Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Amendment of Parts 2 and 25 of the	)	
Commission's Rules to Allocate Spectrum and	)	
Adopt Service Rules and Procedures to Govern	)	IB Docket No. 07-101
the Use of Vehicle-Mounted Earth Stations in	)	
Certain Frequency Bands Allocated to the	)	
Fixed Satellite Service	)	

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 (CORF),[1] hereby submits its comments in response to the Commission's May 15, 2007, Notice of Proposed Rulemaking in the above-captioned docket (NPRM). In these comments, CORF discusses the importance to the Radio Astronomy Service (RAS) of observations at 14.47-14.50 GHz and supports portions of the Commission's proposal, as modified below, to protect RAS observations in this band with coordination requirements.

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

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 RAS bands.

[1] A list of CORF members is given in the attachment.

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, generated in the early universe, which later formed the stars and galaxies we know today. 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.

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. The emissions that radio astronomers review are extremely weak--a typical radio telescope receives less than one-trillionth of a watt from even the strongest cosmic source, and as many as 10 orders of magnitude less (one tenth of one billionth of one billionth of a watt) from the weakest. Because radio astronomy receivers are designed to pick up such remarkably weak signals, such facilities are therefore particularly vulnerable to interference from in-band emissions, 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 to 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 *understand 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 importance in this proceeding are observations at 14.47-14.50 GHz. Radio astronomers make critical spectral line observations of formaldehyde in this band. The formaldehyde line with a rest frequency of 14.488 GHz is included in Table 1 of Recommendation ITU-R RA. 314, which lists the radio frequency lines of greatest importance to radio astronomy. It is also included in U.S. Footnote 203, which provides radio astronomy observations of this formaldehyde line with protection from interference

at 14.47-14.50 GHz.[2]

Formaldehyde is one of the primary molecules used in radio astronomy to study comets, star formation in and structure of our galaxy, the early stages of planet formation in disks around nearby stars, and the inner regions of distant galaxies where disks of molecular material form and serve as fuel for quasars and related activity. The relative populations of the *ortho*- and *para*-forms of this molecule provide important evidence of the astrochemical processes at work in the interstellar regions where the molecule is observed. Observations of formaldehyde in this frequency band are particularly useful for determining the density of interstellar molecular clouds. The formaldehyde molecule is also on the path to prebiotic molecules of intense interest to those scientists attempting to understand the origin of living organisms.[3]

II. CORF Supports Certain Protections for RAS Observations.

In proposing rules for the operation of satellite vehicle-mounted earth stations (VMES) uplinking at 14.0-14.50 GHz, paragraph 35 of the NPRM notes the use of the 14.47-14.50 GHz band by the Radio Astronomy Service and seeks comments on the feasibility of coordination between VMES and RAS operations to preclude harmful interference to RAS observations. CORF appreciates the Commission's recognition of the importance of protecting observations in this band. The Commission specifically proposes that VMES operators "planning to travel in the vicinity of the radio observatories listed in US203 and of Arecibo, Puerto Rico, Mauna Kea, Hawaii, and St.

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[2] See 47 C.F.R. § 2.106.

[3] See also National Research Council, *Handbook of Frequency Allocations and Spectrum Protection for Scientific Uses*, Washington, D.C.: National Academies Press (2007), pp.52, 55.

Croix, Virgin Islands" coordinate with RAS, and that such coordination would be a post-licensing condition, rather than a prerequisite to licensing. In paragraph 36, the Commission seeks comment on whether such coordination should be through the National Science Foundation or the Commission's International Bureau. Furthermore, in paragraph 73, the Commission seeks comments as to whether use of VMES should be limited to government agencies. CORF's responses are as follows.

A. The Commission Should Prohibit VMES Transmissions at 14.47-14.50 GHz.

The proponents of the VMES proposal appear to envision thousands, or tens of thousands, of VMES operating throughout the United States. CORF believes that given the proposal that operators of VMES will receive blanket licenses for these thousands of mobile terminals whose location will not be under the direct control of the operator, it will be very difficult for the operator to ensure that such terminals do not end up in locations that could cause harmful interference to RAS operations, especially given that every major RAS observatory has public roads nearby, and even if that were not the case, VMES appear to be intended even for off-road use. It should be noted that Footnote US203 states that "[r]adio astronomy observations of the formaldehyde line frequencies . . . 14.470-14.500 GHz may be made at certain radio astronomy observatories . . . " and that "[e]very practicable effort will be made to avoid the assignment of frequencies to stations in the fixed or mobile services in these bands. Should such assignments result in harmful interference to these observations, the

situation will be remedied to the extent practicable."[4] The NPRM appears to recognize this issue in paragraph 36 by seeking comments on what technical measures should be incorporated into terminals to assist VMES operators in ensuring that the results of coordination can be implemented. CORF notes in response that technical measures, such as GPS software and/or a VMES control center whereby the operator can remotely turn off any terminal that would operate in a manner inconsistent with coordination agreements, would be useful, but on their own may not be sufficient to protect RAS facilities from prohibited interference. The best way to protect RAS facilities from such in-band interference would be to prohibit VMES uplink transmissions from 14.47 GHz to 14.50 GHz. There is no evidence in the record that such a limitation would be technically infeasible, or even burdensome on VMES operators. The VMES operators will still have use of the 14.0-14.46 GHz band and would be allocated only 6 percent less spectrum than proposed. The resulting benefit to VMES operators is that they would not have to engage in coordination with RAS observatories.

B. Alternatively, the Commission Should Consider Coordination as a Prerequisite to Licensing, Especially If Controls Are Not Embedded into Terminals to Ensure That They Not Operate in Uncoordinated Locations.

If the Commission does not bar VMES transmissions at 14.47-4.50 GHz, CORF recommends the following approach to protect RAS facilities through coordination. First, the Commission should require technical measures such as GPS software and/or a VMES control center whose operator can remotely turn off any terminal that would operate in a manner inconsistent with coordination agreements. Furthermore, CORF

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[4] See 47 C.F.R. § 2.106

recommends that the Commission require that any such hardware or software embedded in the terminals be reasonably impervious to unauthorized modification by end users. If the Commission adopts these technical measures, then coordination could occur as a post-licensing condition to the granting of licenses.

If the Commission does not require that technical measures be incorporated into terminals to ensure that the results of coordination can be implemented, then the Commission should make coordination a prerequisite to licensing, not a post-licensing condition. The only justification that the NPRM provides for making coordination a post-licensing condition is that this is the approach that the Commission took in authorizing 14 GHz Earth stations on vessels (ESVs). *See* NPRM at note 83, citing *ESV Report and Order*, 20 FCC Rcd at 715. However, there are important distinctions between ESVs and VMES that justify a different approach. First, there appears to be commercial and governmental interest in VMES that could easily lead to the licensing of thousands, or tens of thousands, of VMES terminals. *See* NPRM at paragraph 5.[5] Because VMES will be ground based rather than on ships, there may well be a much greater market for use of VMES than for ESVs. Moreover, as a land-based service, VMES can be brought into the direct vicinity of, indeed right onto the grounds of, RAS observatories. This combination of ubiquity and potential immediacy makes it much more likely that VMES may cause interference to RAS observatories and more difficult to identify the source of the interference, and thus more important that VMES be subject to stricter coordination

[5] Indeed, at paragraph 8 the NPRM notes that, "[t]he Commission granted Qualcomm, Inc.'s request for a blanket authorization for over 20,000 technically identical very small antenna mobile earth stations operating in the 12/14 GHz band."

requirements than ESVs.

C. CORF Supports Use of the Coordination Zones Proposed in Section 25.XXX(a)(12), as Modified Herein.

If VMES are licensed on a primary basis in the entire 14.0-14.5 GHz band, they should be subject to coordination with RAS operations if the VMES operate in a coordination zone around certain specific RAS observatories.[6] CORF believes that the radii of the coordination zones proposed in Section 25.XXX(a)(12) would be sufficient to protect RAS observations in this band. CORF also recommends that, if the Commission does not bar VMES transmissions at 14.47-14.50 GHz, but rather requires coordination of VMES operations in that band, then VMES operations at 14.44-14.47 GHz should also be subject to coordination in order to protect the observatories from out-of-band emissions from VMES. The coordination zones for operations at 14.44-14.47 GHz could be smaller than those at 14.47-4.50 GHz because of the frequency separation. For operations at 14.44-14.47 GHz, CORF would recommend coordination zones of 2 or 3 kilometers from the VLBA sites, and 10 kilometers around each of the other sites listed in Footnote US203.

CORF also supports the proposal in Section 25.XXX(a)(12) to have the National Science Foundation (NSF) be the entity with which ESV operators coordinate. The NSF has performed well in this role in connection with a number of coordination agreements with commercial services, including for example, Aeronautical Mobile Satellite Service

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[6] As noted in paragraph 37 of the NPRM, dynamic scheduling is common in RAS observatories. The scheduling of observations on a particular frequency at a particular time in order to maximize both the use of the observatory facilities and the use of the frequency by an entity such as a VMES operator is a common part of the coordination process, and is consistent with CORF's coordination proposals herein.

uplinks at 14.0 to 14.5 GHz.[7]

CORF also notes that the footnote that provides the basis for protection of RAS at 14.47-14.50 GHz, Footnote US203, should be revised and updated as follows. The Five Colleges Radio Observatory and the Haystack Observatory no longer operate at 14 GHz and thus can be deleted from the footnote. The Hat Creek Observatory has been replaced by the Allen Telescope Array (ATA) (which is located at Hat Creek, California), and the highest frequency currently observed on the ATA is 12 GHz. Accordingly, the name "Hat Creek Observatory" should be replaced by the name "ATA," and the reference to observation at 14 GHz should be deleted (the reference to observation at 4.8 GHz should be retained). However, the Very Long Baseline Array (VLBA) stations of the National Radio Astronomy Observatory, listed in Footnote US311, observe at both 4.8 GHz and 14 GHz and thus should be added to Footnote US203. In addition, the University of Michigan Radio Astronomy Observatory located at Stinchfield Woods, Michigan (Lat: 42° 24' N, Long: 83° 56' W), and the Pisgah Astronomical Research Institute located at Rosman, North Carolina (Lat: 35° 12' N, Long: 82° 55' W), observe at both 4.8 and 14 GHz, and thus both observatories should be added to US203.

Lastly, in paragraph 73 of the NPRM, the Commission seeks comments as to whether use of VMES should be limited to government agencies. Because this proposal, if enacted, would likely reduce the number of potential VMES mobile terminals, and thus the potential for interference to RAS observations, CORF supports

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[7] *See, e.g., In the Matter of ARINC Incorporated, Order and Authorization*, 20 FCC Rcd

the proposal.

III. Conclusion.

CORF supports protection of RAS observations at 14.47-14.50 GHz. As discussed herein, CORF primarily recommends prohibition of VMES transmissions at 14.47-14.50 GHz; however, if the Commission chooses not to take this approach, CORF recommends that the Commission consider coordination as a prerequisite to licensing, especially if controls are not embedded into terminals to ensure that they not operate in uncoordinated locations.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

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7553 (Int'l Bur. 2005) at paragraph 51.

Attachment

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