Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Unlicensed Operation in the TV Broadcast Bands	)	ET Docket No. 04-186
	)	
Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band	)	ET Docket No. 02-380
	)	

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[1] (hereinafter, CORF), hereby submits its comments in response to the Commission's May 25, 2004, Notice of Proposed Rule Making in the above-captioned docket (NPRM). In these comments, CORF supports the Commission's proposal to prohibit transmissions by unlicensed devices on TV Channel 37 (608-614 MHz). The harm to radio astronomy observations by such transmissions would be significant, protection of radio astronomy sites would likely be difficult or impracticable, and there is no evidence that transmissions on Channel 37 are necessary to achieve the Commission's goal of promoting unlicensed services. CORF also suggests other means of preventing harmful out-of-band interference to radio astronomy observations, primarily the limiting of transmissions by unlicensed devices on TV Channels 36 and 38. To avoid interference from out-of-band emissions to the

[1]A roster of the committee is attached.

primary 1400-1427 MHz radio astronomy band, CORF supports the Commission's proposal in the NPRM to prohibit additional unlicensed transmissions on TV Channels 52-69. To avoid interference in the National Radio Quiet Zone, CORF suggests that the Commission prohibit additional unlicensed transmissions on TV Channels 14, 36, and 38, given the policy set forth in Section 1.924 of the Commission's rules.

I. Introduction: The Role of Radio Astronomy, the Unique Vulnerability of Passive Services to Interference, and the Importance of Observations in the 608-614 MHz Band.

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 Radio Astronomy Service (RAS) bands. RAS observers perform extremely important yet vulnerable research.

As the Commission has 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. Measurements of radio spectral line emission have identified and characterized the birth sites of stars in our own galaxy, and the complex distribution and evolution of galaxies in the universe. Radio astronomy measurements have discovered ripples in the cosmic microwave background that were imposed on the signals by acoustic vibrations of the early universe, which evolved into today’s stars and galaxies. Observations of supernovas have allowed us to witness the creation and distribution of heavy elements essential to the formation of planets like Earth, and of life itself.

The emissions that radio astronomers review are extremely weak--the signal received in a typical spectral observation of a strong source is less than a millionth of a trillionth of a watt (i.e., 10^{-18} watts).[2] Moreover, it is necessary to study sources that are even weaker than that as astronomers probe deeper into the distant, early universe. 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.

In addition to the gains in scientific knowledge that result from radio astronomy, CORF notes that such research spawns technological developments that are of direct and tangible benefit to the public. For example, radio astronomy techniques have contributed significantly to major advances in the following areas:

—*Computerized tomography* (CAT scans) as well as other technologies for studying and creating images of tissue inside the human body;

—Increasing abilities to *forecast earthquakes* by the use of very-long-baseline interferometry (VLBI) measurements of fault motions; and

—Use of VLBI techniques in the development of *wireless telephone geographic location technologies*, which can be used in connection with the Commission's E911 requirements.

[2]For example, if a typical garage door opener (assumed to radiate 1 mW) were operated on the Moon, it would be one of the strongest radio sources in the sky as seen from a terrestrial radio telescope.

Continued development of new critical technologies from passive scientific observation of the spectrum depends on scientists having ongoing access to interference-free spectrum. More directly, the underlying science undertaken by radio astronomy and earth remote sensing observers cannot be performed without access to interference-free spectrum. Loss of such access constitutes a loss for the scientific and cultural heritage of all people, as well as for the practical applications from the knowledge gained and the technologies developed.

Of particular concern in this proceeding is protection of RAS observations at 608-614 MHz (TV Channel 37). This band is one of the preferred RAS bands for continuum observations.[3] For continuum observations, the approximate spacing between bands throughout the spectrum should be no greater than a factor of two in frequency (see ITU-R Recommendation RA.314). The loss of Channel 37 for radio astronomy would result in an unacceptably wide gap.

In addition to continuum observations, this band is used for studying the interstellar medium, pulsars, and the Sun. In regard to the interstellar medium, the 608-614 MHz band has great importance for observations of thermal and non-thermal diffuse radiation in our own Milky Way Galaxy. Such observations give information on the high-energy cosmic-ray particles in our galaxy and their distribution, and also on the hot ionized plasma in the disk of our galaxy.

Observations in this band are also important for the study of pulsars, which are highly condensed neutron stars that rotate with a period as short as a millisecond.

[3] *See* ITU Handbook on Radio Astronomy (Geneva, 1995) at page 11, Table 1.

Pulsars are commonly the remains of supernova outbursts, and the discovery and study of such objects in the last two decades have opened up a major new chapter in the physics of highly condensed matter, and have contributed immensely to our understanding of black holes and the final state in stellar evolution. Observations of binary pulsars by radio astronomers have verified the existence of gravitational radiation at the level predicted by the theory of relativity.

Observations are made of the neutral hydrogen line (rest frequency of 1420 MHz) reduced in frequency by the Doppler effect (redshifted) into the 608-614 MHz band. Such observations are used to investigate interstellar matter and the rotation and evolution of galaxies.

Lastly, important observations in the 608-614 MHz band are made of radio frequency outbursts from our Sun. These bursts of high-energy particles interact with Earth's atmosphere and can cause severe interruptions in radio communications and power systems, and can also have dangerous effects on aircraft flights at altitudes above 15,000 meters. Study of these solar bursts aims to allow prediction of failures in radio communications. In addition, knowledge regarding high-energy solar bursts is essential for successful space exploration, both manned and unmanned.

II. The Commission's Current Limitations on Unlicensed Transmissions in the 608-614 MHz Band Should Be Retained.

The Commission has long recognized the importance of protecting RAS observations in the 608-614 MHz band. The *Report and Order* adopted by the Commission in 1963 reserved Channel 37 exclusively for the RAS for a period of 10

years.[4] This protection for the RAS was made permanent through a number of actions taken from 1975 to 1986.[5]

Similar protection has long been in place in Part 15 of the Commission's rules. Section 15.205(a) generally prohibits intentional transmissions of unlicensed devices in the 608-614 MHz band, and in combination with Section 15.209, limits spurious emissions into the band to a field strength of 200 microvolts per meter at 3 meters.[6]

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[4] *Report and Order*, Docket No. 15022, 39 FCC 884 (1963).

[5] *Order*, 53 FCC 2d 627 (1975); *Second Report and Order*, Gen. Docket No. 80-739, 49 Fed Reg. 2357 (January 19, 1984) (amending Footnote US 246 to U.S. Table of Allotments to reflect allocation to the RAS); *Order*, Mimeo 4385 (released May 12, 1986) (amending Section 73.606 (c) to reflect the allocation).

[6] Although CORF recognizes that biomedical telemetry devices may currently transmit in the 608-614 MHz band, it notes that important distinctions between those authorized operations and the operations proposed in other bands in the *NPRM* reduce the harmful impact of biomedical telemetry devices on radio astronomy observations. First, these devices operate at significantly less e.i.r.p. than the 4 watt or 400 mW (power levels of 1 watt or 100 mW with antenna gain of 6 dB) proposed in the *NPRM*. CORF has calculated that in order to comply with the maximum field strength limit of 200 mV/m at 3 meters given in Section 15.242(c), medical telemetry devices can operate with no more than 12 mW of e.i.r.p. Furthermore, even with that significantly lower power output, users of medical telemetry devices must coordinate and obtain concurrence for any operations within 32 km of any VLBA observatory, and within 80 km of other major observatories. Thus, the protections proposed in the *NPRM* would be much weaker than the protection the RAS currently receives from existing rules governing the use of medical

Removing this long-standing protection would create a high likelihood of significant interference to RAS observations. Furthermore, although use of Global Positioning System transmitters might keep such use outside a geographic protection zone, it is far from clear that manufacturers will agree to inclusion of GPS receivers, and the risk of failure or improper manipulation of such receivers is significant. However, there is no need to take that risk, given the numerous other bands proposed for use in this proceeding.

Accordingly, CORF appreciates and fully supports the Commission's proposal in paragraph 34 of the NPRM to prohibit transmissions on TV Channel 37 by new unlicensed devices. CORF urges the Commission to adopt that proposal.

III. Additional Protections from Out-of-Band Emissions, Primarily By Devices Transmitting on TV Channels 36 and 38, Are Required; CORF Also Supports Protections from Devices Transmitting on TV Channels 52-59 and 14.

While the Commission's proposed prohibition of transmissions by new unlicensed devices on TV Channel 37 provides important protection to radio astronomy observations, CORF remains concerned about harmful interference from out-of-band emissions into Channel 37 from devices transmitting on TV Channels 36 and 38, and other channels.

The Commission has previously recognized the need to limit transmissions on TV Channels 36 and 38 in order to protect radio astronomy observations. For example, in allocating channels for digital TV, the Commission removed an allocation for Channel

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telemetry devices.

38 in Fajardo, Puerto Rico, in order to protect the radio astronomy observatory in Arecibo, Puerto Rico.[7]

The levels of effective isotropically radiated power (e.i.r.p.) for transmissions by for unlicensed devices considered in the NPRM are 0.4 watts e.i.r.p. for portable devices (para. 22) and 4 watts e.i.r.p. for fixed access devices (para. 25). The proposed limits on out-of-band emissions are 20 dB in any 100 kHz band relative to the power of the in-band 100 kHz that contains the highest emission levels (para. 39).[8] As an example, consider the case in which the transmitted signal is spread uniformly over a

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[7] *See* Advanced Television Systems, Memorandum Opinion and Order, 13 FCC Rcd 7418 (1998) at paras. 213-215.

[8] CORF agrees with what it believes to be the core intent of paragraph 39 of the *NPRM*, namely, that emissions outside the TV channel being used, and outside bands allocated to these devices in general, must comply with the general limits of Section 15.209(a). However, CORF finds the wording of Section 15.244(d) unclear and potentially ambiguous. Specifically, the language of proposed Section 15.244(d) appears to contradict itself because the phrase "TV broadcast channel(s)" is not very well defined and could be interpreted to include Channel 37 (608-614 MHz), which is allocated to the Radio Astronomy Service and is outside the bands allocated to the devices covered by this *NPRM*. Accordingly, CORF suggests the following change, which it believes is consistent with the Commission's intent as expressed in paragraph 39: the last two sentences of Section 15.244(d) should be deleted and replaced with the following text: "Radiated emissions that fall outside the bands allocated to these devices must comply with the radiated emission limits specified in §15.209(a). Within the bands allocated to these devices, attenuation below the general limits specified in §15.209(a) is not required."

bandwidth of 1 MHz. So that the power of a spurious emission 20 dB below the intended emission will not exceed the detrimental threshold for radio astronomy in the 608-614 MHz band -253 $dBWm^{-2}Hz^{-1}$, (as given in ITU-R Recommendation RA.769), the distance of the transmitter from the radio astronomy antenna should be no less than 50 km for a portable device or 75 km for a fixed one. These distances are based on the propagation model described by Equation (1) of ITU-R Recommendation P.529-3, and they can also be derived approximately from Figures 4 and 5 of the same recommendation. Assumed in this calculation are heights for the transmitting antenna and radio astronomy antenna of 1.5 and 30 m, respectively, and a gain of 0 dBi for the sidelobe of the radio astronomy antenna through which the signal is received. For very-long baseline interferometry the detrimental thresholds are higher than for radio astronomy in general, and for the 608-614 MHz band the threshold is -211 $dBWm^{-2}Hz^{-1}$. The required distances for VLBI are thus become 4 and 8 km for portable and stationary devices, respectively, figures that would apply to the 10 Very Long Baseline Array (VLBA) stations listed in footnote US311 of Section 2.106 of the Commission's rules. These figures for required distances confirm that interference to radio astronomy stations is to be expected from out-of-band emissions from unlicensed devices operating according to the proposed standards for TV Channels 36 and 38 in the vicinity of radio astronomy antennas.

Emission limits outside the intended band are based on Section 15.247(c) of the Commission's rules, which applies to limits in *any* 100 kHz band outside the band in which the intentional radiator is operating. CORF therefore assumes that the limits for

out-of-band emissions apply also to spurious emissions such as harmonics. Radio astronomers are particularly concerned about interference to observations in the 1400-1427 MHz primary radio astronomy band from the harmonics of unlicensed devices — principally the second harmonic of devices in TV Channels 52, 53, and 54 and the third harmonic of devices in TV Channel 14. Given the assumptions used above, the distances required for avoidance of harmonic interference are 46 and 65 km for portable and fixed devices, respectively. For the VLBA antennas the corresponding distances are 4 and 7 km, respectively. For these reasons, CORF supports the proposal in the NPRM to prohibit additional unlicensed transmissions on TV Channels 52-69.

Thus, in addition to supporting the Commission's proposal to prohibit additional unlicensed operations on TV Channels 37 and 52-69, based on the distance calculations given above CORF requests that the Commission prohibit new unlicensed transmissions on TV Channels 14, 36, and 38 within 75 km of the radio astronomy observatories listed in Footnote US 311, or within 8 km of the VLBA stations named in that footnote. Also, given the policy set forth in Section 1.924 of the Commission's rules regarding minimizing radio transmissions within the National Radio Quiet Zone, CORF suggests that the Commission prohibit additional unlicensed transmissions on TV Channels 14, 36, and 38 in that Quiet Zone.[9]

[9]If the Commission does not adopt its proposal to prohibit all additional unlicensed transmissions in TV Channels 52-69, then it should subject such transmissions on TV Channels 52-54 to the distance limitations and to the prohibition within the Quiet Zone discussed above.

IV. Conclusion.

CORF appreciates and strongly supports the Commission's proposal not to authorize new transmissions by unlicensed devices on TV Channel 37. CORF also suggests additional protections for radio astronomy observations at 608-614 MHz, as described in Section III above. To avoid interference from out-of-band emissions to the primary 1400-1427 MHz radio astronomy band, CORF supports the Commission's proposal in the NPRM to prohibit additional unlicensed transmissions on TV Channels 52-69. To avoid interference in the National Radio Quiet Zone, CORF suggests that the Commission prohibit additional unlicensed transmissions on TV Channels 14, 36, and 38, given the policy set forth in Section 1.924 of the Commission's rules.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

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Attachment

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