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| **Radiocommunication Study Groups** |  |
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| Source: Document 5A/TEMP/236 | **Annex 10 to**  **Document 5A/543-E** |
| **2 June 2014** |
| **English only** |
| Annex 10 to Working Party 5A Chairman’s Report | |
| preliminary draft new Report ITU-R М.[5 MHz COMPAT] | |
| Compatibility analysis of possible amateur service stations with fixed, land mobile, maritime mobile and radiolocation services in the frequency band  5 250-5 450 kHz and the aeronautical mobile service in an adjacent band | |

# 1 Introduction

The frequency band 5 250-5 450 kHz is allocated to the fixed and mobile services (excluding aeronautical mobile), and in the band 5 250-5 275 kHz to the radiolocation service for oceanographic radar purposes on a non-interference basis to the allocated services in accordance with Resolution **612 (Rev.WRC-12)**.

Resolution **807 (WRC-12)** includes, as agenda item 1.4 for WRC-15 “1.4 to consider possible new allocation to the amateur service on a secondary basis within the band 5 250-5 450 kHz in accordance with Resolution **649 (WRC-12)**”.

This Report gathers together texts submitted during the study period 2012-2014 to address the above question and examines the potential for interference from stations of the amateur service operating in the frequency range 5 250-5 450 kHz to operation of the systems of fixed, radiolocation, and mobile (except aeronautical mobile) services. This Report evaluates the compatibility of the amateur service and incumbent services and also considers potential interference mitigation techniques.

During discussions on the various input documents, diverging views on the conclusions of the input documents were expressed. Accordingly, the following text summarizes common elements and all of the submitted reports are included here as separate annexes.

Relevant ITU Reports and Recommendations and abbreviations used are also contained in a separate annex.

# 2 Background

The high frequency (HF) band supports propagation of radio signals via a reflected path incident on the ionosphere. This is called ionospheric or sky-wave propagation. Because of this unique characteristic, an important feature of the HF spectrum is its ability to support long range communications via sky-wave propagation. However, one disadvantage of sky-wave propagation is the probability that noise and interference from distant sources may affect a desired communication. Therefore, the usability of HF sky-wave communication channels depends on both signal propagation and the absence of excess noise and interference.

The origin of this agenda item, and the perceived need for an amateur service allocation around 5 300 kHz, is because there are times when propagation conditions do not allow reliable communications using the two adjacent amateur bands at 3 500 and at 7 000 kHz. One researcher states[[1]](#footnote-1) “*Operation at 5 MHz is particularly useful for midlatitude locations during daylight hours at low points in the sunspot cycle when ionization is often insufficient to support NVIS communication at higher frequencies, and significant D region absorption occurs at lower frequencies*”

The frequency range 5 250-5 450 kHz is allocated to fixed and mobile (except aeronautical mobile) services in all three Regions on a primary basis. Radiolocation services are also allocated in the range 5 250 to 5 275 kHz as a secondary service in Regions 1 and 3 and Primary in Region 2.

In 2014 the Master International Frequency Register (MIFR) shows 13 314 frequency assignments to the fixed service, 2104 frequency assignments to base stations on land in the mobile service, 251 frequency assignments to transmitting coast stations in the mobile service and 14 frequency assignments to coast maritime receiving stations in the mobile service. Assignments in such numbers illustrate that it is often not feasible to deploy traditional mobile communication networks and satellite communication stations in many sparsely populated, inaccessible and remote areas of the globe including those in the Arctic and Antarctic regions. These links are typically used for different purposes including disaster relief operations. The usage of these assignments is strongly dependent on link distances, time of day, month/season, level of solar activity and real‑time propagation conditions. Technologies for automatic evaluation of propagation channels have resulted in new and different operational use of these HF frequencies which may alter the sensitivity to interference compared to previous systems.

However there are divergent opinions on the value of using the MIFR to assess band occupancy and the view of some administrations is that using the MIFR to determine the number of active stations in the band significantly overestimates the spectrum occupancy by incumbent services as listings of stations that become inactive are not routinely deleted.

# 3 Study methods

Three options were discussed as potential methods to assess the impact of the proposed amateur service allocation upon incumbent services:

Option 1: Calculate SNR of wanted link (must meet S/N requirements discussed below to indicate a successful link), subtract value of SNR for interfering amateur link (must also meet requirement to be a successful link), compare resulting S/I against the required link margin for the fixed service as shown in Recommendations ITU-R F.1761 (Annex 1, Table 4, required S/N), ITU-R F.1762 (Annex 1, Table 1, required S/N), and ITU-R F.1821 (Annex 1, Table 1, required S/N). Although the protection criteria in these tables are an S/N ratio, it also represents the required C/I to successfully close a link at the required reliability levels, taking into account the overall system S/N protection criteria found in Recommendation ITU-R F.339.

Option 2: Calculate SNR of wanted link, subtract SNR of interfering amateur link, convert resulting S/I into S/N ratio and compare to S/N protection criteria of Recommendation ITU-R F.339. Availability objectives for HF systems would also have to be compared to determine impact to long-term and short-term objectives.

Option 3: Calculate SNR of wanted link, subtract SNR of interfering amateur link, convert resulting S/I into Signal-to-Interference + Noise (SINR) taking into account the necessary bandwidth. Calculate resulting SINR from S/N protection criteria in Recommendation ITU-R F.339 and compare to determine potential impact on fixed/mobile service links, also taking into account availability objectives.

While the preference was that the method described in Option 1 be used, it was recognised that other methods might also provide useful information that could be assist the conference in assessing interference potential to incumbent and adjacent services.

# 4 Results of studies

The results of the studies are contained in the annexes at the end of this report. It should be noted that a number of the studies use very similar methods (essentially Option 1 from section 3) but are based upon different, but equally valid, assumptions of channel usage and this complicates the final analysis.

*Editor’s note: What else can we say about results?*

# 5 Conclusions

## 5.1 Summary

Views of the feasibility of sharing between incumbent services and the amateur service in the band 5 275 to 5 450 kHz vary and studies conducted by several administrations have led to different conclusions about the impact of the proposed secondary allocation to the amateur service upon the existing primary users. The particular and differing circumstances and requirements of the various administrations that conducted studies and submitted views are reflected in the following conclusions and it appears impossible to achieve a global view.

Some administrations are of the view that compatibility of amateur stations with the fixed and mobile services systems is extremely difficult and may require operational constraints on the amateur stations.

Other administrations are of the view that compatibility is feasible. One of these administrations cites that there have been few cases of interference to incumbent services by amateur stations operating in the 5 MHz range under domestic authorizations consistent with No. **4.4** of the Radio Regulations. Interaction with the incumbent services, should it occur, generally does not preclude their continued operation and such instances are normally resolvable on a case-by-case basis.

Other administrations report that they are unaware of any such cases of interference by amateur stations operating under similar domestic authorizations.

In the case of the frequency range 5 250 to 5 275 kHz, allocated to radiolocation service for oceanographic applications, previous ITU-R studies have found sharing “seems to be difficult ...”[[2]](#footnote-2) For these reasons a secondary allocation to the amateur service within the frequency band 5 250‑5 275 kHz authorized at WRC-12 should not be considered.

If necessary, to ensure compatibility of amateur stations with the fixed and mobile services, operational constraints on the amateur stations additional to those already incumbent on a secondary user might be required.

## 5.2 Compatibility with stations in the fixed service

One administration analyzed the potential interference to a fixed-link operating over a 1 500 km path from an amateur link of a similar path length and determined that – notwithstanding the assumed amateur secondary status and practice of listen-before-transmit – operation of the amateur link on the same frequency as the fixed link was using was generally not practical. After taking account of the few remaining occasions when the amateur link might nonetheless operate co‑channel with the fixed link, the incidence of potential interference should be infrequent and generally would not preclude continued operation of the fixed link and should be resolvable on a case-by-case basis.

However, a study conducted by another administration concluded that harmful interference caused by amateur transmissions could result in unacceptable interference which could lead to loss of FS link functionality and in degradation of wanted signal reception conditions unless separation distances of, e.g., 2 000 km for single-hop links and 6 500 km for double-hop links, were observed.

## 5.3 Compatibility with stations in the mobile service

The characteristics of stations in the mobile service are similar to the characteristics of stations in the fixed service, but the use of omnidirectional whip antennas on mobile units in the mobile service has two results:

1) otherwise identical circuits being less reliable in the mobile service than the fixed service, and

2) equal sensitivity of mobile units to both wanted and potentially interfering signals in all directions.

Studies on these two points are not complete.

## 5.4 Compatibility with the adjacent aeronautical mobile service

Adjacent band analysis with stations in the aeronautical mobile service above 5 450 kHz indicates compatibility with potential amateur service stations in the 5 250-5 450 kHz frequency range.

## 5.5 Compatibility with the radiolocation service

*Editor’s note: What do we need to add here? Give protection distances etc.?*

Annex 1

Reference information

Related ITU‑R Recommendations and Reports

Recommendation ITU-R [F.339-8](http://www.itu.int/rec/R-REC-F.339-8-201302-I/en) – Bandwidths, signal-to-noise ratios and fading allowances in HF fixed and land mobile radiocommunication systems

Recommendation ITU-R [P.368-9](http://www.itu.int/rec/R-REC-P.368-9-200702-I/en) – Ground-wave propagation curves for frequencies between 10 kHz and 30 MHz

Recommendation ITU-R [P.372-10](http://www.itu.int/rec/R-REC-P.372) – Radio noise

Recommendation ITU-R [P.525-2](http://www.itu.int/rec/R-REC-P.525-2-199408-I/en) – Calculation of free-space attenuation

Recommendation ITU-R [P.533-11](http://www.itu.int/rec/R-REC-P.533-11-201202-I/en) – Method for the prediction of the performance of HF circuits

Recommendation ITU-R [P.832-3](http://www.itu.int/rec/R-REC-P.832-3-201202-I/en) – World Atlas of Ground Conductivities

Recommendation ITU-R [F.1610](http://www.itu.int/rec/R-REC-F.1610-0-200302-I/en) – Planning, design and implementation of HF fixed service radio systems

Recommendation ITU-R [M.1732-1](http://www.itu.int/rec/R-REC-M.1732-1-201203-I/en) − Characteristics of systems operating in the amateur and amateur-satellite services for use in sharing studies

Recommendation ITU-R [F.1761](http://www.itu.int/rec/R-REC-F.1761-0-200602-I/en) – Characteristics of HF fixed radiocommunication systems

Recommendation ITU-R [F.240](http://www.itu.int/rec/R-REC-F.240/recommendation.asp?lang=en&parent=R-REC-F.240-7-200602-I)-7 – Signal to interference protection ratios for various classes of emissions in the fixed service below about 30 MHz

Recommendation ITU-R [F.162](http://www.itu.int/rec/R-REC-F.162/recommendation.asp?lang=en&parent=R-REC-F.162-3-199203-I)-3 – Use of directional transmitting antennas in the fixed service operating in bands below about 30 MHz

Recommendation ITU-R [BS.705-1](http://www.itu.int/rec/R-REC-BS.705/recommendation.asp?lang=en&parent=R-REC-BS.705-1-199510-I) – HF transmitting and receiving antennas characteristics and diagrams

Recommendation ITU-R [M.1874](http://www.itu.int/rec/R-REC-M.1874/recommendation.asp?lang=en&parent=R-REC-M.1874-1-201302-I) – Technical and operational characteristics of oceanographic radars operating in sub-bands within the frequency range 3-50 MHz

Recommendation ITU-R [SM.1541](http://www.itu.int/rec/R-REC-SM.1541/en)-5 –Unwanted emissions in the out-of-band domain

Recommendation ITU-R [SM.329](http://www.itu.int/rec/R-REC-SM.329/en)-12 –Unwanted emissions in the spurious domain

Report ITU-R [M.2234](http://www.itu.int/pub/R-REP-M/publications.aspx?lang=en&parent=R-REP-M.2234) – The feasibility of sharing sub-bands between oceanographic radars operating in the radiolocation service and fixed and mobile services within the frequency band 3‑50 MHz

[Preliminary] draft new Report ITU-R M.[5 MHz CHAR] –Characteristics of amateur radio stations in the range 5 250-5 450 kHz for sharing studies

Report [ITU-R M.2080](http://www.itu.int/pub/R-REP-M.2080) – Consideration of sharing conditions and usage in the 4-10 MHz band

ITU-R Handbook – Ionosphere and its Effects on Radiowave Propagation Handbook, Edition 1998

Abbreviations

AS Amateur service

BW Bandwidth

FS Fixed service

LBT “Listen-Before-Transmitting” protocol used by amateur operators

LUF Lowest Usable Frequency

MUF Maximum Usable Frequency

NVIS Near-Vertical Incidence Skywave

OOB Out Of Band

SNR S/N, Signal-to-Noise Ratio

SNIR S/(N+I), Signal-to-Noise plus Interference Ratio

SSB Single-Sideband Suppressed Carrier Analogue Voice Transmission

SSN Smoothed Sunspot Number

UTC Coordinated Universal Time

Annex 2

*Editor’s note: Each input contribution will be attached or embedded here as annexes to this study. Those below will need to be updated with newer versions as required.*

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| 5A/242 (Canada) | 5A/250 (USA) | 5A/254 (Canada) |
| 5A/280 (China) | 5A/289  (UK, Netherlands, Norway) | 5A/237 (Russian Federation) |
| 5A/253 (Canada) | Include modified 5A/400, 5A/383, 5A/368. |  |

**Also include the most recent inputs**

[**5A/468**](https://www.itu.int/md/dologin_md.asp?lang=en&id=R12-WP5A-C-0468!!MSW-E) **(Russian Federation),** [**5A/482**](https://www.itu.int/md/dologin_md.asp?lang=en&id=R12-WP5A-C-0482!!MSW-E) **(USA),** [**5A/489**](https://www.itu.int/md/dologin_md.asp?lang=en&id=R12-WP5A-C-0489!!MSW-E) **(China),** [**5A/503**](https://www.itu.int/md/dologin_md.asp?lang=en&id=R12-WP5A-C-0503!!MSW-E) **(Canada)**

Annex 2 Russian Federation

Annex 3 Canada

Annex 4 China

Annex 5 USA

Annex 6 IARU

Annex 7 TBD

1. Walden: HF Near-Vertical Incidence Sky Wave Links. Radio Science, Vol. 47, RS0L09, 2012. [↑](#footnote-ref-1)
2. Report of the Conference Preparatory Meeting to the 2012 World Radiocommunication Conference § 2/1.15/3. [↑](#footnote-ref-2)