

RECOMMENDATION ITU-R S.1340*

**SHARING BETWEEN FEEDER LINKS FOR THE MOBILE-SATELLITE SERVICE
AND THE AERONAUTICAL RADIONAVIGATION SERVICE IN THE
EARTH-TO-SPACE DIRECTION IN THE BAND 15.4-15.7 GHz**

(Question ITU-R 243/4)

(1997)

The ITU Radiocommunication Assembly,

considering

- a) that Resolution 117 of the World Administrative Radio Conference (Geneva, 1995) (WARC-95) calls for studies by the ITU-R of the sharing situation between feeder links (Earth-to-space) for the mobile-satellite service (MSS) and the aeronautical radionavigation service in the band 15.45-15.65 GHz;
- b) that the band 15.4-15.7 GHz is allocated to the aeronautical radionavigation service on a primary basis and that No. 953 (S4.10) of the Radio Regulations (RR) applies;
- c) that the WRC-95 has added an allocation to the fixed-satellite service (FSS) in the band 15.45-15.65 GHz for feeder links of non-geostationary (non-GSO) satellite networks in the MSS in the Earth-to-space direction;
- d) that the requirements for feeder links (Earth-to-space) of non-GSO satellite systems in the MSS need to be accommodated in this band;
- e) that emissions from stations in the aeronautical radionavigation service can cause unacceptable interference to satellites;
- f) that administrations operating stations in the aeronautical radionavigation service are urged to limit the average e.i.r.p. to 42 dBW in order to limit interference to non-GSO satellites; this value is subject to review and study by the ITU-R (see RR No. S5.511C);
- g) that coordination of emissions from aeronautical radionavigation stations with feeder-link space stations is not considered practical;
- h) that emissions from feeder-link earth stations propagated along the Earth's surface can cause harmful interference to aeronautical radionavigation stations;
- j) that certain limitations have been placed on the fixed-satellite service for the protection of the aeronautical radionavigation service in accordance with RR No. S5.511C;
- k) that there is fairly extensive use of this band by the aeronautical radionavigation service for airborne, land and ocean based stations;
- l) that aircraft stations are not permitted to transmit in the band 15.45-16.45 GHz in accordance with RR No. S5.511B;
- m) that the technical and operational characteristics of the aeronautical radionavigation stations are reasonably well known;
- n) that the technical and operational characteristics of feeder links are not well defined;
- o) that methods are needed to determine the coordination and separation distances required between feeder-link earth stations and aeronautical radionavigation stations in order to protect the aeronautical radionavigation stations;
- p) that studies have been made with respect to the preceding *considerings*,

* This Recommendation should be drawn to the attention of Radiocommunication Study Group 8.

recommends

- 1 that feeder links for the MSS should be limited to the band 15.43-15.63 GHz (see Note 1);
- 2 that the emissions expressed as effective e.i.r.p. (E_{eff}) from aeronautical radionavigation stations should not exceed the following:

- 2.1 for aircraft landing systems and for feeder-link bandwidths greater than 3 MHz:

$$E_{eff} = \begin{cases} 53 & \text{dBW} & \text{for } 0 \leq \varphi < 8 \\ 53 - 0.833(\varphi - 8) & \text{dBW} & \text{for } 8 \leq \varphi < 14 \\ 48 & \text{dBW} & \text{for } 14 \leq \varphi < 32 \\ 48 - 9(\varphi - 32) & \text{dBW} & \text{for } 32 \leq \varphi < 34 \\ 30 & \text{dBW} & \text{for } 34 \leq \varphi < 40 \\ 30 - 0.2(\varphi - 40) & \text{dBW} & \text{for } 40 \leq \varphi \leq 90 \end{cases}$$

- 2.2 for general purpose aircraft radars and for feeder-link bandwidths greater than 1 MHz:

$$E_{eff} = \begin{cases} 62 & \text{dBW} & \text{for } 0 \leq \varphi < 20 \\ 62 - 0.56(\varphi - 20)^2 & \text{dBW} & \text{for } 20 \leq \varphi < 25 \\ 48 & \text{dBW} & \text{for } 25 \leq \varphi < 29 \\ 71.86 - 25 \log(\varphi - 20) & \text{dBW} & \text{for } 29 \leq \varphi < 68 \\ 29.8 & \text{dBW} & \text{for } 68 \leq \varphi \leq 90 \end{cases}$$

where:

$$E_{eff} = E_p - 15 \log(1 + 5/PW) \quad \text{dBW}$$

E_{eff} : e.i.r.p. which causes the same level of interference to a phase modulated signal as a continuous noise like interferer

E_p : peak pulse e.i.r.p. (dBW) of the aeronautical radionavigation station

PW : pulse duration (μ s) of the aeronautical radionavigation station

φ : angle of elevation (degrees) above the local horizontal plane;

- 3 that feeder links in the Earth-to-space direction should be designed to operate in the interference environment defined in *recommends* 2;
- 4 that with *recommends* 2 and 3 coordination of emissions from aeronautical radionavigation stations with satellite receiving stations is not required;
- 5 that the e.i.r.p. transmitted toward the local horizontal plane by a feeder-link earth station should not exceed 54 dB(W/MHz) (see Note 2);
- 6 that surface based radars as described in Annex 1 should not operate in the 15.43-15.63 GHz band;
- 7 that the coordination distances required to protect the aeronautical radionavigation stations from harmful interference from feeder-link earth station emissions are:
 - 515 km from the aircraft landing surface for aircraft landing systems (ALS);
 - 600 km from aircraft using general purpose radars (MPR);
 - 270 km from the aircraft landing for radar sensing and measurement systems;
- 8 that additional information is contained in Annexes 1, 2 and 3.

NOTE 1 – The frequency band given in *recommends* 1 is slightly different to that allocated by the WRC-95. This difference is recommended to facilitate sharing between the non-GSO MSS feeder links and the aeronautical radionavigation service. *Recommends* 1 will be reviewed at a later date in accordance with the outcome of a future WRC.

NOTE 2 – Additional design and operational constraints may be placed on MSS Earth-to-space feeder links in order to take into account the threshold levels for the radio astronomy service given in Recommendation ITU-R RA.769.

ANNEX 1

Aeronautical radionavigation systems in the 15.4-15.7 GHz band**1 Surface based radars (SBR)**

The land and ship based SBR are used for the detection, location and movement of aircraft and other vehicles on the surface of airports and other aircraft landing areas.

1.1 Antenna patterns

- Nominal 3 dB beamwidth: $<3.5^\circ$ vertical, inverted cosecant to -31°
 0.35° horizontal
- Frequency range: 15.65-16.7 GHz
- Polarization: circular
- Typical gain: 43 dBi
- Maximum side-lobe level: 25 dB below peak gain
- Maximum back-lobe level: 35 dB below peak gain
- Vertical tilt range: $\pm 1.5^\circ$
- Maximum horizontal scan range: 360° .

1.1.1 Antenna elevation envelope pattern

Based on measured data and side-lobe level specifications and with the peak gain directed at $+1.5^\circ$, an elevation envelope gain pattern is defined as follows where φ is the elevation angle (degrees):

$$G(\varphi) = \begin{cases} 43 & \text{dBi} & \text{for } 0 \leq \varphi < 4 \\ 43 - 5(\varphi - 4) & \text{dBi} & \text{for } 4 \leq \varphi < 9 \\ 18 & \text{dBi} & \text{for } 9 \leq \varphi < 16 \\ 43.2 - 21 \log \varphi & \text{dBi} & \text{for } 16 \leq \varphi < 48 \\ 8 & \text{dBi} & \text{for } 48 \leq \varphi \leq 90 \end{cases}$$

1.1.2 Antenna azimuth envelope pattern

Based on measured data and side-lobe level specifications, the azimuth gain pattern is defined as follows where x is the relative azimuth angle (degrees):

$$G(\varphi) = \begin{cases} 43 - 110 \varphi^2 & \text{dBi} & \text{for } 0 \leq \varphi < 0.4767 \\ 18 & \text{dBi} & \text{for } 4.4767 \leq \varphi < 0.72 \\ 17.07 - 6.5 \log \varphi & \text{dBi} & \text{for } 0.72 \leq \varphi < 48 \\ 8 & \text{dBi} & \text{for } 48 \leq \varphi \leq 180 \end{cases}$$

1.2 Other characteristics**1.2.1 Transmitting**

- Peak e.i.r.p.: 86 dBW
- Pulse repetition frequency: 8 192 Hz
- Pulse duration: 0.04 μ s
- Pulse 3.5 dB bandwidth: 25 MHz.

1.2.2 Receiving

- Typical antenna gain: 43 dBi
- Typical noise figure: 6.2-6.9 dB.

2 Aircraft landing systems (ALS)

These ALS are general purpose systems and are used on ships, as portable or permanent land based systems and for shuttle landings. The microwave scanning beam landing system (MSBLS) is one such system. Some of the characteristics vary with the particular applications.

2.1 Surface based station antenna patterns

The antenna patterns are similar for all applications including the MSBLS. The scanning ranges vary with application. The scanning ranges given below cover all applications.

The antenna complement of the ALS consists of an elevation antenna and an azimuth antenna.

The elevation antenna portion of the ALS is used to transmit vertical angle data to the aircraft.

- nominal 3 dB beamwidths: 1.3° vertical
40° horizontal
- frequency range: 15.4-15.7 GHz
- polarization: horizontal and vertical
- typical gain: 28 dBi
- maximum side-lobe level: 17 dB below peak gain in both planes
- maximum vertical scan range: 0 to 30°.

The azimuth antenna portion of the ALS is used to transmit azimuth information to the aircraft.

- nominal 3 dB beamwidths: 2.0° horizontal
6.5° vertical
- the vertical pattern is spoiled to achieve at least a 20 dBi gain at 20° above the horizon
- frequency range: 15.4-15.7 GHz
- polarization: horizontal and vertical
- typical gain: 33 dBi
- maximum side-lobe level: 17 dB below peak gain in both planes
- maximum horizontal scan range: $\pm 35^\circ$.

2.1.1 Combined antenna elevation envelope pattern

A combined vertical envelope gain pattern based on measured data is defined as follows where φ is the elevation angle (degrees):

$$G(\varphi) = \begin{cases} 33 & \text{dBi} & \text{for } 0 \leq \varphi < 8 \\ 33 - 0.833 (\varphi - 8) & \text{dBi} & \text{for } 8 \leq \varphi < 14 \\ 28 & \text{dBi} & \text{for } 14 \leq \varphi < 32 \\ 28 - 9 (\varphi - 32) & \text{dBi} & \text{for } 32 \leq \varphi < 34 \\ 10 & \text{dBi} & \text{for } 34 \leq \varphi < 40 \\ 10 - 0.2 (\varphi - 40) & \text{dBi} & \text{for } 40 \leq \varphi \leq 90 \end{cases}$$

2.1.2 Azimuth antenna patterns

The azimuth envelope pattern of the elevation antenna is defined as follows where φ is the relative azimuth angle (degrees):

$$G(\varphi) = \begin{cases} 28 - 0.0062 \varphi^2 & \text{dBi} & \text{for } 0 \leq \varphi < 70 \\ -2.37 & \text{dBi} & \text{for } 70 \leq \varphi \leq 180 \end{cases}$$