Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
The 4.9 GHz Band Transferred from Federal Government Use	)	WT Docket No. 00-32
	)	

CONSOLIDATED OPPOSITION TO PETITIONS FOR RECONSIDERATION

The National Academy of Sciences, through the National Research Council's Committee on Radio Frequencies (hereinafter, CORF),[1] hereby submits its Consolidated Opposition to Petitions for Reconsideration filed by Microwave Radio Communications (MRC) on May 8, 2002, and by the Los Angeles County Sheriff's Department (LASD) on May 9, 2002, in the above-captioned proceeding. As shown below, the Commission's ban on aeronautical operations in the 4940–4990 MHz (4.9 GHz) band in order to protect radio astronomy observations was proper and follows from the record in this proceeding. However, CORF does not oppose the use of 4940–4950 MHz for aeronautical use, subject to appropriate out-of-band emission protections. Accordingly, the Commission should deny the LASD and MRC petitions as applied to 4950–4990 MHz.[2]

I. The Record in This Proceeding Supports a Ban on Aeronautical Use of the 4.9 GHz Band.

Because it represents the interests of the scientific users of the radio spectrum, including users of the Radio Astronomy Service (RAS), CORF has a substantial interest in this proceeding. As documented

[1] A roster of the committee membership is attached.
[2] CORF recognizes that in addition to seeking reconsideration of the Commission's decision to prohibit aeronautical use in the 4.9 GHz band, MRC also sought clarification that Section 90.423(a) of the Commission's rules would allow aeronautical use at altitudes of up to one kilometer to be considered a "land mobile" use, rather than an "aeronautical mobile" use. While CORF would oppose such a ruling, it does not address that matter herein, as CORF believes that it will be addressed by other parties.

in Comments filed by CORF in this proceeding on April 26, 2000 and December 19, 2000, radio astronomers perform extremely important, yet vulnerable research. Of particular concern in this proceeding is protection of RAS observations in the 4.9 GHz band. The need for protection of observations in this band is valid. Such observations are extremely useful in studying the brightness distribution of objects such as ionized hydrogen clouds surrounding young stars, remnants of supernovas that mark the cataclysmic end of stars, and ejecta traveling near the speed of light from black holes in the nuclei of galaxies. Observations of radio emission from neutron stars and black holes are particularly vulnerable to interference due to the variability of the emissions, and one cannot just re-observe such phenomena at a later time.

The Second Report and Order in this proceeding (2nd R&O)[3] properly recognized the need to protect RAS observations at 4.9 GHz and properly concluded that aeronautical transmissions in this band posed a significant threat of interference to those observations.[4] *Id.* at paragraph 9. Contrary to the assertions of MRC (Petition at p. 5) and of LASD (Petition at pp. 2–3), there is indeed substantial and sufficient evidence in the record to support this finding. First, the 2nd R&O properly acknowledged the footnote protection given to the Radio Astronomy Service in this band. As noted in paragraph 3, international Footnote S5.149 provides that "administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference," because "emissions from space borne or airborne stations can be particularly serious sources of interference to the radio astronomy service."[5] Similarly, the 2nd R&O acknowledges that Footnote US257 previously provided, and footnote US311 currently provides, that "every practicable effort will be made to avoid the assignment of frequencies in this band to stations in the aeronautical mobile service . . . which may cause harmful interference to the

[3] FCC 02-47, released February 27, 2002.
[4] See 2nd R&O at para. 9.
[5] 2nd R&O at para. 3, citing Table of Frequency Allocations, 47 C.F.R. Section 2.106.

listed observatories." [6] These footnotes are based on widely accepted scientific calculations, and are the result of international negotiations at World Radio Conferences. For both of these reasons, the Commission cannot ignore the footnotes, and in fact, the footnotes were the basis for the Commission's decision to prohibit aeronautical use in the 4.9 GHz band.[7] The footnotes alone provide a sufficient basis for the Commission's ban on aeronautical use.

Nevertheless, there was additional evidence in the record that formed the basis for the ban on aeronautical use. First, as the Commission recognized, this band was originally allocated solely for government use, and when it was reallocated for private use, one explicit condition on the reallocation set by the Department of Commerce was that the band would not be used for aeronautical transmissions at 4950–4990 MHz.[8] Again, this condition on reallocation was solidly based on science and could not be ignored by the Commission.

The record also contained the Comments filed by CORF on April 26, 2000, and on December 19, 2000. In the December 2000 Comments, CORF provided the calculations demonstrating the potential impact of transmissions in the 4.9 GHz band on radio astronomy observations.

In sum, the domestic and international footnotes, and the filings made by CORF and the Department of Commerce, provided a substantial and sufficient basis for the ban on aeronautical use of the 4.9 GHz band in the 2nd R&O. Accordingly, there is no validity to the assertion of MRC (Petition at p. 5) and of LASD (Petition at p. 3) that the ban on aeronautical use is not supported by the record in this proceeding.

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[6] Id., citing Table of Frequency Allocations, 47 C.F.R. Section 2.106.
[7] See 2nd R&O at paragraph 9.
[8] 2nd R&O at paras. 3 and 9, citing March 30, 1999 letter from Larry Irving, Assistant Secretary for Communications, United States Department of Commerce, to William Kennard, Chairman, FCC (*"Reallocation Letter*"), and citing *Transfer of 4.9 GHz Band From Federal Government, Notice of Proposed Rulemaking*, 15 FCC Rcd 4778, 4788 (2000).

II. Other Arguments Provided for Reconsideration Are Invalid.

As discussed above, there is no validity to arguments in the Petitions that the record does not support the ban on aeronautical use. Most other arguments for reconsideration in the Petitions are equally invalid.

On page 4 of its Petition, LASD asserts that the Commission should have considered options for the protection of radio astronomy sites other than a complete ban on aeronautical use, including "geographic limitations, limitations on the altitudes from which the aeronautical mobile signals could be transmitted, limitations on duration of aeronautical mobile transmissions, the use of directional antennae, and other interference-limiting technologies, spectrum sharing arrangements, frequency coordination and waiver provisions." The core problem with each of these proposals is that they would contradict the prohibitions set forth in the domestic and international footnotes cited above and also contradict the condition of reallocation established by the Department of Commerce. On this basis alone, they should be rejected. However, each of these proposals has additional flaws:

- *Geographical Limitations*: It is not clear what sort of limitations the LASD is referring to, but CORF notes that in paragraph 17 of the 2nd R&O, the Commission rejected the use of geographical coordination/exclusion zones as a means of protecting radio astronomy observatories. While CORF supported the use of such zones for protection against interference from terrestrial fixed and mobile operations, it would oppose them for aeronautical uses. While any geographical area excluding aeronautical use would have to be significantly larger than the zones in Footnote US311 in order to

account for the greater distance traveled by airborne transmissions,[9] CORF believes that no single rule could properly account for differing altitudes of and topography surrounding the 15 radio astronomy sites listed in US311. Since these factors (along with the altitude of the transmitting vehicle) would determine the distance necessary to provide the required protection, it is unlikely a rule with a single separation distance could properly proper protect each of the RAS sites.

- *Limitations on Transmission Altitude*: The core problem of trying to set an altitude limitation to protect 15 different observatory sites is similar to the problem of establishing a geographical limit to protect those sites: Each site is sitting at a different altitude, with different surrounding topography, and thus no single altitude limitation could properly address those differing situations.
- *Use of Directional Antennae:* Based on the mere off hand suggestion in the LASD and MRC petition, it is hard for CORF to understand how this would be a solution. A directional antenna for a video link from an aeronautical mobile unit such as a "scene management" helicopter to a base command station is unlikely to limit its transmissions to a narrow direction. The expected flight pattern is typically circuitous, and therefore maintenance of antenna gain from the mobile unit in the direction of the base station (in spite of rapid changes in direction, altitude, pitch, and roll) would appear either to require near omnidirectional transmission or to result in such omnidirectional transmission. If so, one cannot appeal to the benefit of a directional antenna of an aeronautical mobile transmitter to limit power emitted in the direction of a radio observatory in the manner that is

[9] The use of distance to provide protection to observatories from aeronautical transmissions is premised on the idea that the curvature of Earth will create a radio horizon, which will significantly attenuate the transmitted signal. The standard model for the radio horizon given reception at ground level is 4.1 times the square root of the transmitter height in meters. For a flying altitude of 1.6 km (5,280 feet) this would be164 km. The location of a number of observatory sites at high altitude relative to the local terrain leads to much larger distances for the radio horizon, because when both transmitter and receiver are elevated, the distance that counts is the sum of the radio horizons. So, for an aeronautical transmission from a height of 1,600 meters the radio horizon is 164 km (see ITU-R p. 1546); for a telescope at an altitude of 4,000 meters, the horizon is 259 km. The distance at which line-of-sight propagation takes place between an aircraft transmitter at 1,600 meters and a receiver at 4,000 meters elevation is then 164 + 259 = 423 km. Furthermore, this "radio horizon" concept is the simplest of all propagation models, not including the effect of tropospheric propagation modes such as forward scatter and ducting, which dominate beyond the radio horizon.

possible with fixed stations.

- *Spectrum Sharing Arrangements*: It is unclear what LASD means by this. If LASD is proposing that the sharing be based on each party using different times of the day, this seems impractical for the public safety community, since emergencies can occur at any time of day. If LASD is suggesting that different parties can use the same frequency at the same time, doing so would make sense only if there were other means of ensuring that the aeronautical use did not interfere with radio astronomy observations. However, as discussed here, those other means appear to be flawed.
- *Frequency Coordination*: Again, this approach appears impractical for the public safety community. If coordination means agreement in advance on when and how aeronautical uses would occur, then this advance planning seems to be inconsistent with the idea that aeronautical transmissions are necessary to assist public safety agencies in addressing emergencies, which occur without notice rather than at prearranged times.
- *Waiver Provisions*: As is the case with frequency coordination, generally a waiver is sought in advance of violation of a rule, but such action in advance cannot address unplanned emergencies.

In sum, the alternatives proposed by LASD do not appear to solve the problem, either for public safety agencies or for radio astronomy observatories. Similarly flawed is the citation by MRC (on page 5 of its Petition) to language in the 2nd R&O wherein the Commission stated that terrestrial fixed and mobile use of the 4.9 GHz band should not have a significant impact on radio astronomy, "given the small number and remote location of radio astronomy observatories." While the Commission may have come to that conclusion in connection with terrestrial use of the 4.9 GHz band, as shown above, aeronautical transmissions raise significantly different issues, given the fact that aeronautical transmissions travel a much greater distance than terrestrial transmissions.

III. Use of 4940-4950 MHz for Aeronautical Transmissions.

As shown above, the record in this proceeding supports the Commission's complete ban on aeronautical transmissions as a proper means of protecting radio astronomy observations. Furthermore, the proposals in the Petitions for means by which observations would allegedly be protected from aeronautical transmissions at 4950–4990 MHz are impractical or otherwise flawed. Nevertheless, CORF would not oppose aeronautical transmissions at 4940–4950 MHz if appropriate technical standards are used to eliminate damaging out-of-band and spurious emissions in the adjacent 4950–4990 MHz shared band and the 4990–5000 MHz primary RAS band in the vicinity of the radio astronomy sites listed in Footnote US311. Such an approach would give public safety agencies some aeronautical use of the 4.9 GHz band while significantly reducing the risk of interference to radio astronomy observations, since the 4940–4950 MHz portion of the 4.9 GHz band is the portion farthest away from protected RAS frequencies, thus providing the least risk for out-of-band and spurious emissions.

III. Conclusion.

The Commission's ban on aeronautical operations in the 4.9 GHz band in order to protect radio astronomy observations was proper and follows from the record in this proceeding. However, CORF does not oppose the use of 4940–4950 MHz for aeronautical use, subject to appropriate protections against damaging out-of-band and spurious emissions. Accordingly, the Commission should deny the LASD and MRC petitions as applied to 4950–4990 MHz.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
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CERTIFICATE OF SERVICE

I, Nelson Quiñones, a project assistant in the Board on Physics and Astronomy of the National Research Council, do hereby certify that a true copy of the foregoing *Consolidated Opposition to Petitions for Reconsideration* by the National Academy of Sciences' Committee on Radio Frequencies was sent this 1st day of July, 2002, via United States First Class Mail, postage prepaid, to the following:

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