operations are conducted at frequencies above 30 MHz. Owing to propagation limitations, VHF/UHF frequencies are reliable only for line-of-sight paths and some distances beyond, depending on topography, vegetation, man-made structures, ground constants, the troposphere and the ionosphere.

Frequencies in the 2-30 MHz range are used for paths exceeding those possible with frequencies above 30 MHz. Ground-wave and sky-wave propagation may be used, according to path distances, electrical properties of the surface, antenna properties and other factors.

2 Ground-wave and sky-wave factors

The distance over which reliable communications can be achieved by the surface, or *ground wave*, depends on the frequency and the physical properties (i.e. ground conductivity and dielectric constant) of the Earth along the transmission path. A ground wave can only be established with useful efficiency where the wavelength is greater than several tens of metres and is therefore a useful method at MF where reliable communications can be achieved over distances of tens to hundreds of km. Reliability can, however, be compromised by interference between ground and sky-wave signals. Particularly at MF, the situation can arise where the ground-wave and sky-wave signals are somewhat equal, giving rise to a possibly quite extensive interference zone. Beyond the interference zone, the sky-wave signal predominates and the ground-wave signal is no longer significant. Often there can be an area where the ground-wave signal is too weak and the distance is too close to the transmitter for a usable sky-wave signal. This situation gives rise to a skip zone, where neither the ground-wave or sky-wave signal is usable – a common occurrence at MF and the lower HF bands. While ground-wave propagation is not particularly time-dependent, usability and quality of service will vary according to overall conditions such as background noise and interference from other stations and sources.

Sky wave may be used for distance ranges up to about 3 000 km using single-hop propagation or as much as 10 000 km using multi-hop propagation. Single-hop propagation using high elevation angles approaching 90° is often referred to as near-vertical-incidence-sky wave (NVIS). NVIS paths range from just beyond the optical line of sight to about 250 km and generally use frequencies below the critical frequency f_o (the highest frequency which will be reflected vertically back to ground by any particular layer of the ionosphere depending on its prevailing condition). To avoid problems caused by short-term ionospheric variations, and to avoid the effects of deviative absorption at frequencies close to the critical frequency, successful NVIS operation will require the use of frequencies up to about 80% of the critical frequency. However, lower frequencies can still be used, depending on the system link budget and, particularly on the high angle performance of the antennas in use.

In practice, the dependence of conditions in the ionosphere on factors such as location, time of day, season of year, and path length, mean that NVIS operation is limited to frequencies below 8 MHz at best and could be less than 3 MHz during high latitude winter nights.

For longer distance coverage higher frequencies using oblique angle reflection from the ionosphere is employed. The maximum usable frequency (MUF) for oblique incidence, is related approximately by to the critical frequency by $MUF = f_o/\cos A$, where A is the angle of incidence of the ray to the predominate reflecting layer of the ionosphere.

Selection of operating frequencies depends on a number of factors, such as equipment, path length, time of day, season, sunspot activity and availability of operating frequencies. If sky-wave propagation is used, the typical procedure is to select an operating frequency as close as possible to the frequency of optimum transmission (FOT), which is commonly taken as 85% of the monthly median value of the MUF for the specified time and path.

In respect of the critical frequency, f_o, the optimum frequency for oblique incidence long range transmission can range from about 10% greater than f_o for the minimum sustainable range of around 200 km up to around three times f_o for the longest sustainable single hop paths.

3 Practical considerations

The need for mobility limits the practical transmitter output power and types of antennas, thus limiting the e.i.r.p. Mobile station transmitter power can range from about 1 W to 1 kW. Practical considerations often require use of short, inductively loaded vertical antennas at mobile stations. Such short antennas have disadvantages including inefficiency, narrow bandwidth and minimum radiation at high elevation angles necessary for NVIS. Base stations generally do not have these limitations and can select antennas most suitable for the paths.

The radio path length in the land mobile services can reach 7 000-10 000 km. In this case the size of the service areas and distance between them are determined by the state of ionosphere, antenna pattern width and working frequency.

4 Technical characteristics

When performing sharing studies, the following technical characteristics of MF/HF land mobile systems should be used.

4.1 Interference criteria

There are many methodologies used to ensure a relative interference-free shared operation between MF/HF land mobile systems. Typical signal-to-noise ratios for the land mobile service:

– 23 dB (analogue voice)

– 9 dB (digital voice)

– 26 dB (high speed data).

4.2 MF/HF land mobile equipment characteristics

Representative characteristics of base stations and mobile units are listed in Table 1.

TABLE 1*

Representative technical characteristics of land mobile systems in the bands between 2 and 30 MHz

	Group A	**Group B**	**Group C**	**Group D**	**Group E**
Type	Base station	Base station	Base station	Base station	Base station
Frequency (MHz)	1.5-30	1.5-30	1.5-30	1.5-30	2-30
Bandwidth (kHz)	2.8	2.8	2.8	2.8	2-3
Transmitter power (dBW)	30-40	1-10	20-25	1-10	1-20
Antenna gain (dBi)	0	0	0	0	–2.5-2.5
Antenna height (m)	10-60	10-60	10-60	10-60	10-60
Antenna type	Co-linear, whip, dipole			Vee	Fan dipole
Polarization	Horizontal and vertical				
Modulation	Analogue or digital, single-sideband suppressed carrier				
Typical minimum path lengths (km)	300-350				

	Group F	**Group G**	**Group H**	**Group I**	**Group J**
Type	Mobile unit	Mobile unit	Mobile unit	Mobile unit	Mobile unit
Frequency (MHz)	1.6-30	1.5-30	1-30	1.6-30	2-30
Bandwidth (kHz)	2-2.3	2.8-3	2.7-3.6	2-3	2-3
Transmitter power (dBW)	1-13	10-30	7	10-27	1-10
Antenna gain (dBi)	–10-0	0-2	2	0-2	–10-2
Antenna height (m)	3-10	3-10	15	3-10	10-20
Antenna type	Whip			Vee	Whip
Polarization	Vertical	Vertical and horizontal	Vertical	Vertical and horizontal	Horizontal
Modulation	Analogue or digital, single-sideband suppressed carrier				
Typical minimum path lengths (km)	300-350				

* These characteristics are not to be used for notifications.