Draft CEPT Brief on agenda item 1.20

Agenda item 1.20: ***to consider the results of studies, and proposals for regulatory measures regarding the protection of the Earth exploration-satellite service (passive) from unwanted emissions of active services in accordance with Resolution 738 (WRC–03)***

Issue

Resolution 738 invites the ITU-R to study the compatibility between EESS (passive) and the corresponding active services as listed in the table below; and also to study the impact of implementing the values provided in Recommendation ITU-R SM.1633 for the bands 31.3-31.5 GHz and 52.6-54.25 GHz in relation to fixed-service systems operating in Regions 2 and 3.

EESS (passive) band	Active service band	Active service
1 400-1 427 MHz	1 350-1 400 MHz	Fixed service (FS) Mobile service (MS) Radiolocation service
1 400-1 427 MHz	1 427-1 429 MHz	FS, MS (except aeronautical mobile service) and space operation ~~research~~ service (Earth-to-space)
1 400-1 427 MHz	1 429-1 452 MHz	FS and MS
23.6-24 GHz	22.55-23.55 GHz	Inter-satellite service
31.3-31.5 GHz	30-31 GHz	FSS (Earth-to-space)
50.2-50.4 GHz[1]	50.4-51.4 GHz[1]	FSS (Earth-to-space)[1]
50.2-50.4 GHz[1]	47.2-50.2 GHz (Regions 2 and 3) 49.44-50.2 GHz[1] (Region 1)	FSS[1]

[1] Studies in this band must take into account No. **5.340.1** of the Radio Regulations.

Note : The text in Resolution 738, instead of the correct service designation space operation (Earth- to- space), calls for study with the space research (Earth- to- space) which is not allocated in this band

Preliminary CEPT position

CEPT supports the definition of a single entry unwanted emission power limit for each corresponding active service operating near the EESS (passive) bands covered by Resolution 738, taking into account the results of the compatibility analysis as well as the reservations expressed by some administrations concerning the 1.4 GHz. : Those non-retroactive operational limits are preferred to be included in the Radio Regulations through a footnote in Art 05 or referring to (a) Resolution(s) with the appropriate conditions which will vary for the different band pairs. CEPT could also support these conditions to be directly included as footnotes in Article 5. For European

conditions it should be noted that in most cases equipment complying with relevant ETSI-standard, when available, or spurious limits in ECC Rec 74-01 would also comply with the limits which are necessary for the protection of the passive service (see section 3.6).

Background

1. History

ITU-R Task Group 1/7 conducted studies between the EESS (passive) and active services in certain adjacent or nearby bands, the results are contained in Recommendation ITU-R SM.1633. The results of this work were considered by WRC-03 under agenda item 1.8.2.

CEPT made proposals to WRC-03 for the inclusion in the Radio Regulations of limits on the unwanted emissions of active services to protect the EESS (passive) in the bands 31.3-31.5 GHz and 52.6-54.25 GHz, and for continued studies on other specific bands with the results to be considered at WRC-07.

Many administrations supported regulatory measures for the protection of passive services, including EESS, at WRC-03; however, after difficult discussions up to the last few days of the conference there was no agreement to take such action. The compromise solution was to continue the studies according to Resolution 738 and re-visit the issue at WRC-07.

2. EESS (passive) operation in bands covered by Resolution 738

Within WRC-07 Agenda Item 1.20 covered by Resolution 738, a total of five EESS (passive) bands, all protected by footnote 5.340 ("all emissions prohibited") need to be addressed, i.e.

- 1400 – 1427 MHz
- 23.6 – 24.0 GHz
- 31.3 – 31.5 GHz
- 50.2 – 50.4 GHz
- 52.6 – 54.25 GHz

In this section the particular use of these bands by the EESS (passive) will be highlighted, e.g. their use in operational meteorology, climatology and numerical weather prediction (NWP).

Measurements over a single country are not only used for weather forecasts in that country where the measurement was obtained but also for global modelling of the atmosphere used by and exchanged among all National Weather Services (NWS) to develop weather forecasts for other countries. Passive sensor products are used in support of farming, transportation, flood warnings and control, and other endeavours that are important to national interests and economies. The progress made in the recent years in weather and climate analysis and forecasts, including warnings for dangerous weather phenomena (heavy rain, storms, cyclones) that affect all populations and economies, is to a great extent attributable to spaceborne observations and their assimilation into numerical models.

EESS (passive) sensors are unable to discriminate between the very low power level of natural radiations which have to be measured and low or moderate levels of interference. Measurements corrupted by such interference would be mistaken to be accurate data. Interference that could impact a given "passive" frequency band could thus have a negative impact on the overall measurement of several atmospheric components.

Information from measurements in these bands, all protected by footnote 5.340 ("all emissions prohibited") is not only used for weather forecasts, but also for climate research where continuity of these measurements over a long period (i.e. many decades) is crucial to the understanding of the climate, its related changes and its variability on all timescales. Taking into account the decrease of traditional measuring networks, national meteorological offices and international weather centres are increasingly relying on satellite data. where satellite remote sensing is a crucial method of achieving global coverage.

2.1 1400 – 1427 MHz

Applications arising from use of this passive band can be classified as long term usage: the data retrieved from this band are not dedicated for immediate forecasting, but are of significant importance to global change issue. This band is able to provide data that would deliver crucial variables of the land surfaces (soil moisture, vegetation and biomass) and of ocean surfaces (sea surface salinity fields). NASA/JPL is currently developing an instrument for measuring soil moisture (the HYDROS mission), which will collect measurements in the entire passive microwave band under consideration (1 400 to 1 427 MHz). The European Space Agency (ESA) is developing a separate instrument (the SMOS mission), using a different technological approach, for measurements of soil moisture and ocean salinity. HYDROS and SMOS are complementary missions, both requiring high-precision radiometric measurements globally and continuously in time.

The only direct way to access to Soil Moisture and Sea surface salinity is through the use of microwave radiometers operating at frequencies near 1 400 MHz. Other means (higher frequency radiometry, optical domain, active remote sensing) suffer strong deficiencies, due to vulnerability to cloud and various perturbating factors (such as roughness or vegetation cover) as well as poor sensitivity. Soil moisture is a key variable in the hydrologic cycle with significant influence on evaporation, infiltration and runoff. In the vadose zone (i.e. the region between the land surface and underlying groundwater aquifers/ducts), soil moisture governs the rate of water uptake by vegetation. Sea surface salinity has an influence on deep thermohaline circulation[1] and the meridional heat transport. Variations in salinity influence the near surface dynamics of tropical oceans.

As this band seems to be best qualified for enabling on a global basis the direct observations of soil moisture and sea surface salinity, the protection of this passive band is essential.

2.2 23.6 – 24.0 GHz

Of the total 447 MHz bandwidth exclusively allocated for purely passive applications in the first 30 GHz of the spectrum (i.e. less than 1.5 %) , the 400 MHz in the band 23.6-24 GHz represents by far the largest .This indicates the vital importance of this band for the passive services. This band covers the flank of the water vapour spectral line (located at 22.235 GHz).

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[1] The thermohaline circulation is a global ocean circulation. It is driven by differences in the density of the sea water which is controlled by temperature (thermal) and salinity (haline). In the North Atlantic it transports warm and salty water to the North. There the water is cooled and sinks into the deep ocean. This newly formed deep water is subsequently exported southward. This slow (~0.1 m/s), but giant circulation has a flow equal to about 100 Amazon Rivers. Together with the Gulfstream it contributes (2/3 and 1/3) to the comparatively warm sea surface temperature along the coast of western Europe and to the relative mild European winters. Once the water are in the deep, they remain from the atmosphere for up to 1000 years.

The measurements made at 24 GHz directly lead to the total column water vapour content in the atmosphere. This is crucial for weather forecasting at local and global level. The potential loss of these data that are assimilated in Numerical Weather Prediction (NWP) models will severely affect the quality of weather forecasting.

Also, this band is used for correcting temperature measurements (made between 50-60 GHz) for attenuation due to water vapour. Without correct measurements at 24 GHz, temperature measurements at 50-60 GHz cannot be corrected for attenuation due to water vapour content in the atmosphere and thus have severely increased errors that feed back in the NWP models and potentially result in wrong interpretation and in degraded weather forecasts.

2.3 31.3 – 31.5 GHz

Above 26 GHz the opacity of the atmosphere due to water vapour declines to a minimum close to 30 GHz, before slowly rising again. Sensitivity to cloud liquid water continues to rise such that at 30 GHz sensitivity to cloud is greater than sensitivity to water vapour. Sensor measurements in this band are used to determine cloud liquid water content. The water vapour absorption is largely due to the water vapour continuum.

This band is unique in that is a frequency range where emissions from other sources (water vapour and oxygen) reach a minimum. Data collected in this band are essential for predicting all forms of precipitation over land and oceans. This channel is therefore used as a window channel to correct at other frequencies for cloud liquid water as well as surface contributions. It is also used for carrying out polarimetric sea surface observations to derive wind speed and direction. In particular these wind observation are extremely vulnerable to contamination due to their very low signal intensity.

This band is used together with the band 23.6-24 GHz to get a couple of measurements able to both provide the surface temperature and the integrated water vapour absorption. This is the reason why both 23.6 to 24 GHz and 31.3 to 31.5 GHz must be used together with the sounding bands between 50 to 60 GHz. Most of the instruments retrieving those parameters have the capability to perform operations at several channels in order to provide coherent information.

2.4 50.2 – 50.4 GHz & 52.6 – 54.25 GHz

These channels are used for temperature profile observation using the O_2 absorption spectrum in the vicinity of 60 GHz.

The main purpose of using channels in this frequency range is to provide temperature sounding information. The provision of channels in this frequency regime has a proven very large positive impact on NWP equating to 1-2 days in forecast period (a 2 day benefit means that the 3 day forecast with the observations is as accurate as the one day forecast without the data).

The volume-mixing ratio of oxygen in the atmosphere up to approximately 90 km stays constant while the atmosphere pressure becomes larger towards the Earth surface according to a known exponential law. By making use of these two effects, the atmospheric temperature can be calculated. Channels further away from the oxygen absorption spectrum (e.g. 52.6 – 54.25 GHz are sensitive to lower altitudes than those channels closer to 60 GHz).

By measuring at several channels within the flank of the O_2 absorption spectrum and correcting for several factors (for which information is obtainable in the 31 GHz and 24 GHz frequency bands), an accurate temperature profile of the atmosphere results.

3. Summary of ITU-R Studies

ITU-R Task Group 1/9 was responsible for the studies under Resolution 738 (WRC-03) that led to Report ITU-R SM.2092. The results for each of the bands under consideration can be found in this Report or, alternatively, summarised in the CPM text under section 1/1.20/1.3

During this process, CEPT proposed a limit in terms of an unwanted emission power level at the active antenna port for all band pairs even for the situations where compatibility would be easily achieved in order to prevent EESS (passive) from interference coming from future active systems whose characteristics would be greatly different from existing ones.

For the EESS (passive) band 1400-1427 MHz, a single limit for the different band pairs have been identified to protect EESS (passive) service sometimes after a long debate and discussions involving different opinions on the relevance of the proposed limit.

For the EESS (passive) bands 23.6-24 GHz and 31.3 – 31.5 GHz, the need for introducing limits are still under discussion. CEPT has proposed respectively -46 dBW/200 MHz for the ISS and -20 dBW/200MHz for the FSS (E to s) . The CEPT position is that these limits may be met by active service without undue constraints and would adequately protect existing and planned EESS (passive) sensors.

Where in the CPM text a range is indicated ,CEPT agreed on the compatibility conditions but the results differ from one to another set of simulations. For the EESS (passive) band 50.2 – 50.4 GHz, compatibility analyses with the FSS (E-s) in the bands directly adjacent on both sides of the passive band have shown that, in order to protect EESS (passive), the level of unwanted emissions would be between -10 and -20 dBW/200MHz where CEPT has proposed an unwanted emission limit of -20 dBW/200MHz.

Table of results

Passive band	Active band	Active service	Measure to protect passive band*
1400 – 1427 MHz	1350 – 1400 MHz	RL	Limit unwanted emissions of radiolocation stations into the passive band to -29 dBW/27 MHz
1400 – 1427 MHz	1350 – 1400 MHz	FS	Limit unwanted emissionsof FS stations into the passive band to - 45 dBW/27 MHz
1400 – 1427 MHz	1350 – 1400 MHz	MS	Limit unwanted emissions of MS stations into the passive band to -60 dBW/27MHz except transportable radio relays[1] limited to -45dBW/27 MHz
1400 – 1427 MHz	1427 – 1429 MHz	SO (E to s)	Limit unwanted emissions of SO Earth stations into the passive band to -36 dBW/27MHz
1400 – 1427 MHz	1427 – 1452 MHz	MS	Limit unwanted emissions of MS stations into the passive band to -60 dBW/27MHz except transportable radio relays[1] limited to -45dBW/27 MHz and aeronautical telemetry[2] limited to -28 dBW/27MHz
1400 – 1427 MHz	1427 –- 1452 MHz	FS	Limit unwanted emissions of FS stations into the passive band to - 45 dBW/27 MHz

23.6 – 24.0 GHz	22.55- – 23.55 GHz	ISS	Limit unwanted emissions of ISS space stations into the passive band to -46 dBW in 200 MHz
31.3 – 31.5 GHz	30.0 – 31.0 GHz	FSS (E to s)	Limit unwanted emissions of FSS Earth stations into the passive band to -20 dBW/200MHz
31.3 – 31.5 GHz	31 – 31.3 GHz	FS	Limit unwanted emissions of FS stations into the passive band to -38 dBW/100 MHz
50.2 – 50.4 GHz	47.2 – 50.2 GHz Regions 2 and 3, 49.44 – 50.2 GHz Region 1	FSS (E to s)	Limit unwanted emissions of the FSS Earth stations into the passive band to an emission power of -20 dBW/200 MHz
50.2 – 50.4 GHz	50.4 – 51.4 GHz	FSS (E to s)	Limit unwanted emissions of the FSS Earth stations into the passive band to an emission power of -20 dBW/200 MHz
52.6 – 54.25 GHz	51.4 – 52.6 GHz	FS	Limit unwanted emissions of FS stations into the passive band to - 33 dBW/100 MHz

The unwanted emission power level is defined as the level at the antenna port (i.e. not including the antenna gain).

(1): some administrations operate transportable radio relay systems within the mobile service, while others operate such systems within the fixed service.

(2): The band 1 429-1 435 MHz is also, on a primary basis, allocated to the aeronautical mobile service exclusively for the purposes of aeronautical telemetry within the national territory of eight Region 1 administrations (RR No. **5.342**).

3.7 Other issues

A significant difficulty in the work of Task Group 1/9 was the identification of suitable OOB emission characteristics. In the absence of more accurate data, TG1/9 used the OOB masks from Recommendation ITU-R SM.1541. However the recommendation was not intended for this purpose and its use as it is would significantly over estimate the level of interference. TG1/9 improved the use of SM.1541 for this purpose developing an appropriate methodology (introduction of the fill factor) or introducing some refined estimation of the unwanted power spectrum (radiolocation for example).

It was pointed out in the last TG1/9 meeting that some annexes of the ITU-R Recommendation SM.1541 need to be refined due to some inconsistencies. WP4A raised this issue to the attention of WP1A.

CPG PT2 has developed a draft ECP based on the results of TG1/9 as provided in the ITU-R report SM.2092, applying Method A of the draft CPM text for each band pair. This proposed ECP has been split between the frequency band 1.4 GHz and the other set of frequency bands, given the reservations expressed by some administrations concerning the 1.4 GHz. Administrations were urged to study the proposals contained in this document with a view to its future development and approval.

List of relevant documents

ITU Resolution 738 (scope of the work for agenda item 1.20)

ITU-R Recommendation SM.1633 or Report ITU-R SM.2092 (details of the compatibility studies)

ECC Recommendation 02-05 (unwanted emissions)

ERC Recommendation 74-01 (spurious emissions)

Actions to be taken

Proposals from outside CEPT

Regional telecommunication organisations

APT (January 2007)

APT Preliminary views

APT position is that adequate protection should be given to EESS (passive) from unwanted emissions without imposing undue burden on active services in adjacent bands. For each band pair studied, the appropriate regulatory method to satisfy the agenda item should be decided independently taking into account the results of ITU-R studies.

CITEL (October 2006)

Preliminary Views:

Canada intends to participate in the compatibility studies to be carried out by TG 1/9, paying particular attention to the Earth exploration satellite passive service and the active services bands of interest to Canada. Also the studies should be limited to the specific bands identified in the table above.

RCC (January 2007)

Creation of the maximum levels of unwanted emissions in the Radio Regulations for active services operating in the frequency range below 3 GHz are not supported

When developing the conditions for achieving compatibility between active and passive services operating in the bands identified in Resolution **738 (WRC-03)** one should take into account both the technical capabilities of active services on limitation of unwanted emissions, as well as interference mitigation techniques at the passive service stations.

International organisations

NATO (February 2007)

NATO Military Position

Alliance interests are related to the following bands and service applications:

- Military tactical mobile radio relay equipment is capable of tuning between 1 350 MHz and 1 850/2 690 MHz. This is a typical deployable communications asset used by lead and framework nations of a Combined Joint Task Force and / or of a NATO Response Force.

• Military radars are generally capable of tuning and operating up to 1 375 MHz, in some cases, even up to 1 400 MHz;
• Future military satellite uplinks may be accommodated in the bands 30-31 GHz and 50.4-51.4 GHz, both being harmonised resources to meet respective requirements.
From an Alliance point of view it is felt to be important that possible consequences for the operating of the above mentioned military service applications are duly taken into account.

(a) Spectrum access for military mobile services, radiolocation radars and satellite communication systems needs to be adequately safeguarded.

(b) The protection requirements of the EESS (passive) are noted. They must be balanced against the well-justified spectrum access requirements of essential active radiocommunication services.

(c) Any additional regulatory constraints on the Radio Determination Services are not an acceptable solution.

ICAO (December 2006)

Protection of the Earth exploration-satellite service in the band 1 400 – 1 427 MHz should not impose undue constraints to the use of the adjacent bands by aviation.

WMO

WMO supports appropriate regulatory measures in the Radio Regulations to ensure the protection of the Earth exploration satellite service (passive) from unwanted emissions. Such measures should minimize the burden on the relevant active services but the protection of the related passive bands should be a prerequisite.

SFCG (Space Frequency Coordination Group) (January 2007)

SFCG supports the protection of these EESS (passive) allocations that are critically required to provide continued availability of satellite-based data used in disaster prediction and in the development of global weather and climate models. Appropriate mandatory power limits for unwanted emissions developed on a band-by-band basis, as identified by Method A in the draft CPM Report, would be most effective if included in the Radio Regulations. SFCG members are encouraged to take an active role in the development of proposals and positions within their respective Administrations' preparatory processes for the CPM and WRC-07 with the aim of developing appropriate measures to ensure the protection of the Earth exploration satellite service (passive) from unwanted emissions.

Regional organisations

EUMETNET / ESA/ EUMETSAT (October 2006)

The scientific and meteorological needs as described in the CPM text can only be satisfied by Method A that proposed to include in the Radio Regulations mandatory unwanted emissions limits.

These limits should minimize to the best possible extent the burden on the relevant active services but should provide adequate protection for the related passive bands.

It should also be stressed that EESS (passive) bands in the range 23.6 –54.25 GHz are currently used together on multi-channel instruments and processed simultaneously in order to isolate and retrieve each individual atmospheric component contribution at every altitude, justifying a consistent regulatory approach for these frequency bands

Eurocontrol

To ensure that protection of the Earth exploration-satellite service in the band 1 400-1 427 MHz should not impose undue constraints to the use of the adjacent bands by aviation.

RSPG (Radio Spectrum Policy Group)

Scientific use of spectrum has a considerable societal value. Most of the data retrieved from the use of the so-called "scientific bands" are directly dedicated to the benefit of every citizen as they relate in particular to meteorology, climatology, environment, civil security and fundamental research. Most of the associated investments are coming from public funds.

Most of this societal value is incommensurable in financial terms, as they relate to preventing large losses of lives or threats to socio-political stability and security. However, scientific use of spectrum also has a direct impact in many economic areas, which can be estimated, and in producing economic spin-offs in technology and economic developments in energy, transportation, agriculture, communications, medicine, etc. An assessment of the overall benefits of scientific uses of spectrum needs to be taken into account and complemented, as appropriate, using the guidelines set out below, in order to facilitate future decisions by administrations which may impact on such uses.

The importance of inter-governmental commitments, among which the GMES initiative (Global Monitoring for Environment and Security), is a European priority, as is the World Weather Watch program of the World Meteorological Organisation, which rely on the availability of observations on every point of the Earth. This requires spectrum harmonisation at a global level, which is already achieved and should be maintained.

Members States should take appropriate measures to ensure the availability and adequate protection of this globally harmonised spectrum in all countries, since unilateral European or national decisions may have worldwide impact on the quality and availability of data.

Exclusive allocations to scientific services are needed only to a limited portion of the spectrum, corresponding to unique frequencies. The RSPG considers that these represent essential natural resources and urges Member States to respect their obligations under No. 5.340 of the Radio Regulations, which prohibits all emissions in the corresponding frequency bands. The RSPG recommends the EC, when preparing appropriate measures on spectrum, to support the needs of the scientific services in these particular bands.