Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
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 December 20, 2002, Notice of Inquiry in the above-captioned docket (NOI). In these Comments, CORF urges the Commission not to authorize new 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.

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

[1] A roster of the committee is attached.

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 and that evolved to today's stars and galaxies. Observations of supernovae 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--a typical radio telescope receives only about one-trillionth of a watt from even the strongest cosmic source. 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 very-long-baseline interferometric (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.

Continued development of new critical technologies from passive scientific observation of the spectrum depends on scientists having continued access to interference-free spectrum. More directly, the underlying science undertaken by the 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 information learned and the technologies developed.

Of particular concern in this proceeding is protection of RAS observations at 608-614 MHz (Channel 37). This band is one of the preferred RAS bands for continuum observations.[2] Observations in this band are important for studying the interstellar medium, pulsars, and the Sun. In regard to the interstellar medium, the 608-614 MHz band has great importance in 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

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

plasma and magnetic fields 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. Pulsars are 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 general theory of relativity.

Important observations are made in this band by astronomers searching for neutral hydrogen line emission (rest frequency of 1420 MHz) that has been redshifted there by the Doppler effect. Such observations are used to investigate galaxy dynamics and evolution.

In addition, important observations in this 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, as well as having 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.

Lastly, it has long been recognized that the frequency spacing in radio astronomy should not be more than about one octave in order to enable spectra of continuum

sources to be determined. The nearest RAS bands below and above 608-614 MHz are 406.1-410 MHz and 1400-1427 MHz, respectively, so loss of the 608-614 MHz band would leave a gap of almost 1.8 octaves.

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. In 1963, the Commission adopted a Report and Order, which reserved Channel 37 exclusively for the RAS for a period of 10 years.[3] This protection in the broadcast service was made permanent through a number of actions taken from 1975 to 1986.[4]

Similar protection has been in place for a long time in Part 15 of the Commission's rules. Section 15.205(a) prohibits intentional transmissions of unlicensed devices at 608-614 MHz, 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. In addition, radio astronomers throughout the world use the 608-614 MHz band, and this frequency band is needed to compare observations made in other countries in order to strengthen our knowledge of the behavior and variability of sources as observed by other facilities throughout the world. Removing this long-standing protection would

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

[4] *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 RAS); *Order,* Mimeo 4385 (released May 12, 1986) (amending Section 73.606 (c) to reflect the allocation).

create a high likelihood of significant interference to RAS observations.

Operation at 1 watt (as discussed in the NOI) would have a significant impact on RAS observations unless the wireless operations were at a great distance from the observatory. CORF has made an estimate of the radius of the required protection zone, based on Recommendation ITU-R P.1546, "Method for Point to Area Predictions for Terrestrial Services in the Frequency Range 30 MHz to 3000 MHz." Figures 10 and 11 of this Recommendation contain curves of field strength, for 1 kW e.r.p. at 600 MHz, not to be exceeded for 10 percent and 1 percent of the time, respectively. For 1 watt, and interpolating for values not exceeded for more than 2 percent of the time (as required by Recommendation ITU-R RA.1513), distances of 375 km are required for complying with the 608-614 MHz threshold (-185 dBW/m^2) for non-VLBI sites.[5] Wireless operations at greater than 1 watt of power (see NOI at para. 15) would require even greater distance protection.

Thus, the minimum radius of protection for wireless operations at 608-614 MHz would be 375 kilometers for the National Astronomy and Ionosphere Center at Arecibo, Puerto Rico, and for the National Radio Astronomy Observatories at Socorro, New Mexico and Green Bank, West Virginia; and 48 kilometers for each of the 10 sites of the Very Long Baseline Array. However, CORF is concerned that allowing such unlicensed operations subject to exclusion zones is an unwise approach. First, if elimination of uses inside the exclusion zones is to be based on voluntary compliance by users, this

[5] For Very Long Baseline Array sites, the threshold would be -211 dBW/m^2/Hz over 6 MHz bandwidth, equaling -143dBw/m^2. This produces a minimum distance of 48 kilometers. These calculations are based on a transmitting height of between 1.5 and 29 meters.

approach is risky since even users who want to comply will not usually know their precise distance from 13 RAS sites. Furthermore, other proposals in the NOI for protecting active incumbent services would not be effective in protecting a passive service such as the RAS: e.g., the wireless devices could not "monitor" whether RAS observations were being made prior to transmitting. See NOI at para. 13. As a result, passive users of this band can only be assured of protection in two ways: by a complete prohibition on unlicensed operation in the 608-614 MHz band, or by incorporation of Global Positioning System units into the wireless devices, so as not to allow operation of the devices in the protection zones described above. Nevertheless, CORF remains concerned about the possibility of malfunction of the built-in GPS units, which could result in unlicensed operation in the protection zones. Furthermore, CORF does not know whether the manufacturers of the wireless devices would find inclusion of a GPS receiver to be technically and/or economically practicable.

While CORF recognizes that biomedical telemetry devices may currently transmit in the 608-614 MHz band, there are important distinctions between those authorized operations and the operations proposed in the NOI that reduce the harmful impact of the biomedical telemetry devices on radio astronomy observations. First, unlike those proposed in the NOI, these devices operate at significantly less power than 1 watt. CORF has calculated that in order to comply with the maximum field strength limit of 200 mV/m at 3 meters imposed in Section 15.242(c), such devices can operate with no more than 12 mW e.i.r.p. of power.[6] Furthermore, even with that significantly lower

[6]The magnitude of Poynting's vector, S, which measures the power flow across one square

power output, the users of medical telemetry devices must coordinate and obtain concurrence for any operations within 32 kilometers of any VLBA observatory, and within 80 kilometers of other major observatories. The reduced level of protection afforded to RAS facilities under the proposals in this NOI would result in a far higher level of interference to the RAS.

Accordingly, CORF asserts that the best policy would be to continue the current limitations on unlicensed transmissions at 608-614 MHz, and to reject the proposal in the NOI to use TV Channel 37. While use of GPS 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 of such receivers still exists. There is no need to take that risk, in light of the numerous other bands proposed for use in this proceeding. CORF does not anticipate a record demonstrating that Channel 37 is the only otherwise feasible channel for such uses.

III. Conclusion.

CORF urges the Commission to not authorize new transmissions by unlicensed devices in the 608-614 MHz band. As shown above, the likelihood of damaging interference by such transmissions to radio astronomy observations is significant, and protection of radio astronomy sites would likely be difficult or impracticable.

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meter, can be calculated from $S = E^2/Z_0$, with E the electric field and Z_0 the impedance of free space, which to a good approximation is 120π ohms. All units are MKS (volts/meter, watts/square meter, ohms, etc.). The total energy radiated is then the Poynting's vector flux, times the surface area of the sphere at this radius R, which is $4\pi R^2$ square meters. Thus, the total power is $(E^2/(120\pi)) \bullet 4\pi R^2$, or with E = 0.2, R = 3, this gives the result of 0.012 W.

Furthermore, there is no evidence that transmissions on Channel 37 are necessary to achieve the Commission's goal of promoting unlicensed services, and, accordingly, the risk of harm created by such transmissions far outweighs the potential benefits.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
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