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RADIOSONDE RADIO SPECTRUM ISSUES

(*Submitted by Mr D. Franc, USA)*

Summary and purpose of document

This document provides background information related to radio spectrum and suggests items for consideration by the ET.

Action proposed

The meeting is invited to take into account information presented in this document when discussing radio spectrum issues.

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Radiosonde Radio Spectrum Issues - Items for Consideration by the Expert Group on Upgrading the Global Radiosonde Network

1.0 Introduction. The worldwide increasing demand for radio spectrum to support new and expanding wireless services has had an impact on many existing users of the radio spectrum, including radiosonde operators. Over the past 10 years wireless service providers have put forward proposals to use radiosonde frequency bands for their commercial operations. This document provides a summary of the radiosonde spectrum issues and provides items that this Expert Group should consider in their work.

2.0 Background.

2.1 The International Telecommunications Union. The International Telecommunications Union (ITU) is a United Nations agency headquartered in Geneva, much like the WMO. Unlike the WMO, the ITU has regulatory authority. The ITU governs the international use of radio spectrum. The International Radio Regulations, a treaty text, are the regulatory guidelines for use of radio spectrum. They provide a large amount of detailed information ranging from the allocation of frequency bands to specific radio services, to the procedures that define how two or more radio services sharing common spectrum must coordinate their operations.

The ITU creates allocations for particular services to use specific bands of frequencies, subject to licensing by their own administrations. To define these terms:

- A SERVICE is a type of radio operation, for example, meteorological satellites, broadcasting, fixed, mobile-satellite or meteorological aids (the last of which includes radiosondes.)
- An ALLOCATION is authority for a particular service to use a particular band. The Meteorological Aids service has an allocation in 1668.4 – 1700 MHz, for example. Allocations are created globally by the ITU, and within a country by its own administration.
- A LICENSE or ASSIGNMENT is permission for a particular radio station to operate at a particular location using specified frequencies, under defined technical conditions and consistent with the frequency allocation.

The International Radio Regulations are modified every two to four years by a World Radiocommunication Conference (WRC). A WRC has a set agenda of issues to consider, which is established by the preceding WRC. The issues on the WRC agenda typically include creating new frequency allocations to allow radio systems to operate in frequency bands already used by other radio services; develop rules, restrictions and procedures defining how radio services may use and share frequency bands; and even deleting frequency allocations from all or part of bands when a radio service no longer needs it, is making inefficient use of the band(s) or a competing prospective user is deemed more important. In the two to four year period between WRCs the ITU technical bodies (Working Parties) meet to consider technical analyses relating to each of the WRC agenda items. The technical studies may investigate issues such as how a radio service seeking spectrum can or cannot share with existing services in a particular band, how existing services in a band can improve their spectrum efficiency to enable sharing, or establish the interference protection criteria (maximum interference levels the systems can withstand and still operate) for a radio system. The results of these studies are summarized in a report the WRC delegates use for the decision making process.

In addition to the technical support work to the WRCs, the ITU Working Parties also develop technical documents that provide guidance to administrations on efficient use of radio spectrum, technical standards for transmitters and receivers, radio spectrum management techniques, interference mitigation techniques and radiowave propagation models for use in interference studies and radio circuit reliability analyses. The ITU Working Parties meet approximately two times per year. ITU Working Party 7C is responsible for radiosonde issues and passive and active remote sensing by satellite. More information on participation in ITU Working Party 7C can be obtained from the ITU website www.itu.int and from your national radio spectrum regulatory agency.

2.2 Frequency Allocations. A frequency allocation is the authority under which a radio service may operate in a particular band. The allocation is defined by a lower and upper frequency, and may have footnotes that further define limitations on how the allocated radio service may use the allocation. Radio services are allocated on a primary or secondary basis. A primary allocation (designated in the International Radio Regulations by the name of the service in all uppercase letters) is the higher status, with radio services having a secondary allocation (designated in the International Radio Regulations by the name of the service printed in lower case except for the first letter) required to accept all interference they receive and not cause interference to any of the primary users. When multiple radio services are allocated on a primary basis, each has equal access to the band unless footnotes define precedence. Radiosondes operate within the ITU radio service of Meteorological Aids (MetAids). The MetAids service has several primary allocations in the International Radio Regulations at 400.15 - 406 MHz, 1668.4 -1700 MHz, and 35.2 - 36 GHz. The bands 400.15 - 406 MHz and 1668.4 -1700 MHz are used extensively world wide for radiosonde operations. There is no known use of the band at 35.2 - 36 GHz for radiosonde operations. Annex 1 to this document provides extracts from the International Radio Regulations for each of the MetAids frequency allocations.

2.3 History of Radiosonde Spectrum Issues. Both main radiosonde bands were identified for possible sharing with other radio services in approximately 1992. At that time the mobile-satellite service (MSS) was working to identify additional spectrum for providing service to users. The MSS is satellite-based communications systems that provide voice and data communications services to mobile users. The radiosonde bands were considered ideal targets for several reasons. First, the bands were allocated on a global basis. The MSS was seeking a band that they could use worldwide rather than using different bands in different parts of the world. A single worldwide band allows the MSS operators to build satellites and subscriber terminals that can be used anywhere in the world. The second reason was radiosondes were known to exhibit very poor radio frequency characteristics in comparison to other radio systems. These poor characteristics made very inefficient use of the radio spectrum in comparison. The MSS saw this as an adequate justification to propose spectrum should be removed from availability to the MetAids service. It is true that in comparison to all other radio communications systems, typical radiosondes transmit very little information relative to the amount of spectrum required for their operation. Radiosonde spectrum requirements are defined by the density of radiosonde stations, the bandwidth of the radiosonde signal, and the amount of drift that occurs during flight (refer to Figure 1).

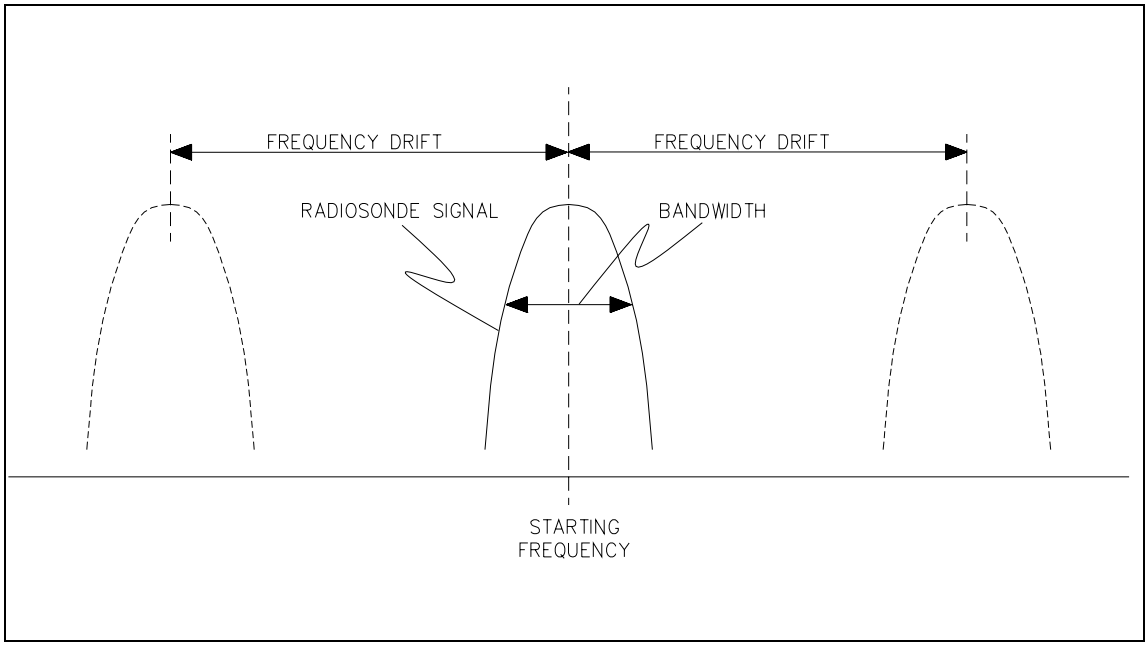

Figure 1- Graphic depicting signal bandwidth and frequency drift.

The 1992 World Administrative Radio Conference (WARC-92)* considered proposals to create an MSS allocation in various frequency bands including the band 1675-1710 MHz, which is used for radiosonde and meteorological satellite operations. An allocation was provided to the MSS on a co-primary basis in ITU Region 2 (the vicinity of North and South America) in the band 1675-1710 MHz. The co-primary status gave the MSS equal rights to use spectrum in the band already being used by radiosondes and meteorological satellites. No study work had been completed prior to WARC-92 to determine the effect MSS operations could have on meteorological operations, nor were meteorological experts present at the WARC to oppose the action. A regional allocation is of little use to satellite system operators with global operations. The MSS proponents pressed for expansion of the ITU Region 2 allocation to a worldwide allocation at WRC-95, WRC-97, WRC-2000 and WRC-2003, with many technical studies submitted to the ITU Working Parties between the WRCs. The studies concluded the MSS and radiosondes could not use the same spectrum. Any parts of the band 1675-1710 MHz determined by a WRC to be used by the MSS would need to be vacated by radiosonde operators.

At WARC-92 the band 400.15-406 MHz was also identified as a potential source of spectrum for MSS systems intending to provide data-only services, and 400.15 - 401 MHz portion of the band was allocated to the MSS on a worldwide, co-primary basis. Additional unsuccessful proposals were made to WRC-95, WRC-97 and WRC-2000 for additional allocations to the MSS in 401-406 MHz. As with the sharing situation in the higher frequency band, technical studies showed that the MSS could not use the band without causing interference to radiosonde systems and radiosondes causing interference to the MSS. Sharing of the band would require removal of radiosondes from a portion of the band so that the MSS could operate.

2.4 Outcome of WRC-2003. The ITU held the most recent WRC in Geneva during June 9 – July 4, 2003. Creation of worldwide MSS allocations in both radiosonde bands were two items on the 44 item agenda. Meteorological system experts from WMO, EUMETSAT, United States of America, Australia, United Kingdom, China, Japan, Netherlands, and Brazil had participated in the preparatory work during the 2001-2003 study cycle in preparation for WRC-2003. With the exception of the creation of the Region 2 allocation and the 400.15-401 MHz allocation at WARC-92, the radiosonde frequency allocations had been status quo prior to WRC-2003. The MSS proponents made proposals through their administrations to the previous WRCs and those proposals were effectively opposed by meteorological experts from other administrations. At WRC-2003, both issues were resolved and the work was closed on MSS sharing with the meteorological services.

2.4.1 WRC-2003 Decision on 1675-1710 MHz. The preparatory work immediately prior to WRC-2003 had concentrated efforts on the possibility of the MSS using the sub-band 1683-1690 MHz. Earlier studies had discouraged further work on creating a worldwide allocation in 1675-1683 MHz or 1690-1710 MHz. Studies completed in preparation for WRC-2003 showed that the MSS could not use the band 1683-1690 MHz without impacting meteorological satellite downlinks. As a result, an alternative band, 1670-1675 MHz, was studied as a potential source of MSS spectrum. This 5 MHz has only a few meteorological satellite earth stations and a low number of radiosonde systems operating primarily in Asia. The meteorological satellite earth stations could be protected from interference by use of exclusion zones. The exclusion zones are areas where the MSS terminal would automatically be inhibited from transmitting. The radiosonde stations could be protected in a similar manner if the administration operating the system chooses. The alternative is to move radiosonde operations from below 1675 MHz to above 1675 MHz. The final decision at WRC-2003 was to create a worldwide MSS allocation in 1668-1675 MHz. WRC-2003 also deleted the ITU Region 2 MSS allocation in 1675-1710 MHz, where the bulk of the meteorological systems operate.

* The name World Administrative Radio Conference (WARC) was changed to World Radiocommunication Conference (WRC) after WARC-92.

2.4.2 WRC-2003 Decision on 401-406 MHz. The resolution of the proposed MSS use of the band 401- 406 was simple. No proposals to create an allocation for the MSS in 401-406 MHz were made to WRC-2003. Many of the companies seeking the additional spectrum had failed due to lack of demand for the services they provide. Sufficient spectrum has already been allocated to support the operations of those companies that still are in operation. WRC-2003 concluded that no further technical work or future agenda item was needed on this issue, and an allocation was not created.

3.0 Other Radiosonde Spectrum Issues. In addition to the frequency allocation issues considered within the ITU, there are a number of other spectrum issues relating to radiosonde operations.

3.1 Radiosonde Spectrum Sharing with Meteorological Satellites. Radiosondes and Meteorological Satellites (MetSats) share radio spectrum in the sub-bands 400.15 - 403 MHz and 1670 - 1700 MHz. In those bands, the allocations for radiosondes and MetSats are established on a co-primary basis. This sharing situation has lead to a number of incompatibility issues between MetSats and radiosondes. The coordination of the shared use has been very poor in the past. This coordination process has been improved in recent years through the activities of the WMO Steering Group on Radio Frequency Coordination (SG-RFC).

Radiosondes and MetSats have a co-primary allocation in the sub-band 400.15-403 MHz. The majority of the meteorological satellite systems operating in the band 400.15-403 MHz are data collection platforms (DCPs) that periodically transmit a burst of hydrologic or meteorological data to geostationary satellites. The nature of DCP operation allows them to share the spectrum with radiosonde systems without serious interference problems. A second type of MetSat system planned for operation in the band is a constellation of polar orbiting MetSats (the National Polar Orbiting Environmental Satellite System, NPOESS) that will transmit a data downlink within the sub-band 400.15-401 MHz. Calculations show that the downlink from these MetSats may cause interference to radiosondes that are operating on or near the same frequency as the NPOESS data downlink. Unfortunately, the system design was established for this MetSat system prior to the existence of the SG-RFC. Coordination between the MetSat operators and radiosonde operators failed at several levels. First, discussion of the proposal between the meteorological operators did not occur due to the lack of a mechanism to allow such coordination between meteorological operators at an international level. Second, the satellite system was properly coordinated through the ITU to all other administrations. When the NPOESS proposal was sent by the ITU to all administrations for coordination, no objections were voiced back to the ITU and the system design was approved for international operation. It appears that the proposed use was never brought to the attention of radiosonde operators by their regulatory agencies within countries that use the band 400.15 - 406 MHz for radiosonde operations.

The band 1668.4 - 1700 MHz is shared between radiosondes and the MetSat service over the range 1670-1700 MHz. Studies submitted to the ITU and operational experience show that radiosondes cause interference to meteorological satellite receive earth stations if they are operated in the same frequency range in the same geographic region. The SG-RFC has recommended radiosonde operators should strive to limit their operations to the sub-band 1675-1683 MHz, while MetSat operators should use the spectrum below 1675 MHz and above 1683 MHz. The SG-RFC recognizes that the frequency requirements vary in different parts of the world. Some countries still have requirements for more than 8 MHz of spectrum for radiosonde operations into the future. Working towards the SG-RFC recommendation will ensure frequency separation of the two incompatible meteorological systems. Some MetSat operators still see expansion into the radio spectrum used by radiosondes as a potential source of the additional needed bandwidth.

Since the meteorological data users rely on both radiosonde and MetSat data, a sharing arrangement that prevents interference and makes maximum use of the spectrum will benefit worldwide meteorological operations. The discussion in this section provides insight into areas where improvements were or are needed:

1) A coordination mechanism was needed where the meteorological spectrum users could coordinate plans for spectrum use. This was achieved through the establishment of the WMO Steering Group for Radio Frequency Coordination (SG-RFC).

2) The meteorological services should develop a working relationship with their national spectrum regulatory authority. This working relationship will allow the regulatory authority to call attention of the meteorological service to any issue or proposal that could impact meteorological operations within or availability of data to their country.

3) Radiosonde operators should make the most efficient use of the radio spectrum as is economically feasible. In comparison to the amount of spectrum used for a single radiosonde flight, a meteorological satellite can transmit orders of magnitude more data in the same amount of radio spectrum.

3.2 Interference to Cospas/Sarsat. Cospas/Sarsat is a life-saving search and rescue system used for locating emergencies. Watercraft, aircraft, and outdoor enthusiasts carry radio beacons that can be activated in an emergency situation. When activated, the beacon transmits a signal that is tracked by satellite-based receivers, providing the information necessary for locating the emergency and conducting a rescue. Cospas/Sarsat operates the beacon to satellite link in the band 406.0 - 406.1 MHz, directly above the radiosonde band 400.15 - 406 MHz. Cospas/Sarsat receives interference from various sources even though the International Radio Regulations prohibit transmissions from any other radio system capable of causing interference in the band 406.0 - 406.1 MHz. Interference can cause the satellite-based Cospas/Sarsat receiver to not receive an emergency beacon signal. Radiosonde transmitters, and primary and secondary radars used with some radiosonde systems are some suspected sources of interference to Cospas/Sarsat. Interference can occur in two ways. Some radiosonde transmitters drift in frequency so that the signal falls within the band 406.0 - 406.1 MHz, and some radiosonde systems generate unwanted emissions that fall within the band 406.0 - 406.1 MHz (see figures 2 and 3 in section 3.3 for example radiosonde unwanted emission measurements).

3.3 Interference to Radio Astronomy Stations. Radio astronomers use very large parabolic dish antennas and ultra sensitive receivers to conduct space research by receiving very weak signals buried in atmospheric radio noise. The radio astronomy service has a frequency allocation in the band 1660 -1670 MHz, adjacent to and partially overlapping the radiosonde allocation of 1668.4-1700 MHz. In the case of the overlap in the two bands, the radio astronomy and radiosonde stations have equal rights. However, there are radiosondes in use capable of drifting out of the allocated radiosonde band down into the radio astronomy band. When a radiosonde drifts near a radio astronomy station and is operating in the radio astronomy band, interference will occur. Some radiosondes also radiate unwanted signals outside the bandwidth of the desired signal, which can also cause interference to a radio astronomy stations. (Refer to Radio Regulations footnote 5.379 in Annex 1).

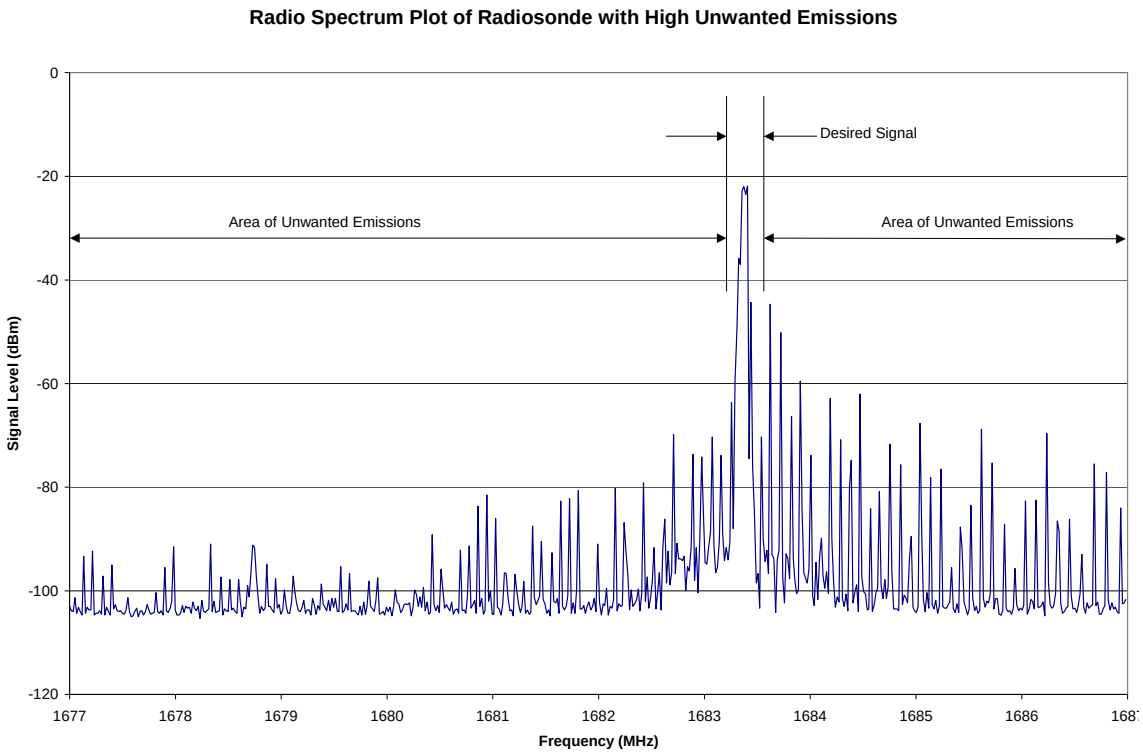

Figure 2- Example radio spectrum plot of a radiosonde operating at 1683.5 MHz producing high levels of unwanted emissions.

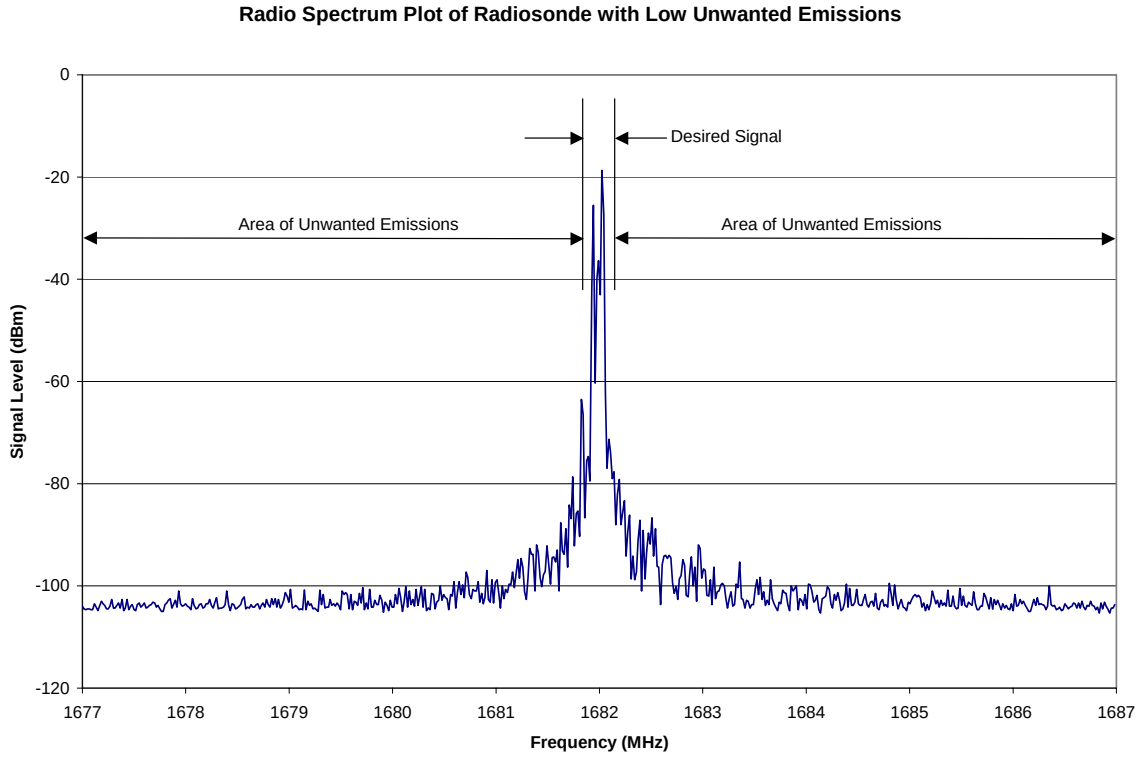

Figure 3- Example radio spectrum plot of a radiosonde operating at 1682.0 MHz producing low levels of unwanted emissions.

4.0 Items for consideration by the Expert Team. A number of spectrum regulatory and equipment design issues should be considered as this Expert Group conducts its work. The WMO has provided the ITU with present and future radiosonde spectrum requirements. The WMO contributions to ITU indicate that radiosonde transmitter designs will improve and the spectrum requirements will decrease. Some of the decrease in spectrum requirements is expected to provide spectrum to additional radiosonde stations. The WMO statements to the ITU have been based on input from Members. Radiosondes are perceived to make very inefficient use of radio spectrum relative to all other radio services. This perception within the ITU has led to proposals to decrease the radio spectrum available to radiosondes, forcing better spectrum efficiency on radiosonde manufacturers and operators. A reduction in spectrum requirements forced by a regulatory means will have a detrimental impact on meteorological operations. A proactive approach by the meteorological community is the best response. As the Expert Group conducts its work, the following items should be considered:

4.1 Improved Radiosonde Transmitters. As the Expert Group conducts its work, objectives for implementing radiosonde transmitters with higher stability, narrow emissions, and low unwanted emissions should be considered. A wide range of transmitter technologies are used around the world leading to vastly different transmitter characteristics. Radiosondes are used in parts of Europe that have very narrow band transmissions that drift no greater than 10 kHz in frequency, and the unwanted emissions are very well suppressed. Radiosondes are in use in other parts of the world that have large bandwidth emissions and that drift 10 MHz or greater while in flight. In the case of the latter, these characteristics result in the radiosonde operating outside the frequency range recommended by the WMO, and in some cases outside the frequency range allocated by the International Radio Regulations. In order to prevent interference to other radio services and to meet the obligations established by the International Radio Regulations, Members must ensure their radiosonde transmissions do not fall outside the allocated frequency bands. Operation of systems that do not adhere to the international rules will erode the credibility of the WMO and meteorological users in the ITU. This will make defense of meteorological spectrum requirements difficult in the future. Members should strive to deploy radiosonde systems that follow the WMO recommendations for the sub bands in which radiosondes should operate. This will ensure better compatibility between radiosondes and MetSats, a benefit to all members. The WMO recommended bands established by the SG-RFC for radiosonde operations are 401-406 MHz, and 1675-1683 MHz.

4.2 Documentation of Radiosonde Radio Frequency Characteristics and Operations. Though the work has been complete on the possibility of MSS sharing spectrum with radiosondes, with a conclusion favorable to meteorological operations, other radio services continue to try to identify radio spectrum for their new systems. It is only a matter of time until the radiosonde bands are identified for possible sharing with other radio systems. Complete, accurate documentation of radiosonde characteristics and operational practices is essential to defending worldwide radiosonde spectrum requirements. Documentation within the ITU contains detailed information on RF characteristics and operational practices for North America and Europe. Additional information on RF characteristics and operational practices from South America, Asia and Africa would be beneficial in providing a complete summary of radiosonde operations and characteristics to the ITU technical bodies. It is recommended Members submit information documents on the RF characteristics of their radiosonde systems and operational practices for their country. This submission can be made directly to ITU Working Party 7C if a national representative can be provided to present and defend the document in WP 7C, or the submission can be made through this Expert Group to the WMO Steering Group on Radio Frequency Coordination (SG-RFC). The SG-RFC may then submit the information to Working Party 7C in their contributions and present the information at the meeting.

4.3 Relationship Between Radiosonde Operators and National Spectrum Regulatory Agencies. Members should develop a working relationship, if it does not already exist, with their national spectrum regulatory agencies. A working relationship will provide a mechanism for coordinating responses to proposals that could impact the availability of radio spectrum to radiosondes. A

working relationship will also raise the awareness of national radio spectrum regulators to the spectrum requirements for meteorological operations and the importance of radiosonde operations to protection of life and property and enhancement of national economies.

4.4 Input to the SG-RFC on Future Radiosonde Transmitter and Spectrum Trends and Requirements. The SG-RFC continues to meet periodically to coordinate efforts of Members at ITU meetings and to discuss current and future meteorological spectrum requirements and issues. Input from this Expert Group would aid the SG-RFC in formulating strategy, preparing inputs to the ITU, and defending radiosonde spectrum requirements. The Expert group may wish to consider providing the SG-RFC input on anticipated future radiosonde transmitter and receiver technology, deployment plans that will affect spectrum requirements, and other useful information.

5.0 Conclusion. The Expert Group on Upgrading the Worldwide Radiosonde Network should take into account the improvement of radiosonde transmitters and enhancing spectrum efficiency of radiosonde systems. This will help ensure that sufficient spectrum is available in the future for sustained radiosonde operations. Improved performance of radiosonde transmitters also will help mitigate interference to other radio services that operate in the same or adjacent bands as radiosondes. Improved spectrum efficiency is critical to ensuring decisions are not taken by the International Telecommunications Union (ITU) to reduce spectrum available to radiosonde operators due to perceived spectrum inefficiency. Imposed reduction in radio spectrum available to radiosonde operations would be detrimental, whereas a gradual reduction in spectrum requirements driven by the manufacturer and operators implementing better transmitter designs will allow changes to occur in manner that will not harm worldwide meteorological operations. Reduction in spectrum requirements will provide additional spectrum for new radiosonde stations, prevent interference to meteorological satellite operations, and will prevent interference to other sensitive and safety critical radio services.

ANNEX 1-

Extracts from The International Radio Regulations for Radiosonde Frequency Allocations

The Band 400.15 – 406 MHz:

400.15-401	METEOROLOGICAL AIDS METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208A 5.209 SPACE RESEARCH (space-to-Earth) 5.263 Space operation (space-to-Earth) 5.262 5.264
401-402	METEOROLOGICAL AIDS SPACE OPERATION (space-to-Earth) EARTH EXPLORATION-SATELLITE (Earth-to-space) METEOROLOGICAL-SATELLITE (Earth-to-space) Fixed Mobile except aeronautical mobile
402-403	METEOROLOGICAL AIDS EARTH EXPLORATION-SATELLITE (Earth-to-space) METEOROLOGICAL-SATELLITE (Earth-to-space) Fixed Mobile except aeronautical mobile
403-406	METEOROLOGICAL AIDS Fixed Mobile except aeronautical mobile
406-406.1	MOBILE-SATELLITE (Earth-to-space) 5.266 5.267
406.1-410	FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY 5.149

5.260 Recognizing that the use of the band 399.9-400.05 MHz by the fixed and mobile services may cause harmful interference to the radionavigation satellite service, administrations are urged not to authorize such use in application of No. **4.4**.

5.261 Emissions shall be confined in a band of ± 25 kHz about the standard frequency 400.1 MHz.

5.262 *Additional allocation:* in Saudi Arabia, Armenia, Azerbaijan, Bahrain, Belarus, Bosnia and Herzegovina, Bulgaria, Colombia, Costa Rica, Cuba, Egypt, the United Arab Emirates, Ecuador, Georgia, Hungary, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kazakhstan, Kuwait, Liberia, Malaysia, Moldova, Nigeria, Uzbekistan, Pakistan, the Philippines, Qatar, Syria, Kyrgyzstan, Slovakia, Romania, the Russian Federation, Singapore, Somalia, Tajikistan, Turkmenistan, Ukraine and Yugoslavia, the band 400.05-401 MHz is also allocated to the fixed and mobile services on a primary basis. (WRC-2000)

5.263 The band 400.15-401 MHz is also allocated to the space research service in the space-to-space direction for communications with manned space vehicles. In this application, the space research service will not be regarded as a safety service.

5.264 The use of the band 400.15-401 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. The power flux-density limit indicated in Annex 1 of Appendix **5** shall apply until such time as a competent world radiocommunication conference revises it.

5.265 Not used.

5.266 The use of the band 406-406.1 MHz by the mobile-satellite service is limited to low power satellite emergency position-indicating radiobeacons (see also Article **31** and Appendix **13**).

5.267 Any emission capable of causing harmful interference to the authorized uses of the band 406-406.1 MHz is prohibited.

The Band 1668.4 – 1700 MHz:

1 668-1 668.4	MOBILE-SATELLITE (Earth-to-space) ADD 5.BB06 RADIO ASTRONOMY SPACE RESEARCH (passive) Fixed Mobile except aeronautical mobile 5.149 5.341 ADD 5.BB07 5.379 5.379A ADD 5.BB08 ADD 5.BB09	
1 668.4-1 670	METEOROLOGICAL AIDS FIXED MOBILE except aeronautical mobile MOBILE-SATELLITE (Earth-to-space) ADD 5.BB06 RADIO ASTRONOMY 5.149 5.341 ADD 5.BB07 ADD 5.BB08 ADD 5.BB09 ADD 5.BB10	
1 670-1 675	METEOROLOGICAL AIDS FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE 5.380 MOBILE-SATELLITE (Earth-to-space) ADD 5.BB06 5.341 ADD 5.BB07 ADD 5.BB08 ADD 5.BB10 ADD 5.BB11	
1 675-1 690 METEOROLOGICAL AIDS FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.341	**1 675-1 690** METEOROLOGICAL AIDS FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.341	**1 675-1 690** METEOROLOGICAL AIDS FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.341
1 690-1 700 METEOROLOGICAL AIDS METEOROLOGICAL-SATELLITE (space-to-Earth) Fixed Mobile except aeronautical mobile 5.289 5.341 5.382	**1 690-1 700** METEOROLOGICAL AIDS METEOROLOGICAL-SATELLITE (space-to-Earth) 5.289 5.341 5.381	**1 690-1 700** METEOROLOGICAL AIDS METEOROLOGICAL-SATELLITE (space-to-Earth) 5.289 5.341 5.381
1 700-1 710 FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.289 5.341	**1 700-1 710** FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.289 5.341	**1 700-1 710** FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.289 5.341 5.384

5.BB06 For the use of the bands 1 518-1 525 MHz and 1 668-1 675 MHz by the mobile-satellite service, see Resolution **225 (Rev.WRC-03)**. (WRC-03)

5.BB07 The use of the band 1 668-1 675 MHz by the mobile-satellite service is subject to coordination under No. **9.11A**. (WRC-03)

5.BB08 For sharing of the band 1 668-1 675 MHz between the mobile-satellite service and the fixed, mobile and space research (passive) services, Resolution **[COM5/12] (WRC-03)** shall apply. (WRC-03)

5.BB09 In order to protect the radio astronomy service in the band 1 668-1 670 MHz, the aggregate power flux-density (pfd) values produced by mobile earth stations in a network of the mobile-satellite service operating in this band shall not exceed –181 dB(W/m^2) in 10 MHz and –194 dB(W/m^2) 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)

5.BB10 In the band 1 668.4-1 675 MHz, stations in the mobile-satellite service shall not cause harmful interference to stations in the meteorological aids service in China, Iran (Islamic Republic of), Japan and Uzbekistan. In the band 1 668.4-1 675 MHz, administrations are urged not to implement new systems in the meteorological aids service and are encouraged to migrate existing meteorological aids service operations to other bands as soon as practicable. (WRC-03)

5.BB11 In the band 1 670-1 675 MHz, stations in the mobile-satellite service shall not cause harmful interference to, nor constrain the development of, existing earth stations in the meteorological-satellite service notified in accordance with Resolution **[COM5/13] (WRC-03)**. (WRC-03)

5.376A Mobile earth stations operating in the band 1 660-1 660.5 MHz shall not cause harmful interference to stations in the radio astronomy service. (WRC-97)

5.377 Not used.

5.378 Not used.

5.379 *Additional allocation:* in Bangladesh, India, Indonesia, Nigeria and Pakistan, the band 1 660.5-1 668.4 MHz is also allocated to the meteorological aids service on a secondary basis.

5.379A Administrations are urged to give all practicable protection in the band 1 660.5-1 668.4 MHz for future research in radio astronomy, particularly by eliminating air-to-ground transmissions in the meteorological aids service in the band 1 664.4-1 668.4 MHz as soon as practicable.

5.380 The bands 1 670-1 675 MHz and 1 800-1 805 MHz are intended for use, on a worldwide basis, by administrations wishing to implement aeronautical public correspondence. The use of the band 1 670-1 675 MHz by stations in the systems for public correspondence with aircraft is limited to transmissions from aeronautical stations and the use of the band 1 800-1 805 MHz is limited to transmissions from aircraft stations.

5.381 *Additional allocation:* in Afghanistan, Costa Rica, Cuba, India, Iran (Islamic Republic of) and Pakistan, the band 1 690-1 700 MHz is also allocated to the fixed and mobile, except aeronautical mobile, services on a primary basis. (WRC-03)

5.382 *Different category of service:* in Saudi Arabia, Armenia, Austria, Azerbaijan, Bahrain, Belarus, Bosnia and Herzegovina, Bulgaria, the Congo, Egypt, the United Arab Emirates, Eritrea, Ethiopia, Guinea, Hungary, Iraq, Israel, Jordan, Kazakhstan, Kuwait, the Former Yugoslav Republic of Macedonia, Lebanon, Mauritania, Moldova, Mongolia, Oman, Uzbekistan, Poland, Qatar, Syria, Kyrgyzstan, Romania, Russian Federation, Somalia, Tajikistan, Tanzania,

Turkmenistan, Ukraine, Yemen and Yugoslavia, the allocation of the band 1 690-1 700 MHz to the fixed and mobile, except aeronautical mobile, services is on a primary basis (see No. **5.33**), and in the Dem. People's Rep. of Korea, the allocation of the band 1 690-1 700 MHz to the fixed service is on a primary basis (see No. **5.33**) and to the mobile, except aeronautical mobile, service on a secondary basis. (WRC-97)

5.383 Not used.

5.384 *Additional allocation:* in India, Indonesia and Japan, the band 1 700-1 710 MHz is also allocated to the space research service (space-to-Earth) on a primary basis. (WRC-97)

The Band 35.2 –36 GHz:

35.2-35.5	METEOROLOGICAL AIDS RADIOLOCATION 5.549
35.5-36	METEOROLOGICAL AIDS EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active) 5.549 5.BE02
36-37	EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE SPACE RESEARCH (passive) 5.149

5.549 *Additional allocation:* in Saudi Arabia, Bahrain, Bangladesh, Egypt, the United Arab Emirates, Gabon, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Malaysia, Mali, Malta, Morocco, Mauritania, Nepal, Nigeria, Oman, Pakistan, the Philippines, Qatar, Dem. Rep. of the Congo, Syria, Senegal, Singapore, Somalia, Sudan, Sri Lanka, Togo, Tunisia and Yemen, the band 33.4-36 GHz is also allocated to the fixed and mobile services on a primary basis. (WRC-97)

5.BE02 In the band 35.5-36.0 GHz, the mean power flux-density at the Earth's surface, generated by any spaceborne sensor in the Earth exploration-satellite service (active) or space research service (active), for any angle greater than 0.8º from the beam centre shall not exceed −73.3 dB(W/m^2) in this band. (WRC-03)