Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Amendment of Part 90 of the Commission's Rules	)	WP Docket No. 07-100
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	)	

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

The National Academy of Sciences, through its Committee on Radio Frequencies (hereinafter, CORF),[1] hereby submits its Comments in response to the Commission's Sixth Further Notice of Proposed Rulemaking (FCC 18-33) in the above-captioned docket (FNPRM). In these Comments, CORF discusses the proposed new rules for aeronautical mobile use of spectrum at 4940-4945 MHz. CORF acknowledges the Commission's recognition in the FNPRM of the need to limit potential interference impact on Radio Astronomy Service (RAS) observations in the 4.9 GHz band. CORF has long supported the thoughtful sharing of spectrum among services, when such sharing is practical. Regarding potential interference problems for RAS facilities, an aeronautical service transmitting down to Earth presents the worst-case scenario. While CORF remains concerned about potential interference from aeronautical transmissions in the 4.9 GHz band, it supports the protections for the RAS proposed in the FNPRM that are discussed below.

[1] See the Appendix for the membership of the Committee on Radio Frequencies.

I. Introduction: The Role of Radio Astronomy and the Unique Vulnerability of Passive Services to Interference.

CORF has a substantial interest in this proceeding because 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.[2]

As the Commission has also long recognized, radio astronomy is a vitally important tool used by scientists to study our universe. It was through the use of radio astronomy that scientists discovered the first planets outside the solar system, circling a distant pulsar. The Nobel Prize-winning discovery of pulsars by radio astronomers has led to the recognition of a widespread population in the Milky Way Galaxy of rapidly spinning neutron stars with gravitational fields at their surface up to 100 billion times stronger than on Earth's surface. Subsequent radio observations of pulsars have revolutionized the understanding of the physics of neutron stars and resulted in the first experimental evidence for gravitational radiation, which was recognized with the awarding of another Nobel Prize. A growing array of distant, rapidly spinning pulsars are now on the verge of detecting a completely new type of gravitational wave. Radio astronomy has also enabled the discovery of organic matter and prebiotic molecules outside our solar system, leading to new insights into the potential existence of life elsewhere in the Milky Way. Radio spectroscopy and broadband continuum observations have identified and characterized the birth sites of stars in the Milky Way, the processes by which stars slowly die, and the complex distribution and evolution of

[2] As noted in previous CORF comments in this proceeding, the 4.9 GHz band is also an important source for observations in the Earth Exploration Satellite Service (EESS). However, these comments will address the Commission's request for information on protecting RAS observations.

galaxies in the universe. Within our own solar system, radio astronomy observations of the Sun have been used for more than half a century to aid in the prediction of terrestrial high-frequency radio propagation. The enormous energies contained in the enigmatic quasars and radio galaxies discovered by radio astronomers have led to the recognition that most galaxies, including our own Milky Way, contain supermassive black holes at their centers, a phenomenon that appears to be crucial to the creation and evolution of galaxies. Synchronized observations using widely spaced radio telescopes around the world give extraordinarily high angular resolution, far superior to that which can be obtained using the largest optical telescopes on the ground or in space.

Radio astronomy measurements led to yet another Nobel Prize-winning discovery of the cosmic microwave background (CMB), the radiation left over from the original Big Bang, which has now cooled to only 2.7 K above absolute zero. Later observations revealed the weak temperature fluctuations in the CMB of only one-thousandth of a percent—signatures of tiny density fluctuations in the early universe that were the seeds of the stars and galaxies we know today. The CMB is a unique probe for the ongoing search for gravity waves in the inflationary period of growth after the Big Bang, a particularly active topic in modern astrophysics.

This critical science undertaken by RAS observers, however, cannot be performed without access to interference-free bands. Notably, the emissions that radio astronomers receive are extremely weak—a radio telescope receives less than 1 percent of one-billionth of one-billionth of a watt (10^{-20} W) from a typical cosmic object. Because radio astronomy receivers are designed to pick up such remarkably weak signals, radio observatories are particularly vulnerable to interference from in-band

emissions, spurious and out-of-band emissions from licensed and unlicensed users of neighboring bands, and emissions that produce harmonic signals in the RAS bands, even if those human-made emissions are weak and distant.

Of particular concern in this proceeding is protection of RAS observations in the 4.9 GHz band. As stated in footnote 57 of the FNPRM, radio astronomy observations in the 4.9 GHz band are extremely useful in studying the brightness distributions of objects such as ionized hydrogen clouds surrounding young stars; remnants of supernovae, which mark the cataclysmic end of stars; and ejecta traveling at nearly the speed of light—from black holes in the nuclei of galaxies. Such observations allow scientists to construct detailed maps of such phenomena, to understand their structures and dynamics, and to derive physical parameters from the sources, such as their total masses. Observations of radio emissions from neutron stars and black holes are particularly sensitive to interference due to their natural variability, and one cannot just re-observe such phenomena at a later time. The current benefits of this scientific research, obtained through years of work and substantial federal investment, as well as future benefits, must be protected.

In recognition of the importance of the radio astronomy research done in the 4.9 GHz band, Footnote US385 states that “[i]n the bands . . . 4950-4990 MHz, every practicable effort will be made to avoid the assignment of frequencies to stations in the fixed and mobile services that could interfere with radio astronomy observations” at certain RAS observatories listed therein and further states that “every practicable effort will be made to avoid assignment of frequencies in these bands to stations in the aeronautical mobile service that operate outside of those geographic areas, but which

may cause harmful interference to the listed observatories." Similarly, Footnote US342 states that "all practicable steps shall be taken to protect the radio astronomy service" at 4950-4990 MHz and also states that "[e]missions from spaceborne or airborne stations can be particularly serious sources of interference to the radio astronomy service . . . ." Footnote US342 does not limit that protection to only the RAS observatories listed in Footnote US385.

II. CORF Supports Proposed Protections for the RAS.

CORF has long supported spectrum efficiency and the thoughtful sharing of spectrum among services, when such sharing is practical. Nevertheless, protection of passive scientific use of the spectrum must be addressed.

The FNPRM clearly indicates that the Commission recognizes the significant risks of interference to RAS facilities from aeronautical transmissions at 4.9 GHz and proposes specific means of protecting RAS. While terrestrial services are quite capable of causing interference to sensitive RAS facilities, aeronautical uses are even more capable of such effects, due to the breadth of the geography "seen" by an airborne transmitter and the ease with which such transmissions can be made directly into the RAS receiver due to lack of intervening obstructions.[3] Thus, preventing line-of-sight transmission is critical to any practical sharing of the 4.9 GHz band between RAS and aeronautical mobile uses.

The line-of-sight issue is triggered when aircraft fly above the horizon of an RAS observatory. This is a function of flight altitude, but also of local geography and the presence or absence of terrain-shielding mountains. The FNPRM proposes (at para.

[3] See Footnote US342.

20) a maximum operational altitude of 1,500 feet above ground level. CORF supports that proposal as a simple method for minimizing line-of-sight transmissions into RAS facilities, provided that operation is prohibited within 80.5 km of an observatory listed in Footnotes US385 or US161,[4] as also proposed in para. 22 of the FNPRM.[5] A clear and unambiguous limit eliminates the proliferation of confusing, site specific altitudes close to RAS facilities that may be easily violated, even unintentionally. It also limits the risk associated with disagreements over the effectiveness of terrain-blocking features in a particular scenario.

The other core method for protecting RAS observations is sufficient frequency separation from the active transmissions. Accordingly, CORF supports the proposal in para. 15 of the FNPRM to limit aeronautical use of this band to Channels 1-5 (i.e., 4940-4945 MHz), thus creating a "guard band" of separation from the RAS allocation at 4950-4990 MHz. CORF commends the Commission for also being mindful of the issue of out-of-band emissions, by requiring a specific emission mask in proposed rule Section 90.1219(b).[6]

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[4] Procedures should also be defined for notification when additional RAS observatories commence observing at this frequency band.

[5] CORF suggests that the Commission revise the coordinates for the Allen Telescope Array, as set forth in proposed Section 90.1219(f) of the rules proposal, to use 40° 49' 03" North latitude, 121° 28' 24" West longitude. That proposed rule section also provides for waivers of the geographical restriction but requires any such waiver to be served on the affected observatory. For sake of ease, CORF recommends that such service be sent to the National Science Foundation Spectrum Management Unit (esm@nsf.gov). RAS representatives must have at least 30 days to respond to such waiver requests.

[6] CORF notes that out-of-band emission is always a concern when active uses are located adjacent to passive bands. In this context, the specified guard band and emission mask are important measures to reduce the possibility of interference from aeronautical use at 4940-4945 MHz. In the context of the full frequency range under discussion in this FNPRM (4940-4990 MHz), it is also important to note that ITU-R RA.769 specifies -241 dB(W/m^2/Hz) as the threshold level for interference in the adjacent band of 4990-5000 MHz.

CORF also supports other protections for RAS proposed in the FNPRM, such as the proposal in para. 19 to prohibit the use of the band by unmanned aerial systems. Such vehicles are more likely to be used by non-professionals and thus more likely to inadvertently or purposely violate other limitations such as distance and frequency separations.

While CORF acknowledges that robotic operations in the context of public safety are less likely to take place in the remote areas where RAS sites are typically located (para. 22), it does not follow that robotic operations should be unrestricted in these areas. Due to the limited number of exigent circumstances in which such robots are anticipated to be used for public safety purposes, as well as the remote location of radio astronomy observatories, CORF does not anticipate a significant likelihood of interference to RAS observations from public safety use of robots. This may not be the case, however, with private use of such robots. Accordingly, CORF recommends that robotic use be limited to public safety agencies.

CORF fully supports the requirement in proposed Section 90.1219(d) that applicants provide a description of their operations to demonstrate that such operations will protect radio astronomy (and other terrestrial uses) from interference. This requirement should help focus applicants on the requirements of Section 90.1219 and provide some basis for evaluating their compliance.[7] More broadly, though, CORF notes that the FNPRM proposes (at paras. 27-28) to require frequency coordination for

[7] This requirement would also provide a basis for the Commission to impose special conditions or restrictions on individual licensees, where necessary to reduce the risk of interference to RAS operations, as set forth in proposed Section 90.1219(g). The Commission should clarify that it may impose special conditions not just at the time of issuing an authorization, but subsequently as well, if interference to RAS results from the authorized aeronautical operations.

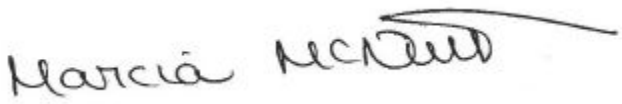
new operations in the 4.9 GHz band. CORF urges the Commission to include in that requirement, coordination with RAS, when the proposed facilities (including terrestrial facilities) would operate within 80.5 km (50 miles) of radio astronomy sites listed in § 2.106 US385 and/or US131.[8] Such coordination should be through the National Science Foundation Spectrum Management Unit (esm@nsf.gov).

III. Conclusion.

CORF is pleased that the Commission recognizes the need to protect RAS observations in the 4.9 GHz band and has proposed specific means of doing so. CORF has long-supported efficient use of the spectrum and the thoughtful sharing of spectrum among services, when such sharing is practical. While CORF remains concerned about the potential for interference from enhanced active use of the 4.9 GHz band, it supports the protections proposed in the FNPRM, as discussed above.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES



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[8] Of course, there may be emergency situations where such coordination is not possible. Radio astronomers are good citizens and would be unlikely to object to interference resulting from legitimate public safety aeronautical use during and immediately following a natural disaster or other critical emergency.

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