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| **World Radiocommunication Conference (WRC-15) Geneva, 2–27 November 2015** |  |
| **INTERNATIONAL TELECOMMUNICATION UNION** |  |
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| PLENARY MEETING | **Addendum 5 to Document 7-E** |
|  | **29 September 2015** |
|  | **Original: English** |
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| Member States of the Inter-American Telecommunication Commission (CITEL) | |
| Proposals for the work of the conference | |
|  | |
| Agenda item 1.5 | |

1.5 to consider the use of frequency bands allocated to the fixed-satellite service not subject to Appendices **30**, **30A** and **30B** for the control and non-payload communications of unmanned aircraft systems (UAS) in non-segregated airspaces, in accordance with Resolution **153 (WRC‑12)**;

Background

The development of Unmanned Aircraft Systems (UAS) is based on recent technological advances in aviation, electronics and structural materials, making the economics of UAS operations more favourable, particularly for more repetitive, routine and long duration applications. The current state of the art in UAS design and operation is leading to the rapid development of UAS applications to fill many diverse requirements. There are a large variety of existing and envisioned applications of UAS such as cargo transportation, fire-fighting, flood monitoring, search and rescue, disaster operations management, oceanographic and atmospheric observations, weather forecasting, geological survey, monitoring of gas pipelines and electricity distribution systems, city and highway traffic, border patrol, law enforcement, counter drug operations, crop and harvest monitoring, broadcast and airborne relay-type services, as well as, of course, national security purposes. As further evidence of this growth, the United States has recently licensed six UAS research and test site operators across the country, set up a centre of excellence (COE) to better understand how UAS can be integrated into the National Airspace System, and developed the first annual UAS Roadmap to address current and future policies, regulations, technologies and procedures that will be required as UAS operations increase in the nation's airspace. Further details on UAS applications in non-segregated airspace can be found in International Telecommunication Union (ITU) Report ITU-R M.2171.

The operation of UAS outside segregated airspace requires addressing the same issues as manned aircraft, namely safe and efficient integration into the air traffic control system. In the context of this agenda item, a UAS consists of an unmanned aircraft (UA) with an earth station on-board to interconnect the UA and the associated earth station of the unmanned aircraft control station (UACS) through a satellite operating in the fixed-satellite service (FSS). UA are aircraft that do not carry a human pilot but that are piloted remotely, i.e. through a reliable communication link. UAS operations up to now have been limited to segregated airspace. However, it is planned to expand UAS deployment outside of segregated airspace.

It is the role of the ITU to address the spectrum and regulatory provisions for the command and control of UAS. It is the role of International Civil Aviation Organization (ICAO) to establish the necessary standards and recommended practices (SARPS).

Report ITU-R M.2171 identified the spectrum requirements for UAS command and non-payload communication (CNPC) links that would be needed to support flight through non-segregated airspace. Those requirements identified the need for both line of sight (LOS) and beyond line of sight (BLOS) spectrum. While the LOS requirements were addressed at the last World Radiocommunication Conference (WRC) held in 2012, the BLOS requirements were only partially addressed. As a result a new agenda item for the 2015 WRC (agenda item 1.5) was established to investigate whether fixed-satellite networks, not subject to Appendix 30, 30A and 30B could be used to provide additional capacity for UAS CNPC links. This agenda item supports the addition of technical and regulatory provisions to enable use of portions of bands allocated to the FSS for UAS CNPC links, provided studies demonstrate compatibility with incumbent services and that the requirements of aviation authorities are satisfied. ITU actions must address providing a regulatory framework for the safe operation of UAS CNPC links in FSS bands under the ITU Radio Regulations and thus obtaining international recognition along with the basis for avoiding harmful interference.

Studies within the ITU-R have provided information on the CNPC radio link performance under various UAS operating conditions. These results along with other information will be used by ICAO in the future as it develops the required communications performance and eventual SARPS for UAS CNPC. Other studies within the ITU-R also address the compatibility between this application of the FSS and other services that may be authorized by administrations. All of these studies, as well as the CNPC performance requirements, can then be used by ICAO to determine the particular UAS CNPC applications and scenarios that may be used safely in the different types of airspace within, and by, each administration. ICAO UAS CNPC SARPS are in the early stage of development.

More than 100 geostationary satellite communication networks operate in frequency bands allocated to the FSS in the bands 10.7-12.75, 14.0-14.5, 17.3-20.2, and 27.5-30.0 GHz. Report ITU‑R M.2171 identifies a large variety of prospects for UAS that would need to fly long-distances (worldwide) through airspaces controlled by civil air traffic control (ATC). Immediate access to this globally existing capacity would provide great advantages for UAS fleet operators fostering new applications, enabling faster developments of new markets, while providing planning stability for significant investments. Studies under this agenda item investigated the link feasibilities and sharing conditions for using UAS CNPC links over typical frequency spectrum allocated in several FSS allocations.

Report ITU-R M.2233 contains examples of technical characteristics for UA CNPC including FSS systems operating in portions of the frequency ranges 10.95-14.5 GHz and 17.3-30.0 GHz. These examples indicated that it may be possible to operate UAS CNPC links in these bands while meeting the desired link performance. It is recognized that a further Report may be available by the time of WRC-15.

This proposal provides a regulatory framework for the safe operation of UAS CNPC links in FSS bands under the ITU Radio Regulations; thus obtaining international recognition along with the basis for avoiding harmful interference. It includes text for a footnote to the appropriate FSS bands which points to a Resolution that spells out the conditions of use for supporting safe and efficient operation of UAS. The deployment of UAS is accelerating. A key component of the ITU’s mandate is to promote the extension of the benefits of new telecommunication technologies to all the world’s inhabitants (ITU Constitution, Article 1, Section 1 d).

It is critical that the ITU address the spectrum and regulatory provisions for UAS CNPC links at WRC-15 to extend the benefits of UAS globally.

Proposals

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations  
(See No. 2.1)

MOD IAP/7A5/1

10-11.7 GHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |
| 10.7-11.7  FIXED  FIXED-SATELLITE (space-to-Earth) 5.441 5.484A ADD 5.A15 (Earth-to-space) 5.484  MOBILE except aeronautical mobile | 10.7-11.7  FIXED  FIXED-SATELLITE (space-to-Earth) 5.441 5.484A ADD 5.A15  MOBILE except aeronautical mobile | |

**Reasons:** To add a footnote allowing the use of UAS CNPC links in the fixed-satellite service not subject to Appendices 30, 30A and 30B.

MOD IAP/7A5/2

11.7-14 GHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |
| 11.7-12.5  FIXED  MOBILE except aeronautical mobile  BROADCASTING  BROADCASTING-SATELLITE     5.492 | 11.7-12.1  FIXED 5.486  FIXED-SATELLITE (space-to-Earth) 5.484A 5.488 ADD 5.A15  Mobile except aeronautical mobile  5.485 | 11.7-12.2  FIXED  MOBILE except aeronautical mobile  BROADCASTING  BROADCASTING-SATELLITE     5.492 |
| 12.1-12.2  FIXED-SATELLITE  (space-to-Earth) 5.484A 5.488 ADD 5.A15 |
|  | 5.485 5.489 | 5.487 5.487A |
|  | 12.2-12.7  FIXED  MOBILE except aeronautical mobile  BROADCASTING  BROADCASTING-SATELLITE     5.492 | 12.2-12.5  FIXED  FIXED-SATELLITE (space-to-Earth) 5.484A ADD 5.A15  MOBILE except aeronautical mobile  BROADCASTING |
| 5.487 5.487A |  | 5.487 |
| 12.5-12.75 | 5.487A 5.488 5.490 | 12.5-12.75 |
| FIXED-SATELLITE (space-to-Earth) 5.484A ADD 5.A15 (Earth-to-space)    5.494 5.495 5.496 | 12.7-12.75  FIXED  FIXED-SATELLITE (Earth-to-space) ADD 5.A15  MOBILE except aeronautical mobile | FIXED  FIXED-SATELLITE (space-to-Earth) 5.484A ADD 5.A15  MOBILE except aeronautical mobile  BROADCASTING- SATELLITE 5.493 |

**Reasons:** To add a footnote allowing the use of UAS CNPC links in the fixed-satellite service not subject to Appendices 30, 30A and 30B.

MOD IAP/7A5/3

14-15.4 GHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |
| 14-14.25 FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A     5.506 5.506B ADD 5.A15  RADIONAVIGATION 5.504  Mobile-satellite (Earth-to-space) 5.504B 5.504C 5.506A  Space research  5.504A 5.505 | | |
| 14.25-14.3FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A    5.506 5.506B ADD 5.A15  RADIONAVIGATION 5.504  Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.508A  Space research  5.504A 5.505 5.508 | | |
| 14.3-14.4  FIXED  FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B ADD 5.A15  MOBILE except aeronautical mobile  Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A  Radionavigation-satellite  5.504A | 14.3-14.4  FIXED-SATELLITE (Earth-to-space) 5.457A 5.484A 5.506 5.506B ADD 5.A15  Mobile-satellite (Earth-to-space) 5.506A  Radionavigation-satellite  5.504A | 14.3-14.4  FIXED  FIXED-SATELLITE (Earth-to-space) 5.457A 5.484A 5.506 5.506B ADD 5.A15  MOBILE except aeronautical mobile  Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A  Radionavigation-satellite  5.504A |
| 14.4-14.47 FIXED  FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A  5.506 5.506B ADD 5.A15  MOBILE except aeronautical mobile  Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A  Space research (space-to-Earth)  5.504A | | |
| 14.47-14.5 FIXED  FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A  5.506 5.506B ADD 5.A15  MOBILE except aeronautical mobile  Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A  Radio astronomy  5.149 5.504A | | |

**Reasons:** To add a footnote allowing the use of UAS CNPC links in the fixed-satellite service not subject to Appendices 30, 30A and 30B.

MOD IAP/7A5/4

15.4-18.4 GHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |
| 17.3-17.7  FIXED-SATELLITE (Earth-to-space) 5.516 (space-to-Earth) 5.516A 5.516B ADD 5.A15  Radiolocation | 17.3-17.7  FIXED-SATELLITE (Earth-to-space) 5.516  BROADCASTING-SATELLITE  Radiolocation | 17.3-17.7  FIXED-SATELLITE (Earth-to-space) 5.516  Radiolocation |
| 5.514 | 5.514 5.515 | 5.514 |
| 17.7-18.1  FIXED  FIXED-SATELLITE (space-to-Earth) 5.484A (Earth-to-space) 5.516  MOBILE | 17.7-17.8  FIXED  FIXED-SATELLITE (space-to-Earth) 5.517 (Earth-to-space) 5.516  BROADCASTING-SATELLITE  Mobile  5.515 | 17.7-18.1  FIXED  FIXED-SATELLITE (space-to-Earth) 5.484A (Earth-to-space) 5.516  MOBILE |
|  | 17.8-18.1  FIXED  FIXED-SATELLITE (space-to-Earth) 5.484A (Earth-to-space) 5.516  MOBILE  5.519 |  |
| 18.1-18.4 FIXED  FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B ADD 5.A15    (Earth-to-space) 5.520  MOBILE  5.519 5.521 | | |

**Reasons:** To add a footnote allowing the use of UAS CNPC links in the fixed-satellite service not subject to Appendices 30, 30A and 30B.

MOD IAP/7A5/5

18.4-22 GHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |
| 18.4-18.6 FIXED  FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B ADD 5.A15  MOBILE | | |
| 18.6-18.8  EARTH EXPLORATION-SATELLITE (passive)  FIXED  FIXED-SATELLITE (space-to-Earth) 5.522B ADD 5.A15  MOBILE except aeronautical mobile  Space research (passive) | 18.6-18.8  EARTH EXPLORATION- SATELLITE (passive)  FIXED  FIXED-SATELLITE (space-to-Earth) 5.516B 5.522B ADD 5.A15  MOBILE except aeronautical mobile  SPACE RESEARCH (passive) | 18.6-18.8  EARTH EXPLORATION-SATELLITE (passive)  FIXED  FIXED-SATELLITE (space-to-Earth) 5.522B ADD 5.A15  MOBILE except aeronautical mobile  Space research (passive) |
| 5.522A 5.522C | 5.522A | 5.522A |
| ... | | |
| 19.7-20.1  FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B ADD 5.A15  Mobile-satellite (space-to-Earth) | 19.7-20.1  FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B ADD 5.A15  MOBILE-SATELLITE (space-to-Earth) | 19.7-20.1  FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B ADD 5.A15  Mobile-satellite (space-to-Earth) |
| 5.524 | 5.524 5.525 5.526 5.527 5.528 5.529 | 5.524 |
| 20.1-20.2FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B ADD 5.A15  MOBILE-SATELLITE (space-to-Earth)  5.524 5.525 5.526 5.527 5.528 | | |

**Reasons:** To add a footnote allowing the use of UAS CNPC links in the fixed-satellite service not subject to Appendices 30, 30A and 30B.

MOD IAP/7A5/6

24.75-29.9 GHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |
| 27.5-28.5 FIXED 5.537A  FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 ADD 5.A15  MOBILE  5.538 5.540 | | |
| 28.5-28.6 FIXED  FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 ADD 5.A15  MOBILE  Earth exploration-satellite (Earth-to-space) 5.541  5.540 | | |
| 28.6-29.1 FIXED  FIXED-SATELLITE (Earth-to-space) 5.516B 5.523A 5.539  MOBILE  Earth exploration-satellite (Earth-to-space) 5.541  5.540 | | |
| ... | | |
| 29.5-29.9  FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 ADD 5.A15  Earth exploration-satellite (Earth-to-space) 5.541  Mobile-satellite (Earth-to-space) | 29.5-29.9  FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 ADD 5.A15  MOBILE-SATELLITE (Earth-to-space)  Earth exploration-satellite (Earth-to-space) 5.541 | 29.5-29.9  FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 ADD 5.A15  Earth exploration-satellite (Earth-to-space) 5.541  Mobile-satellite (Earth-to-space) |
| 5.540 5.542 | 5.525 5.526 5.527 5.529 5.540 | 5.540 5.542 |

**Reasons:** To add a footnote allowing the use of UAS CNPC links in the fixed-satellite service not subject to Appendices 30, 30A and 30B.

MOD IAP/7A5/7

29.9-34.2 GHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |
| 29.9-30 FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 ADD 5.A15  MOBILE-SATELLITE (Earth-to-space)  Earth exploration-satellite (Earth-to-space) 5.541 5.543  5.525 5.526 5.527 5.538 5.540 5.542 | | |

**Reasons:** To add a footnote allowing the use of UAS CNPC links in the fixed-satellite service not subject to Appendices 30, 30A and 30B.

ADD IAP/7A5/8

5.A15 Resolution [IAP-A15-FSS-UA-CNPC] (WRC‑15) shall apply.

**Reasons:** To provide a footnote allowing the use of UAS CNPC links in the fixed-satellite service not subject to Appendices 30, 30A and 30B.

ADD IAP/7A5/9

Draft New Resolution [IAP-A15-FSS-UA-CNPC] (WRC-15)

Regulatory provisions related to earth stations on board unmanned aircraft which operate with geostationary satellites in the fixed-satellite service in a Region where the frequency band is not subject to the Plans or Lists of Appendices 30, 30A, and 30B for the control and non-payload   
communications of unmanned aircraft systems

The World Radiocommunication Conference (Geneva, 2015),

considering

*a)* that worldwide use of unmanned aircraft systems (UAS) ,which includes the unmanned aircraft (UA) and the unmanned aircraft control station (UACS), is expected to increase significantly in the near future;

*b)* that UA need to operate seamlessly with piloted aircraft in non-segregated airspace;

*c)* that the operation of UAS in non-segregated airspace requires reliable control and non-payload communication (CNPC) links, in particular to relay air traffic control communications and for the remote pilot to control the flight;

*d)* that there is a demand for the control of UAS CNPC links via satellite communication networks for communications beyond the radio horizon while operating in non-segregated airspace as shown in Annex 1;

*e)* that there is a need to provide internationally harmonized use of spectrum for UAS CNPC links;

*f)* that the use of fixed-satellite service (FSS) frequency assignments by UAS CNPC links should take into account their Article **11** notification status;

*g)* that in the application of Articles **9** and **11**, no administration would obtain any particular priority as a result of using the FSS to provide UAS CNPC,

considering further

*a)* that there is a need to limit the amount of communication equipment on board a UA;

*b)* that there is urgency to conclude on the regulatory basis for the use of the FSS frequency bands to support short- and medium term implementation of UAS CNPC links because a dedicated satellite system for this application is not likely to be implemented in this time frame;

*c)* that there are various technical methods that may be used to increase the reliability of digital communication links, e.g. modulation, coding, redundancy, etc. that can be used to ensure safe operation of UAS in all air space;

*d)* that UAS CNPC relate to the safe operation of UAS and have certain technical, operational, and regulatory requirements;

*e)* that the requirements in *considering further d)* can be specified for UAS use of FSS networks,

noting

*a)* that International Telecommunication Union (ITU) Report ITU‑R M.2171 provides information on the vast number of applications for UAS needing access to non-segregated airspaces;

*b)* that, although Recommendation **724 (WRC-07)** notes that FSS is not a designated safety service, FSS can be used, under certain conditions, on a permanent or temporary basis for safeguarding human life or property,

recognizing

*a)* that the power flux-density limits in Section V of Article **21** apply to space-to-Earth transmissions for communications with Unmanned Aircraft Systems;

*b)* that the UAS CNPC links shall be operated in accordance with international standards and recommended practices and procedures established in accordance with the Convention on International Civil Aviation;

*c)* that in this context, ITU develops the conditions for operation of CNPC links, and then, International Civil Aviation Organization (ICAO) would be in a position to develop further operational conditions to ensure safe UAS operation,

resolves

1 that FSS networks in a Region where the frequency band is not subject to the Plans or lists of Appendices **30**, **30A**, or **30B** and where No. **5.A15** applies, may be used for the control and non-payload communications of unmanned aircraft systems;

2 that earth stations on-board UA can communicate with a space station operating in the FSS, including while the UA is in motion, and shall meet all the technical and regulatory requirements for FSS earth stations operating in the same frequency band as well as the additional technical requirements identified in Annex 2;

3 that earth stations used by UAS shall operate within the interference, protection, and performance envelope defined by the parameters of typical earth stations associated with the notified FSS network;

4 that UAS CNPC earth stations shall be designed so as to be able to operate in the interference environment created by terrestrial services allocated on a co-primary basis in accordance with the Radio Regulations in these frequency bands in order to ensure their freedom from harmful interference;

5 that the protection of the incumbent fixed service from UAS CNPC transmissions shall be ensured by implementing measures shown in Annex 2;

6 that administrations shall:

– ensure that the use of UAS CNPC links and their associated performance requirements shall be in accordance with the international standards and recommended practices (SARPS) and procedures established by ICAO consistent with Article 37 of the Convention on International Civil Aviation;

– act immediately when their attention is drawn to any such harmful interference as freedom from harmful interference to UAS CNPC links is imperative to ensure safe operation of UAS CNPC links;

– use assignments associated with the FSS networks for UAS CNPC links (see Figure 1 in Annex 1) that have been recorded in the Master International Frequency Register (MIFR) with a favourable finding;

– ensure that real-time interference monitoring, predicting interference risks, and planning solutions for potential interference scenarios, shall be addressed by FSS operators and UAS operators with guidance from aviation authorities,

instructs the Secretary-General

to bring this Resolution to the attention of the Secretary-General of the ICAO.

Annex 1 to Resolution [IAP-A15-FSS-UA-CNPC] (WRC‑15)

UA CNPC links

Figure 1

Elements of UAS architecture using the FSS



Annex 2 to Resolution [IAP-A15-FSS-UA-CNPC] (WRC‑15)

Protection of the fixed service and of other fixed-satellite service   
networks from UA CNPC emissions

# 1 Introduction

Because of the fundamental assumption made that to use the frequency bands allocated to the FSS the UAS CNPC link must operate within the same regulatory and performance limitations as any other FSS earth station and that, from an interference perspective, it must perform its function in exactly the same manner as any other FSS earth station, there are only a limited number of additional requirements, over and above those of a typical FSS earth station, that need to be imposed on UAS CNPC operations to ensure compatibility with other services sharing the same frequency bands.  These additional requirements are listed in Sections 2, 3, and 4 of this Annex.

# 2 Protection of the fixed service

The fixed service is allocated by footnotes in several countries with a co-primary status to the FSS. In those countries, conditions of UA using CNPC shall be such that the fixed service is protected from any harmful interference as defined below.

1) UA shall not operate at latitudes above 70 degrees;

2) UA shall not operate on frequencies in the band 14.00 to 14.5 GHz in altitudes below 5 000 ft;

3) UA shall not operate on frequencies in the band 27.5-28.6 GHz in altitudes below 3 000 ft;

4) earth station on UA shall comply with the two band-specific power flux-density (pfd) masks described below.

In the 14-14.5 GHz frequency band as used by fixed-service networks, within line-of-sight of the territory of an administration where fixed-service networks are operating in this band, the maximum pfd produced at the surface of the Earth by emissions from a single UA should not exceed:

|  |  |
| --- | --- |
| −97 dB(W/(m2  ⋅ 14 MHz)) | for θ ≤ 5° |
| −97 + 2.1 ⋅ (θ - 5°)2 dB(W/(m2  ⋅ 14 MHz)) | for 5° < θ ≤ 7.5° |
| −91.7 - 25 ⋅ log10 (θ) dB(W/(m2  ⋅ 14 MHz)) | for 7.5° < θ ≤ 53° |
| −49.7 dB(W/(m2  ⋅ 14 MHz)) | for 53° < θ ≤ 90° |

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).

NOTE – The aforementioned limits relate to the pfd and angles of arrival that would be obtained under free-space propagation conditions.

figure 2

pfd mask as function of angle of arrival for 14.0-14.5 GHz

In the 27.5-28.6 GHz frequency band as used by fixed-service networks, within line-of-sight of the territory of an administration where fixed-service networks are operating in this band, the maximum pfd produced at the surface of the Earth by emissions from a single UA should not exceed:

|  |  |
| --- | --- |
| −91 dB(W/(m2  ⋅ 14 MHz)) | for θ ≤ 5° |
| −91 + 0.6 ⋅ (θ - 5°)2 dB(W/(m2  ⋅ 14 MHz)) | for 5° < θ ≤ 9.4° |
| −79.4 dB(W/(m2  ⋅ 14 MHz)) | for 9.4° < θ ≤ 90° |

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).

NOTE – The aforementioned limits relate to the pfd and angles of arrival that would be obtained under free-space propagation conditions.

figure 3

pfd mask as function of angle of arrival for 27.5-28.6 GHz

# 3 Protection of other fixed-satellite service networks

Conditions of UA using CNPC shall be such that the FSS is protected from any harmful interference as defined below.

1) UAS CNPC shall comply with Recommendation ITU-R S.524, or other coordinated levels agreed between administrations, at all times including when the aircraft is manoeuvring.

# 4 Protection of radio astronomy

No. **5.149** of the Radio Regulations urges administrations to take all practicable steps to protect the radio astronomy service from harmful interference in certain bands, including 14.47-14.5 GHz, noting that emissions from airborne stations can be particularly serious sources of interference to the radio astronomy service. In the band 14.47-14.5 GHz, consultations will be needed between radio astronomy stations and UAS operating co-frequency UAS CNPC (Earth-to-space) within radio line-of-sight of radio astronomy service observatories in order to address potential incompatibilities.

**Reasons:** To clarify operational and regulatory aspects of UAS CNPC links in the fixed-satellite service not subject to Appendices 30, 30A and 30B.

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