CHAPTER 1

Radionavigation, radionavigation-satellite and radiolocation services

(WRC-03 agenda items 1.4, 1.15, 1.17, 1.24, 1.28)

CONTENTS

1.1 Agenda item 1.4

"to consider the results of studies related to Resolution **114 (WRC-95)**, dealing with the use of the band 5 091-5 150 MHz by the fixed-satellite service (Earth-to-space) (limited to non-GSO MSS feeder links), and review the allocations to the aeronautical radionavigation service and the fixed-satellite service in the band 5 091-5 150 MHz"

1.1.1 Summary of technical and operational studies including a list of relevant ITU-R Recommendations

At WRC-95, the FSS was granted co-primary status along with the ARNS in the 5 150-5 250 MHz band for the use of feeder uplinks for non-GSO MSS systems (No. **5.447A**). The frequency band 5 000-5 250 MHz is allocated on a global basis to the ARNS. The FSS is allocated on a primary basis (Earth-to-space) in the band 5 150-5 250 MHz for the use of feeder uplinks for non-GSO MSS systems (No. **5.447A**). In addition, the 5 091-5 150 MHz band was allocated on a co-primary basis to the FSS for non-GSO MSS feeder uplinks under No. **5.444A** and Resolution **114 (WRC-95)**. Resolution **114 (WRC-95)** requested ITU-R to study issues concerning sharing between ARNS and feeder links to MSS (Earth-to-space) in the band 5 091-5 150 MHz and to report results of the studies to WRC-03. The use of this band by microwave landing systems (MLS) and MSS feeder links is subject to footnotes No. **5.444** and No. **5.444A**.

The dates contained in No. **5.444A** were developed on the basis of information provided by administrations on the short-term development requirements for use of the band 5 091-5 150 MHz by the FSS. No further studies have been presented since WRC-95 to assess the future need for this band by the FSS.

Currently, only the 5 030-5 150 MHz portion has a defined ARNS attribution; namely the MLS under article No. **5.444** as modified by WRC-2000, with only the 5 030-5 091 MHz portion containing defined MLS channels. ICAO has identified the band 5 091-5 150 MHz for expansion for MLS. Results of current studies in ICAO have demonstrated that there is uncertainty of the prospective spectrum requirements for MLS for Cat II and Cat III precision approaches and landings in relation to the services that can be offered by the GNSS system. As a result, most of these MLS requirements are expected to be met in the band 5 030-5 091 MHz. Until these uncertainties have been fully addressed, the band 5 091-5 150 MHz must remain available for MLS purposes. The current radio regulatory mechanism, with an extension of the date 2010 to 2018, would meet the current aviation requirements. A further review of the allocations in this band at a future WRC (about 2010) would be necessary. It should be noted that there are also other requirements for emerging ARNS systems to be accommodated in this band. The aviation community is also exploring other applications in the 5 091-5 150 MHz band, and defining uses for the 5 150-5 250 MHz band, including perhaps provision of non-safety wideband wireless application at airports.

Two MSS systems have implemented spacecraft tracking and control operations. One system (LEO-D) has begun commercial service using the 5 091-5 250 MHz band for transmitting both user-generated telecommunications traffic and telecommand signals, from gateway earth stations to the non-GSO spacecraft. Spacecraft tracking and control operations began in the 5 091-5 250 MHz band with the launch of the first LEO-D satellite on 14 February 1998. Six gateway stations in Argentina, France, Korea, South Africa and the United States carry both command and control operations traffic and user-generated traffic. In addition, thirteen other gateway stations worldwide have been added to the network to carry user traffic. Another system (LEO-F) uses the band 5 150-5 250 MHz to support launch and service operations. That system operates eleven gateways in Australia, Brazil, Chile, Germany, India, Indonesia, Korea, Mexico, South Africa, United Arab Emirates, and United States.

Sharing between FSS and MLS is covered by Recommendation ITU-R S.1342.

Two current aviation safety objectives are to provide more information to the pilot/cockpit, and to reduce runway incursions. A proposed application in the band 5 091-5 150 MHz, the Airport Network and Location Equipment (ANLE), would address both of those goals.

In its most basic form, ANLE is a high integrity, wireless local area network (LAN) that would provide aeronautical radionavigation and safety communications for the airport area, combined with a connected grid of distributed sensors. The wireless LAN would provide the cockpit with access to appropriate information via a high-bandwidth internet-like connection. The grid of distributed sensors would use those same transmissions to derive a 3-dimensional picture of the aircraft terminal, which could then be broadcast via the same data link to provide all users with situational awareness of the airport surface. Adding simple transmitters to other surface-movement vehicles would allow for the development of a high-fidelity complete picture of the airport surface environment. The feasibility of such a wideband system in the band 5 091-5 150 MHz is currently being assessed. The International Air Transport Association (IATA) is considering a system called Airport Vehicle Position System (AVPS) to meet the ANLE requirement. The AVPS is intended to monitor surface movements, reduce runway incursion and increase airport security.

No ITU-R study is currently available for the sharing between these aeronautical applications and already allocated services. ANLE provides both radionavigation signals and communication information and the proper allocation(s) under which ANLE should operate is under study. A feasibility trial of an AVPS has been conducted in one country using adaptive wireless networks. The trial showed that the system provided aircraft and vehicles with the ability to navigate with a higher level of accuracy around the airport.

1.1.2 Analysis of the results of studies

Existing MLS operating in the band 5 030-5 091 MHz and non-GSO MSS feeder link stations operating in the band 5 091-5 250 MHz are able to function without interference, based upon the application of the coordination procedures in Recommendation ITU-R S.1342 and the operating experience gained to date. Future deployment of both MLS and non-GSO MSS facilities should be possible through coordination under Recommendation ITU-R S.1342. The common use of the 5 091-5 150 MHz band by both MLS and non-GSO MSS stations is dependent upon the extent of future deployment of these systems and the characteristics of new ARNS systems. Administrations need to investigate the continuing usage of the 5 091-5 150 MHz band by ARNS and the FSS for non-GSO MSS feeder links to determine if changes in the existing Radio Regulations covering this band are necessary.

In order to ensure a complete coverage of its service area, the initial implementation of at least one MSS system needed the use of the entire 5 091-5 250 MHz band, this being the reason for the short-term allocation to the FSS made by WRC-95. In this system, there is a one-to-one mapping between each of the frequency-division-multiplexed feeder-link radio-frequency channels and a corresponding spot-beam in the downlink service band. The removal of any frequency channel in the feeder uplink would prevent the transmission of the corresponding spot beam in the service downlink and therefore would restrict the operation of this MSS system in its initial implementation. Therefore changing feeder link assignments of the initial implementation of this MSS system below 5 150 MHz is neither expected nor would it be feasible to replace them by assignments in frequencies above 5 150 MHz.

Information presented to ITU-R in preparation for WRC-95 anticipated that future implementations of FSS systems (either new systems or the evolution of current systems) would be more spectrally efficient than those initially implemented and would be designed to operate within the band 5 150-5 250 MHz only. The time limitations placed on the status of the allocation to the FSS below 5 150 MHz relative to that of the ARNS were intended to permit the rapid deployment of the initial implementation of FSS systems and allow sufficient time for more spectrally efficient systems to be designed and implemented. No information has been provided to ITU-R to suggest that this situation has changed. However, it is apparent that the planned transition to more spectrally efficient FSS systems is taking longer than originally anticipated.

Recommendation ITU-R S.1342 provides a methodology to trigger coordination between ARNS systems (specifically MLS) operating in the band 5 030-5 091 MHz and non-GSO MSS feeder-link stations operating in the adjacent band 5091-5150 MHz. No interference has been reported by administrations that have used this methodology.

Nevertheless, this coordination process has been eased by the fact that MLS stations have been implemented effectively in the band 5 030-5 091 MHz. Therefore, the possibility of sharing between MLS of the ARNS and fixed earth stations operating feeder links in the MSS could be dependant on the future use of the 5 091-5 150 MHz band by MLS.

It is expected that if the gateway stations for the two MSS systems currently operating develop as planned, then the number of gateway stations implemented worldwide will be approximately 65.

1.1.3 Methods to satisfy the agenda item and their advantages and disadvantages

1.1.3.1 Method A

No change to Nos. **5.444** and **5.444A** and revise Resolution **114 (WRC-95)**

Advantages:

- The modification to Resolution **114** would only be to change the dates that studies would be completed. The dates could be changed to "a future competent WRC".
- Future systems in both the ARNS and the FSS could be taken into account in order to improve the evaluation of the sharing conditions between these services.

Disadvantages:

- Agenda item 1.4 will not be satisfied.

1.1.3.2 Method B

Revise Nos. **5.444** and **5.444A** and suppress Resolution **114 (WRC-95)**

The only modification to the footnotes would be to remove reference to Resolution **114**.

Advantages:

This would maintain the current relationship between the ARNS and FSS that has resulted in successful coordination between the two services. Suppression of the resolution would end the call for studies that are not necessary.

Disadvantages:

Suppression of the resolution would eliminate an existing mechanism for addressing sharing studies between new ARNS systems and MSS feeder links.

1.1.3.3 Method C

Suppress Resolution **114 (WRC-95)** and revise No. **5.444** by removing reference to Resolution **114**, and revise No. **5.444A** by removing the first condition extending the time-frames that the FSS (Earth-to-space) may remain primary in the last two conditions to allow the FSS transition above 5 150 MHz.

Advantages:

- Agenda item 1.4 will be addressed taking into account the present requirements of FSS in the band 5 091-5 250 MHz.
- Future ARNS requirements (MLS) will be addressed.

Disadvantages:

Suppression of the resolution would eliminate an existing mechanism for addressing sharing studies between new ARNS systems and MSS feeder links.

1.1.3.4 Method D

Change the dates 2008 and 2010 in No. **5.444A** to 2016 and 2018 respectively, and revise Resolution **114 (WRC-95)** accordingly, also changing WRC-01 to a future competent WRC prior to 2018 in *instructs ITU-R* 2 of that Resolution. *Instructs ITU-R* 1 of that Resolution needs to be modified according to the example given under method A. As a consequence, modify No. **5.444** to make reference to the new Resolution **114 (Rev.WRC-03)** as opposed to Resolution **114 (WRC-95)**.

Advantages:

- The modifications to No. **5.444A** and Resolution **114** would only be to change the dates contained therein.
- A future competent conference prior to 2018 would allow time for required information to be obtained, and time for decisions to be available before 2018. Future development of both ARNS and the FSS could be taken into account in order to improve the evaluation of the sharing conditions between these services.

Disadvantages:

- Agenda item 1.4 will not be satisfied.

1.1.4 Regulatory and procedural considerations

1.1.4.1 Method A

The following example is a possible modification to Resolution **114 (WRC-95)**.

MOD

RESOLUTION 114 (REV.WRC-~~95~~03)

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 service)

The World Radiocommunication Conference (Geneva, ~~1995~~2003),

considering

a) the current allocation of the frequency band 5 000-5 250 MHz to the aeronautical radionavigation service;

b) the requirements of both the aeronautical radionavigation and the fixed-satellite (Earth-to-space) (limited to feeder links of non-geostationary (non-GSO) mobile-satellite systems) services in the above-mentioned band,

recognizing

a) that precedence must be given to the microwave landing system (MLS) in accordance with No. **5.444** of the Radio Regulations and to other international standard systems of the aeronautical radionavigation service in the frequency band 5 000-5 150 MHz;

b) that, in accordance with Annex 10 of the Convention of the International Civil Aviation Organization (ICAO), it may be necessary to use the frequency band 5 091-5 150 MHz for the MLS if its requirements cannot be satisfied in the frequency band 5 030-5 091 MHz;

c) that the fixed-satellite service providing feeder links for non-GSO mobile-satellite services will need access to the frequency band 5 091-5 150 MHz in the short term, in order to accommodate already identified requirements,

noting

a) the necessary evolution of the current MLS and of other international standard systems in the aeronautical radionavigation service implementation plans;

b) the small number of fixed-satellite service stations to be considered~~.~~;

c) the development of new systems that will provide supplemental navigation information integral to the aeronautical radionavigation service will reduce runway incursions, increase airport security and provide a high-fidelity complete picture of the airport surface environment,

resolves

~~1 that the provisions of this Resolution and of Nos. **5.444** and **5.444A** shall enter into force on 18 November 1995;~~

~~2~~1 that administrations authorizing stations providing feeder links for non-GSO mobile-satellite systems in the frequency band 5 091-5 150 MHz shall ensure that they do not cause harmful interference to stations of the aeronautical radionavigation service;

~~3~~2 that the allocation to the aeronautical radionavigation service and the fixed-satellite service in the frequency band 5 091-5 150 MHz should be reviewed at ~~WRC-01*~~a future competent conference,

~~* *Note by the Secretariat:* This Conference will be held in 2003.~~

urges administrations

1 when authorizing stations of the aeronautical radionavigation service, to assign frequencies giving priority to the band below 5 091 MHz;

2 when assigning frequencies in the band 5 091-5 150 MHz before 1 January 2010 to stations of the aeronautical radionavigation service or to stations of the fixed-satellite service providing feeder links of the non-GSO mobile-satellite service (Earth-to-space), to take all practicable steps to avoid mutual interference between them,

instructs ITU-R

1 to study in the appropriate time frame the technical and operational issues relating to sharing of this band between the aeronautical radionavigation service and the fixed-satellite service providing feeder links of the non-GSO mobile-satellite service (Earth-to-space);

2 to bring the results of these studies to the attention of ~~WRC-01*~~a future competent conference,

invites

1 ICAO to further review, within the same time-frame, detailed spectrum requirements and planning for international standard aeronautical radionavigation systems in the above-mentioned band;

2 all members of the Radiocommunication Sector, and especially ICAO, to participate actively in such studies,

requests the Secretary-General

to bring this Resolution to the attention of ICAO.

1.1.4.2 Method B

The only modification to Nos. **5.444** and **5.444A** would be to remove reference to Resolution **114** and suppress Resolution **114**.

1.1.4.3 Method C

It would be necessary to suppress Resolution **114 (WRC-95)** and modify Nos. **5.444** and **5.444A** as proposed in the following example.

MOD

5.444 The band 5 030-5 150 MHz is to be used for the operation of the international standard system (microwave landing system) for precision approach and landing. The requirements of this system shall take precedence over other uses of this band. For the use of this band, No. **5.444A** ~~and Resolution **114 (WRC-95)** apply~~applies. ~~(WRC 2000)~~

MOD

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 mobile-satellite systems and is subject to coordination under No. **9.11A**.

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

~~– prior to 1 January 2010, 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 (WRC-95)**;~~

– prior to 1 January ~~2010~~2018, the requirements of existing and planned international standard systems for the aeronautical radionavigation service which cannot be met in the 5 000-5 091 MHz band, shall take precedence over other uses of this band;

– after 1 January 2008, no new assignments shall be made to stations providing feeder links of non-geostationary mobile-satellite systems;

– after 1 January ~~2010~~2018, the fixed-satellite service will become secondary to the aeronautical radionavigation service.

1.1.4.4 Method D

The only regulatory changes necessary would be to change the dates 2008 and 2010 in No. **5.444A** and Resolution **114** to 2016 and 2018 respectively, and change the reference of WRC-01 in Resolution **114** to a future competent conference prior to 2018. *Resolves* 1 of Resolution **114** would be deleted, because it is not required once the normal date for bringing the Final Acts of WRC-95 into force is passed. As a consequence, modify No. **5.444** to make reference to the new Resolution **114 (Rev.WRC-03)** as opposed to Resolution **114 (WRC-95)**.

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1.2 Agenda item 1.15

"to review the results of studies concerning the radionavigation-satellite service in accordance with Resolutions **604 (WRC-2000)**, **605 (WRC-2000)** and **606 (WRC-2000)**"

1.2.1 Resolution 605 (WRC-2000), band 1 164-1 215 MHz

"Use of the frequency band 1 164-1 215 MHz by systems of the radionavigation-satellite service (space-to-Earth)"

1.2.1.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

Relevant RR provisions: No. **5.328A**

Relevant ITU-R Recommendations: DNR ITU-R M.[RNSS1] and M.[RNSS2].

Studies have been carried out by ITU-R in response to Resolution **605 (WRC-2000)**. Among the studies conducted are an assessment of the impact of RNSS into ARNS receivers, an assessment of the impact of ARNS into RNSS receivers, and a determination of whether there is a need for an aggregate epfd limit to ensure the protection of ARNS receivers (combined with a methodology to derive the aggregate equivalent pfd from all RNSS systems in the bands 1 164-1 215 MHz).

1.2.1.2 Analysis of the results of studies

ITU-R conducted studies on the overall compatibility between planned RNSS and current ARNS systems.

1.2.1.2.1 Impact of RNSS into ARNS receivers

An aggregate equivalent pfd by all RNSS transmissions that is less than or equal to −121.5 dB(W/m^2) in any 1 MHz in the 1 164-1 215 MHz band should be sufficient to protect ARNS receivers from harmful interference. This value was derived using an agreed analytic methodology (see DNR ITU-R M.[RNSS1]).

In addition, DNR ITU-R M.[RNSS2] provides the methodologies to be used in order to determine the compliance of RNSS systems with the aggregate protection criterion.

1.2.1.2.2 Impact of ARNS into RNSS receivers

Regarding the impact of current ARNS systems on RNSS receivers and taking into account RNSS receiver characteristics described in ITU-R, a two-step analysis was performed: the first step consists of a theoretical simulation based on worst-case assumptions, the second step is based on flight measurements.

The first step demonstrated that RNSS receivers used on board aircraft may experience a significant increase in the noise level at high altitude when exposed to a large number of ARNS (DME/TACAN) ground beacons within their receiver passband. The capacity for wideband RNSS receivers (20 MHz) to operate at all altitudes would depend on the minimum wanted wideband RNSS signal power.

The second step corresponding to the flight environment measurements in the 1 164-1 215 MHz band over Europe (worst case over the world), has shown by comparison that the simulation tool provides quite realistic results of the RF environment.

However, based on current ARNS (DME/TACAN) system characteristics, several mitigation techniques have been explored to avoid any harmful interference from these ARNS systems to the RNSS systems. Therefore, the RNSS receiver architecture can be designed to operate in the same band as ARNS (DME/TACAN), while not claiming protection as required in No. **5.328A**.

1.2.1.3 Method to satisfy the agenda item

Aggregate protection criterion for ARNS incorporated into the Radio Regulations with compliance to be assured by administrations.

This method mandates the provision of aggregate interference protection to the ARNS at the level identified in ITU-R studies, regardless of the number of RNSS systems operating in the band. It commits enforcement of the requirement to those administrations that operate or intend to operate RNSS systems. The aggregate protection criterion for ARNS would be specified in a Resolution (an epfd of –121.5 dB(W/m^2) in any 1 MHz of the 1 164-1 215 MHz band) that leaves to administrations the obligation to assure that protection is provided.

This method would manage the total amount of interference caused by these systems through the collaborative agreement on the part of administrations proposing and operating the RNSS systems, and there would be no additional regulatory task for the BR to validate compliance with the protection criterion.

There would be a need for coordination between RNSS administrations having GSO/non-GSO networks under Article **9**, and associated transitional measures, that would entail discussion between RNSS operators. This process would commence at an early point in the implementation of the system.

There would also be a need for consultation among RNSS administrations under the provisions of the proposed new resolution and associated provisions in the Radio Regulations to ensure that the aggregate protection criterion is met. Since RNSS operators should know sufficiently in advance the conditions under which their systems would operate, the consultations should be open to any administration having sent complete coordination or notification information to the Radiocommunication Bureau. However, only "real" systems should be included in the calculations. A mechanism needs to be put into place to determine which systems are "real" for purposes of participating in the calculations.

RNSS administrations would send the results of the aggregate protection criterion calculation to the BR for publication. This publication could take the form of a simple notification that agreement was

reached or, alternatively, could be in a form that would also permit any administration to verify compliance with the aggregate protection criterion.

In addition, the method includes a provision that would prohibit any single RNSS system from using up the entire interference allowance for all RNSS systems, to ensure the equitable sharing of the available aggregate interference allowance. Agreement has yet to be reached as to whether this provision should take the form of single-entry limits or of a provision in a Resolution.

It is acknowledged that it would be difficult for systems already put into service to modify their characteristics to allow for the entry of new systems, if required as a result of the consultations, and that the aggregate interference allowance is a finite resource.

The method also addresses the Radio Regulations Board's (RRB) concerns about having multiple inconsistent regulations applicable to the same band.

ICAO was invited to, and did, participate in the ITU-R studies that led to the development of this approach.

1.2.1.4 Regulatory and procedural considerations

The existing No. **5.328A** to the allocation 1 164-1 215 MHz contains a double, and thereby potentially confusing provision for the protection of DME (i.e. "shall not cause harmful interference" and "shall not exceed a pfd"). RRB discussions have indicated that such double provisions create confusion. In order to eliminate this confusion, the footnote would be modified to remove the "shall not cause harmful interference" reference, and to retain the "shall not claim protection" reference and state additionally that provision of No. **5.43A** does not apply. In addition, the provisional pfd value would be removed and be replaced with a reference to a new Resolution containing the aggregate epfd limit.

Non-GSO RNSS systems would be made subject to Article **9** coordination obligations with respect to each other and with GSO RNSS systems (Nos. **9.12** and **9.12A**), and GSO RNSS systems would be required to coordinate with non-GSO RNSS systems under No. **9.13.** It is noted that GSO RNSS systems are already obliged to coordinate with each other under No. **9.7**.

Finally, development of this multi-step approach would enable WRC-03 to suppress Resolution **605 (WRC-2000)**.

Examples of how to implement the method described above are included in Annex 1.2.1-1. Each of the examples, as a whole, achieves the principles of the method. The examples differ from each other slightly in the approach they take to achieve the principles of the method.

From a regulatory point of view, one of the unresolved issues of the method described in Section 1.2.1.3 concerns the regulatory implementation of the mechanism that is needed to determine which systems will be considered as "real" for purposes of participating in the calculations. Examples 1 and 3 take the approach that this mechanism should be in the form of milestones that are included in an annex to the resolution containing the aggregate protection criterion. An approach was suggested within ITU-R in order to alleviate regulatory concerns associated with the milestone approach. This approach, described in Example 2, would give the responsibility to develop such a "realness" mechanism directly to the consultation meeting. Under this approach administrations, in compliance with the special arrangements referenced in Article 42 of the ITU Constitution, shall establish, at the consultation meeting, mechanisms to ensure that only real systems are taken into account in the calculation of the aggregate epfd.

Example 1

Example 1 takes the following general approach:

- Modification of No. **5.328A** as described above. In addition, the footnote would also be modified to specify that use of the band 1 164-1 215 MHz by the RNSS (space-to-Earth) is subject to the application of the provisions of Nos. **9.12**, **9.12A**, and **9.13**; and to specify that the provisions of new No. **21.18** apply.
- Addition of a new section to Article **21** (No. **21.18**) that incorporates new Resolution **[RNSS 1.2.1-1]** into the Radio Regulations.
- Adoption of new Resolution **[RNSS 1.2.1-1]** that applies to all RNSS systems for which coordination or notification information, as appropriate, was received after 2 June 2000, and states that all RNSS systems together shall not exceed the aggregate epfd level of -121.5 dB(W/m^2) in any 1 MHz of the 1 164-1 215 MHz band. The Resolution also provides milestone criteria as a mechanism for determining the RNSS systems entitled to engage in the apportioning of the aggregate interference allowance among themselves. However, all administrations having notified RNSS networks/systems in this frequency band should attend the consultations. Administrations participating in this consultation process should meet on a regular basis (e.g. yearly), the first to be held within six months of the end of WRC-03 by any administration with a filed RNSS system. The Resolution directs that the results of aggregate sharing determinations be communicated to the Bureau (which would publish the results for information). The new Resolution may also include a provision that prohibits any single RNSS system from using up the entire interference allowance for all RNSS systems. There should be no priority in sharing the aggregate epfd value between RNSS networks/systems in this frequency band.
- Suppression of Resolution **605 (WRC-2000)**.

Example 2

Example 2 takes the following general approach:

- Modification of No. **5.328A** as described above. In addition, the footnote would also be modified to specify that use of the band 1 164-1 215 MHz by the RNSS is subject to the application of the provisions of Nos. **9.12**, **9.12A**, and **9.13**, and include a reference to a new Resolution containing the aggregate epfd limit.
- Adoption of new Resolution **[RNSS 1.2.1-2]** that applies to all RNSS systems for which coordination or notification information, as appropriate, was received after 2 June 2000, and states that all RNSS systems together shall not exceed the aggregate epfd level of -121.5 dB(W/m^2) in any 1 MHz of the 1 164-1 215 MHz band. This new Resolution states that all administrations subject to the Resolution shall take all necessary steps, including by means of appropriate modifications to their systems or networks, to ensure that the aggregate interference into ARNS systems caused by such RNSS systems or networks operating in these frequency bands does not exceed the level of the aggregate protection criterion.
- Equitable access to spectrum would be ensured through a set of two "per-satellite" pfd limits incorporated in Article **21** and applicable as of 3 June 2000. These limits are derived from the aggregate limit, and answer to the double concern of ensuring access to the resource to a certain amount of RNSS systems while not constraining these systems (considering the current design of planned systems). A first "per-satellite" pfd limit in

51 MHz of –118 dB(W/(m^2 · 51 MHz)) would ensure that a single system does not take more than a certain percentage of the total "power x frequency" resource (20%, leaving enough resource for at least 5 constellations similar to Galileo, GLONASS or GPS, i.e. about 150 satellites). A second limit "per-satellite" pfd limit in 1 MHz of –129 dB(W/(m^2 · MHz)) would ensure that a wideband signal of a given system may overlap with any narrow-band signal of another system. For both "per-satellite" pfd limits, the values stated for application were presented to ITU-R, but were not agreed.

- Transparency of the consultation process would be ensured through publication for information by BR in the International Frequency Information Circular of all RNSS characteristics used for verifying compliance with the aggregate epfd limit, as well as of the calculated aggregate epfd.
- A second Resolution **[RNSS 1.2.1-3]** would contain transitional measures for Article **9** coordination between RNSS systems for which coordination or notification information was received after 2 June 2000 and before the end of WRC-03. The objective is to ensure that "per satellite" limits proposed for inclusion in Article **21** will apply as of 3 June 2000, and to put back into order the coordination queue, including re-publication by BR of the coordination/notification data as coordination information.
- Suppression of Resolution **605 (WRC-2000)**.

Example 3

Example 3 has the same overall structure as Example 1. It differs, however, in the manner in which the allocation is presented in Article **5** (table as opposed to footnote) and also in the details of the example milestones. It also adds some elements similar to Example 2 to include the idea of transitional measures. It contains a footnote **5.328A**, Resolution **[RNSS-1.2.1-4] (WRC-03)**, Resolution **[RNSS-1.2.1-5] (WRC-03)**, and reference to consequential changes to RR Appendix **4**.

ANNEX 1.2.1-1

Examples of how to implement the method described in Section 1.2.1.3

A Example 1

The following is Example 1 of the package of regulatory provisions that would allow the method under Section 1.2.1.3 to be implemented:

1 Modify No. **5.328A** to remove the aggregate power flux-density limit and the "shall not cause harmful interference" provision, but specify in the footnote both that RNSS systems shall not claim protection from ARNS systems (with No. **5.43A** not being applicable), and that the provisions of new Resolution **[RNSS 1.2.1-1] (WRC-03)** shall apply. In addition, the regulation would include references to a new provision in Article **21** (see No. 2 below) and to the formal coordination obligations of Nos. **9.12, 9.12A,** and **9.13**. No. **5.328A**, modified in this fashion, would read as follows:

MOD

5.328A *Additional allocation:* the band 1 164-1 215 MHz is also allocated to the radionavigation-satellite service (space-to-Earth) (space-to-space) on a primary basis. ~~The aggregate power flux-density produced by all the space stations of all radionavigation-satellite systems at the Earth's surface shall not exceed the provisional value of –115 dB(W/m^2) in any 1 MHz band for all angles of arrival.~~ Stations in the radionavigation-satellite service in the band 1 164-1 215 MHz shall

operate in accordance with the provisions of Resolution **[RNSS 1.2.1-1] (WRC-03)** and shall not claim protection from stations in the aeronautical-radionavigation service. No. **5.43A** does not apply. Use of the band 1 164-1 215 MHz by the radionavigation-satellite service is subject to the application of the provisions of Nos. **9.12**, **9.12A**, and **9.13**. The provisions of No. **21.18** apply.~~not cause harmful interference to, nor claim protection from, stations of the aeronautical-radionavigation service. The provisions of Resolution **605 (WRC-2000)** apply. (WRC-2000)~~

*****

2 Include in the Radio Regulations (perhaps in a new Section of Article **21**) a provision that makes mandatory the collective obligation of administrations operating RNSS systems at 1 164-1 215 MHz to ensure that the aggregate protection criterion from *resolves* 1 of Resolution **[RNSS 1.2.1-1]** (see No. 4 below) is not exceeded, as well as the requirement to reduce emissions if administrations operating ARNS systems identify excess emission levels. The provision could read as follows:

ADD

Section VI – Protection of aeronautical radionavigation service systems from aggregate emissions of space stations of radionavigation-satellite service systems in the 1 164-1 215 MHz band

21.18 § 7 Administrations operating or planning to operate radionavigation-satellite service systems or networks in the 1 164-1 215 MHz frequency band, for which complete coordination or notification information, as appropriate, was received by the Bureau after 2 June 2000, shall, in accordance with *resolves* 2 of Resolution **[RNSS 1.2.1-1] (WRC-03)**, take all necessary steps to ensure that the actual aggregate interference into aeronautical radionavigation service systems caused by such RNSS systems or networks operating co-frequency in these frequency bands does not exceed the equivalent power flux-density level shown in *resolves* 1 of Resolution **[RNSS 1.2.1-1] (WRC-03)**.

*****

3 Modify Table 5-1 of Appendix **5** to specify an overlapping band as a coordination threshold under Article No. **9.7** in the band 1 164-1 215 MHz.

*****

4 Adopt Resolution **[RNSS 1.2.1-1] (WRC-03)**, which could take the following form:

RESOLUTION [RNSS 1.2.1-1] (WRC-03)

Protection of aeronautical radionavigation service systems from the equivalent power flux-density produced by radionavigation-satellite service networks and systems in the 1 164-1 215 MHz frequency band

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that the band 960-1 215 MHz is allocated on a primary basis to the aeronautical radionavigation service (ARNS) in all Regions;

b) that the band 1 164-1 215 MHz is also allocated on a primary basis to the radionavigation-satellite service (RNSS), subject to the condition in No. **5.328A** that operation of RNSS systems shall be in accordance with this Resolution;

c) that protection of the ARNS from harmful interference can be achieved if the value of the equivalent power flux-density (epfd) produced by all the space stations of all RNSS systems in the band referred to in *considering a)* does not exceed the level of –121.5 dB(W/m^2) in any 1 MHz band;

d) that WRC-2000 adopted Resolution **605 (WRC-2000)** to provide for implementation of a provisional aggregate power flux-density limit during the period between WRC-2000 and WRC-03, and requested ITU-R studies on the need for an aggregate pfd limit, and revision, if necessary, of the provisional pfd limit given in No. **5.328A**;

e) that only a limited number of RNSS systems are expected to be deployed in the 1 164-1 215 MHz band, and only a few of these systems at most would have overlapping frequencies;

f) that ARNS systems can be protected without placing undue constraints on the development and operation of RNSS systems in this band;

g) that to achieve the objectives in *considering f)*, administrations operating RNSS systems will need to agree cooperatively through consultation meetings to achieve the level of protection for ARNS systems that is stated in *considering c)*;

h) that it may be appropriate for representatives of administrations operating ARNS systems to be involved in determinations made pursuant to *considering g)*,

resolves

1 that, in order to protect ARNS systems, administrations shall ensure, without validation by the Radiocommunication Bureau pursuant either to No. **11.31** or **9.35** of the Radio Regulations, that the equivalent power flux density level produced by all space stations of all RNSS systems does not exceed the level –121.5 dB(W/m^2) in any 1 MHz band;

2 that administrations operating or planning to operate in the 1 164-1 215 MHz frequency band RNSS systems or networks for which complete coordination or notification information, as appropriate, was received by the Radiocommunication Bureau after 2 June 2000, in collaboration, shall take all necessary steps, including by means of appropriate modifications to their systems or networks, to ensure that the aggregate interference into ARNS systems caused by such RNSS systems or networks operating co-frequency in these frequency bands does not exceed the level of the aggregate protection criterion given in *resolves* 1 above;

3 that administrations, in carrying out their obligations under *resolves* 1 and 2 above, shall take into account only those RNSS systems with frequency assignments in the band 1164-1215 MHz that have met all of the milestones listed in the Annex to this Resolution through appropriate information provided to the consultation meetings referred to in *considering g)*;

4 that no single RNSS system shall be permitted to use up the entire interference allowance specified in *resolves* 1 above in any 1 MHz of the 1 164-1 215 MHz band;

5 that administrations participating in this process of epfd calculation should hold consultation meetings on a regular basis (e.g. yearly);

6 that administrations shall communicate to the Bureau the results of any aggregate sharing determinations made in application of *resolves* 2 above, without regard to whether such determinations result in any modifications to the published characteristics of their respective systems or networks;

7 that administrations operating ARNS systems in the 1 164-1 215 MHz band should participate, as appropriate, in discussions and determinations relating to the resolves above.

ANNEX TO RESOLUTION [RNSS 1.2.1-1] (WRC-03)

Milestone criteria

1 Submission of appropriate ITU Advance Publication, and Coordination or Notification documentation.

2 Entry into satellite manufacturing or procurement agreement:

The RNSS system or network operator should possess clear evidence of a binding agreement for the manufacture or procurement of its satellites. The agreement should identify the contract milestones leading to the completion of manufacture or procurement of satellites required for the service provision. The Notifying Administration is responsible for authenticating the evidence of agreement and providing such evidence to other interested administrations in furtherance of its obligations under this Resolution.

3 Entry into satellite launch agreement:

The RNSS system or network operator should possess clear evidence of a binding agreement to launch its satellites. The agreement should identify the launch date, launch site, and launch service provider. The Notifying Administration is responsible for authenticating the evidence of agreement and providing such evidence to other interested administrations in furtherance of its obligations under this Resolution.

B Example 2

The following is Example 2 of the package of regulatory provisions that would allow the method under Section 1.2.1.3 to be implemented:

1 Modify the Table of Frequency Allocations to include radionavigation-satellite (space-to-Earth) (space-to-space).

2 Modify No. **5.328A** to incorporate the reference of Articles Nos. **9.12**, **9.12A**, **9.13**, specify that No. **5.43A** does not apply and specify in the footnote that the provisions of new Resolutions **[RNSS 1.2.1-2] (WRC-03)** and **[RNSS 1.2.1-3] (WRC-03)** shall apply.

MOD

5.328A ~~*Additional allocation:* the band 1 164-1 215 MHz is also allocated to the radionavigation-satellite service (space-to-Earth) (space-to-space) on a primary basis. The aggregate power flux-density produced by all the space stations of all radionavigation-satellite systems at the Earth's surface shall not exceed the provisional value of –115 dB(W/m^2) in any 1 MHz band for all angles of arrival.~~ Stations in the radionavigation-satellite service shall not ~~cause harmful interference to, nor~~ claim protection from~~,~~ stations of the aeronautical-radionavigation service in the

band 960-1 215 MHz. No. **5.43A** does not apply. ~~The provisions of Resolution **605 (WRC-2000)** apply. (WRC-2000)~~ The use of the band 1 164-1 215 MHz by the radionavigation-satellite service is subject to the application of the provisions of Nos. **9.12**, **9.12A**, **9.13**, Resolution **[RNSS 1.2.1-2] (WRC-03)** and Resolution **[RNSS 1.2.1-3] (WRC-03)**.

3 Modify Article **21** to incorporate the limits per system.

4 Modify Table 5-1 of Appendix **5** to specify an overlapping band as a coordination threshold under Article No. **9.7** in the band 1 164-1 215 MHz.

RESOLUTION [RNSS 1.2.1-2] (WRC-03)

Protection of systems in the aeronautical radionavigation service from the maximum aggregate equivalent power flux-density produced by multiple radionavigation-satellite service systems in the band 1 164-1 215 MHz

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that the band 960-1 215 MHz is allocated on a primary basis to the aeronautical-radionavigation service (ARNS) in all Regions;

b) that WRC-2000 (Istanbul) decided to allocate the band 1 164-1 215 MHz to the radionavigation-satellite service (space-to-Earth) (space-to-space), and adopted a provisional limit on the aggregate power flux-density produced by all the space stations within RNSS at the Earth's surface of –115 dB(W/m^2) in any 1 MHz band for all angles of arrival;

c) that this conference has revised the limit referred to in *considering b)*, to ensure protection of ARNS systems operating in the 1 164-1 215 MHz range from the aggregate interference produced by all space stations within RNSS;

d) that this conference has approved and inserted in Article **21** limits –118 dB(W/(m^2 · 51 MHz) and –129 dB(W/(m^2 · MHz))) on the power flux-density produced by each RNSS space station in the band 1 164-1 215 MHz, with the aim to ensure equitable access by RNSS systems to the spectrum resource;

e) that this conference has decided to require coordination between RNSS systems under Nos. **9.12**, **9.12A**, **9.13**,

recognizing

a) that only a few RNSS systems are expected to be deployed in this band, and it is unlikely that more than two systems will have overlapping frequencies;

b) that the decision of this conference to require coordination between RNSS systems in the band 1 164-1 215 MHz under Nos. **9.12**, **9.12A** and **9.13** in addition to **9.7** will ensure that a dialogue will take place between administrations operating or planning to operate RNSS systems on overlapping frequencies in the band 1 164-1 215 MHz,

resolves

1 that the level of –121.5 dB(W/(m^2 · MHz)) for the aggregate equivalent power flux-density (epfd) applying for all the space stations within all RNSS systems, taking into account the reference

worst case DME antenna characteristics described in Annex 2 of Recommendation ITU-R M.[RNSS2], is adequate to ensure the protection of the ARNS in the band 1 164-1 215 MHz;

2 that administrations operating or planning to operate RNSS systems in the band 1 164-1 215 MHz, for which coordination or notification information, as appropriate, was received after 2 June 2000, individually or in collaboration, shall take all necessary steps, including, if necessary, by means of appropriate modifications to their systems, to ensure that the aggregate interference into ARNS systems caused by such RNSS systems does not exceed the level specified in *resolves* 1;

3 that administrations, in developing agreements to carry out their obligations under *resolves* 1 and 2 above, shall establish mechanisms to ensure that only "real" systems are taken into account in the calculation of the aggregate epfd;

4 that administrations participating in this process of epfd calculation should meet on a regular basis (e.g. yearly);

5 that the methodology contained in Recommendation ITU-R M.[RNSS2] shall be used by administrations for calculating the aggregate epfd produced by all the space stations within all RNSS systems in the band 1 164-1 215 MHz;

6 that administrations shall send to the Bureau for publication in the International Frequency Information Circular all RNSS characteristics listed in the Annex to this Resolution used when applying the methodology referred to in *resolves* 5, as well as the calculated aggregate epfd.

Annex to Resolution [RNSS 1.2.1-2] (WRC-03)

List of RNSS system characteristics and format of the result of the aggregate epfd calculation to be provided to the BR for publication for information

I RNSS systems characteristics

I-1 RNSS ITU publication reference

RNSS network name	ITU Publication reference
	AR11/A/....
	API/A/....
	AR11/C/....
	CR/C/....

I-2 Non-GSO satellite system constellation parameters

For each non-GSO satellite system, the following constellation parameters should be provided to BR for publication for information:

N: number of space stations of the non-GSO system

K: number of orbital planes

h: satellite altitude above the Earth (km)

I: inclination angle of the orbital plane above the Equator (degrees)

Satellite index *I*	RAAN $\Omega_{i,0}$ (degrees)	Argument of latitude $E_{i,0}$ (degrees)
1	...	...
2	...	...
...	...	...
N	...	...

I-3 GSO satellite system longitude

For each GSO satellite system, the satellite longitude should be provided to BR for publication for information follows:

$LonGSO_i$: longitude of each of the GSO satellites (degrees)

I-4 Maximum non-GSO space station pfd versus the elevation angle at the Earth's surface (worst 1 MHz)

For the non-GSO satellite system space stations, the maximum pfd in the worst 1 MHz versus elevation angle should be provided to the BR for publication for information in a table format as follows:

Elevation angle (each 1°)	pfd (dBW/m^2/MHz)
–4	pfd (–4°)
–3	pfd (–3°)
…	…
…	…
90	pfd (–90°)

I-5 Maximum GSO space station pfd versus latitude and longitude at the Earth's surface (worst 1 MHz)

For each GSO satellite system space station, the maximum pfd in the worst 1 MHz, defined as the 1 MHz in which the pfd of the signal is maximum versus latitude and longitude should be provided to BR for publication for information in a table format as follows:

Latitude (each 1°)	**0**	**1**	**…**	**360**
Longitude (each 1°)	**Maximum pfd dBW/m^2 in worst 1 MHz**			
–90	Pfd (0,–90)	…	…	…
–89	…	…	…	…
…	…	…	…	…
…	…	…	…	…
90	…	…	…	pfd (360,90)

I-6 GSO/non-GSO satellite system spectrum

For each GSO and non-GSO satellite system, the level of spectrum emission in each 1 MHz relative to the spectrum value at the worst 1 MHz of the whole band (1 164-1 215 MHz) should also be provided to BR for publication for information.

II Results of the aggregate epfd calculation in the worst 1 MHz of the 1 164-1 215 MHz band

Maximum epfd in dBW/m^2 in any 1 MHz in the range 1 164-1 215 MHz.

RESOLUTION [RNSS 1.2.1-3] (WRC-03)

Transitional measures for coordination between RNSS systems in the band 1 164-1 215 MHz

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that WRC-2000 (Istanbul) decided to allocate the band 1 164-1 215 MHz to the radionavigation-satellite service (space-to-Earth) (space-to-space);

b) that this conference has approved and inserted in Article **21** limits on the power flux-density produced by each RNSS space station in the band 1 164-1 215 MHz, with the aim to ensure equitable access by RNSS systems to the spectrum resource;

c) that this conference has decided to apply bandwidth overlap as the only criterion for the identification of coordination requirements under No. **9.7** between RNSS GSO networks in this frequency band;

d) that this conference has decided to require coordination of all RNSS systems under Nos. **9.12**, **9.12A**, **9.13**,

resolves

1 that the limits referred to in *considering b)* shall apply to RNSS systems as of 3 June 2000;

2 that as of 3 June 2000, the provisions of Nos. **9.7**, **9.12**, **9.12A** and **9.13** shall apply to any frequency assignment of a RNSS system in the band 1 164-1 215 MHz with bandwidth overlap as the only criterion to determine that coordination is required;

3 that complete coordination or notification information, as appropriate, for RNSS systems in the band 1 164-1 215 MHz received by the Bureau before [end WRC-03] shall be considered as from their date of receipt as complete coordination information under Nos. **9.7**, **9.12**, **9.12A** or **9.13**, as appropriate,

instructs the Director of the Radiocommunication Bureau

1 as of the end of WRC-03, to review all findings on RNSS systems in the band 1 164-1 215 MHz for which complete coordination or notification information, as appropriate, has been received as of 3 June 2000;2 as of the end of WRC-03, for each RNSS system covered by *resolves* 3 above, to publish the relevant special section in an International Frequency Information Circular.

C Example 3

The following is Example 3 of the package of regulatory provisions that would allow the method under Section 1.2.1.3 to be implemented:

This example is similar to Example 1, except for variations in some areas:

1 In Example 3, the allocation table is modified as shown below, instead of having the allocation shown as an "additional allocation" in a footnote.

MOD

ARTICLE 5

890-1 260 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
960-~~1 215~~1 164	AERONAUTICAL RADIONAVIGATION 5.328	
1 164-1 215	AERONAUTICAL RADIONAVIGATION 5.328 RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) ~~5.328A~~ MOD 5.328A	

2 The example milestones are slightly different from those in Example 1, and a new resolution similar to the one in Example 2 is included to consider transitional measures.

MOD

5.328A ~~*Additional allocation:* the band 1 164-1 215 MHz is also allocated to the radionavigation-satellite service (space-to-Earth) (space-to-space) on a primary basis. The aggregate power flux-density produced by all the space stations of all radionavigation-satellite systems at the Earth's surface shall not exceed the provisional value of –115 dB(W/m^2) in any 1 MHz band for all angles of arrival.~~ Stations in the radionavigation-satellite service in the band 1 164-1 215 MHz shall ~~not cause harmful interference to, nor claim protection from, stations of the aeronautical-radionavigation service.~~ operate in accordance with t~~T~~he provisions of Resolutions **[RNSS-1.2.1-4] (WRC-03)** and **[RNSS-1.2.1-5] (WRC-03)** ~~**605 (WRC-2000)**~~ and shall not claim protection from stations in the aeronautical-radionavigation service. **No. 5.43A** does not apply. Use of the band 1 164-1 215 MHz by the radionavigation-satellite service is subject to the application of the provisions of Nos. **9.12**, **9.12A**, and **9.13**. The provisions of **No. 21.18** apply.

*****

3 Modify Table 5-1 of Appendix **5** to specify an overlapping band as a coordination threshold under Article No. **9.7** in the band 1 164-1 215 MHz.

*****

4 Include in the Radio Regulations (perhaps in a new Section of Article **21**) a provision that makes mandatory the collective obligation of administrations operating RNSS systems at 1 164-1 215 MHz to ensure that the aggregate protection criterion from *resolves* 1 of Resolution **[RNSS 1.2.1-4]** (see No. 5 below) is not exceeded, as well as the requirement to reduce emissions if administrations operating ARNS systems identify excess emission levels. The provision could read as follows:

ADD

Section VI – Protection of aeronautical radionavigation service systems from aggregate emissions of space stations of radionavigation-satellite service systems in the 1 164-1 215 MHz band

21.18 § 7 Administrations operating or planning to operate radionavigation-satellite service systems or networks in the 1 164-1 215 MHz frequency band, for which complete coordination or notification information, as appropriate, was received by the Bureau after 2 June 2000, shall, in accordance with *resolves* 2 of Resolution **[RNSS 1.2.1-4] (WRC-03)**, take all necessary steps to ensure that the actual aggregate interference into aeronautical radionavigation service systems caused by such RNSS systems or networks operating co-frequency in these frequency bands does not exceed the equivalent power flux-density level shown in *resolves* 1 of Resolution **[RNSS 1.2.1-4] (WRC-03)**.

*****

5 Adopt Resolution **[RNSS 1.2.1-4] (WRC-03)**, which could take the following form:

ADD

RESOLUTION [RNSS 1.2.1-4] (WRC-03)

Protection of aeronautical radionavigation service systems from the equivalent power flux-density produced by radionavigation-satellite service networks and systems in the 1 164-1 215 MHz frequency band

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that the band 960-1 215 MHz is allocated on a primary basis to the aeronautical radionavigation service (ARNS) in all Regions;

b) that the band 1 164-1 215 MHz is also allocated on a primary basis to the radionavigation-satellite service (RNSS), subject to the condition in No. **5.328A** that operation of RNSS systems shall be in accordance with this Resolution;

c) that protection of the ARNS from harmful interference can be achieved if the value of the equivalent power flux-density (epfd) produced by all the space stations of all RNSS systems in the band referred to in *considering a)* does not exceed the level of –121.5 dB(W/m^2) in any 1 MHz band;

d) that WRC-2000 adopted Resolution **605 (WRC-2000)** to provide for implementation of a provisional aggregate power flux-density limit during the period between WRC-2000 and WRC-03, and requested ITU-R studies on the need for an aggregate pfd limit, and revision, if necessary, of the provisional pfd limit given in No. **5.328A**;

e) that only a limited number of RNSS systems are expected to be deployed in the 1 164-1 215 MHz band, and only a few of these systems at most would have overlapping frequencies;

f) that ARNS systems can be protected without placing undue constraints on the development and operation of RNSS systems in this band;

g) that to achieve the objectives in *considering f)*, administrations operating RNSS systems will need to agree cooperatively through consultation meetings to achieve the level of protection for ARNS systems that is stated in *considering c)*;

h) that it may be appropriate for representatives of administrations operating ARNS systems to be involved in determinations made pursuant to *considering g)*,

resolves

1 that, in order to protect ARNS systems, administrations shall ensure, without validation by the Radiocommunication Bureau* pursuant either to No. **11.31** or **9.35** of the Radio Regulations, that the equivalent pfd level produced by all space stations of all RNSS systems does not exceed the level, –121.5 dB(W/m^2) in any 1 MHz band;

2 that administrations operating or planning to operate in the 1 164-1 215 MHz frequency band RNSS systems or networks for which complete coordination or notification information, as appropriate, was received by the Radiocommunication Bureau after 2 June 2000, in collaboration, shall take all necessary steps, including by means of appropriate modifications to their systems or networks, to ensure that the aggregate interference into ARNS systems caused by such RNSS systems or networks operating co-frequency in these frequency bands is shared equitably among the systems identified in *resolves* 4 and does not exceed the level of the aggregate protection criterion given in *resolves* 1 above;

3 that there shall be no priority in sharing the aggregate epfd value among RNSS systems/networks in this frequency band;

4 that administrations, in carrying out their obligations under *resolves* 1, 2 and 3 above, shall take into account only those RNSS systems with frequency assignments in the band 1 164-1 215 MHz that have met all of the milestones listed in the Annex to this Resolution through appropriate information provided by the consultation meetings referred to in *considering g)*;

5 that no single RNSS system shall be permitted to use up the entire interference allowance specified in *resolves* 1 above in any 1 MHz of the 1 164-1 215 MHz band;

6 that administrations participating in this process of epfd calculation should hold consultation meetings on a regular basis (e.g. yearly);

7 that administrations shall communicate to the Bureau the results of any aggregate sharing determinations made in application of *resolves* 2 above, without regard to whether such determinations result in any modifications to the published characteristics of their respective systems or networks;

8 that administrations operating ARNS systems in the 1 164-1 215 MHz band should participate, as appropriate, in discussions and determinations relating to the resolves above;

9 that the methodologies contained in draft new Recommendation ITU-R M.[RNSS2] shall be used by administrations for calculating the aggregate epfd produced by all the space stations within all RNSS systems in the band 1 164-1 215 MHz.

---

* Some administrations proposed to delete the words "without validation by the Radiocommunication Bureau" because they believe the Bureau has a role to play in this validation as mentioned in *resolves* 7 of this Resolution.

ANNEX TO RESOLUTION [RNSS 1.2.1-4] (WRC-03)

Milestone criteria

1 Submission of appropriate ITU Advance Publication, and Coordination or Notification documentation.

2 Entry into satellite manufacturing or procurement agreement, and entry into satellite launch agreement:

The RNSS system or network operator should possess clear evidence of a binding agreement for the manufacture or procurement of its satellites agreement, and entry into satellite launch agreement. The agreement should identify the contract milestones leading to the completion of manufacture or procurement of satellites required for the service provision and identify the launch date, launch site and launch service provider. The Notifying Administration is responsible for authenticating the evidence of agreement and providing such evidence to other interested administrations in furtherance of its obligations under this Resolution.

3 In lieu of satellite manufacturing and launch agreements, clear evidence of guaranteed funding arrangements for the project would be accepted. The Notifying Administration is responsible for authenticating the evidence of the financial commitment and for providing such evidence to other interested administrations in furtherance of its obligations under this Resolution.

*****

6 Adopt Resolution **[RNSS 1.2.1-5] (WRC-03)**, which could take the following form:

ADD

RESOLUTION [RNSS 1.2.1-5] (WRC-03)

Transitional measures for coordination between RNSS systems in the band 1 164-1 215 MHz

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that WRC-2000 (Istanbul) decided to allocate the band 1 164-1 215 MHz to the radionavigation-satellite service (space-to-Earth) (space-to-space);

b) that this conference has decided to apply bandwidth overlap as the only criterion for the identification of coordination requirements under No. **9.7** between RNSS GSO networks in this frequency band;

c) that this conference has decided to require coordination of all RNSS systems under Articles Nos. **9.12**, **9.12A**, **9.13**,

resolves

1 that as of 3 June 2000, the provisions of Articles Nos. **9.7**, **9.12**, **9.12A** and **9.13** shall apply to any frequency assignment of a RNSS system in the band 1 164-1 215 MHz with bandwidth overlap as the only criterion to determine that coordination is required;

2 that complete coordination or notification information, as appropriate, for RNSS systems in the band 1 164-1 215 MHz received by the Bureau [before end WRC-03][1] shall be considered as complete coordination information under Articles Nos. **9.7**, **9.12**, **9.12A** or **9.13**, as appropriate,

instructs the Director of the Radiocommunication Bureau

as of the end of WRC-03, for each RNSS system covered by *resolves* 2 above, to publish the relevant special section in an International Frequency Information Circular.

*****

7

APPENDIX 4 (WRC-2000)

ANNEX 2A

A.17c Compliance with aggregate power flux-density limits

Consequential changes to this part of the RR Appendix 4 are required to incorporate the changes in No. **5.328A** and to include the concept of epfd.

#########

1.2.2 Resolution 606 (WRC-2000), band 1 215-1 300 MHz

"Use of the frequency band 1 215-1 300 MHz by systems of the radionavigation-satellite service (space-to-Earth)"

1.2.2.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

Relevant ITU-R Recommendations: M.1463, M.1461, M.1317, M.1088, M.1227 and M.1477.

Studies have been carried out by ITU-R in response to Resolution **606 (WRC-2000)**. Among the studies conducted are:

1) a worst-case study, assuming that the RNSS signal is continuously received in the main beam of the radar system;

2) a statistical study, taking into account models of real satellite constellations;

3) studies which try to explain the current situation, as stipulated in *considering b)* of Resolution **606 (WRC-2000)**;

4) studies including the mitigation techniques used by radiolocation and radionavigation services.

The GPS, an RNSS system which operates on 1 227.6 MHz (24 MHz bandwidth, designated as the "L2" signal), has been in operation in the band 1 215-1 260 MHz since 1978. It provides positioning and navigation services from space. Currently, this signal provides precision RNSS applications in

[1] This date may need to include additional time after WRC-03 in order to allow for BR to receive complete coordination information for the systems for which advanced publication information has already been received.

high productivity applications, such as machine guidance, construction, agriculture, and mining. In addition, the GLONASS has been also operating in the frequency band 1 215-1 260 MHz since 1982. It currently operates in the band 1 240.89-1 256.7975 MHz. This system also provides precision positioning and navigation services from space.

Furthermore, these systems are used for ionospheric correction by many users. These signals have been transmitted at their current power levels for over 12 years and have not caused any reports of interference to other users of the band.

A modernization of the GPS and GLONASS systems is now under way, including new and improved signals for civil and commercial applications, in the 1 215-1 260 MHz range. These signals are expected to provide enhanced accuracy, and dual frequency application, as well as improving the capabilities of existing applications.

1.2.2.2 Analysis of the results of studies

Based upon the results in ex-CCIR Report 766-2 (1990) and over 12 years of operational experience by the GPS system in the frequency range 1 215-1 240 MHz and over 10 years of operational experience by the GLONASS system in the frequency range 1 240-1 260 MHz, current RNSS signals have successfully demonstrated co-primary sharing between this radionavigation-satellite service systems and radars in the band 1 215-1 260 MHz. Operational experience with current GPS and GLONASS system characteristics in the 1 215-1 260 MHz band, has not led to any reports of harmful interference being caused to existing radar systems.

The frequency band 1 270-1 295 MHz is indicated, among others, in Resolution **217 (WRC-97)** for administrations to implement wind profiler radars in the radiolocation service. The characteristics of these radars, as used in ITU-R studies, are stated in Recommendations ITU-R M.1227 and M.1463.

As RNSS system characteristics are expected to evolve and new systems are planned, analyses, along with testing, are being conducted to determine the impact of a more powerful RNSS space-to-Earth signal on radar systems in the 1 215-1 300 MHz band. In order to ensure that radar systems are protected from more powerful RNSS space-to-Earth emissions, it may be necessary to identify a maximum pfd value for such RNSS emissions, although a technical basis for such a pfd value has yet to be completed. However, any such pfd value should take into proper account the operational experience with RNSS systems which exceed protection requirements based on the existing Recommendations currently applicable to radar systems, while leading to no reports of harmful interference.

Several analyses were performed as follows.

1.2.2.2.1 A worst-case study: RNSS signal received in the main beam of the radar system

A study was performed using Recommendations ITU-R M.1463 and M.1461, which provide respectively the characteristics and protection criteria of the radar systems. This study is based on a worst-case assumption, which corresponds to a satellite in the radar main beam and a protection criterion of I/N of –6 dB.

The study shows that, with these assumptions, current RNSS systems do not meet the protection criteria of Recommendation ITU-R M.1461. This seems in contradiction with the current situation, reported in *considering b)* of Resolution **606 (WRC-2000)**: "in the band 1 215-1 260 MHz radionavigation-satellite service (space-to-Earth) systems have been successfully operated for a considerable time in a band used by radars."

1.2.2.2.2 Statistical studies

The study mentioned in Section 1.2.2.2.1 based on current recommendations, was not able to explain the current and past situation (no interference with radars since the implementation of

RNSS systems (around 1989)). Additional studies performed were based on statistical approaches (the RNSS satellite is not always in the main beam of the radar).

The statistical studies show that the present RNSS systems exceed the protection criteria of radar systems in short but frequent periods of time corresponding overall to a small portion of the time. However, no statistical criterion for the amount of time that the protection criteria of radar systems may be exceeded has been elaborated within the ITU-R.

1.2.2.2.3 An explanation of the current and past situations on sharing between radars and RNSS in the band 1 215-1 260 MHz

The studies on the operational impact of RNSS systems into radar systems showed that the degradation of radar performance may not be operationally noticeable, even when the required protection criterion in relevant ITU-R recommendations dealing with radar protection in this band is exceeded, in particular due to the fact that this criterion is only defined for worst cases and does not take into account any statistical aspect, particularly, with respect to the signal-to-noise performance of the radar. However, there is no agreement on the statistical approach to be taken.

The main conclusions of the studies presented to the ITU-R are the following:

- The current protection criterion given in Recommendations ITU-R M.1461 and M.1463 may need to be revised in order for realistic conclusions to be reached on the operational impacts of sharing between radar systems and RNSS in the band 1 215-1 300 MHz. This matter is under study within the ITU-R.
- The current sharing experience shows that the maximum pfd level of transmissions from RNSS satellites currently in operation is acceptable to at least some radars in portions of the band 1 215-1 260 MHz, since no cases of harmful interference have been reported by operators of those radars which operate co-frequency. The calculated maximum pfd level of transmission for existing RNSS systems is –133 dB(W/(m^2 · MHz)), based on Recommendation ITU-R M.1317. Some administrations have planned RNSS systems that have a future requirement which will result in a pfd level higher than –133 dB(W/(m^2 · MHz)) into the 1 215-1 260 MHz band.

Initially, ITU-R indicated that "a few administrations successfully use radar systems co-frequency with existing RNSS systems in the 1 215-1 260 MHz band, without any spectrum management techniques" and "the same sharing conditions should be applied in the whole 1 215-1 300 MHz range". Subsequently, ITU-R sent Circular Letter CA/102, inquiring of administrations about experiences of sharing between RNSS systems and radiolocation/radionavigation systems in the 1 215-1 260 MHz band.

The 15 responses to the Questionnaire sent to administrations in Circular Letter CA/102 show that, in the band 1 215-1 260 MHz:

- a rather large number of radars are used in this frequency band in different countries, although six countries having responded do not operate any radar in the frequency band;
- air traffic control radars largely operate above 1 240 MHz;
- radars operate in this band without specific procedure of spectrum management. Most radars use frequency diversity signal processing and other techniques not intended to facilitate sharing with RNSS;
- one administration conducted operational tests and those tests showed no noticeable interference.

Based on the studies presented in ITU-R and the responses to the questionnaire CA/102 on the frequency band 1 215-1 260 MHz, the conclusion could be drawn that sharing between RNSS

systems and at least some radars is feasible without causing harmful interference. Furthermore, there is difficulty in drawing a firm conclusion in response to Resolution **606**. Further studies are under way which may assist in satisfying this WRC-03 agenda item.

1.2.2.3 Methods to satisfy the agenda item and their advantages and disadvantages

1.2.2.3.1 Method A1

No pfd limit in the band 1 215-1 300 MHz; no change to the RR.

Under this method, no pfd limits would be included in the Radio Regulations for the protection of radiolocation/radionavigation systems, based on the fact the no interference have been reported between the RNSS (space-to-Earth) and systems in the radiolocation/radionavigation services (some of which may have had to utilize interference mitigation techniques) in the 1 215-1 260 MHz band. However, ITU-R has not concluded that the characteristics of existing RNSS systems are providing sufficient protection to the radionavigation and radiolocation service.

Advantages:

- The designers of RNSS systems would have freedom to develop new or improved systems, and there would be no need to develop additional regulatory provisions. Any harmful interference concerns would continue to be managed using existing RR (Article **15**).
- No additional burden to the ones expressed in the disadvantages would be imposed on the Bureau because it would be up to the administrations operating RNSS systems to resolve problems, if any arise.

Disadvantages:

- RNSS systems may evolve to employ more powerful signal levels, which may require the implementation of interference mitigation techniques by radar operators in order to avoid harmful interference to certain radiolocation radar systems, as indicated in ex-CCIR Report 766-2 (1990).
- RNSS systems may evolve to employ more powerful signal levels, and thus may need to make modifications to their systems in order to avoid causing harmful interference to certain radionavigation radar systems, as indicated in ex-CCIR Report 766-2 (1990).
- The designers of RNSS systems will have no information on how to take into account the current regulatory protection of the radionavigation service (i.e. how to avoid causing harmful interference to the radionavigation service).
- The radars of the radiolocation service are not included in No. **5.329**, which provides protection of the radionavigation service from harmful interference.
- If application of Article **15** is required, harmful interference already is being caused. This is unacceptable to a safety service.
- Application of Article **15**'s harmful interference provisions represents a burden to both administrations and the Radiocommunication Bureau.

1.2.2.3.2 Method A2

No pfd limit in the band 1215-1300 MHz; modification of No. **5.329**, consistent with *resolves* 1 of Resolution 606 (WRC-2000).

a) Modify existing No. **5.329** to extend the protection from harmful interference afforded to the radionavigation service so that it includes the protection of the radiolocation and the aeronautical radionavigation service authorized under No. **5.334**.

b) Adopt a Resolution [Method A2] (no example text included) retaining the requirement of *resolves* 1 of Resolution **606 (WRC-2000)** "that no additional constraints shall be placed on radionavigation-satellite service (space-to-Earth) systems operating in the band 1 215-1 260 MHz," and requesting ITU-R to finalize studies and prepare appropriate Recommendations to facilitate implementation of provisions in the modified No. **5.329**.

Advantages:

- The designers of RNSS systems would have freedom to develop new or improved systems (including operational and technological changes) without the need to further change the Radio Regulations. Any harmful interference concerns would continue to be managed using the existing Radio Regulations (Article **15**).
- No additional burden to the ones expressed in the disadvantages would be imposed on the Bureau because it would be up to the administrations operating RNSS systems to resolve problems, if any arise.
- Radars of the radiolocation service, which have many characteristics in common with the radionavigation service, would be protected.
- Resolution [Method A2] would ensure that the obligations on the RNSS would be consistent with *resolves* 1 of Resolution **606**.

Disadvantages:

- The ITU-R will be required to conduct studies, which identify ways to ensure that harmful interference from the RNSS into the radars and radiocommunication services is avoided.
- If application of Article **15** is required, harmful interference already is being caused. This is unacceptable to a safety service.
- Application of Article **15**'s harmful interference provisions represents a burden to both administrations and the Radiocommunication Bureau.
- RNSS systems would have the additional (although perhaps not significant) burden of protecting radiolocation service systems, which have many characteristics in common with radionavigation service systems.

1.2.2.3.3 Method B

pfd limit in the band 1 215-1 300 MHz, consistent with *considering b)* and *resolves* 1 of Resolution **606 (WRC-2000).**

A single entry RNSS space station pfd limit in the 1 215-1 300 MHz frequency band to protect the radiolocation and radionavigation services would be specified in the Radio Regulations. A pfd limit of –133 dB(W/(m^2 · MHz)) is proposed for consideration. However, the ITU-R has not concluded which pfd value is sufficient to protect the RNS and RLS. The proposed pfd limit is based on a calculation of the maximum pfd level using the characteristics for the existing RNSS system described in Recommendation ITU-R M.1317. The implementation of this method should be consistent with *resolves* 1 of Resolution **606**, which states "that no additional constraints shall be placed on RNSS (space-to-Earth) systems operating in the band 1 215-1 260 MHz."

Advantages:

- If the pfd limit is sufficient, the required protection of the RLS and RNS from the interference produced by the RNSS systems in the 1 215-1 300 MHz frequency band would be ensured.
- The designers of RNSS systems will know in advance the maximum level of pfd that is needed to protect radars.

- No additional constraints are placed on existing RNSS satellites in the band 1 215-1 260 MHz (in accordance with *considering b)* and *resolves* 1 of Resolution **606 (WRC-2000)**).

Disadvantages:

- Development and modernization of RNSS systems would be unnecessarily restricted in the band 1 215-1 300 MHz if a pfd limit that is too low is imposed.
- ITU-R has not reached final conclusion on which pfd value is sufficient to protect radars or on the operational impact of the proposed value or on the potentially required mitigation techniques.
- If the pfd value is not sufficient to protect radars, modification of existing radars would be required in the frequency band 1 215-1 300 MHz in addition to development and implementation of specific techniques for mitigating harmful interference caused by new RNSS systems.
- A pfd limit, even if sufficient to protect current radars, could also restrict the development of future radar systems.

1.2.2.3.4 Method C

pfd limit in one portion of the band 1 215-1 300 MHz and no pfd limit in the other portion of the band 1 215-1 300 MHz, consistent with *considering b)* and *resolves* 1 of Resolution **606 (WRC-2000)**

A single entry RNSS space station pfd limit in the one portion of the 1 215-1 300 MHz frequency band would be imposed to protect the radiolocation and radionavigation services and would be specified in the Radio Regulations, and there would be no pfd limit imposed in the other portion of the 1 215-1 300 MHz band. A pfd limit of –161 dB(W/(m^2 · MHz)) has been proposed for consideration in the portion of the band where a pfd limit would be imposed. The proposed pfd limit is based on the worst-case analysis and the application of Recommendation ITU-R M.1463 (which applies to the band 1 215-1 400 MHz) and Recommendation ITU-R M.1461. However, the ITU-R has not concluded which pfd value is necessary to protect the radionavigation and radiolocation services from RNSS emissions. The implementation of this method should be consistent with *resolves* 1 of Resolution **606** (**WRC-2000**), which states "that no additional constraints shall be placed on RNSS (space-to-Earth) systems operating in the band 1 215-1 260 MHz".

Advantages:

- Protection of the radiolocation/radionavigation services from the interference produced by the new or modified RNSS systems is provided in the portion of the band with the pfd limit.
- If the band without the pfd limit encompasses the bands with operating RNSS (space-to-Earth) systems, no further consideration of how to ensure consistency with *resolves* 1 of Resolution **606** would be needed.

Disadvantages:

- All of the disadvantages of Method A1 apply to the portion of the band with no pfd limit.
- Development and modification of RNSS systems would be prevented in the portion of the band with the pfd limit, given the very low proposed pfd limit of –161 dB(W/(m^2 · MHz)). This would lead to a situation where RNSS systems planning to operate in the portion of the band with the limit would be significantly disadvantaged with respect to RNSS systems in the portion of the band without the limit.

- ITU-R has not reached a final conclusion on which pfd value is necessary to protect radars, taking into account operational impact of proposed RNSS emissions and mitigation techniques.
- RNSS and radar systems in the 1 215-1 300 MHz band would be subject to differing regulatory constraints dependent solely on which portion of the band they operate.
- One of the principles upon which this method is based is that some radionavigation radars currently avoid operating within the band 1 215-1 260 MHz, to avoid the risk of harmful interference by existing RNSS systems which significantly exceed the pfd level of –161 dB(W/(m^2 · MHz)). If such radars were to be introduced in this band, and in fact be harmfully interfered with, existing RNSS systems would not practically comply with No. **5.329** and would be under the obligation to reduce their power if any administration quoted in No. **5.331** wished to operate such radionavigation radars within the band 1 215-1 260 MHz.
- If the same sharing conditions between RNSS and radars were to be applied in the whole 1 215-1 300 MHz band, as initially concluded by the ITU-R, there would be no reason why a pfd limit could not be applied equally to all portions of the band 1 215-1 300 MHz.

Other considerations

The meaning of *resolves* 1 of Resolution **606** is unclear. As a result, it is not possible to determine at this time whether specifying additional constraints under Methods B or C on future developments of existing RNSS systems is in contradiction, or not, with *resolves* 1 of Resolution **606 (WRC-2000))**.

1.2.2.4 Regulatory and procedural considerations

The only changes to the Radio Regulations needed to implement Method A1 would be consequential (modification of a footnote to delete reference to Resolution **606 (WRC-2000))**. Implementation of Method A2 would require modification of No. **5.329** and a new resolution as described in Section 1.2.2.3 above. An example of how No. **5.329** could be modified under this method is as follows:

MOD

5.329 Use of the radionavigation-satellite service in the band 1 215-1 300 MHz shall be subject to the condition that no harmful interference is caused to, and no protection is claimed from, the radionavigation service authorized under No. **5.331,** the aeronautical radionavigation service authorized under No. **5.334**, and the radiolocation service. See also Resolution ~~**606 (WRC-2000)**~~ **[Method A2] (WRC-03)**.

*****

Methods B and C could be implemented by modifications to No. **5.329** of the Radio Regulations and addition of the pfd limits in Table **21-4** of Article **21**. Under Method B, the "harmful interference" provision of No. **5.329** could be removed (No. **5.43A** would be stated not to apply in this case) and the "shall not claim protection" provision of No. **5.329** could, if appropriate, be extended to the radiolocation service.

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1.2.3 Resolution 604 (WRC-2000), band 5 010-5 030 MHz

"Studies on compatibility between the radionavigation-satellite service (space-to-Earth) operating in the frequency band 5 010-5 030 MHz and the radio astronomy service operating in the band 4 990-5 000 MHz"

1.2.3.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

Relevant ITU-R Recommendations: RA.769-1; RA.1513 and M.1583.

During WRC-2000, the band 5 010-5 030 MHz was allocated to the RNSS (space-to-Earth) (space-to-space) on a primary basis. Due to the fact that unwanted emissions from space stations of the RNSS in the frequency band 5 010-5 030 MHz may cause interference to the RAS operating in the nearby band 4 990-5 000 MHz, No. **5.443B** was added. This footnote specifies that the aggregate power flux-density produced in the 4 990-5 000 MHz band by all space stations within any RNSS (space-to-Earth) system operating in the 5 010-5 030 MHz band shall not exceed the provisional value of –171 dB(W/m^2) in a 10 MHz band at any radio astronomy observatory site for more than 2% of the time.

This value of –171 dB(W/m^2) in a 10 MHz band comes from Table 1 of Recommendation ITU-R RA.769-1. This Recommendation, however, does not define explicitly the percentage of time for which this level applies in case of non-GSO systems. The revision of Recommendation ITU-R RA.1513 defines that, over the sky, for elevations higher than the minimum operating elevation angle of the radio telescope, the epfd threshold level limit defined in Recommendation ITU-R RA.769-1 should not be exceeded for more than 2% of the time.

This provisional pfd level and percentage of time criteria needed to be reviewed by using an appropriate methodology to conduct compatibility studies between non-GSO systems and radio astronomy sites. ITU-R has developed such methodology, based on the epfd concept, to assess the unwanted emission levels from RNSS systems at radio astronomy sites (see Recommendation ITU-R M.1583).

1.2.3.2 Analysis of the results of studies

The studies can be divided into two parts:

- the assessment of unwanted emission levels (aggregate power levels) produced by space stations of a RNSS (space-to-Earth) system. This relates to the above-mentioned methodology requested by Resolution **604**;
- the definition, if needed, of adequate protection criteria for the RAS. This relates to the reviewing of the provisional pfd limit of No. **5.443B** as requested by Resolution **604**.

Two cases need to be considered depending on the type of RNSS systems which may cause interference to the RAS:

1) *For GSO satellite systems:*

- The assessment of pfd levels produced by GSO satellite networks presents no difficulty.
- The RAS protection criteria with regard to unwanted emissions from space service transmissions are based on the pfd value, which is given in Table 1 of Recommendation ITU-R RA.769-1.

2) *For non-GSO satellite systems:*

- The methodology requested in Resolution **604** to calculate the aggregate unwanted power levels has been developed within ITU-R, and can be found in Recommendation ITU-R M.1583. This Recommendation takes into account operational characteristics of the radio astronomy station (e.g. minimum operational elevation angle).
- The definition of specific protection criteria for the radio astronomy service with regard to non-GSO constellations has been made through revision of Recommendations ITU-R RA.769-1 and RA.1513 (taking into account the type of observation conducted at the radio

astronomy station). This allows for the definition of an epfd limit associated to a percentage of time.

A study which was an example of application of these two Recommendations for a given RNSS system showed that protection of the radio astronomy service in the band 4 990-5 000 MHz could be achieved through adequate technical measures, i.e. that the provisional aggregate pfd value indicated in No. **5.443B** could be met by non-GSO RNSS systems operating in the band 5 010-5 030 MHz.

1.2.3.3 Methods to satisfy the agenda item and their advantages and disadvantages

Modification of No. **5.443B** as proposed for consideration in § 1.2.3.4. Mention of a new Resolution (Resolution **[RNSS 1.2.3-1]**) in the footnote to clarify the application of the pfd/epfd limits.

Advantage:

Allows the deployment of RNSS systems in the band 5 010-5 030 MHz without causing interference detrimental to the RAS in the band 4 990-5 000 MHz.

Disadvantage:

Radio astronomy stations notified after RNSS stations may not be protected.

1.2.3.4 Regulatory and procedural considerations

Modification of No. **5.443B** could be done as shown in the example given below.

Both No. **5.443B** as adopted by WRC-2000 and *resolves* 1 and 2 of Resolution [RNSS 1.2.3-1] state that the pfd and epfd limits apply at any radio astronomy station (i.e. not at the whole Earth surface and for all angles of arrival).

Modification to RR Appendix **4** would be required to insert additional characteristics of the radio astronomy stations, specifically the type of observation and the minimum operating elevation angle of the antenna.

Modification to RR Appendix **4 (§ A.17a)** would also be required in order to assess the compliance of RNSS systems received as of end WRC-03 with the pfd or epfd limits given in *resolves* 1 and 2 in Resolution [RNSS 1.2.3-1].

ANNEX

Example of regulatory provision

MOD

5.443B *Additional allocation:* The band 5 010-5 030 MHz is also allocated to the radionavigation-satellite service (space-to-Earth) (space-to-space) on a primary basis. In order not to cause harmful interference to the microwave landing system operating above 5 030 MHz, the aggregate power flux-density produced at the Earth's surface in the band 5 030-5 150 MHz by all the space stations within any radionavigation-satellite service system (space-to-Earth) operating in the band 5 010-5 030 MHz shall not exceed –124.5 dB(W/m^2) in a 150 kHz band. In order not to cause ~~harmful~~ interference to the radio astronomy service in the band 4 990-5 000 MHz, radionavigation-

satellite service systems operating in the band 5 010-5 030 MHz shall comply with the limits in the band 4 990-5 000 MHz defined in Resolution **[RNSS 1.2.3-1] (WRC-03)**.~~the aggregate power flux-density produced in the 4 990-5 000 MHz band by all space stations within any radionavigation-satellite service (space-to-Earth) system operating in the 5 010-5 030 MHz band shall not exceed the provisional value of –171 dB(W/m^2) in a 10 MHz at any radio astronomy observatory site for more than 2% of the time. For the use of this band, Resolution **604 (WRC-2000)** applies.~~

NOTE – The following Resolution is intended to clarify the application of the pfd/epfd limits, and to define the assumptions to be made for epfd calculations.

ADD

RESOLUTION [RNSS 1.2.3-1] (WRC-03)

Protection of the radio astronomy service in the band 4 990-5 000 MHz from unwanted emissions of the radionavigation-satellite service (space-to-Earth) operating in the frequency band 5 010-5 030 MHz

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that unwanted emissions from space stations of the radionavigation-satellite service (RNSS) operating in the frequency band 5 010-5 030 MHz may cause interference to the radio astronomy service (RAS) in the band 4 990-5 000 MHz;

b) that WRC-2000 (Istanbul) decided to introduce a provisional power flux-density (pfd) limit in the band 4 990-5 000 MHz to protect the RAS, and invited ITU-R to conduct studies to review this limit;

c) that protection requirements for the RAS are given in Recommendations ITU-R RA.769-1 and ITU-R RA.1513, and are different for GSO and non-GSO satellite systems,

noting

a) that ITU-R has developed Recommendation ITU-R M.1583 providing a methodology for interference calculations between non-GSO MSS or RNSS satellite systems and radio astronomy telescope sites, and containing in its Annex 2 a model of radiotelescope antenna pattern;

b) that all studies related to the protection of the radio astronomy service in the band 4 990-5 000 MHz are made using a reference radiotelescope antenna with a maximum gain of 74 dBi (a diameter of 100 m),

resolves

1 that in order not to cause interference to the radio astronomy service in the band 4 990-5 000 MHz, the power flux-density produced in this band by any GSO RNSS network operating in the 5 010-5 030 MHz band shall not exceed –171 dB(W/m^2) in a 10 MHz band at any radio astronomy station;

2 that in order not to cause interference to the radio astronomy service in the band 4 990-5 000 MHz, over the sky, for elevations higher than the operating elevation angle θ_{min}* specified for

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* Until adoption of a definition of θ_{min} by the ITU, and publication of notified radio astronomy observatory data, a value of 5° may be assumed in appropriate calculations.

the radio telescope, the equivalent power flux-density (epfd) produced in this band by all space stations within any non-GSO RNSS system operating in the 5 010-5 030 MHz band shall not exceed –245 dB(W/m^2) in a 10 MHz band at any radio astronomy station for more than 2% of the time, using a reference antenna with one of the beam patterns described in Annex 2 of Recommendation ITU-R M.1583 and a maximum gain of 74 dBi;

3 that administrations planning to operate a GSO or a non-GSO RNSS system in the band 5 010-5 030 MHz, for which complete coordination or notification information, as appropriate, has been received by the Bureau after 2 June 2000, shall send to the Radiocommunication Bureau the value of the maximum level of pfd as referred to in *resolves* 1 or the value of the maximum level of epfd as referred to in *resolves* 2, as appropriate,

instructs the Radiocommunication Bureau

as of the end of WRC-03, to review all RNSS systems for which complete coordination or notification information, as appropriate, has been received by the Bureau before the end of WRC-03 for the band 5 010-5 030 MHz, and, if appropriate, to revise its findings regarding compliance with No. **5.443B**, taking into account additional information received under *resolves* 3.

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1.3 Agenda item 1.17

"to consider upgrading the allocation to the radiolocation service in the frequency range 2 900-3 100 MHz to primary"

1.3.1 Summary of technical and operational studies including a list of relevant ITU-R Recommendations

Since WARC-79, at which 452 MHz of spectrum below 6 GHz allocated to the RLS was either removed or downgraded to secondary status, needs for radiolocation spectrum below 6 GHz have increased. This has been due to changes in requirements, missions, and technology that are driving a need for wider bandwidth to pick smaller and less reflective targets out of background clutter, and because of the unique propagation properties below 6 GHz. Over the years, the radiolocation service has been demonstrated to be compatible in bands where aeronautical and maritime radionavigation radars operate.

The RLS, while recognizing the special needs of RNS, noted in No. **4.10**, has, in a number of countries and at sea, a long successful history of sharing the band 2 900-3 100 MHz with radionavigation systems as they have evolved over many years.

Relevant Recommendations ITU-R: M.1313, M.1372, M.1460, M.1464.

Radiolocation radars, including those documented in Recommendation ITU-R M.1460, have operated in the 2 900-3 100 MHz band for decades and this use is compatible with the use of the same band by systems operating in the RNS. Similarly, weather radars, which resemble radiolocation radars in their beam scanning, have operated successfully in close proximity with aeronautical navigation radars in the 2 700-2 900 MHz band.

Draft new Report ITU-R M.[COMPAT] describes tests in which signals representative of radiolocation radars were applied to representative maritime radionavigation radars to assess their interference rejection capabilities.

1.3.2 Analysis of the results of studies

Studies have shown that compatibility between radiolocation radars and radionavigation radars has been achieved through the implementation of interference suppression/rejection circuitry as

described in DRR ITU-R M.1372, which identifies many signal-processing features provided in radiolocation and radionavigation radars that mitigate pulsed interference from other radars.

The compatibility testing documented in the draft new Report ITU-R M.[COMPAT] showed that no interference was experienced by the maritime radionavigation radars from emissions of a radiolocation radar, primarily due the interference suppression circuitry/signal processing.

1.3.3 Methods to satisfy the agenda item and their advantages and disadvantages

1.3.3.1 Method A

Upgrade the radiolocation service to primary and add a new footnote.

Upgrade the RLS to a primary allocation in the band 2 900-3 100 MHz with a footnote to the Table of Frequency Allocations indicating that the RLS shall not cause harmful interference to, nor claim protection from or constrain the use and development of, the RNS.

Advantages:

- Provides a primary allocation to the radiolocation service, contiguous with the existing band 3 100-3 400 MHz, with sufficient bandwidth to meet today's requirement for improved radar target imaging resolution and less-reflective target detection against a clutter environment.
- Assures long-term operating and development environment for radiolocation systems.
- Provide primary allocation to the radiolocation service at frequencies in the vicinity of 3 GHz as needed to meet radar operational requirements while explicitly protecting the radionavigation service.
- Restores primary allocation to the radiolocation service at frequencies in the vicinity of 3 GHz as needed to meet radar operational requirements.
- The band in the vicinity of 3 GHz provides for medium-long range detection of relatively small targets from mobile platforms.
- Indicates that the radiolocation service should not cause harmful interference to nor claim protection from the radionavigation service.

Disadvantages:

- May constrain the development or deployment of radiolocation systems.

1.3.3.2 Method B

Upgrade the radiolocation service to a primary status in the band 2 900-3 100 MHz.

Advantages:

- Provides a primary allocation to the radiolocation service, contiguous with the existing band 3 100-3 400 MHz, with sufficient bandwidth to meet today's requirement for improved radar target imaging resolution and less-reflective target detection against a clutter environment.
- Assures long-term operating and development environment for radiolocation systems.
- Provides a solution to existing and foreseeable requirements of the radiolocation service without the undue added regulatory burden of an additional footnote while protecting the radionavigation service, recognizing that the latter service is afforded special measures by Member States to ensure freedom from harmful interference under No. **4.10.**
- Restores primary allocation to the radiolocation service at frequencies in the vicinity of 3 GHz as needed to meet radar operational requirements.

- The band in the vicinity of 3 GHz band provides for medium-long range detection of relatively small targets from mobile platforms.

Disadvantages:

- The upgrade to co-primary status without a footnote does not clearly indicate that the RLS should not cause harmful interference to nor claim protection from the RNS.
- The upgrade to co-primary without a footnote could preclude the use of certain types of navigation safety systems, particularly in the future.

1.3.4 Regulatory and procedural considerations

The following footnote could be adopted if Method A is selected:

ADD

5.AAA In the band 2 900-3 100 MHz, stations in the radiolocation service shall not cause harmful interference to, nor claim protection from or constrain the development of the radionavigation service.

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NOTE - Some administrations and the BR indicated that the inclusion of the expression “or constrain the development of”gives rise to some difficulties in the application of the RR”.

No regulatory provision is required for Method B.

No. **4.10** provides guidance to administrations in the assignment and use of frequencies in the radionavigation and other safety services.

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1.4 Agenda item 1.24

"to review the usage of the band 13.75-14 GHz, in accordance with Resolution **733 (WRC-2000)**, with a view to addressing sharing conditions"

1.4.1 Summary of technical and operational studies including a list of relevant ITU-R Recommendations

Relevant ITU-R Recommendations: P.452, S.465, SA.510-2, S.524, P.526, S.580, S.728, SA.1018, S.1068, SA.1071, SA.1155, SA.1414, S.1428, M.1461, and DNR ITU-R M.[RAD.CHARZ].

1.4.1.1 Sharing between RLS and FSS

WARC-92 allocated the band 13.75-14 GHz to FSS (Earth-to-space) under conditions, which were reviewed by WRC-95 and WRC-2000 and are specified in Nos. **5.502**, **5.503** and **5.503A.** These conditions as far as they relate to GSO FSS result from ITU-R studies conducted in the 1992-1995 time-frame and summarized in Recommendations ITU-R SA.1071, S.1068 and S.1069. They were adopted by WRC-95 and amended by WRC-2000 in relation to non-GSO FSS. During the 2000-2002 study period additional technical data was made available and allowed more accurate technical analysis. Any changes to the footnotes should ensure an appropriate balance between all the services involved.

The studies considered that the current constraint on FSS use of the band to earth stations with antennas no smaller than 4.5 m in diameter had been imposed with a view to limiting the number of FSS earth stations likely to be deployed, and thus limiting the interference to radar terminals. Noting also the desire of the FSS community to operate earth station antennas having diameters smaller than 4.5 m, it was agreed that other ways of protecting the radiolocation service would be

needed if the dish size constraint should be relaxed or removed. Possibilities studied in this regard, which might be employed individually or in combination, were identified as a) zones where FSS earth stations would not normally be deployed, b) the imposition of pfd limits and c) the imposition of off-axis e.i.r.p. density limits more stringent than the 14/11 GHz band limits in Recommendations ITU-R S.524 and S.728.

In addition one study assessed the impact to FSS links of an increase in radiolocation station radiated e.i.r.p. to 65 dBW below 2° elevation, while retaining the existing constraint of 59 dBW above 2° elevation. Results of this study showed no significant increase in the interference compared to the existing condition at the FSS satellite receiver.

1.4.1.2 Sharing between SRS and FSS

In addition to the points above the 13.75-14 GHz band is used by the SRS for feeder links and service links of a global data relay satellite network. SRS currently operates over a bandwidth of 10 MHz from 13.770-13.780 GHz to fully achieve the international science/exploration objectives and to safely manage and control on board International Space Station (ISS) and space shuttle equipment/modules in accordance with No. **5.503**. This is a continuing requirement that is satisfied under existing sharing conditions where the FSS earth station antenna diameter is maintained at 4.5 m or above. Also in accordance with No. **5.503** only 6 MHz of this bandwidth is protected, from 13.772 to 13.778 GHz. Taking into account Resolution **733** *considering g)*, should smaller FSS earth station antenna diameters within GSO networks be introduced into the 13.75-14 GHz band, then it will be necessary to expand the protection of these SRS operations over the 10 MHz band centred on 13.775 GHz.

A number of ITU-R studies on the sharing between SRS and FSS in the band 13.772-13.778 GHz were performed over the last decade. These studies derived current sharing conditions based on a SRS link margin degradation of 0.4 dB for no more than 0.1% of the time for a single orbit considering a population of 32 FSS earth stations operating within GSO networks over the Atlantic Ocean Region.

1.4.2 Analysis of the results of technical and operational studies

It was agreed that all studies addressing radiolocation protection would also apply to radionavigation, which is also allocated in the band 13.75-14 GHz by No. **5.501**.

Studies assessed the impact of a reduction of the minimum FSS earth station antenna size on the use of radiolocation in the band and an assessment of operational and regulatory measures that would ensure that a reduction in antenna size and consequential increase in the number of FSS earth stations do not lead to harmful interference to radar receivers.

Other studies assessed the sharing conditions between FSS earth stations of all diameters and SRS systems (e.g. space shuttle and ISS) in the bands 13.772 -13.778 GHz and 13.77-13.78 GHz.

Consideration was also given to the possible impact on the EESS allocated in the band on a secondary basis.

1.4.2.1 Sharing between RLS and FSS

Studies focused on the impact on radiolocation of the relaxation of the current 4.5 m minimum antenna size for FSS earth stations. Studies performed agreed that the expected increase in the number of FSS earth stations, which would result from the relaxation of this constraint, would increase the probability of interference into radiolocation. In the case of maritime/land mobile radiolocation/FSS sharing studies, although many of the parameters were agreed some differences in deployment scenarios and assumptions occurred.

Other studies focused on the impact on FSS earth station deployment, in particular in coastal areas, to ensure an assumed protection of maritime radiolocation devices. The results show that there is a clear impact on the coastal deployment of the FSS earth stations.

1.4.2.1.1 Protection of fixed radiolocation stations from FSS earth stations

It was noted that Table 7 of Appendix **7** of the RR, which would be used to determine the need for coordination of an FSS earth station with fixed radiolocation stations at specified points, does not currently include parameters for radiolocation stations in the 13.75-14 GHz band. The studies considered that it would be more appropriate to include in Table 7 of Appendix **7** the relevant values to protect ground based radiolocation stations located at fixed points. Suitable values for fixed radiolocation stations in the band 13.75-14 GHz have been suggested and will be considered in the framework of updating Appendix **7**. This approach is irrespective of the FSS earth station antenna diameter.

1.4.2.1.2 Protection of maritime and land mobile radiolocation stations from FSS earth station interference

a) Protection criterion and proposed sharing criterion for maritime and land mobile radars

Interference into radiolocation systems was assessed in term of a decrease in probability of detection, which leads to a decrease in radar range and/or target tracking ability. Taking into account these factors, the studies concluded that the appropriate criterion to ensure the protection of maritime and land mobile radars would be a I/N of –6 dB, corresponding to an interference power level of –133 dBW in a bandwidth of 10 MHz at the receive output flange of a radar antenna.

A proposed sharing criterion to satisfy the above radiolocation protection level for FSS earth stations with a diameter less than 4.5 m, would be a single entry interfering pfd level of:

for maritime radar: X dB(W/(m^2 · 10 MHz)) not to be exceeded for more than Y% of the time produced at 36 m above sea level at the normal baseline (low water mark) as defined in UN Convention on the Law Of the Sea 1982.

for land mobile radar: X dB(W/(m^2 · 10 MHz)) not to be exceeded for more than Y% of the time produced 3 m above ground at the border.

For X and Y, two views were considered:

- An X value of –126 dB(W/(m^2 · 10 MHz)) at the normal baseline or land border as appropriate, would protect all radiolocation configurations to the agreed –6 dB I/N recommended level for Radiolocation in ITU-R M.1461. Any value for X higher than this will exceed the ITU-R recommended interference protection criteria and cause unacceptable interference. The pfd level of –126 dB(W/(m^2 · 10 MHz)) causes a 5.4% range loss for the most sensitive configuration of radiolocation stations. With the aim to reach an appropriate balance of constraints for both radiolocation and FSS, the radiolocation service in this band can accept a 0.01% of time value for Y at the –126 dB(W/(m^2 · 10 MHz)) level.
- A distinction between the probability of exceedance of a given –6 dB I/N threshold as calculated at a given location using ITU-R propagation models and the actual occurrence of an exceedance of –6 dB I/N threshold at an operating radiolocation site which is considered to be much lower. In addition radiolocation stations have been considered to be protected only when at some distance from the baseline. Based on this approach, values were considered in the range of –105.2 dB(W/(m^2 · 10 MHz)) for 1% of time (this pfd

corresponds to an I/N of 0 dB, an I/N of –6 dB would be exceeded for a larger percentage of time) and –113.2 dB(W/(m^2 · 10 MHz)) for 0.5% of the time with the aim to reach an appropriate balance of constraints for both radiolocation and FSS.

Percentages of time are calculated using the ITU-R appropriate propagation model.

Some administrations are of the opinion that the measurement point of the pfd shall be determined by the concerned administration operating the FSS earth station in which case the values of X and Y should be adapted accordingly. Some other administrations believe that the measuring point of the pfd must be determined consistently by all administrations for it to be effective.

b) Conclusions of the studies on sharing between FSS and maritime and land mobile radars

Based on representative deployment scenarios of FSS earth stations with antenna diameters between 1.2 m and 4.5 m and on the protection and sharing criteria described in a), studies were conducted which lead to the areas of general agreement listed below.

1) The level of interference at the input to the radar receivers is a function of FSS earth station locations, deployment density, e.i.r.p., and the radar antenna pattern.

2) 4.5 metre or larger diameter FSS earth stations, currently allowed, may cause interference into radiolocation systems; however due to the low numbers of FSS earth stations deployed, this situation is acceptable to the radiolocation service.

3) For all sizes of FSS earth station antennas, in the absence of mitigation techniques the –6 dB I/N radar threshold would be exceeded for certain distances between the FSS earth stations and land or ship radar terminals.

4) The separation distance at which FSS interference exceeds the radiolocation –6 dB I/N interference threshold is a function of FSS and radiolocation platform antenna heights, the bearings of the FSS earth stations (assuming equal e.i.r.p. levels), FSS e.i.r.p., FSS aggregate effects, the radar antenna pattern, the terrain profile, and the mitigation techniques used by the FSS.

5) Natural or artificial site shielding cannot be considered in determining general sharing criteria, but may be used as a mitigation technique on a case-by-case basis in order to meet the sharing criteria. Limiting the area of deployment of FSS earth stations can also be considered as a way to limit interference into radiolocation.

6) Coordination as defined in the RR cannot be used as a method for resolving interference between FSS earth stations and mobile radiolocation stations irrespective of FSS earth station antenna diameter.

7) In certain cases mitigation techniques are required, to permit FSS earth stations to utilize smaller than 4.5 m dish sizes, to avoid harmful interference to radiolocation systems.

8) Interference mitigation techniques are not currently available for use by maritime radiolocation systems.

9) Line-of-sight paths between FSS earth stations and radiolocation receiver platforms provide the predominant source of interference. Non line-of-sight FSS earth stations may add to the interference.

10) Irrespective of its source, interference into radiolocation systems results in all or a combination of the following factors: a decrease in probability of detection, decrease in radar range, decrease in radar resolution and/or target tracking ability.

11) The activity factor for FSS earth stations has a significant impact on sharing conditions between FSS and radiolocation systems.

12) Limitation of off-axis e.i.r.p. density for FSS earth stations would reduce interference to the ship/land-based radars but would not be sufficient by itself to protect these radars in all cases.

13) Realistic worst-case FSS characteristics and modelling should be utilized when deriving a sharing arrangement. It would be reasonable to take into account the probability of occurrence of the worst case of interference if it can be determined.

14) There would be a need to develop recommendations which would deal with verification of compliance with pfd constraints on FSS earth stations.

15) In order for FSS to meet pfd limits at the normal baseline, deployment of FSS earth stations will be impeded in the coastal areas, the size of which depends on the FSS earth station characteristics, the local terrain and on the values of X and Y.

16) The determination of X and Y has to take into account the probability of interference from two or more terminals located near each other and that are simultaneously transmitting within a 10 MHz band.

17) Studies did not consider transmitting earth stations that employed uplink power control.

However the following points were not agreed upon:

1) Using probability of interference into 10 radars vs. 1 radar. Consideration of a realistic ship deployment which involves multiple co-located radiolocation devices. In such a case, the probability of interference is increased over that experienced by a single radiolocation device.

2) Probabilistic modelling of radar rotation.

3) A significant percent of coast lines are likely to have steadily rising terrain profiles providing possible line of sight propagation path over a large distance. No correlation was done between these high terrain configurations and the probability of presence of FSS earth stations.

1.4.2.1.3 Protection of FSS satellite receivers from maritime radiolocation stations

Interference into FSS satellite receivers was assessed in terms of a difference of interference power received at the FSS Satellite using the current radiolocation antenna configuration (10° elevation beamwidth, beam centre at 4.5° elevation) and a second antenna configuration with the beam centred at 0° and a reduced elevation beamwidth of 2.5°. The increase in antenna gain results in an e.i.r.p. increase at the output of the antenna. Due to a longer propagation path and propagation losses and the increased angle of incidence between the radiolocation transmit beam and the satellite receive beam results showed no increase in interference power at the satellite receiver. The change between the antenna types result in an increased sensitivity of radiolocation device to FSS interference.

1.4.2.1.4 Protection of aeronautical radiolocation stations from FSS earth stations

Based on the studies below, the following additional agreements were reached:

1) Airborne radiolocation technical characteristics create a unique sharing situation which limits the available mitigation techniques.

2) An FSS earth station pfd for sharing with airborne radiolocation systems is not possible due to the airborne radiolocation unique technical characteristics.

3) A limit on the off-axis e.i.r.p. density of FSS earth stations having antenna diameters down to 1.2 m would be sufficient to limit interference into airborne radars to levels comparable to those under the current regulatory situation for the studied scenario.

The ITU-R studies focused on comparing the impact, into an airborne radar, of signals coming from many FSS earth stations having a diameter less than 4.5 m, with the impact of signals coming from a smaller number of FSS earth stations compliant with the current regulations (4.5 m in diameter). The interference into airborne radar flying over the territory of one country was simulated, with FSS earth stations located close to the border, but in the territories of adjacent countries. The transmit power of the 4.5 m earth stations was taken as representative of the current situation (79 dB(W/10 MHz)). The transmit power of the FSS earth stations having a diameter less than 4.5 m, was adjusted to correspond to the maximum e.i.r.p. density level specified in Recommendation ITU-R S.728. In both cases, the earth station antenna radiation patterns used in the simulations were those contained in Recommendation ITU-R S.1428, which characterizes interference sweeping through the side lobes.

The number of FSS earth stations was calculated so as to use the entire spectrum resource available from 15 GSO satellites in the same 10 MHz band. Two scenarios were therefore assessed: a first scenario representing the situation under the current regulations, with 30 earth stations using 4.5 m antennas and a bandwidth of 10 MHz per station, and a second scenario under a possible future regulatory situation, with 150 FSS earth stations using 1.2 m antennas and a bandwidth of 2 MHz per station.

The results of the simulations showed that the interference caused into the airborne radar by many FSS earth stations with 1.2 m antennas was more damaging to the radar operation than the impact of a small number of larger FSS earth stations, because the 1.2 m FSS earth stations interference resulted in a significant reduction in the range of the radar (up to 45%) in many directions, whereas the smaller number of 4.5 m earth stations result in a larger reduction in range (up to 65%), but in only a few directions.

More specifically, it was found that the average range loss of the radar was about 25% in the scenario with 4.5 m antennas, and about 35% in the scenario with 1.2 m antennas. Increasing the number of FSS earth stations having a diameter less than 4.5 m by reducing the bandwidth per station resulted in an average range loss asymptotic to 36%.

The conclusion of the study was that, with an e.i.r.p. restriction to levels 4 dB below the off-axis e.i.r.p. density specified for VSATs in Recommendation ITU-R S.728, the average range loss would be the same in both scenarios, irrespective of the number of small FSS earth stations and their diameter. These results apply to both static and dynamic simulations.

It was found that main beam coupling between the radiolocation antenna and the FSS earth station antennas was not a factor in this scenario. Avoiding such coupling would require that FSS earth stations irrespective of their diameter, require exclusion zones of a maximum of 70 km. The exact size of this exclusion zone would depend, among other factors, on the satellite link elevation and on the aircraft typical operating altitude.

1.4.2.1.5 Analysis of interference from radiolocation into GSO FSS space stations

Interference into GSO FSS satellites from radars was assessed in terms of a decrease in the data rate of satellite links.

It was shown that the existing conditions of No. **5.502** still allow for significant interference level at the GSO FSS space station. Encoding techniques currently used in FSS systems allow FSS links to be operated in this environment.

The radar operating parameters (power level, pulse repetition frequency and duty cycle) are decisive for designing the satellite links in order to avoid correlation between the satellite frame/encoding rate and the radar PRF and duty cycle. There is a need to include FSS and radiolocation parameters in ITU-R Recommendations, which would assist in defining the interference environment for FSS.

1.4.2.2 Sharing between FSS and SRS

a) Interference from earth stations of GSO FSS networks to SRS space stations

Studies have been performed to analyse the impact of the interference from GSO FSS earth stations with antenna diameters of 4.5 m and smaller into low-orbiting user SRS satellites operating in a data relay satellite network, taking into account the expected increase in the number of FSS earth stations.

Recent ITU-R studies were conducted assessing sharing criteria between the SRS and FSS in the 13.77-13.78 GHz band. The SRS transmission links examined were from data relay satellite networks to receivers such as ISS and space shuttle. The studies were based on two relaxations of the interference protection of the SRS data relay satellite forward links: higher interference threshold (based on an I/N of –6 dB), and a reduced link availability based on the average interference threshold exceedance calculated over 200 orbits rather than the single orbit worst case. The simulations performed for these studies considered the deployment of FSS antennas with diameters of 4.5 m and smaller. E.i.r.p. density masks were produced based partially on simulation of FSS earth station deployment.

b) Interference from FSS earth stations to SRS earth stations

SRS earth stations are adequately protected by coordination given the data available in RR Appendix **7**.

1.4.2.3 Analysis of studies relating to the interfering environment of the EESS

The frequency band 13.75-14 GHz is used on a secondary basis by non-GSO systems in the Earth exploration-satellite service (non-GSO EESS).

The study on possible implications on the operation of EESS systems of revising the limits to FSS earth stations on EESS systems included:

a) an analysis of increasing the areas within which an interference to a non-GSO space station in the EESS would exceed the current performance requirement in the event that earth stations smaller than 4.5 m in diameter are operated with e.i.r.p. between 50 and 60 dBW per 1 MHz;

b) evaluation in the increase of the probability of harmful interference to the EESS due to a growth in the number of FSS earth stations with antenna diameter smaller than 4.5 m and transmitting between 50 and 60 dBW per 1 MHz e.i.r.p.

It was concluded from this analysis of the evaluation of potential interference that reviewing the limits on FSS earth stations in the band 13.75-14 GHz contained in No. **5.502** may lead to an increase in the probability of harmful interference to altimeters potentially resulting in impeding their operation. This may be mitigated by an improvement in the off axis e.i.r.p. density of earth station antennas and consideration of minimum elevation angle for earth station antennas. These considerations should be accounted for in the limitations being expressed for FSS-SRS/RLS sharing.

As a secondary service no protection is required for the EESS in the context of the current regulations.

1.4.3 Methods to satisfy the agenda item and their advantages and disadvantages

It should be noted that in the current regulatory framework, the sharing conditions between the services allocated on a primary basis in the 13.75-14 GHz band are essentially described by the limits contained in Nos. **5.502** and **5. 503**. Since any change in the limits on the FSS in No. **5.502** would also affect the sharing situation between FSS and SRS, it is not possible to address these

two footnotes independently, hence only three methods have been identified to satisfy the agenda item.

1.4.3.1 Method A

No change to the current regulations and associated sharing criteria in Nos. **5.502** and **5.503.**

Advantages:

- The delicate balance between the services in the band 13.75-14 GHz, as established by WARC-92 modified by WRC-95 and WRC-2000, in Nos. **5.502** and **5.503**, would be maintained. Since these footnotes indirectly limit the number of FSS earth stations deployed in the band, the protection they provide to Radiolocation and Space Research would be adequate.
- No additional regulatory burden is placed upon administrations.

Disadvantages:

- No protection is afforded to Radiolocation other than limiting the number of interference sources.
- FSS development would continue to be unduly constrained by the minimum size of 4.5 m in diameter in this band.

1.4.3.2 Method B

Relaxation of the current limit on the FSS antenna size, with additional regulatory provisions and increase in the protected bandwidth of SRS.

In order to maintain the delicate balance between the services involved, this method is based on reducing the current limit on the minimum antenna size to 1.2 m and by adding technical conditions, which would adequately manage the interference caused by FSS earth stations into Radiolocation and SRS stations:

- Off-axis e.i.r.p. density limits to manage the interference into airborne radars, based on a 4 dB tightening of Recommendation ITU-R S.728, and specified in the Radio Regulations on a mandatory basis.
- A single entry pfd limit (specified in the RR on a mandatory basis but not subject to compliance verification by the BR):

  for maritime radar X dB(W/(m^2 · 10 MHz)) not to be exceeded for more than Y% of the time produced at 36 m above sea level at the normal baseline as defined in UN Convention on the Law Of the Sea 1982.

  for land mobile radar, X dB(W/(m^2 · 10 MHz)) not to be exceeded for more than Y% of the time produced 3 m above ground at the border of a neighbouring country deploying land mobile radar in this band.
- Table 7 of RR Appendix **7**, would be updated in order to determine the need for coordination of an FSS earth station with radiolocation stations at specified fixed points, as part of the procedure of No. **9.17**.
- To maintain the current protection of SRS operations, the on-axis e.i.r.p. limit in the 6 MHz bandwidth contained in No. **5.503** would be made a function of the FSS antenna diameter, f(D) where D is the FSS earth station antenna diameter. In addition the protected bandwidth would be extended to 10 MHz centred on 13.775 GHz.
- 6 dB relaxation of the limit on the e.i.r.p. level averaged over 1s on radiolocation emission at elevation angles below 2°.

Advantages:

- FSS development would no longer be constrained to use only earth station antennas larger than 4.5 m. This would grant relaxation of the current limit to 1.2 m with the addition of appropriate limits to ensure the protection of the other services, thus leaving greater flexibility.
- A quantified protection from each individual FSS earth station is afforded to Radiolocation systems.
- Relaxation of the constraints on the radiolocation emission.
- SRS is assured a managed interference environment in the wider protected bandwidth.

Disadvantages:

- Administrations wishing to deploy FSS earth stations will have to ensure that the pfd limits are met, which is likely to include some territorial constraints.
- Future earth station antennas equal to or greater than 4.5 m could be limited in their deployment in coastal areas, which currently is not the case.
- Depending on the values of X and Y, the terrain and the size of the country, there will be cases where a country as a whole could be excluded from implementing FSS service in this band.
- There is a need to develop ITU-R Recommendations which would deal with verification of compliance with pfd constraints on FSS earth stations.
- SRS will have to accept a performance degradation as a result of the relaxed sharing criterion used to derive the e.i.r.p. mask.

Some administrations are of the opinion that the measurement point of the pfd shall be determined by the concerned administration operating the FSS earth station in which case the values of X and Y should be adapted accordingly. Some other administrations believe that the measuring point of the pfd must be determined consistently by all administrations for it to be effective.

1.4.3.3 Method C

- Suppression of footnote **5.502** and extension of the SRS bandwidth defined in the current No. **5.503** to 10 MHz bandwidth 13.770-13.780 GHz.
- For those administrations that wish to retain the limitation on FSS earth station antennas size for protection of the RLS/RNS, a country footnote similar in language to the current No. **5.502** could replace this footnote.
- Table 7 of RR Appendix **7**, would be updated in order to determine the need for coordination of an FSS earth station with fixed radiolocation stations at specified points, as part of the procedure of No. **9.17**.

Advantages:

- Administrations would be enabled to regulate usage of this band according to their own preferences and determine their own preferred methods for protection of the services in the band.
- In some countries, FSS development would no longer be constrained to use only earth station antennas equal to or greater than 4.5 m.
- Uplink spectrum in the 13.75-14 GHz band will be available for FSS with more flexibility than under the current **5.502** footnote. The current imbalance between downlink and uplink spectrum for FSS in the 10-14 GHz range would be reduced particularly in Region 3.

- The increased flexibility of uplink spectrum usage at 13.75-14 GHz would ease the pressure to migrate into operations at higher frequencies, which will be particularly advantageous for countries in zones with high rainfall, owing to attenuation constraints.
- SRS will be given access to more spectrum.

Disadvantages:

- This method does not provide an internationally consistent protection method for radiolocation thus requiring country by country consultation for radiolocation operators noting that international coordination under the ITU Regulations is not a suitable mechanism to establish a shared use of this band between FSS and mobile radiolocation stations. This country by country process may unduly constrain the radiolocation operation.
- In absence of adequate regulatory mechanisms, this method will create a potential for increased interference to the radiolocation service and will create an uncertainty in the level of protection offered to the globally allocated radiolocation service.
- No protection will be offered to FSS space receivers.
- There could be a regulatory burden on the administrations.
- SRS will not have a managed interference environment.
- SRS will have to accept performance degradation.
- Operation of secondary EESS could eventually be precluded.
- The effects of implementing this method cannot be confidently predicted as it has not been studied in detail by ITU-R. As an example this method would allow deployment of FSS earth stations antenna diameters below 1.2 m, the effect of which on other services has not been studied per Resolution **733**.
- The exact regulatory mechanisms need to be further developed for international protection of the radiolocation.

1.4.4 Regulatory and procedural considerations

Since Method **A** described in § 1.4.3 above does not require any regulatory or procedural changes, this Section only addresses the regulatory and procedural aspects relating to Methods **B and C**.

1.4.4.1 Regulatory and procedural considerations for Method B

1.4.4.1.1 Sharing between FSS and RLS

a) Current regulatory/procedural situation

It was noted that, pursuant to No. **11.14**, frequency assignments to ship stations and to mobile stations of other services shall not be notified under Article **11**. It was also noted that, pursuant to No. **11.20**, in the frequency band 13.75-14 GHz, which is allocated to FSS and RLS with equal rights, radiolocation stations located within the coordination area of an FSS earth station can only be notified through individual notices, i.e. at specified fixed points. This situation appears to preclude the possibility of taking into account, within the coordination of an FSS earth station under No. **9.17**, the protection of mobile radiolocation stations, which by nature, may be located at any geographical point.

The studies therefore concluded that the application of No. **9.17** would be possible only in respect of radiolocation stations located at fixed, predetermined, geographical points, which excludes land, maritime and aeronautical mobile radiolocation stations. Also, since **9.17** is a coordination procedure between administrations on the territories of which the earth station and the radiolocation station are located, it could not be carried out with maritime or aeronautical radiolocation stations.

b) Possible regulatory solutions for radiolocation stations located at specified fixed points

Table 7 of RR Appendix **7**, which would be used to determine the need for coordination of an FSS earth station with radiolocation stations located at specified fixed points, does not currently include parameters for radiolocation stations in the 13.75-14 GHz band. The studies considered that it would be more appropriate to include, in Table 7 of RR Appendix **7,** the relevant values to protect ground based radiolocation stations located at fixed points. Suitable values have been suggested and will be considered in the framework of updating RR Appendix **7** under agenda item 7.1.

c) Possible regulatory solutions for mobile radiolocation stations

The ITU-R studies concluded that, since the protection of mobile radiolocation stations cannot be effected by the coordination procedure of No. **9.17**, other regulatory measures would be needed for that purpose.

The ITU-R studies noted that, currently, the protection of mobile radiolocation stations was obtained only through the limitation of the number of FSS earth stations resulting from the minimum antenna diameter to 4.5 m.

For the protection of airborne radiolocation stations, as shown in § 1.4.2.1.3, the ITU-R studies have concluded that in situation where main beam coupling between the radiolocation antenna and the FSS earth station can be avoided, a reduction of 4 dB from the off-axis e.i.r.p. density levels currently specified for VSATs in Recommendation ITU-R S.728 would maintain the current interference situation caused by 4.5 m antennas into airborne radiolocation receivers, in a scenario where the airborne receiver is flying within one country and the interfering FSS earth stations are located in the neighbouring countries. Such limits may be implemented from a regulatory point of view, as shown in the following example of a possible addition to Section III of RR Article **21:**

ADD

21.XX In the band 13.75-14 GHz, the level of e.i.r.p. emitted by an earth station of a GSO FSS network shall not exceed the following values:

Angle off-axis	***Maximum e.i.r.p. in any 1 MHz band***
$2° \le \varphi \le 7°$	$43 - 25 \log \varphi$ dBW
$7° < \varphi \le 9.2°$	22 dBW
$9.2° < \varphi \le 48°$	$46 - 25 \log \varphi$ dBW
$\varphi > 48°$	4 dBW

These limits do not apply to FSS earth stations brought into service prior to WRC-03.

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To avoid situations where main beam coupling between the stations of both services could happen, additional regulatory provisions may be required such as exclusion zones. Further studies are needed to define a possible regulatory implementation.

For the protection of maritime and land mobile radiolocation stations, the off-axis e.i.r.p. density limits mentioned above would improve the interference environment in which the radiolocation systems would operate. However they would not be sufficient by themselves to ensure the protection of RLS in all cases. The proposed method to implement the protection of maritime and land mobile RLS systems, as described in section 1.4.3 b), would rely on pfd limits. From a regulatory point of view, this may be implemented by modifying No. **5.502** as in the following example:

MOD

5.502 In the band 13.75-14 GHz, an earth station ~~in the~~of a geostationary fixed-satellite service network shall have a minimum antenna diameter of 1.2~~4.5~~ m and an earth station of a non-geostationary fixed satellite service system shall have a minimum antenna diameter of 4.5 m. ~~and the e.i.r.p. of any emission should be at least 68 dBW and should not exceed 85 dBW.~~ In addition the e.i.r.p., averaged over one second, radiated by a station in the radiolocation or radionavigation services shall not exceed 59 dBW above 2° elevation and 65 dBW below. ~~The protection of assignments to receiving space stations in the fixed-satellite service operating with earth stations that, individually, have an e.i.r.p. of less than 68 dBW shall not impose constraints on the operation of the radiolocation and radionavigation stations operating in accordance with the Radio Regulations. No. **5.43A** does not apply. See Resolution **733 (WRC-2000)**. (WRC-2000)~~An administration planning to use FSS earth stations in a geostationary network in this band shall ensure that the single entry power flux-density produced by any earth station operating within its territory does not exceed:

X dB(W/(m^2 · 10 MHz)) not to be exceeded for more than Y% of the time produced at 36 m above sea level at the normal baseline as defined in UN Convention on the Law Of the Sea 1982.

X dB(W/(m^2 · 10 MHz)) not to be exceeded for more than Y% of the time produced 3 m above ground at the border of a neighbouring country deploying land mobile radar in this band.

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Comments:

– The suppression of the last two sentences of the current footnote No. 5.502 takes into account the fact that the 59/65 dBW limit on radiolocation average e.i.r.p. is intended to protect FSS space stations. Hence no complaint for harmful interference can be made as long as these limits are met by radiolocation stations.

– The suppression of the provision relating to the FSS earth station e.i.r.p. levels of 85 dBW and 68 dBW results from the fact that this provision has no regulatory implication. These levels are reflected in Recommendation ITU-R S.1068.

– Transitional arrangements need to be developed to ensure consistency with current regulatory provisions.

– The proposed regulatory text only covers Method B for a pfd limit measured at the normal baseline. If a different measurement point were to be included for some administrations additional regulatory text would have to be defined.

d) Protection of FSS receive space stations

The ITU-R studies have concluded that the e.i.r.p. limits included in the example modification of No. **5.502** given in c) radiated by radiolocation stations require further technical, operational and regulatory studies to ensure that correlation between the radiolocation pulse repetition frequency and duty cycle and the FSS frame/coding rate do not occur in future operational designs of these systems different from those currently implemented.

1.4.4.1.2 Sharing between FSS to SRS

The on-axis e.i.r.p. density limit on FSS earth stations addressed in § 1.4.2.2 above would replace the current limit in No. **5.503** and would be a mandatory one, i.e. subject to examination by the

Bureau under No. **11.31.** This could be done by modifying the relevant part of No. **5.503** as shown in the following example:

MOD

5.503 In the band 13.75-14 GHz, geostationary space stations in the space research service for which information for advance publication has been received by the Bureau prior to 31 January 1992 shall operate on an equal basis with stations in the fixed-satellite service; after that date, new geostationary space stations in the space research service will operate on a secondary basis. Until those geostationary space stations in the space research service for which information for advance publication has been received by the Bureau prior to 31 January 1992 cease to operate in this band:

– the e.i.r.p. density of emissions from any earth station in the fixed-satellite service operating with a space station in geostationary-satellite orbit shall not exceed ~~71 dBW in the 6 MHz band from 13.772 to 13.778 GHz~~4.7D + 28 dBW/40 kHz, where D is the fixed-satellite service earth station antenna diameter (m) from 13.770 to 13.780 GHz for earth station diameters equal to or greater than 1.2 m and less than 4.5 m;

49.2 + 20 log(D/4.5) dBW/40 kHz, where D is the fixed-satellite service earth station antenna diameter (m) from 13.770 to 13.780 GHz for earth station diameters equal to or greater than 4.5 m and less than 31.9 m;

66.2 dBW/40 kHz for any fixed-satellite service earth station emission in the band 13.770-13.780 GHz for antenna diameters (m) equal to or greater than 31.9 m;

for any fixed satellite service earth station antenna diameter (m) a maximum e.i.r.p. spectral density of 56.2 dBW/4 kHz for narrow-band (less than 40 kHz of necessary bandwidth) fixed-satellite service earth station emissions in the band 13.770-13.780 GHz;

– the e.i.r.p. density of emissions from any earth station in the fixed-satellite service operating with a space station in non-geostationary-satellite orbit shall not exceed 51 dBW in the 6 MHz band from 13.772 to 13.778 GHz.

Automatic power control may be used to increase the e.i.r.p. density ~~in the 6 MHz band~~ in these~~is~~ frequency ranges to compensate for rain attenuation, to the extent that the power flux-density at the fixed-satellite service space station does not exceed the value resulting from use by an earth station of an e.i.r.p. ~~of 71 dBW or 51 dBW~~meeting the above limits, ~~as appropriate, in the 6 MHz band~~ in clear-sky conditions. (WRC-2000)

1.4.4.1.3 Regulatory and procedural considerations relating to EESS

Since most provisions of No. **5.503A** related to EESS and FSS operation with equal status have expired, it may be possible to reflect the remaining provisions by introducing in the table of allocation a secondary allocation to EESS and consequently to suppress No. **5.503A**.

1.4.4.2 Regulatory and procedural considerations for Method C

Implementation of Method C would require changes to at least No. **5.502** and No. **5.503**.

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1.5 Agenda item 1.28

"to permit the use of the band 108-117.975 MHz for the transmission of radionavigation satellite differential correction signals by ICAO standard ground-based systems"

1.5.1 Summary of technical and operational studies including a list of relevant ITU-R Recommendations

A new aviation requirement has emerged for the transmission of augmentation data for the Global Navigation Satellite Service (GNSS) to be used by aircraft receivers to satisfy the stringent accuracy and integrity requirements for GNSS applications such that they can be used for precision approach and landing. This new Ground-Based Augmentation System (GBAS) is planned to operate in the frequency band 108-117.975 MHz. The systems, that currently use this band, are ILS and VOR.

ICAO has also developed international standards for a surveillance system in which data derived from navigation systems on board an aircraft are transmitted over a data link to other aircraft and to air traffic control. This system supports navigation and surveillance functions and is intended to operate in the frequency bands 108-117.975 MHz and 117.975-137 MHz.

Compatibility of the new navigation and surveillance systems with FM broadcasting stations will be secured by ensuring that the new systems do not cause interference to the reception of FM broadcasting signals or impose constraints to the BS, operating in the band at about 87-108 MHz. These concerns have already been addressed during the development of GBAS, and no new protection requirements beyond that provided for ILS/VOR are needed with GBAS implementation. Compatibility of the surveillance systems with FM broadcasting has not yet been fully addressed.

Digital sound broadcasting systems have been designed to operate in the frequency band at about 87-108 MHz (see Recommendation BS.1114). At least one administration is planning to introduce such a system in this band. No compatibility studies within ITU-R have been conducted between these systems and the existing and additional aeronautical systems in the band 108-117.975 MHz*.

1.5.2 Analysis of the results of studies

The band 108-117.975 MHz is currently allocated to the ARNS. The new navigation and surveillance applications envisaged for implementation in this band do not fall within the definition of a RNS (i.e., using the propagation properties of radio waves) and that an amendment to the allocation of this band is required. An appropriate additional allocation would, therefore, need to be made to allow for these systems to operate in the band 108-117.975 MHz. Without making an allocation to a specific aeronautical service, the preferred way would be to permit the use of this band by ICAO standard systems that support air navigation and surveillance functions through the addition of a footnote to this band. ICAO is establishing standards, which will ensure compatibility between these systems and the ICAO standard ILS/VOR systems. These compatibility Standard and Recommended Practices will be incorporated, with the necessary Guidance Material, in Annex 10 to the ICAO Convention.

1.5.3 Methods to satisfy the agenda item and their advantages and disadvantages

1.5.3.1 Method A

Adopt a footnote that will permit the use of the band 108-117.975 MHz on a global basis for the transmission of radionavigation satellite differential correction signals by international aeronautical standard ground-based systems.

Introduce an agenda item for WRC-07, which addresses expanded aeronautical surveillance applications in the band 108-117.975 MHz.

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* The Arab administrations recognized that the handling of the Agenda item by ITU-R has gone beyond its original by including a newly proposed ICAO surveillance system.

Advantages:

- Facilitates the global implementation of GBAS
- No further consideration of issues relating to the compatibility between FM broadcasting and ground to air data links supporting air navigation functions, such as GBAS, is required.
- This would allow additional time to address FM broadcasting compatibility requirements of the surveillance systems and to reach an agreement with the broadcasting community.

Disadvantages:

- Implementation of ICAO standard systems for surveillance applications in this band will be delayed until after WRC-07.
- An additional agenda item for WRC-07 would need to be introduced.
- Does not consider the impact of introducing digital sound broadcasting in the band at about 87-108 MHz.

1.5.3.2 Method B

Adopt a footnote that will permit the use of the band 108-117.975 MHz on a global basis by ICAO standard systems that support navigation and surveillance functions through a data link on the condition that priority and protection be given to the ARNS. This footnote would reference a Resolution **[Method B]** , which lays down the minimum criteria for such systems operating in this band in terms of compatibility requirements with and the protection of the broadcasting service. To ensure that compatibility with the broadcasting service does not become an issue at WRC-03, and that Recommendation ITU-R SM.1009 does not have to be revised prior to implementation of the new aeronautical systems, operation of the new systems should be limited to frequencies above 112 MHz. Based on previous studies and experience with applying Recommendation ITU-R SM.1009 (given that the ICAO immunity specification for the new receivers exceeds current standards for ILS/VOR), this guardband is sufficient to ensure that interaction between the services involved can be discounted. The frequency limitation is not significant in operational terms, because the part of the band below 112 MHz will remain heavily occupied by ILS systems for a considerable period of time, plus there is no immediate need to operate the new systems below 112 MHz.

The situation between 108 and 112 MHz does however require more study to assess and resolve any compatibility problems. The entire frequency band 108-117.975 MHz would then be made available to the new aeronautical applications, following the ITU-R studies and, if necessary, the endorsement of these studies by a future competent WRC.

Advantages:

- A footnote in the Radio Regulations, referencing a Resolution, will facilitate the global introduction of current and future internationally standardised GNSS augmentation systems and automatic dependent surveillance while not constraining current/planned FM broadcasting.
- No immediate review of compatibility issues by WRC-03 is required. Frequencies above 112 MHz can be used for these new aeronautical systems in accordance with the WRC-03 Final Acts, while use of the range 108-112 MHz can wait upon the outcome of ITU-R studies.
- No future changes to footnotes would be necessary.
- Introduction of International Standardised GNSS augmentation and surveillance applications would not be delayed due to the time constraints of re-opening the table of allocations at a future WRC.

- The broadcasting community would be continuously assured of no additional adverse effects to FM broadcasting services in the band below 108 MHz.

Disadvantages:

- Consideration of surveillance systems in the band 108-117.975 MHz is not an element of this agenda item for WRC-03.
- Insufficient time to assess all compatibility issues between the broadcasting service and aeronautical services.
- Does not consider the impact of introducing digital sound broadcasting in the band at about 87-108 MHz.

1.5.3.3 Method C

Adopt a footnote that will permit the use of the band 108-117.975 MHz on a global basis by ICAO standard systems that support navigation and surveillance functions, through a data link, on the condition that priority and protection be given to the aeronautical radionavigation service.

Advantages:

- Does not delay the introduction of either GNSS augmentation or surveillance applications.
- No further consideration of issues relating to the compatibility between FM broadcasting and the data links supporting air navigation functions, such as GBAS, is required.

Disadvantages:

- Studies with respect to the impact of the surveillance applications on FM broadcasting in the lower adjacent band will not be completed by WRC-03.
- Does not consider the impact of introducing digital sound broadcasting in the band at about 87-108 MHz.

1.5.4 Regulatory and procedural considerations

1.5.4.1 Method A

Introduce a new provision into Article 5 of the Radio Regulations that might read as follows:

ADD

5.AAA The band 108-117.975 MHz also may be used to transmit supplementary navigational information, using internationally standardized ground based augmentation systems in support of aeronautical navigation functions.

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NOTE – The conference will determine under which service the stations referred to in No. **5.AAA** should operate

1.5.4.2 Method B

Introduce a new provision in Article **5** of the Radio Regulations along the lines of the example text shown below, together with a new WRC-03 resolution, which would condition the immediate and future use of the band.

ADD

5.BBB The band 108-117.975 MHz may also be used by international aeronautical standard systems to transmit navigational information in support of air navigation and surveillance functions in accordance with recognized international aviation standards. Such use shall be in accordance

with Resolution **[Method B]** and shall not cause harmful interference to nor claim protection from stations operating in the aeronautical radionavigation service, which operate in accordance with international aeronautical standards.

Example text of Resolution **[Method B]** is given in Annex [METHOD B-1.28] to Chapter 1.

1.5.4.3 Method C

Introduce a new provision into Article **5** of the Radio Regulations that might read as follows:

ADD

5.CCC The band 108-117.975 MHz may be used by international aeronautical standard systems supporting navigation and surveillance functions. Such use shall not cause harmful interference to nor claim protection from international standard systems operating in the aeronautical radionavigation service.

ANNEX [METHOD B–1.28]

ADD

RESOLUTION [METHOD B] (WRC-03)

Use of the band 108-117.975 MHz by aeronautical services other than the aeronautical radionavigation service

The World Radiocommunication Conference (Geneva, 2003),

considering

a) the current allocation of the frequency band 108-117.975 MHz to the aeronautical radionavigation service;

b) the requirements of the broadcasting service operating in the frequency band at about 87-108 MHz;

c) the need for the aeronautical community to provide additional services in order to enhance navigation and surveillance systems through a communication datalink,

recognizing

a) that precedence must be given to the aeronautical radionavigation service operating in the frequency band 108-117.975 MHz;

b) that, in accordance with Annex 10 of the Convention of the International Civil Aviation Organization (ICAO), all aeronautical systems must meet Standards and Recommended Practices (SARPs) requirements;

c) that within ITU-R, compatibility criteria between the broadcast service operating in the frequency band at about 87-108 MHz and the aeronautical radionavigation service operating in the frequency band 108-117.975 MHz already exist as indicated in Recommendation ITU-R SM.1009;

d) that all compatibility issues between FM broadcasting systems and ICAO standard ground-based systems for the transmission of radionavigation-satellite differential correction signals have been addressed,

noting

a) that aeronautical systems are converging towards a communication datalink environment to support aeronautical navigation and surveillance functions, which need to be accommodated in existing radio spectrum;

b) that no compatibility criteria currently exist between the broadcast service operating in the frequency band at about 87-108 MHz and the planned additional aeronautical services in the adjacent band 108-117.975 MHz using airborne transmission;

c) that studies by ICAO have confirmed that the planned additional aeronautical systems are compatible with the existing use of the adjacent band 108-117.975 MHz,

resolves

1 that the provisions of this Resolution and of No. **5.[BBB]** shall enter into force on [4 July 2003];

2 that any additional aeronautical systems planned to operate in the frequency band 108-117.975 MHz shall, as a minimum, meet the FM broadcast immunity requirements contained in Annex 10 of the Convention of the International Civil Aviation Organization (ICAO) for existing aeronautical radionavigation systems operating in this frequency band;

3 that additional aeronautical systems operating in the band 108-117.975 MHz shall place no additional constraints on current and planned stations the broadcast service operating in the band at about 87-108 MHz;

4 that frequencies below 112 MHz shall not be used for these new aeronautical systems until all compatibility issues with the lower adjacent frequency band at about 87-108 MHz, have been considered,

invites ITU-R

1 to study any compatibility issues between the broadcast service and new aeronautical services that may arise from the introduction of these new services and to develop new or revised ITU-R recommendations as appropriate;

2 to bring the results of these studies, if necessary, to the attention of a future competent WRC to determine any further action required,

requests the Secretary-General

to bring this Resolution to the attention of ICAO.