IWG-3/028
(8/20/2013)
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2015 WORLD RADIOCOMMUNICATION CONFERENCE

DRAFT PROPOSALS FOR THE WORK OF THE CONFERENCE

AGENDA ITEM 1.7: *to review the use of the band 5 091-5 150 MHz by the fixed-satellite service (Earth-to-space) (limited to feeder links of the non-geostationary mobile-satellite systems in the mobile-satellite service) in accordance with Resolution **114 (Rev.WRC-12)***

ISSUE: This agenda item invites the ITU-R to conduct appropriate studies to review the use of the band 5091-5150 MHz by feeder links (Earth-to-space) of non-geostationary mobile-satellite systems with respect to the aeronautical radionavigation service in accordance with Resolution **114 (WRC-12).**

BACKGROUND: At WRC-95, a Primary allocation, subject to **5.444A,** was made to the fixed-satellite service in the 5091-5150 MHz band for feeder links to non-GSO mobile-satellite service systems, in the Earth-to-space direction.
The 5091-5150 MHz band was originally designated for expansion of the international standard Microwave Landing System (MLS) and Recommendation ITU-R S.1342 describes a method for determining coordination distances between international standard MLS stations operating in the band 5030-5090 MHz and FSS stations providing Earth-to-space feeder links in the 5091-5150 MHz band.
At WRC-07, an additional allocation subject to **5.444B** was made, in the 5091-5150 MHz band, to the aeronautical mobile service (AMS) for use by surface applications at airports, aeronautical telemetry transmissions from aircraft stations and aeronautical security transmissions. The latter application was suppressed by WRC-12. Compatibility between the newly allocated aeronautical mobile service planned usage and the existing fixed-satellite service usage was demonstrated by extensive studies carried out by the ITU-R in the lead up to WRC-07.
The fixed-satellite service allocation at 5091-5150 MHz is currently used by the HIBLEO-4FL and HIBLEO-X systems and has been used compatibly with other services since 1998. The extensive studies undertaken in preparation for WRC-07 resulted in the creation of **No. 5.444B** and Resolutions **748(WRC-07)**, **418(WRC-07)** and **419(WRC-07)** and demonstrated compatibility between the fixed-satellite service and each of the aeronautical mobile (route) service applications.
The operator of the HIBLEO-4FL and HIBLEO-X systems has completed initial phase of the replenishment of its satellite constellation. As these new spacecraft are replacements for existing equipment, they will also utilize the 5091-5150 MHz range for feeder links in the Earth-to-space direction. The replacement satellites are expected to remain in service beyond the year 2025.
As a result of these developments, continued FSS use of the 5091-5150 MHz band for feeder links of the MSS, Earth-to-space, is required. Taking into account the time constraints contained

in **5.444A**, it is necessary to comply with Resolution **114 (WRC-03)** prior to 2018. Recognizing the considerable effort expended in studying the compatibility between the Earth-to-space feeder links of the MSS systems and the Aeronautical Mobile Service in preparation for WRC-07, and since the interference budgets and scenarios studied before remain the same for the HIBLEO-4FL and HIBLEO-X replacement spacecraft, study of technical and operational issues can and should be limited to the sharing of this band between new systems of the aeronautical radionavigation service (ARNS) and the FSS providing feeder links of the non-GSO systems in the MSS.
The continued use of this allocation by feeder uplinks is of great importance in providing ongoing service by MSS systems to developing countries, under-served areas and critical response in the event of natural disasters and other civil emergencies.
Reflecting the preliminary nature of this document, both options for the thus Agenda Item have been presented. The USA prefers Option A2.

Note: Since Resolution **748 (Rev. WRC-12)** and Recommendation ITU-R M.1827 and part of the Radio Regulations, modifications to these documents are included in this proposal.

Proposal:

USA/1.7/1

5.444A *Additional allocation:* the band 5 091-5 150 MHz is also allocated to the fixed-satellite service (Earth-to-space) on a primary basis. This allocation is limited to feeder links of non-geostationary satellite systems in the mobile-satellite service and is subject to coordination under No. **9.11A**. Such use shall be in accordance with Resolution **114 (WRC-12).**

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{Editorial note: Changes to Resolution 748 (Rev.WRC-12) and ITU-R Recommendation M.1827 are shown first according to Option A1 and then according to Option A2}

Option A1

MOD
Resolution **748 (Rev.WRC-12)**

considering

f) that ITU-R studies have examined potential sharing among aeronautical applications and have shown that the aggregate interference to the FSS in the 5 091-5 150 MHz frequency band from aeronautical telemetry, AM(R)S and ARNS should total no more than 6% $\Delta T_s/T_s$;

MOD
Recommendation ITU-R M.1827

recognizing

a) that the band 5 000-5 250 MHz is allocated to the aeronautical radionavigation service (ARNS) on a primary basis;

…

Deleted: In the band 5 091-5 150 MHz, the following conditions also apply:

Deleted: prior to 1 January 2018,

Deleted: the use of the band 5 091-5 150 MHz by feeder links of non-geostationary-satellite systems in the mobile-satellite service shall be made in accordance with Resolution **114 (Rev.WRC-03)**;.

Deleted: – . after 1 January 2016, no new assignments shall be made to earth stations providing feeder links of non-geostationary mobile-satellite systems;¶

Deleted: – . after 1 January 2018, the fixed-satellite service will become secondary to the aeronautical radio-navigation service. (WRC-07)

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ANNEX 1 (TO RECOMMENDATION ITU-R M.1827)

Essential requirements related to compatibility with FSS networks in the band 5 091-5 150 MHz

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II Additional requirements on the AM(R)S

The requirements that follow represent technical guidelines to be used by administrations for establishing conformance requirements for stations for worldwide use. Other limits may also be acceptable, however further study is required.

The pfd defined in this section is based on ensuring that the increase in noise temperature of the FSS satellite (i.e. $\Delta T_s/T_s$) due to operation in the 5 091-5 150 MHz frequency band of the AM(R)S plus any ARNS does not exceed 5% (i.e. –13 dB). To accomplish this, first the $\Delta T_s/T_s$ of the ARNS is calculated, then that value is subtracted from the allowed aggregate 5%. The remaining $\Delta T_s/T_s$ is then allocated to the AM(R)S. Two examples of this calculation are provided below. The first assumes that the $\Delta T_s/T_s$ due to the ARNS is 3%. The second assumes no ARNS is present in the frequency band 5 091-5 150 MHz.

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The methodology for both examples assumes 250[3] co-channel AM(R)S transmitters operating concurrently within the field of view of the FSS satellite.

Example 1: $\Delta T_s/T_s$ ARNS = 3% and $\Delta T_s/T_s$ AM(R)S = 2% (i.e., -17 dB).

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Assuming the Table 1 characteristics for the FSS, the maximum aggregate interference level tolerable at the receiver input is $I_{Agg\text{-}Rec}$:

$$I_{Agg-Rec} = KTB - 17 \text{ dB} = -157.3 \text{ dB(W / 1.23 MHz)}$$

where:

K: Boltzmann's constant (1.38×10^{-23});

T: represents the receiver noise temperature;

B: receiver bandwidth.

Therefore at the satellite receiver antenna input the maximum pfd level produced by one AMRS transmitter is:

$$pfd_{Max} = I_{Agg-Rec} - Gr + L_{Feed} + L_P - 10\log_{10}(250) + 10\log\left(\frac{4\pi}{\lambda^2}\right)$$

$$= -157.3 - 4 + 2.9 + 1 - 23.97 + 35.6$$

$$= -145.77 \text{ dBW}/(\text{m}^2 \times 1.23 \text{ MHz})$$

[3] Based on an assumption of 500 airports and a 50% duty cycle.

where:

Gr: FSS receiver antenna gain;

250: maximum number of AM(R)S stations emitting simultaneously in the FSS receiver bandwidth.

Example 2: $\Delta T_s/T_s$ ARNS = 0% and $\Delta T_s/T_s$ AM(R)S = 5% (i.e., -13 dB).

The methodology is the same as that in Example 1, however:

$$I_{Agg-Rec} = KTB - 13 \text{ dB} = -153.3 \text{ dB(W/1.23 MHz)}$$

Hence

$$pfd_{Max} = I_{Agg-Rec} - Gr + L_{Feed} + L_P - 10\log_{10}(250) + 10\log\left(\frac{4\pi}{\lambda^2}\right)$$

$$= -153.3 - 4 + 2.9 + 1 - 23.97 + 35.6$$

$$= -141.77 \text{ dBW}/(\text{m}^2 \times 1.23 \text{ MHz})$$

Reasons: The 5 091-5 150 MHz band was originally designated for expansion of the international standard Microwave Landing System (MLS). At WRC-95, a Primary allocation, subject to RR No. **5.444A,** was made to the fixed-satellite service (FSS) in the 5 091-5 150 MHz band for feeder links to non-GSO mobile-satellite service systems, in the Earth-to-space direction. Recommendation ITU-R S.1342 established a method for determining coordination distances between international standard MLS stations operating in the band 5 030-5 090 MHz and FSS stations providing Earth-to-space feeder links in the 5 091-5 150 MHz band.
At WRC-07 an aeronautical mobile service allocation was added to support various applications with studies indicating compatibility among these applications and the FSS. Mobile-satellite service operations are continuing in the 5 091-5 150 MHz band with the recent completion of a constellation replenishment program that is expected to remain in service beyond the year 2025.
In order to ensure that a long term stable operating environment is maintained between the services allocated in the 5 091-5 150 MHz band, the date limitation constraints in RR No. **5.444A** should be suppressed, as indicated. Noting the current lack of new ARNS planned for the band, flexibility for introduction of the AM(R)S is improved while ensuring protection of the FSS, by revising Resolution **748 (Rev.WRC-12)** and Recommendation ITU-R M.1827. Those revisions will ensure that the combination of ARNS plus AM(R)S not exceed a ΔT/T of 5%, instead of the current allocation of 2% to AM(R)S and 3% to ARNS.

Option A2

MOD
Resolution **748 (Rev.WRC-12)**

considering

f) that ITU-R studies have examined potential sharing among aeronautical applications and the FSS in the band 5 091 – 5150 MHz;

MOD
Recommendation ITU-R M.1827

recognizing

a) that the band 5 000-5 250 MHz is allocated to the aeronautical radionavigation service (ARNS) on a primary basis;

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ANNEX 1(TO RECOMMENDATION ITU-R M.1827)

Essential requirements related to compatibility with FSS networks in the band 5 091-5 150 MHz

…

II Additional requirements on the AM(R)S

The requirements that follow represent technical guidelines to be used by administrations for establishing conformance requirements for stations for worldwide use. Other limits may also be acceptable, however further study is required.

The pfd defined in this section is based on ensuring that the increase in noise temperature of the FSS satellite due to operation of the AM(R)S (i.e. $(\Delta T_s/T_s)_{AM(R)S}$) does not exceed the greater of the following two values:

1) 2%

2) 5% - $(\Delta T_s/T_s)_{ARNS}$

where $(\Delta T_s/T_s)_{ARNS}$ is the increase in noise temperature due to the ARNS in the same band.

Three examples of this calculation are provided below. The first assumes that the Δ $(\Delta T_s/T_s)_{ARNS}$ is 3%. The second assumes that no ARNS is present in the band. The third assumes that $(\Delta T_s/T_s)_{ARNS}$ is >3%. The methodology assumes 250[3] co-channel AM(R)S transmitters operating concurrently within the field of view of the FSS satellite.

Example 1: $(\Delta T_s/T_s)_{ARNS}$ = 3%

In this case, 5% - $(\Delta T_s/T_s)_{ARNS}$ equals 2%, hence, $(\Delta T_s/T_s)_{AM(R)S}$ = 2%, i.e. -17 dB. Assuming the Table 1 characteristics for the FSS, the maximum aggregate interference level tolerable at the receiver input is $I_{Agg\text{-}Rec}$:

$$I_{Agg-Rec} = KTB - 17 \text{ dB} = -157.3 \text{ dB(W/1.23 MHz)}$$

where:

K: Boltzmann's constant (1.38×10^{-23})

T: receiver noise temperature

B: receiver bandwidth.

Therefore at the satellite receiver antenna input the maximum pfd level produced by one AMRS transmitter is:

$$pfd_{Max} = I_{Agg-Rec} - Gr + L_{Feed} + L_P - 10\log_{10}(250) + 10\log\left(\frac{4\pi}{\lambda^2}\right)$$

$$= -157.3 - 4 + 2.9 + 1 - 23.97 + 35.6$$

$$= -145.77 \text{ dBW}/(\text{m}^2 \times 1.23 \text{ MHz})$$

where:

Gr: FSS receiver antenna gain

250: maximum number of AM(R)S stations emitting simultaneously in the FSS receiver bandwidth.

[3] Based on an assumption of 500 airports and a 50% duty cycle.

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Example 2: $(\Delta T_s/T_s)_{ARNS} = 0$.

In this case, 5% - $(\Delta T_s/T_s)_{ARNS}$ equals 5%, which is greater than 2%, Hence, $(\Delta T_s/T_s)_{AM(R)S}$=5%, i.e. -13 dB. Hence:

$$I_{Agg-Rec} = KTB - 13 \text{ dB} = -153.3 \text{ dB(W/1.23 MHz)}$$

Therefore at the satellite receiver antenna input the maximum pfd level produced by one AMRS transmitter is:

$$pfd_{Max} = I_{Agg-Rec} - Gr + L_{Feed} + L_P - 10\log_{10}(250) + 10\log\left(\frac{4\pi}{\lambda^2}\right)$$

$$= -153.3 - 4 + 2.9 + 1 - 23.97 + 35.6$$

$$= -141.77 \text{ dBW}/(\text{m}^2 \times 1.23 \text{ MHz})$$

Example 3: $(\Delta T_s/T_s)_{ARNS}$ >3%.

In this case, 5% - $(\Delta T_s/T_s)_{ARNS}$ is smaller than 2%, Hence, $(\Delta T_s/T_s)_{AM(R)S}$=2%, i.e. -17 dB, as in Example 1, and the same pfd_{max} value is obtained as in Example 1.

Reasons: The 5 091-5 150 MHz band was originally designated for expansion of the international standard Microwave Landing System (MLS). At WRC-95, a primary allocation, subject to RR No. **5.444A,** was made to the fixed-satellite service (FSS) in the 5 091-5 150 MHz band for feeder links to non-GSO mobile-satellite service systems, in the Earth-to-space direction. Recommendation ITU-R S.1342 established a method for determining coordination distances between international standard MLS stations operating in the band 5 030-5 090 MHz and FSS stations providing Earth-to-space feeder links in the 5 091-5 150 MHz band.

At WRC-07 an aeronautical mobile service allocation was added to support various applications with studies indicating compatibility among these applications and the FSS. Mobile-satellite service operations are continuing in the 5 091-5 150 MHz band with the recent completion of a constellation replenishment program that is expected to remain in service beyond the year 2025.

In order to ensure that a long term stable operating environment is maintained between the services allocated in the 5 091-5 150 MHz band, the date limitation constraints in RR No. **5.444A** should be suppressed, as indicated. Noting the current lack of new ARNS planned for the band, flexibility for introduction of the AM(R)S is improved while ensuring protection of the FSS, by revising Resolution **748 (Rev.WRC-12)** and Recommendation ITU-R M.1827. Those revisions achieve the desired improvement in flexibility for the AM(R)S by allowing its contribution to increase beyond the 2% limit whenever the ARNS contribution is below 3%. When the ARNS contribution is above 3%, the current hard limit of 2% on the AM(R)S contribution still applies.

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