Commonwealth of Australia

Radiocommunications Act 1992

Radiocommunications Advisory Guidelines (Protection of Apparatus-licensed and Class-licensed Receivers — 2 GHz Band) 2000

THE AUSTRALIAN COMMUNICATIONS AUTHORITY makes the following guidelines under section 262 of the *Radiocommunications Act 1992*.

Dated 4 December 2000.

A J Shaw
Chair

G W Luther
Senior Executive Manager
Radiocommunications

Australian Communications Authority

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Clause

BACKGROUND

The Minister has designated parts of the 2 GHz band for re-allocation by the issue of spectrum licences. Receivers of apparatus licensed and class licensed services currently operate in those frequency bands and in adjacent frequency bands. These receivers may suffer interference from unwanted emissions and blocking, caused by a spectrum licensed transmitter. Unwanted emissions are by-products of a transmitter's emissions and include broadband noise, harmonics, intermodulation products, transient signals and other spurious signals. Blocking occurs when a high level off-tune signal overloads a receiver's front-end and causes a degradation in the quality of the wanted output signal. Intermodulation products can be generated in-band in the input stages of receivers in the presence of 2 or more high level signals at the receiver input.

These guidelines have been made for the management of all these types of interference to licensed receivers operating in the following circumstances:

- Point to point fixed services operating in and adjacent to the 2 GHz spectrum licensed bands;
- Mobile Satellite Services (MSS) operating in the bands above 1980 MHz and 2170 MHz, adjacent to the 2 GHz spectrum licensed bands;
- Multipoint Distribution Services (MDS) operating in the band below 2110 MHz;
- Cordless Telecommunications Services (CTS) authorised by apparatus licences or class licences and operating in the band 1880-1900 MHz; and
- Space Services authorised by Apparatus Licences in the 2025-2120 MHz and 2200-2300 MHz bands.

As radio waves propagate in different ways because of factors such as frequency, terrain, atmospheric conditions and topography, there are a number of ways to predict path loss, in addition to those discussed in RALI FX-3. Some suitable propagation models appropriate to the 2 GHz bands and various system types are set out in the Schedule.

PART 1—INTRODUCTION

Title

1.1. These guidelines are called the *Radiocommunications Advisory Guidelines (Protection of Apparatus-licensed and Class-licensed Receivers—2 GHz Band) 2000.*

Commencement

1.2. These guidelines commence on 4 December 2000.

Purpose of these guidelines

1.3. (1) The purpose of these guidelines is to manage interference by providing for the protection of receivers of apparatus licensed or class-licensed services operating in or adjacent to the 2 GHz band.

(2) The ACA will take these guidelines into account in determining whether a spectrum licensed transmitter is causing interference to an apparatus licensed or class-licensed receiver operating in the circumstances set out in these guidelines. These guidelines do not prevent a licensee negotiating other protection requirements with another licensee.

Interpretation

1.4. (1) In these guidelines, unless the contrary intention appears:

Act means the *Radiocommunications Act 1992.*

designation, for spectrum space, means a declaration made under subsection 153B(1) of the Act to subject parts of the spectrum in designated areas to re-allocation by the issue of spectrum licences.

HAPS means a high altitude platform station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the earth (see Radio Regulations No.S1.66A).

in-band means:

(a) for a transmitter operated under a spectrum licence, or for a receiver operated within the space of a spectrum licence—the frequencies within the frequency band to which the licence relates: and

(b) for a transmitter or a receiver operated under an apparatus licence—the frequencies within the lower and upper frequency limit of its spectrum access.

incumbent, for a receiver, means a receiver that has part of the frequency band of its spectrum access, and its location, within the 2 GHz band when that band was designated.

ITU means the International Telecommunication Union.

ITU Recommendation means a Recommendation made by the ITU.

Marketing Plan means the *Radiocommunications Spectrum Marketing Plan (2 GHz Band) 2000.*

RALI FX-3 means the Radiocommunications Assignment and Licensing Instruction No. FX-3 issued by the ACA, as in force from time to time, copies of which are available from the ACA.

RALI MS-25 means the Radiocommunications Assignment and Licensing Instruction No. MS-25 issued by the ACA, as in force from time to time, copies of which are available from the ACA.

section 145 determination means the *Radiocommunications (Unacceptable Levels of Interference—2 GHz Band) Determination 2000.*

2 GHz band means the following frequency bands:

(a) 1900 MHz – 1920 MHz (the 2 GHz Lower Band)
(b) 1920 MHz – 1980 MHz (the 2 GHz Upper Band A)
(c) 2110 MHz – 2170 MHz (the 2 GHz Upper Band B).

[NOTES: 1. The following terms, used in this determination, are defined in the *Radiocommunications Act 1992* and have the meanings given to them by that Act:

ACA	frequency band
interference	spectrum licence
transmitter.]	

(2) A term used in these guidelines that is defined in the s.145 determination has the same meaning as in that determination.

Propagation models

1.5. The propagation models set out in the Schedule may assist in establishing the protection requirements in these Guidelines.

PART 2– POINT TO POINT FIXED SERVICE RECEIVERS

Background

2.1. This Part applies to point to point fixed services operating in and adjacent to the 2 GHz band.

2.2. The fixed services channelling arrangements around the 2 GHz bands that need to be considered in the compatibility requirements are:

- The “2.1 GHz channelling plan”, which supports use by medium capacity fixed point to point links in line with ITU-R Recommendation F-382. The band operates from just below 1900 MHz to about 2300 MHz and contains 6 main and 6 interleaved 29 MHz channels with a 213 MHz paired spacing. A number of channels in this band are affected by the 2 GHz spectrum-licensing proposals.
- The “1.8 GHz channelling plan”, which supports use by low to medium capacity fixed point to point links in line with ITU-R F-283. The band operates from

1700 MHz to about 1907.5 MHz and contains 6 main and 6 interleaved 14 MHz channels with a 119 MHz paired spacing. Channel 5'I, 6' and 6I' are affected by the 2 GHz licensing. The *1.9 GHz Band Plan (1996)* prohibits the issue of new licences in the 1880-1900 MHz band.

- The ITU-R F-1098 channelling plan proposed by the ACA to be introduced in the near future to assist in the relocation of the 2.1 GHz channels. Channels adjacent to the 2110 MHz spectrum licence boundary need to be considered in the interference management framework.

2.3. For managing interference caused by transmitters operating under spectrum licences, receivers of fixed services operating in the 2 GHz band, belong to one of the following categories:

- ***Category 1*** *covers* incumbent receivers; and

- ***Category 2*** covers a receiver that is not an incumbent receiver and whose apparatus licence was issued before the date of issue of the *Radiocommunications Spectrum Marketing Plan (2 GHz Band) 2000*; and

- ***Category 3*** covers a receiver that is not an incumbent receiver and whose apparatus licence was issued after the date of issue of the *Radiocommunications Spectrum Marketing Plan (2 GHz Band) 2000*.

2.4. Fixed services in the above bands are licensed in accordance with the frequency assignment criteria in RALI FX-3. This provides details about channel plans for individual microwave bands and guidance on interference criteria and frequency coordination between microwave links to achieve certain performance objectives. It provides assignment criteria for each frequency band and specifies protection ratios. In bands that are shared with other services, e.g. fixed satellite and cordless systems, RALI FX-3 directs the reader to other relevant RALIs or guidelines for additional coordination criteria and advice. The criteria are typically based on internationally accepted ITU recommendations.

2.5. RALI FX-3 is subject to continuing review in consultation with industry, to incorporate improved assignment techniques and changing technology requirements. Particular account is taken of changes in ITU recommendations and standards made by other bodies. As revisions seek to improve spectrum access opportunities, without undue detriment to current licensees, users of the RALI are urged to consult the current version when planning systems, to increase spectrum productivity.

Protection requirements

2.6 (1) The protection requirements for fixed services are specified in RALI FX-3. In planning for the operation of transmitters under a spectrum licence, spectrum licensees are to provide the same level of out-of-band and in-band protection from those transmitters as would be provided from apparatus licensed fixed service transmitters whose frequencies are assigned in accordance with RALI FX-3.

(2) For the categories of fixed service receivers listed in clause 2.2:

Category 1 receivers are to be provided with out-of-band and in-band protection from interference for the re-allocation period set out in the re-allocation declaration made under subsection 153B(1) of the Act for the 2 GHz band; and

Category 2 receivers are to be provided with continuing out-of-band and in-band protection from interference for the full period of the spectrum licence; and

Category 3 receivers:
(a) are to be provided with out-of-band protection from interference caused by frequency adjacent transmitters that were registered after the issue date of the apparatus licence under which the receiver operates; and
(b) are required to accept levels of in-band emissions from a device operated under a spectrum licence, if the device is operated in accordance with the core conditions of the licence and the relevant s.145 determination of unacceptable levels of interference.

PART 3– MOBILE SATELLITE SERVICE

Background

3.1. The Mobile Satellite Service (MSS) is allocated in the bands 1980-2010 MHz (Earth to space) and 2170-2200 MHz (space to Earth). At the time of this guideline issue, no MSS services were licensed in these bands in Australia.

3.2. It is anticipated that the operation of the MSS systems in these bands will be authorised in the near future by the apparatus licensing of the space stations and the class licensing of the mobile earth stations (MES). This is in line with similar arrangements for MSS and some fixed satellite services in other bands.

3.3. (1) The interference management issues for MSS are:

- For 2 GHz mobile terminal transmit compatibility with MSS satellite receivers in the adjacent band 1980-2010 MHz, at the 1980 MHz boundary: the 2 GHz spectrum licence core conditions are considered adequate for the provision of reasonable spectrum access by the MSS in this band.

- For 2 GHz base station transmit compatibility with MES receivers in the adjacent band 2170-2200 MHz, at the 2170 MHz boundary, the following factors are relevant:
  - the anticipated low density of MSS subscribers, compared with likely 2 GHz users;
  - the expectation that most MSS use would be in regional / remote areas. In areas where terrestrial systems were deployed, it is likely that the terminal would default to the terrestrial system in many instances; and
  - automatic frequency assignment techniques that lessen interference.

(2) For spectrum licensed terrestrial transmitters in the 2 GHz band, the conditions established in the spectrum licence are adequate protection for the MSS. For

HAPS transmitters, regard should also be paid to the requirements of ITU-R Recommendations M-1456 for the protection of MES earth terminals.

Protection Requirements

3.4. The ACA would not regard interference to MSS satellite receivers operating in the band 1980-2010 MHz as unacceptable if the spectrum licensee complies with all relevant conditions of the spectrum licence.

3.5. The ACA would not regard interference to MSS earth station receivers operating under a class licence in the band 2170-2200 MHz as unacceptable if the spectrum licensee complies with all relevant conditions of the spectrum licence for terrestrial transmitters. For HAPS transmitters operating as base stations, the requirements of Recommends 4 of ITU-R Recommendation M-1456 "*Minimum performance characteristics (HAPS) and operational conditions for High Altitude Platform Stations providing IMT-2000 in the bands 1885-1980 MHz, 2010-2025 MHz and 2110-2170 MHz in Regions 1 and 3 and 1885 -1980 MHz and 2110 -2160 MHz in region 2*", apply.

PART 4– MULTIPOINT DISTRIBUTION SYSTEMS

4.1. A multipoint distribution system (MDS) is a fixed service comprising at least one multipoint distribution station (a transmitting station), four multipoint distribution station receivers and any number of multipoint distribution repeater stations. The frequency band relevant to these Guidelines is the MDS "A" band at 2076-2111 MHz, adjacent to and partially overlapping the IMT-2000 band above 2110 MHz.

4.2. The MDS allocation in this band is prescribed in the *MDS Band Plan 2000*. This plan provides that the MDS allocation will terminate on 25 July 2002, well before the earliest re-allocation date possible for the 2 GHz spectrum licensed bands. MDS services will require protection from spectrum licensed services up to 25 July 2002.

4.3. Under the technical framework for MDS, hub transmitters servicing an area are required to be co-sited and to transmit at the same power level. This approach combined with appropriate subscriber receiver performance, enables adjacent MDS channels to be used at any particular location. This framework was used in allocating MDS apparatus licences. The protection level for MDS receivers currently established in various MDS legal instruments is 32 dBμV/m.

Protection requirements

4.4. In planning for the operation of transmitters under a spectrum licence, spectrum licensees will be required to provide a level of protection of 32 dBμV/m to licensed MDS services until 25 July 2002.

PART 5– CORDLESS TELECOMMUNICATIONS SERVICES

Background

5.1. Cordless Telephone Services (CTS) operate in the frequency band 1880-1900 MHz in accordance with the *1.9 GHz Band Plan 1996*. This band is adjacent to the 2 GHz band. Technologies which may operate in the 1.9GHz band[1] are those complying with the Digital Enhanced Cordless Telecommunications (DECT) and the Japanese Personal Handyphone Service (PHS) standards[2]. Typical CTS applications, referred to as "private CTS" and for which radiocommunications licensing arrangements are established, include domestic and business telephones, wireless PABX and wireless local area networks. These CTS technologies may also be used for wireless local loop (WLL) applications (also called fixed wireless access FWA). There are currently no WLL systems in operation and suitable licensing arrangements for these "public CTS" applications would be developed if there is demand for this service.

5.2. The following licensing arrangements apply to the operation of private CTS in the 1.9 GHz band:

Until 30 June 2001. All CTS base station operations must be authorised by apparatus licences. The issue of a licence is subject to successful frequency coordination with fixed service point-to-point link receivers operating in the same band. CTS handset and other terminal operation connected with an apparatus licensed base station is authorised by the *Radiocommunications Class Licence (Cordless Telecommunications Devices) 1999.* The licensing arrangements and frequency coordination procedure are described in the ACA RALI MS-25.

From 1 July 2001. Apparatus licensing of private CTS base stations will not be required from 1 July 2001. Fixed service receivers will no longer be protected from CTS. Ongoing operation of all private CTS devices in this band will be authorised by a class licence. The class licence will require compliance with relevant CTS standards. There will be no requirement (or capability) for individual CTS frequency coordination with fixed services or with spectrum licensed services under the class licence.

5.3. A potential interference situation exists between uncoordinated DECT or PHS stations and time division duplex (TDD) technologies, the equipment most likely to be used in the adjacent 2 GHz band, as follows:

- Interference between DECT and 2 GHz spectrum licensed systems is very unlikely to occur, mainly due to the inherent wide separation between the two closest radiofrequency carriers of each technology. Where two stations are in very close proximity, DECT dynamic frequency selection (DFS) would assist in minimising interference.

- Interference between PHS and 2 GHz spectrum licensed systems is possible, mainly in the case of 2 GHz mobile interference to PHS base receivers when in close proximity. In particular, blocking of the two PHS fixed control channels[3] would

[1] As at September 2000.

[2] ACA Standards TS-028 and TS -034. The DECT standard supports operation over the entire 1880-1900 MHz band, whilst the PHS standard restricts operation to 1895-1900 MHz.

[3] At date of issue of this guideline, PHS control channels are located at 1898.45 MHz (channel 16) and 1899.65 MHz (channel 18).

negate the benefit of the DFS feature of the PHS traffic channels and in effect prevent the operation of the base station. To assist in minimising the effects of this interaction:

– more severe out of band core condition limits will apply to 2 GHz spectrum licensed services at the 1900 MHz frequency boundary than at other frequencies; and
- reduced in-band power limits will apply to 2 GHz mobile transmitters in the immediate 500 kHz above 1900 MHz. This limit is included as a deployment constraint in the section 145 Determination.

The inclusion of PHS in the new class licence will rely on the implementation of modifications, such as relocating the fixed control channels to the lower part of the PHS operating band, or an equivalent solution.

Protection requirements

5.4. The ACA would not regard interference to a private CTS device in the 1.9 GHz band as unacceptable if the spectrum licensee complies with all relevant conditions of the spectrum licence.

PART 6– SPACE SERVICES

Background

6.1. The band 2025-2110 MHz is allocated to Space Services (Earth to space, space to space) and to the Space Research Service (deep space, Earth to space) in the 2110-2120 MHz band, as well as to other services. Licensed space service segment receivers in these bands are protected in accordance with relevant ITU-R Recommendations. The ACA has taken account of interference studies of the interference into these space services from 2 GHz mobile systems. Based on these, the risk of interference to these space services is very slight, even from high-density mobile systems.

6.2. The band 2200-2290 MHz is allocated to the Space Services (space to Earth, space to space) and to the Space Research Service (deep space, space to Earth) in the 2290-2300 MHz band, as well as to other services. Earth stations of these services operate[4] in the Canberra region (at Tidbinbilla), in WA (at New Norcia and Gnangara) and in Tasmania. Spectrum licensees at 2 GHz are required to protect these stations in accordance with relevant ITU-R Recommendations. In particular, spectrum licensees implementing HAPS based services should pay regard to the location of these stations. Because of the 30 MHz isolation between the spectrum licensed and these space service bands due to MSS allocations, terrestrial IMT interference to space service earth stations is very unlikely. The ACA encourages direct liaison between spectrum licensees and space station operators during the system planning phases of spectrum licence usage when near these stations.

Protection requirements

[4] At date of issue of this guideline.

6.3. The protection requirements for Space Service station receivers operating in the bands 2025-2120 MHz and 2200-2300 MHz are set out in the following ITU-R Recommendations:

- ITU-R Recommendation SA.1154: Provisions to protect the Space Research (SR), Space Operations (SO) and Earth Explorations Satellite Services (EES) and to facilitate sharing with the Mobile Service in the 2025-2110 MHz and 2200-2290 MHz bands.
- ITU-R Recommendation SA.363-5: Space operation systems frequencies, bandwidths and protection criteria.
- ITU-R Recommendation SA 1157: Protection criteria for deep-space research.

Additional Information on Space Service Protection

6.4. The following ITU Recommendations are relevant to, and provide information on, the prediction of appropriate coordination distances, propagation models, threshold coordination levels, and earth station receiver and antenna characteristics. These may assist in assessing compliance with interference criteria:

- ITU Recommendation M-1456: Minimum performance characteristics (HAPS) and operational conditions for High Altitude Platform Stations providing IMT-2000 in the bands 1885-1980 MHz, 2010-2025 MHz and 2110-2170 MHz in Regions 1 and 3 and 1885 -1980 MHz and 2110 -2160 MHz in region 2.
- ITU Recommendation IS.849: Determination of the coordination area for earth stations operating with non-geo-stationary spacecraft in bands shared with terrestrial services.
- ITU Recommendation IS.847: Determination of the coordination area of an earth station operating with a geostationary space station and using the same frequency band as a system in a terrestrial service.

SCHEDULE

Clause 1.5

PROPAGATION MODELS

Introduction

A number of propagation models have been developed to estimate the path loss between a transmitter and receiver. The choice of a particular propagation model will depend on a number of factors such as the terrain between the radio path end points, any obstructions on the path either natural or man-made, the heights of the transmit and receive antennas, and the limitations of applicability of the various propagation models.

ITU Recommendation P.1144 gives a guide on the applications of the various propagation methods developed internationally by the ITU. Table 1 is an extract of the 1995 issue of ITU Recommendation P.1144 and provides a summary of the ITU propagation models relevant to services operating in the 2 GHz bands. The models provide an estimation of either path loss or received field strength.

Most models include statistical evaluation of path loss or signal levels expected at certain percentages of locations for certain percentages of times. Some propagation models produce a result that represents the median signal level. The median signal level corresponds to a level that is exceeded 50% of the time in 50% of locations. The median level is useful for estimating coverage. It is not suitable for interference calculations as interference for 50% of the time is generally considered unacceptable. Therefore, care must be taken when using propagation models to predict interference levels to ensure that the result represents the signal level exceeded for a sufficiently small percentage of locations for a sufficiently low percentage of time, as appropriate for the circumstance. Median signal levels may be converted to other time and location percentages (eg, 1% of the time and 10% of locations) by applying appropriate correction factors.

Propagation models

Propagation models can be classified into two different types; point-to-point and point-to-area.

Point-to-Point Models

Point-to-point models allow the prediction of path loss between a fixed transmitter and a fixed receiver. Two of the main propagation modes are:

- free space loss (line-of-sight); and
- diffraction loss including smooth earth diffraction and diffraction over obstacles and irregular terrain (knife-edge diffraction).

The free space loss propagation model is usually used where paths are line-of-sight and there are no obstructions within the first Fresnel zone for a given k-factor. This usually occurs with services located on high sites such as mountain tops, towers or buildings.

The diffraction loss propagation model is typically used where paths are obstructed by the earth's curvature or terrain. The model gives a loss due to diffraction which must be added to the free space loss to give the total path loss.

A plot of the terrain profile is usually generated to determine which propagation model is most appropriate to a particular propagation path.

Information on how to determine propagation losses due to free space and diffraction over a spherical earth, obstacles and irregular terrain can be found in ITU-R Recommendation P.526. Additional propagation loss due to effects such as tropospheric scatter, ducting, layer reflections and clutter can be found in ITU-R Recommendation P.452. The ITU has available a computer program to predict propagation loss in accordance with ITU-R Recommendation P.452.

Point-to-Area Models

Point-to-area models provide for the prediction of field strength levels in a geographic area from a base station transmitter. They are useful for estimating the coverage area of base stations in which receivers are to be protected from interference and to estimate interference to mobile receivers from other services. They are statistical in nature and usually based on the statistical analysis of measured data and take into account factors such as Raleigh fading, shadowing and clutter loss.

ITU-R Recommendation P.529 provides guidance on the prediction of field strength for the land mobile service in the VHF and UHF bands. It contains curves for predicting median field strengths for 50% of locations for 50% of the time under average conditions. It also provides various correction factors which can be used to refine the average predictions to take account of the terrain. The curves are based on measurements made by Okamura and Hata in Japan. They are normally applied to mobile applications where the base station antenna is high and the mobile antenna is low (typically 1.5 metres above ground). Correction factors can be applied to the curves to accommodate other percentages of time and percentages of locations.

Other point-to-area models such as those developed by Hata (Okumura) or Longley-Rice may also be appropriate as they include factors for clutter (buildings, trees etc) with low receive antenna heights. The Hata model also makes allowance for the difference in path losses between urban, suburban and rural areas. The Hata model was derived from experiments measuring signal levels of land mobile services in Japan, so care must be taken when applying it to Australian environments.

It should be noted that there are significant restrictions in the range of applicability of the Hata model as it is:

- limited to propagation paths up to 20 km in length; and

- limited in the range of valid antenna heights: the low antenna must be in the range 1 to 10 m; and the high antenna must be in the range 30 to 200 m. It should be noted that the Hata model does not take into account specific path variations, so the antenna

heights used should be the effective height above the surrounding terrain and not solely the antenna height above ground level.

The Modified Hata model (ITU-R Report 567-4) extends the path length range to 100 km.

TABLE 1

ITU-R Propagation Prediction Methods for the 1800 MHz Frequency Bands

Method	Application	Type	Output	Frequency	Distance	% time	% location	Terminal height	Input data
Rec. ITU-R P.370	Broadcasting	Point-to-area	Field strength	30 MHz to 1000 MHz	10 to 1 000 km	1, 5, 10, 50	1 to 99	*Tx:* effective height from less than 0 m to greater than 1 200 m *Rx:* 1.5 to 40 m	Distance Tx antenna height Frequency Percentage time Rx antenna height Terrain clearance angle Terrain irregularity Percentage locations
Rec. ITU-R P.452	Services employing stations on the surface of the Earth; interference and coordination	Point-to-point	Path loss	700 MHz to 30 GHz	Not specified but up to and beyond the radio horizon	0.001 to 50 Average year and worst month	Not applicable	No limits specified	Path profile data Frequency Percentage time Tx antenna height Rx antenna height Latitude and longitude of Tx Latitude and longitude of Rx Meteorological data
Rec. ITU-R P.526	Fixed	Point-to-point	Field Strength	Not specified but generally >30 MHz	Not specified but up to and beyond the radio horizon	Not specified but dependent on k-factor chosen	Not applicable	No limits specified	Path profile data Frequency Tx antenna height Rx antenna height Latitude and longitude of Tx Latitude and longitude of Rx Meteorological data

Rec. ITU-R P.528	Aeronautical mobile	Point-to-area	Path loss	125 MHz to 15 GHz	0 to 1 800 km (For aeronautical applications 0 km horizontal distance does not mean 0 km path length)	5, 50, 95	Not applicable	H1: 15 m to 20 km H2: 1 to 20 km	Distance Transmitter height Frequency Receiver height Percentage time
Rec. ITU-R P.529	Land mobile	Point-to-area	Field strength	30 MHz to 3 GHz (Limited application above 1.5 GHz)	VHF: 10 to 600 km UHF: 1 to 100 km	VHF: 1, 10, 50 UHF: 50	Unspecified	Base: 20 m to 1 km Mobile: 1 to 10 m	Distance Base antenna height Frequency Mobile antenna height Percentage time Ground cover
Rec. ITU-R P.530	Line-of-sight Fixed links	Point-to-point Line-of-sight	Path loss Diversity improvement (clear air conditions) XPD	Approximately 150 MHz to 40 GHz	Up to 200 km	All percentages of time in clear-air conditions; 1 to 0.001 in precipitation conditions	Not applicable	High enough to ensure specified path clearance	Distance Transmitter height Frequency Receiver height Percentage time Path obstruction data Climate data
Rec. ITU-R P.617	Trans-horizon fixed links	Point-to-point	Path loss	>30 MHz	100 to 1 000 km	20, 50, 90, 99, and 99.9	Not applicable	No limits specified	Frequency Tx antenna gain Rx antenna gain Path geometry
Rec. ITU-R P.618	Fixed satellite	Point-to-point	Path loss. Diversity gain and (for precipitation condition) XPD	1 to 30 GHz	Any practical orbit height	0.001, 0.01, 0.1, and 1 (for both rain attenuation and XPD)	Not applicable	No limit	Meteorological data Frequency Elevation angle Height of earth station Separation and angle between earth station sites (for diversity gain) Antenna diameter and efficiency (for scintillation) Polarization angle (for XPD)

Rec. ITU-R P.620	Earth station frequency coordination	Coordination distance	Distance of which the required pro-pagation loss is achieved	1 to 40 GHz	100 to 1 200 km	0.001 to 1	Not applicable	No limits specified	Frequency Percentage of time Earth-station elevation angle
Rec. ITU-R P.681	Land mobile satellite	Point-to-point	Path fading Fade duration Non-fade duration	0.8 to 3 GHz	Any practical orbit height	Not applicable Percentage of distance travelled 1 to 20%	Not applicable	No limit	Frequency Elevation angle Percentage of distance travelled Approximate level of optical shadowing
Rec. ITU-R P.1146	Land mobile Broadcasting	Point-to-area	Field strength	1 to 3 GHz	1 to 500 km	1 to 99	1 to 99	Tx: ≥ = 1 m Rx: 1 to 30 m	Distance Frequency Tx antenna height Rx antenna height Percentage time Percentage location Terrain information