

RESOLUTION 166 (WRC-19)

**Use of the frequency band 24.25-27.5 GHz by high-altitude platform stations
in the fixed service in Region 2**

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

- a) that there is a need for greater broadband connectivity in underserved communities and in rural and remote areas;
- b) that WRC-15 invited the ITU Radiocommunication Sector (ITU-R) to study additional spectrum needs for fixed high-altitude platform station (HAPS) links to provide broadband connectivity and to facilitate the use of HAPS links on a global or regional basis, recognizing that the existing HAPS identifications were established without reference to today's broadband capabilities;
- c) that HAPS can provide broadband connectivity with minimal ground network infrastructure;
- d) that ITU-R has conducted studies dealing with compatibility between HAPS systems and systems in existing services in the frequency band 24.25-27.5 GHz and in the adjacent band in Region 2, leading to Report ITU-R F.2472-0,

considering further

that current technologies can be used to deliver broadband applications by HAPS, which can provide broadband connectivity and disaster-recovery communications with minimal ground network infrastructure,

recognizing

that, in the frequency bands 24.75-25.25 GHz and 27.0-27.5 GHz, with respect to earth stations in the fixed-satellite service (FSS) (Earth-to-space) and HAPS ground station receivers which operate in the fixed service, No. 9.17 applies,

resolves

1 that, for the purpose of protecting fixed-service systems in the territory of other administrations in the frequency band 27-27.5 GHz, the power flux-density (pfd) level per HAPS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, developed for clear-sky conditions, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

0.39 θ – 132.12	dB(W/(m ² · MHz))	for	$0^\circ \leq \theta < 13^\circ$
2.715 θ – 162.3	dB(W/(m ² · MHz))	for	$13^\circ \leq \theta < 20^\circ$
0.45 θ – 117	dB(W/(m ² · MHz))	for	$20^\circ \leq \theta < 60^\circ$
–90	dB(W/(m ² · MHz))	for	$60^\circ \leq \theta \leq 90^\circ$

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees.

RES166-2

During periods of rain, the equivalent isotropically radiated power (e.i.r.p.) of the beam suffering rain fade may be increased by a level commensurate with the level of rain fade, by up to 20 dB above the e.i.r.p. associated with the above pfd mask at the surface of the Earth;

2 that, for the purpose of protecting mobile-service systems in the territory of other administrations in the frequency band 24.25-25.25 GHz, the pfd level per HAPS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, developed for clear-sky conditions, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

-110.3	dB(W/(m ² · MHz))	for	0° ≤ θ ≤ 4°
-110.3 + 1.2 (θ - 4)	dB(W/(m ² · MHz))	for	4° < θ ≤ 9°
-104.3	dB(W/(m ² · MHz))	for	9° < θ ≤ 90°

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees.

The limits above take into account the 3 dB aggregate loss due to polarization mismatch, and body loss was not taken into account.

During periods of rain, the e.i.r.p. of the beam suffering rain fade may be increased by a level commensurate with the level of rain fade, by up to 20 dB above the e.i.r.p. associated with the above pfd mask at the surface of the Earth;

3 that, for the purpose of protecting mobile-service systems in the territory of other administrations in the frequency band 27-27.5 GHz, the pfd level per HAPS produced at the surface of the Earth in the territory of other administrations shall not exceed the following limits, developed for clear-sky conditions, unless the explicit agreement of the affected administration is provided at the time of notification of HAPS:

0.95 θ - 114	dB(W/(m ² · MHz))	for	0° ≤ θ < 5.7°
0.6 θ - 112	dB(W/(m ² · MHz))	for	5.7° ≤ θ < 20°
-100	dB(W/(m ² · MHz))	for	20° ≤ θ ≤ 90°

where θ is the angle of arrival of the incident wave above the horizontal plane, in degrees.

The limits above take into account the 3 dB aggregate loss due to polarization mismatch, and body loss was not taken into account.

During periods of rain, the e.i.r.p. of the beam suffering rain fade may be increased by a level commensurate with the level of rain fade, by up to 20 dB above the e.i.r.p. associated with the above pfd mask at the surface of the Earth;

4 that, for the purpose of protecting mobile-service systems operating in the frequency band 25.25-27 GHz in the territory of neighbouring administrations, coordination of a transmitting HAPS ground station is required when the pfd in dB(W/(m² · MHz)) at the border of a neighbouring administration exceeds a pfd limit of -110.3 dB(W/(m² · MHz)), and the pfd values shall be verified considering a percentage of time of 1% using the most recent version of Recommendation ITU-R P.452 and a mobile-station antenna height of 20 m;

5 that, for the purpose of protecting the inter-satellite service and the FSS, the e.i.r.p. density per HAPS in the frequency band 27-27.5 GHz shall not exceed -10.7 dB(W/MHz) for off-nadir angles higher than 85.5°;

6 that, for the purpose of protecting the inter-satellite service, the e.i.r.p. density per HAPS in the frequency band 24.45-24.75 GHz shall not exceed -19.9 dB(W/MHz) for off-nadir angles higher than 85.5° ;

7 that, for the purpose of protecting non-geostationary space stations of the inter-satellite service, the e.i.r.p. density per HAPS ground station in the frequency band 25.25-27 GHz shall not exceed 12.3 dB(W/MHz) under clear-sky conditions;

In addition, for the purpose of protecting geostationary space stations of the inter-satellite service, the maximum e.i.r.p. density in the frequency band 25.25-27 GHz of HAPS ground stations shall not exceed 0.5 dB(W/MHz) in the direction of geostationary arc under clear-sky conditions. It is also needed to take into account a possible orbit inclination of GSO space stations of between -5° and 5° .

Automatic power control may be used to increase the e.i.r.p. density only to the level to compensate rain fade, by up to 20 dB;

8 that, for the purpose of protecting the FSS, the e.i.r.p. density per HAPS in the frequency band 24.75-25.25 GHz shall not exceed -9.1 dB(W/MHz) for off-nadir angles higher than 85.5° ;

9 that, for the purpose of protecting the Earth exploration-satellite service (EESS) (passive) in the frequency band 23.6-24 GHz, the e.i.r.p. density in the frequency band 23.6-24 GHz per HAPS operating in the frequency band 24.25-25.25 GHz shall not exceed:

$$-0.7714 \theta - 16.5 \quad \text{dB(W/200 MHz)} \quad \text{for} \quad -4.53^\circ \leq \theta < 35^\circ$$

$$-43.5 \quad \text{dB(W/200 MHz)} \quad \text{for} \quad 35^\circ \leq \theta \leq 90^\circ$$

where θ is the elevation angle in degrees at the platform height;

10 that, in order to ensure the protection of in-band space research service (SRS)/EESS in the territory of other administrations from the HAPS gateway in the frequency band 25.5-27.0 GHz, the pfd shall not exceed the threshold values given below at the SRS/EESS earth stations at a height of 20 m above the ground level. If the pfd threshold values below are exceeded, then HAPS shall coordinate in accordance with No. **9.18**, taking into account the parameters of the relevant systems. These limits relate to the pfd which would be obtained under assumed propagation conditions predicted by Recommendation ITU-R P.452 using the following time percentages: 0.001% for SRS, 0.005% for EESS non-GSO and 20% for EESS GSO:

SRS: $\text{pfd} = -121 \text{ dB(W/(m}^2 \cdot \text{MHz))}$

EESS non-GSO: $\text{pfd} = -97 \text{ dB(W/(m}^2 \cdot \text{MHz))}$

EESS GSO: $\text{pfd} = -129 \text{ dB(W/(m}^2 \cdot \text{MHz))};$

11 that, in order to ensure the protection of the radio astronomy service (RAS), the pfd level produced by unwanted emissions from HAPS downlink transmissions in the frequency band 24.25-25.25 GHz shall not exceed -177 dB(W/($\text{m}^2 \cdot 400$ MHz)) for continuum observations and -191 dB(W/($\text{m}^2 \cdot 250$ kHz)) for spectral line observations in the frequency band 23.6-24 GHz at an RAS station location at a height of 50 m; this limit relates to the pfd which would be obtained using a time percentage of 2% in the relevant propagation model.

RES166-4

To verify compliance, the following formula shall be used:

$$pfd = e.i.r.p.\textit{.nominal clear sky}(Az, \theta) + Att_{618, p=2\%} - 10 \log(4\pi d^2) - GasAtt(\theta)$$

where:

e.i.r.p.nominal clear sky: nominal unwanted emission e.i.r.p. density towards the RAS station at which the HAPS operates under clear-sky conditions in dB(W/400 MHz) for continuum observations and in dB(W/250 kHz) for spectral line observations in the frequency band 23.6-24 GHz

Az: azimuth in degrees from the HAPS towards the RAS station

θ: elevation angle in degrees at the HAPS towards the RAS station

Att_{618p=2%}: attenuation in dB from Recommendation ITU-R P.618 corresponding to *p* = 2% of the time at the radio astronomy location

d: separation distance in metres between the HAPS and the RAS station

pfd: pfd at the Earth's surface per HAPS in dB(W/(m² · 400 MHz)) for continuum observations and in dB(W/(m² · 250 kHz)) for spectral line observations in the frequency band 23.6-24 GHz

GasAtt(θ): gaseous attenuation for an elevation angle of *θ* (see Recommendation ITU-R SF.1395);

12 that *resolves* 11 applies at any radio astronomy station that was in operation prior to 22 November 2019 and has been notified to the Radiocommunication Bureau (BR) in the frequency band 23.6-24 GHz before 22 May 2020, or at any radio astronomy station that was notified before the date of receipt of the complete Appendix 4 information for notification, for the HAPS system to which *resolves* 11 applies; radio astronomy stations notified after this date may seek an agreement with administrations that have authorized HAPS;

13 that administrations planning to implement a HAPS system in the frequency band 24.25-27.5 GHz shall notify the frequency assignments by submitting all mandatory elements of Appendix 4 to BR for the examination of compliance with respect to this Resolution with a view to their registration in the Master International Frequency Register,

instructs the Director of the Radiocommunication Bureau

to take all necessary measures to implement this Resolution.