Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Amendment of Sections 15.35 and 15.253 of the Commission's Rules Regarding Operation of Radar Systems in the 76-77 GHz Band.	)	ET Docket No. 11-90
	)	
Amendment of Section 15.253 of the Commission's Rules to Permit Fixed Use of Radar in the 76-77 GHz Band.	)	ET Docket No. 10-28

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, 2011, Notice of Proposed Rulemaking (NPRM), in the above-captioned docket.[2] In these comments, CORF discusses the importance to the Radio Astronomy Service (RAS) of observations at 76-77 GHz and notes that it does not oppose sharing of spectrum in this band to permit fixed radars at airports for monitoring the movement of terrestrial vehicles, as set forth in the NPRM. However, in light of the primary allocation of this band to the RAS, CORF believes that rules increasing the average power density limit for automotive vehicular radars operating in

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1 A committee roster is given in Appendix A.

2 CORF hereby seeks leave to file these comments after the stated deadline. This was necessitated by the press of business on CORF. No significant harm will be imposed on other parties, because these comments are being filed prior to the deadline for reply comments, and thus other parties will still have an opportunity to address the showing made herein.

this band should not be considered unless radar manufacturers are required to work with representatives of the RAS community to minimize interference with RAS observations.[3]

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.

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. It 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 our galaxy. Measurements of radio spectral line emission have identified and characterized the birth sites of stars in our own galaxy, the processes by which stars slowly die, and the complex distribution and evolution of galaxies in the universe. Radio astronomy measurements have discovered fluctuations in the cosmic microwave background, generated in the early universe, which later formed the stars and galaxies we know today. Radio astronomy has established the existence of a black hole in our galactic center, a phenomenon that may be crucial to galaxy formation. Observations of supernovas have allowed us to witness the creation and distribution of heavy elements

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[3] Work between manufacturers and the RAS community could be facilitated by the National Science Foundation.

essential to the formation of planets like Earth, and of life itself.

However, the critical science undertaken by RAS observers cannot be performed without access to interference-free spectrum. Notably, the emissions that radio astronomers receive are extremely weak—a radio telescope receives only about one-billionth of one-billionth of a watt (10^{-18} 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 weak, distant in-band man-made emissions can preclude RAS use.

In sum, the important science performed by radio astronomers 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 a loss of practical applications from the information learned and the technologies developed.

It should be noted that the RAS has a primary allocation at 76.0-77.5 GHz. More than 900 spectral lines are cataloged within this frequency range. Of particular importance in this proceeding are observations of deuterated molecules, long-chain molecules, and sulfur dioxide. This band is also important for sensitive characterization of continuum phenomena from various physical mechanisms.

II. CORF's Concerns Regarding Use of the 76-77 GHz Band for Mobile Radars.

The NPRM seeks comments on rules that would expand the use of the 76-77 GHz band to include fixed airport radars, and would also increase the average power density limit for automotive vehicular radars. CORF recognizes the importance of maximizing spectrum efficiency through thoughtful sharing of spectrum bands, and accordingly, it does not oppose the use of the 76-77 GHz band for fixed airport radars, subject to the limits proposed in the NPRM. CORF believes that such use is unlikely to cause interference to RAS observations, and any interference should be reasonably easily identified and remedied, owing to the fixed nature of the proposed use.

CORF is concerned, however, about the potential for interference from more powerful mobile automotive radars. These concerns were raised in comments filed previously in this proceeding by the National Radio Astronomy Observatory. CORF believes that the NPRM and the proponents of new rules for automotive radars have not adequately addressed some of these concerns.

For example, the NPRM notes at para. 11 the skepticism of automotive radar proponents that automotive radar beams parallel to the horizon could cause interference to radio astronomy dishes that are pointed upward. But this assertion ignores the significant interference that can be caused by transmissions received through a radio astronomy facility's sidelobes. Such interference can saturate a receiver and drive it non-linear, with the result that spectral line and total power measurements are compromised because the measured power is not exactly related to the power being emitted by radio sources.

Compounding the potential for significant interference received into the sidelobes is the difficulty of finding a remedy for such interference at the site of the RAS observatory. The NPRM suggests (at para. 10), without any stated support, that "interference mitigation can be accomplished through erection of fences and other local shielding." Such an approach, however, does not appear to be a realistic, practical solution. Calculations show that, taking into account the effects of knife-edge diffraction, to achieve the minimum requirement of 40-dB attenuation while allowing unblocked telescope access at an elevation limit of 12 degrees would require a solid metal fence with a height of 25 meters (plus terrain drop-off) at a distance of 100 meters (minimum) from a 12-meter-diameter radio astronomy dish, such as the Kitt Peak radio telescope.[4] The requirements for the 100-meter-diameter Green Bank telescope would be greater by a correspondingly large factor. Furthermore, at these frequencies any gaps or perforations in a fence render it useless, and so the needed barrier would have to be a continuous metal wall, making even a compromised fencing structure impractical. In sum, even if such shielding were shown to be effective, the cost would likely be very substantial.[5] Further, even if the cost were covered by the automobile manufacturers, it seems unlikely that shielding of this size and required material would be approved by local zoning boards.

Thus, in light of the primary allocation of this band to the RAS, and the distinct possibilities for increased interference from increased average power density limits for automotive vehicular radars operating in this band, such increases should not be authorized unless radar manufacturers are required to work with representatives of the

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4 See Appendix B for an explanatory note for these calculations.

5 Although the NPRM appears to suggest that the cost of mitigating interference should be imposed on the RAS facilities, logic and good spectrum management policy suggest otherwise. That is, if the Commission enacts the proposed rules, such costs should be imposed on the auto manufacturers as the new user of the spectrum, especially since the incumbent service has a primary allocation, and the new user would be unlicensed. Consistent with those principles, a more appropriate interference protection/cost allocation would involve small protection zones around RAS facilities capable of observing in this band, with manufacturers covering the limited cost of connecting the operation of the radars with automotive GPS units, which could turn off the radars when the autos are in close proximity to RAS facilities.

RAS community to find solutions to minimize resulting interference with RAS observations.

Last, even if the Commission chooses to enact the stated average power density limits for 76 GHz automotive radars, principles of efficient spectrum management suggest that there is no reason to authorize full-power radar transmissions from a vehicle when that vehicle is not in motion (NPRM at para. 12). The mere fact that the Commission has concluded that doing so would not expose humans to excessive radio-frequency radiation (NPRM at para. 13) does not address the spectrum management concern of unnecessarily increasing the power of potentially interfering transmissions when the radar is not in use for vehicle protection. This action would be directly inconsistent with a thoughtful approach to sharing spectrum bands.[6]

III. Conclusion.

CORF does not oppose sharing of spectrum in the 76-77 GHz band to permit fixed radars at airports for monitoring the movement of terrestrial vehicles, as set forth in the NPRM. However, in light of the primary allocation of this band to the RAS, CORF believes that rules increasing the average power density limits for automotive vehicular radars operating in this band should not be enacted unless radar manufacturers are required to work with representatives of the RAS community to find solutions that will minimize resulting interference with RAS observations. This work could be facilitated by the National Science Foundation. If the Commission authorizes increased average power density limits for automotive radars operating in this band, it should not authorize

[6] For similar reasons, the Commission should consider requiring the presence of on/off switches for automotive radar. At the very least, such radars should have the capability of being turned off when vehicles enter the grounds of a radio astronomy observatory or are being serviced.

full-power radar transmissions from a vehicle when that vehicle is not in motion.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

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Appendix A

Committee on Radio Frequencies

Members

David DeBoer, University of California at Berkeley, *Chair*
Sandra L. Cruz-Pol, University of Puerto Rico - Mayaguez
Todd C. Gaier, NASA Jet Propulsion Laboratory
Jasmeet Judge, University of Florida at Gainesville
Kenneth Kellermann, National Radio Astronomy Observatory
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Loris Magnani, University of Georgia
Darren McKague, University of Michigan
Timothy Pearson, Caltech
Steven C. Reising, Colorado State University
Alan E.E. Rogers, Massachusetts Institute of Technology/Haystack Observatory
Gregory Taylor, University of New Mexico
Liese van Zee, Indiana University

Consultants

Paul Feldman, Esq., Fletcher, Heald and Hildreth
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Appendix B

Calculation of the Minimum Fence Height Given in CORF's Comments

As an example of a possible situation causing interference to radio astronomy observations CORF considered the case of 50 automobile radars operating at a distance of 10 km from a radio telescope.[1] With a single radar operating at a distance of 10 km and radiating power at -3 dBm/MHz (a power figure taken from ECC Report 56[2]), radiation in the direction of the telescope is emitted through 0 dBi sidelobes of the radar, and at the telescope the spectral power flux density (spfd) is 4.0×10^{-19} W m^{-2} Hz^{-1} for free-space transmission. CORF used this value as the average level of interference contributed by each of 50 cars, and the combined effect at the telescope was 2.0×10^{-17} W m^{-2} Hz^{-1}, or, in decibel units, -167 dBW m^{-2} Hz^{-1}. Allowing 0.135 dB/km for atmospheric attenuation, the spfd at the telescope becomes -168 dBW m^{-2} Hz^{-1}.[3] The interference threshold for the nearest radio astronomy band listed in Recommendation ITU-R RA 769-2[4] is -208 dBW m^{-2} Hz^{-1} for spectral line observations at 1-MHz resolution. This figure is 40 dB lower than the estimated spfd from the 50 radars.

The height of a fence to provide the necessary 40-dB attenuation is calculated by

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1 CORF believes that it is most important to consider a fairly large number of cars on a road at some distance from an observatory because this scenario is likely to be a serious and constant source of interference in the 76-77 GHz band. Thus, CORF chose to use a distance of 10 km and 50 cars in its calculations.

2 Electronic Communications Committee (ECC), within the European Conference of Postal and Telecommunications Administrations (CEPT), ECC REPORT 56, "Compatibility of Automotive Collision Warning Short Range Radar Operating at 79 GHz with Radiocommunication Services," Stockholm, Sweden, October 2004.

3 This figure for atmospheric attenuation is appropriate for a dry climate, the kind of climate typical of sites for millimeter-wavelength telescopes.

4 ITU-R RA 769-2 provides "protection criteria used for radioastronomical measurements." The text of ITU-R RA 769-2 can be found in International Telecommunications Union, Radiocommunication Sector

use of the method described in ITU-R Recommendation ITU-R P.526-11 for knife-edge diffraction. There is a second requirement, which is that the fence should not block any part of the aperture of a 12-meter diameter radio telescope pointed at an elevation angle of 12 degrees above the horizon. Determination of the minimum fence height given in the comments and of the corresponding distance from the telescope to provide the necessary protection required some iterative adjustments in the calculations.

(ITU-R), *ITU Recommendations*, Geneva, Switzerland, approved May 2003, available at URL http://www.itu.int/pub/R-REC, last accessed July 14, 2011.