

WRC-07 Radio Astronomy Preparations

CORF Meeting

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WRC-07 Preparations

- **Conference Preparatory Meeting (CPM-07) was held February 19 – March 2, 2006, Geneva**
- **WRC-07 Scheduled to Be Held October 22 -November 16, Geneva, Preceded by the Radiocommunications Assembly (15-19 October)**



WRC-07 Agenda Items of Interest to Radio Astronomy

- WRC-07 Radio Astronomy issues
 - Allocations near 1.4 GHz for satellite up and downlinks (AI 1.17)
 - Regulation of unwanted emissions by satellites operating close to radio astronomy bands (AI 1.21)
 - Future Development of IMT-2000 and beyond (AI 1.4)
 - Consider additional allocations for aeronautical telemetry and telecommand (AI 1.5)
 - Consider additional allocations for aeronautical mobile (R) service between 108 MHz and 6 GHz (AI 1.6)
 - Sharing with Mobile Earth Stations in the 1668-1670 MHz range (AI 1.7)
 - Continuation of regulatory studies of HAPS (AI 1.8)
 - Future Agenda Items (AI 2.2)
- WRC-10 Radio Astronomy issues
 - Allocations between 275-1000 GHz (AI 2.2)
 - Sharing with the Fixed Service at 81-86 and 92-100 GHz (AI 2.7)
 - Allocations to the Radiolocation Service at 15.4 –15.7 GHz (new US Proposal)



AI 1.17 - 1.4 GHz Allocations for Satellite Up and Downlinks

- WRC-03 allocated the 1390-1392 MHz and 1430-1432 MHz bands to feeder links (up and down, respectively) for non-GEO systems in the mobile-satellite service
 - > On a secondary basis
 - > Subject to ITU-R studies on compatibility between the fixed-satellite service and other services (including passive services) around 1.4 GHz [in accordance with Resolution 745 (WRC-03)]
 - > Not to be used, until ITU-R studies reviewed at WRC-07!
- Some studies carried out - mostly positive, but
- Sole proponent company is out of business
- CPM report lists only one method to satisfy the AI: suppress allocation
- US, Canada, Europe, Asia-Pacific Proposals: Suppress allocation
- The bottom line: Unless something unexpected happens, (extremely unlikely at this time) the allocation will be suppressed!



Regulation of Unwanted Emissions of Satellite Downlink Near Radio Astronomy Bands

Mandatory limits:

exist for unwanted emissions from satellites near three radio astronomy bands (5 GHz, 15.4 GHz, 43 GHz)

Non- Mandatory Levels for Consultation:

Resolution 739 (WRC-03) calls for

- Administrations to take all reasonable steps to ensure that space stations, being designed, constructed or operating in some bands, do not exceed unwanted emission threshold levels in certain radio astronomy bands, at the site of observatories (see Tables 739-1 and 739-2)
- the administration operating the satellite system, and the one operating the radio astronomy station to enter into consultations to identify all practicable steps to be taken if the threshold levels are exceeded,
- with the aim of reaching a mutually acceptable solution,
- using as guidance Rec. ITU-R SM.1633 (essentially the Rec. ITU-R RA.769 levels)



Limitations of Regulations

SITE RELATED

- Trigger levels reference site of RA stations
- RA station **MUST** be registered with ITU
- RA station **must have been registered before satellite system was advance published**

TIME RELATED

- Level **not to be exceeded for more than 2% of 2000 second integrations** (ITU-R Rec. RA.1513)

REGULATORY

- **No examination or certification by Bureau (Strictly bilateral consultation, with no ITU intervention)**
- ***The epfd* methodology to be used to calculate unwanted emissions by NGSO systems (Rec. ITU-R M.1583 and ITU-R S.1586), along with a specific radio astronomy antenna model (Rec. ITU-R RA.1631)**



Band pairs in which consultations may be triggered if the threshold levels (Rec. ITU-R RA.769) are not met by GEO and non-GEO satellite systems, respectively

Space service	Space service Band (MHz)	Radio astronomy Band (MHz)
BSS (s-to-E) MSS (s-to-E)	1 452-1 492 1 525-1 559	1 400-1 427
MSS (s-to-E) MSS (s-to-E)	1 525-1 559 1 613.8-1 626.5	1 610.6-1 613.8
BSS (s-to-E) FSS (s-to-E)	2 655-2 670	2 690-2 700
FSS (s-to-E)	2 670-2 690	2 690-2 700 (in Regions 1 and 3)
	GHz	GHz
BSS (s-to-E)	21.4-22.0	22.21-22.5

Space service	Space service Band (MHz)	Radio astronomy Band (MHz)
MSS (s-to-E)	1 613.8-1 626.5	1 610.6-1 613.8



AI 1.21 - Continuation of Unwanted Emissions Study

Resolution 740 (WRC-03) calls for compatibility studies to review and update:

1. **Recommendation ITU-R SM.1633 (and others, if appropriate)**
2. **The Tables in Res. 739, based on ITU-R studies, limited only to the band pairs in the Table in Resolution 740**
 - > Task 1 carried out in a special Task Group (TG 1/9), established in the ITU-R for this purpose
 - > Task 2 to be carried out at WRC-07, based on the work performed in TG 1/9



Band-pairs considered by TG 1/9 (Table-Res. 740)

137-138	MSS (space-to-Earth)	150.05-153.0
387-390	MSS (space-to-Earth)	322-328.6
400.15-401	MSS (space-to-Earth)	406.1-410
620-790(No. 5.311) see Resolution 545 (WRC-03)	BSS (space-to-Earth)	608-614
1 452-1 492	BSS (space-to-Earth) (non-GSO systems only)	1 400-1 427
1 525-1 559	MSS (space-to-Earth) (non-GSO systems only)	1 400-1 427
1 525-1 559	MSS (space-to-Earth) (non-GSO systems only)	1 610.6-1 613.8
1 559-1 610	RNSS (space-to-Earth)	1 610.6-1 613.8
2 655-2 670	BSS (space-to-Earth)	2 690-2 700
2 655-2 670	FSS (space-to-Earth) (Region 2)	2 690-2 700
2 670-2 690	FSS (space-to-Earth) (Region 2)	2 690-2 700
10.7-10.95	FSS (space-to-Earth)	10.6-10.7
21.4-22.0	BSS (space-to-Earth)	22.21-22.5



Detour- GLONASS Issue

- GLONASS (a non-GEO system) operates in the top portion of the 1559-1610 MHz band, where GPS, Galileo, etc. also operate
- In 1992 GLONASS Administration agreed to:
 - Operate below 1610.6-1613.8 MHz band
 - Reduce unwanted emissions of single satellites to below Rec. 769 levels in the 1610.6-1613.8 and 1660-1670 MHz bands
- Currently:
 - All GLONASS satellites operate below 1610 MHz
 - Unwanted emissions of single satellites are below Rec. 769 level in 1660-1670 MHz band; about 12 dB above that level in 1610.6-1613.8 Hz band (by satellites closest in frequency), with promise to further reduce unwanted emissions to below the Rec. 769 levels
- Non-GEO systems, (GPS and Galileo design) now reduce their unwanted emission in the 1610.6-1613.8 MHz band to the *epfd* (aggregate) interference level, derived from Rec. 769
- GLONASS (Russian Administration) refuses to discuss further reductions (to *epfd* levels), arguing that:
 - GLONASS is disadvantaged, by operating closest to RA band
 - Further reductions of unwanted emissions would result in unacceptable reduction of system signal strength.



Possible Outcomes

(Methods to Satisfy the Agenda)

- Incorporate the Band Pairs Studied into the Tables of Res. 739
- Incorporate the Band Pairs Studied into the Tables of Res. 739, with the Exception of the 1.6 GHz RNSS/RAS band pair –GLONASS Issue
- Do not Incorporate Any New Levels into the Res. 739 Tables.



AI 1.4 –Frequency Matters Related to IMT-2000 (and beyond)

- **Long term (2020) requirements ~ 1500 MHz**
- **Bands under study, of interest to radio astronomy include:**
 - > 410- 430 MHz
 - > 470 - 806/862 MHz
 - > 4400 – 4990 MHz
- **Satellite component may include the 1668-1675 MHz band**



AI 1.5 –Consider Additional Spectrum for Aeronautical Telecommand and High-bit Rate Aeronautical Telemetry

- Requirement: additional **650 MHz** of spectrum for aeronautical telemetry for flight testing
- The **4900-4990 MHz** band is already allocated to the mobile service, footnote sought to designate it as “suitable” for T&T applications
- Candidate bands studied are: **4 400-4 940 MHz**, **5 925-6 700 MHz**, **5 030-5 091 MHz**, **5 091-5 150 MHz** and **5 150-5 250 MHz**
- **4825-4835 MHz** band allocated to radio astronomy on a primary basis in Argentina, Australia and Canada, however, US 203 provides only “all practicable steps” protection
- Studies show large separation distances required with radio astronomy stations in all parts of the band
- US proposal: Protection of radio astronomy via a Resolution



AI 1.5 –Consider Additional Spectrum for Aeronautical Telecommand and High-bit Rate Aeronautical Telemetry (2)

- **US proposal:**

- ✓ **Footnote 1** The bands 4 400-4 940 MHz and 5 925-6 700 MHz are suitable for the implementation of aeronautical mobile telemetry applications for flight testing by aircraft stations.
- ✓ **Modify 5.442, by adding:** In the band 4 825-4 835 MHz, applications in the aeronautical mobile service are limited to aeronautical mobile telemetry for flight testing in the air-to-ground direction. Resolution [AMT4-6 GHz] shall apply.

Resolution [AMT4-6 GHz]

recognizing

that the band 4 825-4 835 MHz is allocated to the radio astronomy service on a primary basis in Argentina, Australia and Canada (see No. 5.443), and that the band 4 800-4 990 MHz is allocated to the radio astronomy on a secondary basis worldwide and that No. 5.149 applies;

Resolves

2. if operation of AMT aircraft stations are planned within 500 km of the territory of an administration in which the band 4 825-4 835 MHz is allocated to radio astronomy on a primary basis (see No. 5.443), consult with that administration to determine whether any special measures are needed to prevent interference to their radio astronomy observations;

This coordination distance is not sufficient for high flying aircraft



AI 1.6 –Consider Additional Allocations for the Aeronautical Mobile (R) Service in Bands between 108 MHz and 6 GHz

- **Spectrum required (approx 60-100 MHz) for:**
 - a) Surface applications at airports (short range, highly reusable spectrum), and
 - b) Communications with UAVs (longer range, out to radio line-of-sight)

The bands 5000-5010 MHz and 960-1164 MHz are the prime candidates considered, for applications a) and b) respectively

Issue a) presents problem(s) due to compatibility with radio astronomy, (and sharing and/or compatibility with RNSS)



AI 1.6 –Consider Additional Allocations for the Aeronautical Mobile (R) Service in Bands between 108 MHz and 6 GHz (cont)

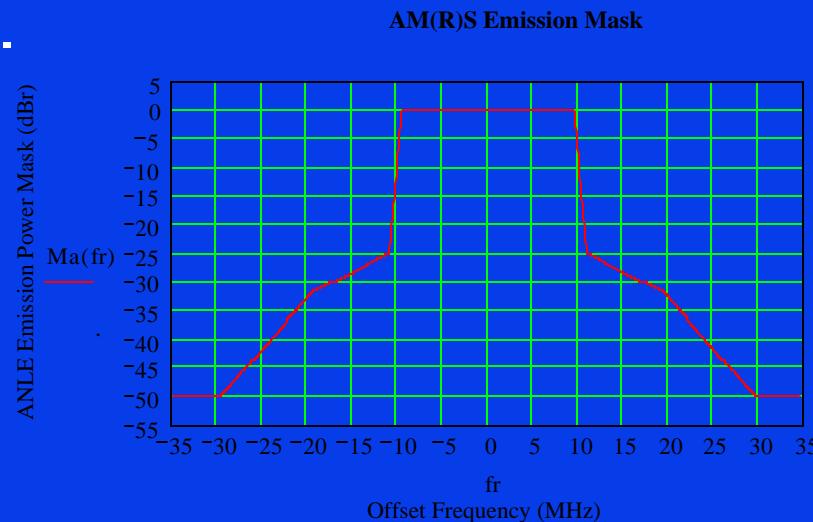
Proposal still being finalized

Radio astronomy issue dealt with by:

- a) *constraining applications to Earth's surface,*
- b) *at airports only*
- c) *local coordination, if necessary (possibly through a Resolution)*

Possible characteristics of system (IEEE 802.16e):

$P_t = 34.6 \text{ dBm}$; Omnidirectional antenna



AI 1.7 - Sharing with MES in the 1668-1670 MHz Range

- **AI: Consider the results of sharing in the 1668-1668.4 MHz band between space research service (passive) and the mss (Earth to space)**
- **WRC-03 added MSS (Earth-to-space) allocations to the 1668-1675 MHz band(s)**
- **Also added footnote 5.379C**

In order to protect the radio astronomy service in the band 1 668-1 670 MHz, the aggregate power flux-density (pf_d) values produced by mobile earth stations in a network of the mobile-satellite service operating in this band shall not exceed – 181 dB(W/m²) in 10 MHz and –194 dB(W/m²) in any 20 kHz at any radio astronomy station recorded in the Master International Frequency Register, for more than 2% of integration periods of 2 000 s. (WRC-03)

- **Allocation not implemented in U.S.**



AI 1.7 - Sharing with MES in the 1668-1670 MHz Range (2)

- Outstanding Issue: Sharing with the Space Research Service (SRS) aka Radio Astronomy from Space (Space VLBI) in the 1668-1668.4 MHz portion of the band
- HALCA no longer operating and Japan has no plans to observe in the band
- RadioAstron is interested in observations
- Proposed (and likely) Solution: Footnote limitation placed on transmitter power that would allow operations in highly elongated, elliptical orbits, such as RadioAstron
- Countries Behind Proposal: U.K (Inmarsat), Arab countries
- US draft proposal:

Footnote: In order to protect the space research service (passive) in the band 1 668-1 668.4 MHz the maximum emission power density of any mobile earth station in a mobile satellite service network in the geostationary satellite orbit network operating in this band, shall not exceed -12.5 dBW/4 kHz in any part of the frequency band 1 668-1 668.4 MHz.



WRC-10 AI 2.2 - Allocations Between 275-3000 GHz

- **No support from Administrations for WRC-10 Agenda, except to revise RR 5.565**
- **The science community must contribute to studies (in WP 7D), documenting the uses and requirements of bands above 275 GHz by radio astronomy**
- **Rec. ITU-R RA.314 lists the astrophysically important lines, based on those recommended by the IAU.**
- **WG (Div. X) on astrophysically important spectral lines of the IAU met during the Prague GA (but attendance low and few lines added to list)**



RR 565

The frequency band 275-1 000 GHz may be used by administrations for experimentation with, and development of, various active and passive services. In this band a need has been identified for the following spectral line measurements for passive services:

- - Radio astronomy service: 275-323 GHz, 327-371 GHz, 388-424 GHz, 426-442 GHz, 453-510 GHz, 623-711 GHz, 795-909 GHz and 926-945 GHz.
- - Earth exploration-satellite service (passive) and space research service (passive): 275-277 GHz, 294-306 GHz, 316-334 GHz, 342-349 GHz, 363-365 GHz, 371-389 GHz, 416-434 GHz, 442-444 GHz, 496-506 GHz, 546-568 GHz, 624-629 GHz, 634-654 GHz, 659-661 GHz, 684-692 GHz, 730-732 GHz, 851-853 GHz and 951-956 GHz.
- - Future research in this largely unexplored spectral region may yield additional spectral lines and continuum bands of interest to the passive services. Administrations are urged to take all practicable steps to protect these passive services from harmful interference until the date when the allocation Table is established in the above-mentioned frequency band. (WRC-2000)



WRC-10 AI 2.2 - Allocations Between 275-3000 GHz (cont)

- If this issue is to become a future AI, the science community must contribute to studies in WP 7D, documenting the uses of bands above 275 GHz by radio astronomy
- Contact person: Andy Clegg
aclegg@nsf.gov
- Rec. ITU-R RA.314 lists the astrophysically important lines, based on those recommended by the IAU.
- WG (Div. X) on astrophysically important spectral lines of the IAU met during the Prague GA
- Some lines added to list, but attendance low



AI 2.7 - Sharing with the Fixed Service at 81-86 and 92-100 GHz

- Consider the progress of studies concerning regulatory and technical issues relative to the fixed service in the bands 81-86 GHz and 92-100 GHz
- In accordance with Resolutions 731 and 732 (adopted at WRC-00 along with the reallocation of spectrum above 71 GHz)
- While there is now some use of these bands by the fixed service, there are no studies, except for a preliminary one in WP 7D
- U.S.: this is an ITU-R issue, not appropriate for WRC, delete AI



Possible New Proposals

- **Add Radiolocation Allocation to the 15.4 –15.7 GHz band?**
- **Radio astronomy Allocation in the neighboring 15.35 – 15.4 GHz band**
- **Would require compatibility studies**
- **Others?**

