Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Allocation and Designation of Spectrum for	)	
Fixed-Satellite Services in the 37.5-38.5 GHz,	)	IB Docket No. 97-95
40.5-41.5 GHz, and 48.2-50.2 GHz Frequency	)	RM-8811
Bands; Allocation of Spectrum to Upgrade	)	
Fixed and Mobile Allocations	)	
in the 40.5-42.5 GHz Frequency Band;	)	
Allocation of Spectrum in the 46.9-47.0 GHz	)	
Frequency Band for Wireless Services; and	)	
Allocation of Spectrum in the 37.0-38.0 GHz	)	
and 40.0-40.5 GHz for Government Operations	)	

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 31, 2001, Notice of Proposed Rulemaking in the above-captioned docket (NPRM). In these Comments, CORF supports the proposal to delete the Broadcasting-Satellite Service (BSS) allocation from the 42.0-42.5 GHz band, supports and provides information regarding the proposed footnote protection of radio astronomy observations in the 42.5-43.5 GHz band, and expresses concern regarding the proposal to add non-government fixed and mobile allocations to the 42.5-43.5 GHz band.

[1] A roster of the committee membership is attached.

I. Introduction: The Importance of Radio Astronomy Observations in the 43 GHz Band and the Unique Vulnerability of Passive Services to Out-of-Band and Spurious Emissions.

CORF has a substantial interest in this proceeding because CORF represents the interests of the scientific users of the radio spectrum, including users of the Radio Astronomy Service (RAS) bands. RAS observers perform important yet vulnerable research.

As the Commission has long recognized, radio astronomy is a vitally important tool used by scientists to study our universe. Through the use of radio astronomy, scientists have in recent years made the first discovery of planets outside the solar system, circling a distant pulsar. Measurements of radio spectral-line emission have identified and characterized the birth sites of stars in our galaxy, and the complex distribution and evolution of galaxies in the universe. Radio astronomy measurements have discovered ripples in the cosmic microwave background, generated in the early universe, that later formed the stars and galaxies we know today. Observations of supernovae have witnessed the creation and distribution of heavy elements essential to the formation of planets like Earth and of life itself.

These current benefits of this scientific research, obtained through years of work and substantial federal investment, as well as future benefits, must be protected.

As passive users of the spectrum, radio astronomers have no control over the frequencies at which they must observe or over the character of the "transmitted" signal. These parameters are set by the laws of nature. Furthermore, the emissions that radio astronomers receive are extremely weak—a typical radio telescope receives only about one-trillionth of a watt from even the strongest cosmic source and routinely receives sources even one million times weaker than that. Because radio astronomy receivers are designed to pick up such remarkably weak signals, such facilities are therefore particularly vulnerable to interference from spurious and out-of-band emissions from licensed and unlicensed users of neighboring bands and those that produce harmonic emissions that fall into the RAS bands.

Of particular concern in this proceeding is protection of RAS observations in the 42.5-43.5 GHz band. The 42.5-43.5 GHz band is allocated on a primary basis to the Radio Astronomy Service. Use of this band provides a wide variety of astrophysical observations, ranging from measurements of the formation of solar systems in the Milky Way, to probing of some of the most violent environments in the distant universe. Indeed, the dynamics of the Milky Way itself, dominated by the massive black hole at its center, are currently being probed using millimeter observations at 43 GHz.

Both continuum and spectral line observations are made in the 42.5-43.5 GHz band. Recommendation ITU R.RA 314-8 specifically lists spectral line observations of silicon monoxide (SiO) at 42.82 GHz and 43.12 GHz as among the lines of greatest importance to radio astronomy.[2] SiO is a primary tracer of the atmospheres of stars at all stages of evolution: it is used to study stars as they are born, while they still possess the disks of material out of which orbiting planets will eventually form. Because these disks are thick, most other wavelengths are blocked from view, leaving millimeter emissions as one of the few clear probes. In more evolved stars, SiO masers, the astrophysical equivalent of lasers, allow astronomers to actually trace motions and chemical reactions in stellar atmospheres. Such chemistry is important to understanding the formation of pre-biotic molecules. Polarization observations are used to trace the magnetic field distribution around the stars. At the edges of the universe, emission in this band is used to probe the powerful quasars and their relativistic jets. The environments of quasars, even though they are extremely distant, can be probed in detail using the absorption of SiO due to surrounding material in gravitationally lensed systems.

The 42.5-43.5 GHz band is also used for sensitive continuum emission observations. This band is important to radio astronomy because, owing to its 1 GHz width and its location in the spectrum at approximately twice the frequency of the 23.6-24 GHz continuum band, it provides an effective point for the sampling of continuum emission at octave or better frequency intervals.

Because the sensitivity of continuum observations increases with the bandwidth of the continuum, and this band is the only RAS band below 75 GHz that is a full gigahertz wide, this particular band is quite valuable. Continuum observations in this band provide critical information on the physical state of the interstellar medium associated with star-forming regions. The 42.5-43.5 GHz band is also used for cosmic microwave background observations that reveal details of the early universe.

While important observations are made regularly in this band at the current time, the region of the spectrum in which this band occurs is likely to receive increased attention from new instruments now coming into use, such as the 100-meter Robert C. Byrd telescope at Green Bank, West Virginia, and the Very Large Array (VLA) and its updated version, the Extended Very Large Array (EVLA) in Socorro, New Mexico.

In sum, observations in the 42.5-43.5 GHz band at issue in this proceeding are important, yet like all passive scientific observations are uniquely vulnerable to interference from out-of-band and spurious emissions. Accordingly, protection from harmful interference to RAS facilities that observe in this band would serve the public interest.

II. CORF Supports the Proposed Footnote Protection and the Proposal to Delete the Broadcasting-Satellite Service (BSS) Allocation From the 42.0-42.5 GHz Band.

CORF is concerned that BSS operations in the 42.0-42.5 GHz band have a large potential for harmful interference with RAS observations at 42.5-43.5 GHz. In essence, CORF believes that it will be difficult for BSS operators at 42.0-42.5 GHz to meet the technical challenges to be overcome in filtering their emissions to the degree required to prevent harmful interference to RAS observations in the immediately neighboring band, especially at a cost that will be acceptable to commercial operators. It is also difficult and costly for the radio astronomy observatories to provide the necessary filtering to reduce the strong BSS signals, within the adjacent BSS band, to manageable levels. CORF's concern is increased in light of the potentially

[2] *See* ITU Handbook on Radio Astronomy (1995), at pages 12-13, Table 2.

large amount of traffic that can be expected from BSS operators, as the line between Fixed-Satellite Service (FSS) and BSS service blurs due to the increasing convergence of video entertainment and data services currently provided from the same facilities by some satellite operators. For that reason, CORF strongly supports the Commission's proposal to delete the BSS allocation from the 42.0-42.5 GHz band and opposes the allocation of the 42.0-42.5 GHz band to the FSS.

The NPRM proposes to enact a new domestic footnote modeled on S5.551G, which was enacted at 2000 World Radio Conference (WRC-2000). This footnote would provide a power flux-density limit of -167 dB (W/m^2) in any 1 MHz band at the site of an RAS observatory. CORF strongly supports the enactment of such a footnote. However, CORF notes that while such a limit may adequately protect radio astronomy observations in the 42.5-43.5 GHz band from unwanted emissions by non-geostationary orbit (NGSO) satellites, it may not adequately protect radio astronomy observations from emissions by geostationary orbit (GSO) satellites. The reason for this discrepancy is that GSO satellites generally reside in a broad band of the sky near the geostationary orbit, as opposed to NGSO satellites, which are typically at low elevations for a majority of their orbital periods. Accordingly, Annex 1 to Recommendation ITU-R RA.769 suggests that for geostationary orbits, the levels should be 15 dB lower than the power flux-density limit in the Commission's proposed footnote.[3] Thus, the Commission's proposed footnote should reflect this additional 15 dB suppression of unwanted emissions in the case of GSO satellites.[4]

[3] *See* Annex 1 at Table 1 and Section 2.1. This protection level is also described in the ITU Handbook on Radio Astronomy, at Table 4 and Section 4.6.3.

[4] CORF believes that the proposed footnote protection is warranted even if the BSS allocation at 42.0-42.5 GHz is deleted. The potentially very large bandwidth of FSS transmissions in the 41.5-42.0 GHz band will increase the likelihood of out-of-band emissions into the RAS band at 42.5-43.5 GHz, in spite of the 500 MHz separation between those bands.

III. CORF Is Concerned About the Allocation of Non-Government Fixed and Mobile Services to the 42.5-43.5 GHz Band.

CORF is also concerned about the potential impact on radio astronomy observations from the proposal (NPRM at para. 28) to add non-government fixed and mobile allocations to the 42.5-43.5 GHz band. Due to the sensitivity of radio astronomy facilities to interference and the propagation characteristics of transmissions in this band, the opportunities for harmful interference to radio astronomy observations are significant. This concern is enhanced by the fact that service rules regarding limits on transmitter power for such proposed fixed and mobile operations are not offered in the NPRM. Accordingly, CORF remains concerned about the Commission's proposal to add non-government fixed and mobile allocations to this band. CORF recognizes that there currently is an allocation for government fixed and mobile uses in the band, but CORF is not aware of any actual such fixed or mobile user at this time.

However, if the Commission believes that this band should be allocated to non-government users, then CORF recommends the following means of protecting radio astronomy observations in the band. First, aeronautical mobile uses typically create more potential interference problems than do fixed or other mobile uses, and, thus, if mobile services are allocated to this band, aeronautical mobile uses should be prohibited, just as they currently are in this allocation for government users. Second, following up on the suggestion in para. 28 of the NPRM, "geographic separation" between RAS observatories and fixed and mobile users should be enacted. CORF recommends that if the 42.5-43.5 GHz band is allocated to non-government mobile services, that the license areas for such services exclude certain protected zones around radio astronomy observatories. This is consistent with CORF Comments on proposed revisions to footnote U.S. 311 (in WT Docket No. 00-32, April 26 and December 18, 2000). In this case exclusion zones should be enacted as follows:

- for the following National Radio Astronomy Observatory (NRAO) sites:

  -Socorro, NM: rectangle between latitudes 32º 30′ N and 35º 30′ N and between longitudes 106º W and 109º W
  -Green Bank, WV: rectangle between latitudes 37º 30′ N and 39º 15′ N and between longitudes 78º 30′ W and 80º 30′ W

- within an 80-kilometer radius of the NRAO Very Long Baseline Array[5] sites centered on:

  -Pie Town, NM (34º 18′ N, 108º 07′ W)
  -Kitt Peak, AZ (31º 57′ N, 111º 37′ W)
  -Los Alamos, NM (35º 47′ N, 106º 15′ W)
  -Ft. Davis, TX (30º 38′ N, 103º 57′ W)
  -North Liberty, IA (41º 46′ N, 91º 34′ W)
  -Brewster, WA (48º 08′ N, 119º 41′ W)
  -Owens Valley, CA (37º 14′ N, 118º 17′ W)
  -St. Croix, VI (17º 45′ N, 64º 35′ W)
  -Hancock, NH (42º 56′ N, 71º 59′ W)
  -Mauna Kea, HI (19º 48′ N, 155º 27′ W)

- within a 32-kilometer radius of the Haystack Observatory

  -Westford, MA (42º 37′ N, 71º 29′ W)

Such zones should not be significantly burdensome to advanced mobile service licensees, since the protected areas are small and are distributed reasonably evenly around the United States.

In regard to allocation to new non-government fixed services, CORF recommends the use of mandatory coordination procedures similar to those already enacted in Sections 1.924(a) and 1.924(d) of the Rules. While such protection of the Robert C. Byrd Telescope at Green Bank could be accomplished by merely making fixed licensees in the 42.5-43.5 GHz band explicitly subject to Section 1.924(a), that Section does not apply to other observatories requiring protection. Accordingly, fixed licensees in the 42.5-43.5 GHz band should be made subject to the requirements of Section 1.924(a), and the Commission should enact a new rule Section (perhaps as part of Section 1.924) providing for coordination procedures for applications proposing fixed

[5] The thresholds for harmful interference for interferometry arrays are given in Annex 1 of ITU Recommendation 769 and are higher, i.e., less stringent, than those for single dishes.

uses in this band within 80 kilometers of the NRAO's Socorro, New Mexico, site listed above, as well as within 80 kilometers of the NRAO's VLBA sites listed above.

IV. Conclusion.

CORF supports the proposal to add a footnote to protect the RAS at 42.5-43.5 GHz, but suggests that it be modified to be consistent with ITU Recommendation 769. In addition, CORF supports the proposal to delete the BSS allocation in the 42.0-42.5 GHz band. CORF is also concerned about the proposal to add non-government fixed and mobile allocations to the 42.5-43.5 GHz band. However, if such fixed and mobile allocations are added, then aeronautical uses should be prohibited, and terrestrial mobile and fixed uses should be regulated as discussed above.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

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