Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	GN Dkt. 13-114
Expanding Access to Broadband and	)	RM-11640
Encouraging Innovation through	)	
Establishment of an Air-Ground Mobile	)	
Broadband Secondary Service for	)	
Passengers Aboard Aircraft in the 14.0-14.5 GHz Band		

COMMENTS OF THE
NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

The National Academy of Sciences, through the National Research Council's Committee on Radio Frequencies (hereinafter, CORF),[1] hereby submits its Comments in response to the Commission's May 9, 2013 Notice of Proposed Rulemaking (NPRM) (FCC 13-66) in the above-captioned docket, regarding a bi-directional Air-Ground Mobile Broadband Service (AMS) at 14.0 to 14.50 GHz. In light of the importance to the Radio Astronomy Service (RAS) of observations at 14.47 to 14.50 GHz, CORF recognizes the importance of sharing spectrum among different services where feasible, but notes that an aeronautical service transmitting down to Earth in this band could cause significant interference problems for RAS facilities. CORF recommends that if a new bidirectional service is established in the 14.0-14.5 GHz band, that the 14.47-14.50 GHz portion be limited to uplink (ground-to-air) transmission. In any case, careful consideration of and commitment to solutions, including addressing issues regarding

[1] Members of CORF are listed in the appendix.

coordination and emission levels, must be made should this new service be authorized.

I. Introduction.

CORF has a substantial interest in this proceeding, as it represents the interests of the passive scientific users of the radio spectrum, including users of the RAS bands. RAS observers perform extremely important, yet vulnerable, research.

As noted in Comments CORF filed previously in RM-11640, RAS observation at 14.47 to 14.50 GHz is used for a wide range of scientific investigations, including the study of star formation, active galaxies, and galaxy evolution. Within this allocation there are unique emission lines, including the 14.488 GHz formaldehyde line used to study the inner regions of our Milky Way Galaxy, as well as other galaxies.[2]

CORF appreciates the Commission's recognition in the NPRM of the need to protect RAS observations in the 14.47-14.50 GHz band pursuant to Footnotes US 203 and US 342. Footnote US 342 states that "all practicable steps shall be taken to protect the radio astronomy service from harmful interference. Emissions from spaceborne or airborne stations can be particularly serious sources of interference to the radio astronomy service." Consistent with the text of that Footnote, CORF asserts that air-to-ground transmissions within the RAS band have the potential to be severely damaging to scientific investigations, due to the fact that radio antennas used by RAS are very sensitive to radiation from the sky, since the main beam and higher inner sidelobes are pointed skywards. In addition, transmissions from terrestrial base stations

[2] This line is recognized by the International Telecommunications Union as one of the radio frequency lines of greatest importance to Radio Astronomy. *See,* ITU-R RA.314-10, at Table 1.

that are in the line-of-sight of RAS observatories can also cause harmful interference.

II. Coordination to Protect RAS Observations.

CORF supports the principle of shared use of the spectrum among different users, where practical. In this case, shared use would require detailed coordination, but such coordination would be challenging, given the high velocity and large numbers of aircraft potentially making use of AMS communications. The opportunity for direct interference over the entire line-of-site generated by high-altitude aircraft is great, given the number of U.S. RAS facilities that observe in this band. Another factor to consider will be the number of terrestrial base stations and their proximity to RAS observatories, as well as issues involving the dynamic scheduling of RAS observations. These issues are discussed below.

A. Protected Observatories.

In paragraph 44 of the NPRM, the Commission proposes that the RAS observatories listed in Footnote US203 be protected through coordination. However, in its December 2012 Report and Order on Earth Stations Aboard Aircraft (ESAA), the Commission properly recognized that some of the observatories listed in Footnote US203 no longer observe in the 14 GHz band, while some other facilities not listed in that Footnote do. Accordingly, the Commission required ESAA operators to coordinate with the following operational RAS sites, as identified by the National Telecommunications and Information Administration (NTIA): Kitt Peak, Arizona; Owens Valley, California; Mauna Kea, Hawaii; North Liberty, Iowa; Stinchfield Woods, Michigan; Hancock, New Hampshire; Los Alamos, New Mexico; Pie Town, New Mexico;

the Very Large Array near Socorro, New Mexico; Rosman, North Carolina; Arecibo, Puerto Rico; Fort Davis, Texas; St. Croix, U.S. Virgin Islands; Brewster, Washington; and Green Bank, West Virginia.[3] CORF recommends that this be the current list of observatories to be protected in the context of AMS as well, with two exceptions: CORF has recently learned that one observatory designated as protected in the ESAA proceeding, the observatory at Stinchfield Woods, Michigan, is no longer operational, and it has been or will be repurposed. Similarly, CORF has recently learned that the observatory at Arecibo, Puerto Rico, no longer observes at frequencies as high as 14 GHz. Accordingly, CORF recommends that that these two locations need not be protected in rules proposed in this proceeding or those previously enacted for ESAA operations.

B. Breadth of Protection From Aeronautical Operations.

As the Commission has recognized in an analogous situation, International Telecommunications Union (ITU) Recommendation ITU-R M.1643 states that aircraft earth stations should cease transmission in the 14.47-14.5 GHz band and meet power flux density (PFD) limits in the 14.0-14.47 GHz band when within line of sight of radio astronomy facilities observing in the 14.47-14.5 GHz band.[4] This line-of-sight

[3] *In the Matter of Revisions to Parts 2 and 25 of the Commission's Rules to Govern the Use of Earth Stations Aboard Aircraft Communicating with Fixed-Satellite Service Geostationary-Orbit Space Stations Operating in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz and 14.0-14.5 GHz Frequency Bands,* Notice of Proposed Rulemaking and Report and Order, 27 FCC Rcd 16510 (2012), at page 16527.

[4] *See,* Order*, In the Matter of Panasonic Avionics Corporation; Application for Authority to Operate Up to 50 Technically Identical Aeronautical Mobile-Satellite Service Aircraft Earth Stations in the 14.0-14.4 GHz and 11.7-12.2 GHz Frequency Bands*, 26 FCC Rcd 12557, 12568 (Int'l. Bur. 2011), *citing* Rec. ITU-R M.1643, Annex 1, Part B [That Order's reference to Part B appears to be a typo, as the correct citation appears to be Part C].

requirement would be applicable in the case of AMS downlinks.[5] The limits agreed to in the 2011 coordination agreement between Panasonic and the National Science Foundation (NSF), which were included as a condition in the operator's Federal Communications Commission (FCC) authorization, require aggregate PFD to be limited to -221 dBW/m^2/Hz at the National Radio Astronomy Observatories and -189 dBW/m^2/Hz at other specified radio astronomy sites in the United States.[6] CORF believes that those levels of protection would be appropriate in this context as applied to single-dish spectral line observations and to observations with radio astronomy interferometers, respectively, but protection levels for single-dish continuum observations would have to be separately established, based on the parameters set forth in ITU-R RA.769. That level would be -233 dBW/m^2/Hz, according to CORF's calculations. [7]

CORF recognizes that due to large line-of-sight coverage areas, coordination of airborne transmissions could be particularly challenging for aircraft operators. CORF thus recommends that if a new bidirectional air-ground mobile broadband service is established in the 14.0-14.5 GHz band, the range 14.47-14.50 should be reserved for

[5] Paragraph 109 of the NPRM discusses the possibility of a 500 km exclusion zone around radio astronomy facilities when they are observing. That is a possible solution, but additional calculations would be appropriate, as part of the coordination process, to address the effects of reflection and diffraction of transmissions originated beyond the horizon of the RAS facility.

[6] *Id.*

[7] In addition, significant consideration must also be paid to out-of-band emission (OOBE) attenuation requirements from AMS operations. Because RAS equipment sensitivity is extremely high, only very low levels of spurious or OOBE from neighboring bands (e.g., 14.0-14.47 GHz) can be tolerated. Protection of the RAS from transmitters operating in adjacent bands is discussed in ITU-R Recommendation RA.517-4, which references detrimental interference levels listed in Annex 1 of ITU-R Recommendation RA.769-2. In order to be compatible with the OOBE attenuation specified in the NPRM of [43 + 10 log(P) dB], a line-of-sight separation distance of some 70 km or more from the radio telescope would be required. This argues strongly for keeping aircraft downlinks in the lower part of the band, farther from the RAS allocation.

only uplink transmissions. Coordination between RAS and fixed ground-based transmitters will be easier and more likely to succeed than coordination with moving, airplane-based transmitters.

C. Breadth of Protection From Terrestrial Base Stations.

The proposed modification of Footnote US 133 in the NPRM states that AMS "operations" are subject to coordination. CORF assumes that this coordination obligation would include uplinks from terrestrial base stations, in addition to downlinks. Such a requirement would be necessary, since ground-based transmissions that are in the line of sight of an RAS facility could easily cause significant interference to observations. Indeed, ESAA licensees are subject to just such a requirement for coordination of terrestrial base stations.[8] Accordingly, AMS uplinks in radio line of sight of protected RAS observatories should be subject to coordination.

D. Timing/Scheduling Elements of Coordination Procedure.

Paragraph 42 of the NPRM notes that "RAS observations do not occur continually and are usually scheduled in advance." The NPRM then proposes that coordination requirements be "based on the actual use of a RAS facility."

CORF supports the principle of shared use of spectrum where doing so is practical, and CORF understands the logic of commercial use of the spectrum when an RAS facility is not actually observing on a particular band.[9] Difficult practical issues

[8] *See,* Section 25.227(d)(1) of the Commission's rules.

[9] While it is generally accurate that radio observatories do not observe a particular frequency 24 hours per day, 7 days per week, there are exceptions. Two facilities at Owens Valley, California, currently observe in a range of frequencies that includes the 14 GHz band on a continual, 24-hour per day basis: the 40 meter Owens Valley Radio Observatory telescope, and the Owens Valley Solar Array. In these cases, coordination would have to be based on either total exclusion zones around the observatory or directional exclusion—the telescopes could be arranged to point away from the direction of sources, pursuant to prior coordination.

arise, however, due to the common use of dynamic scheduling by RAS observatories.

Dynamic scheduling refers to the practice of RAS observatories scheduling particular observations at particular frequencies on short notice, often only 24-48 hours in advance, depending on the needs of the specific observatory and operator. The principal goal of dynamic scheduling is maximizing the scientific productivity of the observatory. Atmospheric water vapor from rain and cloud cover causes absorption and emission that degrades the sensitivity of the RAS receiver. In addition, high wind conditions can disrupt observations due to the need to stow or protect certain antennas. Dynamic scheduling allows observers to optimally match their desired weather conditions to their observations, resulting in considerably increased observing efficiency.

Thus, if shared use of this band results in coordination between commercial operators and RAS observatories, that coordination should take into account the use of dynamic scheduling of observations at certain observatories, and allow such observatories to provide operators a schedule no more than 24-48 hours in advance.

III. Conclusion.

CORF recognizes the importance of sharing spectrum among different services where feasible, but notes that an AMS service transmitting in the 14.0-14.5 GHz band could cause significant interference problems for RAS facilities. CORF recommends that if a new bidirectional service is established in the 14.0-14.5 GHz band, that the

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But the significant possibility of receiving transmissions in telescope sidelobes, by reflection from aircraft, etc., suggests that directional exclusion may not be practical or possible.

14.47-14.50 GHz portion be limited to uplink transmission. In any case, careful consideration of and commitment to solutions, including addressing the above issues regarding coordination and emission levels, must be made should this new service be authorized.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

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