In the Matter of	)	
	)	
Amendment of Part 27 of the	)	
Commission's Rules to Revise	)	WT Docket No. 98-136
Rules for Services in the	)	
2.3 GHz Band and to Include	)	
Licensing of Services in the	)	
47 GHz Band	)	

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 (hereinafter, "CORF"; the membership is listed in Appendix A), hereby submits its Comments in response to the Commission's July 29, 1998, Notice of Proposed Rulemaking in the above-captioned docket ("NPRM"). In these Comments, CORF suggests that the Commission forbear from enacting rules on out-of-band and spurious emission limits on high-altitude-platform users of the 47 GHz band until related matters are properly resolved on an international basis. Until such time, aeronautical and space-borne uses of the 47 GHz band should not be authorized. However, if the Commission decides to enact interference limits prior to international resolution, the limits must be significantly more stringent than those proposed in the NPRM, in order to protect Radio Astronomy Service ("RAS") observations in nearby bands from harmful interference.

I. Introduction: The Importance of Radio Astronomy Observations in the 42.5-43.5 and 48.94-49.04 GHz

Bands, and the Unique Vulnerability of Radio Astronomy to Out-of-Band and Spurious Emissions.

CORF represents the interests of the radio astronomy community, as well as that of other scientific users of the radio spectrum, and therefore has a substantial interest in this proceeding. As the Commission has long recognized, radio astronomy is a vitally important tool used by scientists to study our universe. Through the use of radio astronomy, scientists have recently 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 witness the creation and distribution of heavy elements essential to the formation of planets like the Earth, and of life itself. In addition to increasing knowledge of the universe, radio astronomy has produced substantial benefits through the development of very-low-noise receivers and many other applications used in a variety of radio applications. The technique of very-long-baseline interferometry ("VLBI"), developed for high-resolution radio astronomy, is used by geophysicists to study small motions of the Earth’s crust. These terrestrial observations include identification of potential earthquake zones through measurement of fault motion. VLBI techniques also make major contributions to accurate navigation, including the tracking of spacecraft. The benefits of radio astronomy have been obtained through years of work and a large federal investment. They and future benefits must be protected.

As passive users of the spectrum, radio astronomers have no control over the frequencies that they need to study or over the character of the signals from cosmic objects. These parameters are set by the laws of nature. Furthermore, 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. Furthermore, the emissions that radio astronomers receive 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 detect such remarkably weak signals, they are therefore particularly vulnerable to interference from spurious and out-of-band emissions from licensed and unlicensed users of neighboring bands, and from those that produce harmonic emissions that fall within RAS bands.

Of particular concern in this proceeding is interference to radio astronomy observations in the 42.5-43.5 GHz and 48.94-49.04 GHz bands from stratospheric platforms, or other airborne or space-borne users operating in the 47 GHz band. The 42.5-43.5 GHz and 48.94-49.04 GHz bands are allocated on a primary basis to the RAS.[FOOTNOTE 1 Observations in these bands are made at radio astronomy observatories in Goldstone, California; Green Bank, West Virginia (under construction); Socorro, New Mexico; St. Croix, Virgin Islands; Hancock, New Hampshire; North Liberty, Iowa; Fort Davis, Texas; Los Alamos, New Mexico; Pie Town, New Mexico; Kitt Peak, Arizona; Owens Valley, California; Brewster, Washington; Mauna Kea, Hawaii; Amherst, Massachusetts; Hat Creek, California; Westford, Massachusetts; and numerous other observatories in other countries.] Similarly, the International Telecommunication Union Radiocommunication Sector ("ITU-R") Recommendation RA.314-8 specifically lists spectral line observations of silicon monoxide (at 42.82 GHz and 43.12 GHz) and carbon monosulphide (at 48.991 GHz) as among the lines of greatest importance to radio astronomy.[FOOTNOTE 2: ITU-R Recommendation RA.314-8, "Preferred Frequency Bands for Radioastronomical Measurements".] Spectral-line observations of silicon monoxide are important because of the presence of that molecule in interstellar molecular clouds, in the atmospheres of evolved stars, and in external galaxies. These two lines have been observed as strong prominent narrow-band "maser" emission in the atmospheres of hundreds of evolved stars and star-forming regions, and are essential for studies of cosmic phenomena such as the birth and death of stars. The carbon monosulphide ("CS") molecule is a good high-density tracer, and observation of the CS spectral line is an important tool for analyzing the molecular material in active nuclei and starburst galaxies.

The 42.5-43.5 GHz band is also used for sensitive continuum emission observations. To achieve the highest sensitivity in continuum observations, astronomers must use

the maximum observing bandwidth available. This band is important to radio astronomy because, owing to its 1 GHz width and its location in the spectrum (at approximately twice the frequency of the 23.6-24 GHz continuum band), it provides an effective point for the sampling of continuum emission at octave or better frequency intervals. Such observations provide critical information on the physical state of the interstellar medium associated with star-forming regions.

In sum, radio astronomy observations in the 42.5-43.5 and 48.94-49.04 GHz bands are important, yet like all radio astronomy observations, are uniquely vulnerable to interference from out-of-band and spurious emissions.

II. The Commission Should Forbear from Enacting Spurious and Out-of-Band Emission Limits, and from Authorizing Aeronautical and Spaceborne Uses of the 47 GHz Band, Until Resolution at WRC-00 of Interference Standards in That Band.

The 1997 World Radiocommunication Conference (WRC-97) designated certain portions of the 47 GHz band for use by high-altitude platforms ("HAP") operating in the fixed service. However, WRC-97 Resolution 122 specifically noted that "technical studies are required in order to ascertain the extent to which sharing [of the 47 GHz band] is feasible between [HAPs and other services] and to ascertain the requirements to protect radio astronomy services in the adjacent bands from spurious emissions...." Accordingly, that Resolution requests the ITU-R to urgently carry out studies "on the appropriate technical sharing criteria" for users of the band and the RAS, with a view toward further action by WRC-99 (now WRC-00). ITU-R Joint Rapporteur Group 7D-9D was assigned this important investigatory task.

In light of the issues pending before the ITU that may directly affect the interference limits upon which the Commission is seeking Comments in paragraph 131 of the NPRM, CORF recommends that the Commission forbear from setting interference standards that could be rendered irrelevant by ITU action. Indeed, as seen in Appendix B attached hereto, a draft report currently being considered by the U.S. Joint Rapporteurs Group ("USJRG") 7D-9D/8-E recommends significantly more stringent levels of protection in the already strong level of protection for radio astronomy observations.

The above recommendation for forbearance does not mean, however, that airborne or space-borne users operating in the 47 GHz band should be authorized by the Commission without any limits on out-of-band or spurious transmissions. Such a result would be the worst of all possible worlds for the RAS community, as well as for other users of neighboring bands. Rather, the Commission should forbear from authorizing airborne or space-borne users until interference limits are established at WRC-00.

III. If the Commission Enacts Spurious and Out-of-Band Limits at This Time, Stringent Limits Are Required in Order to Protect Important Radio Astronomy Observations in the 42.5-43.5 GHz and 48.94-49.04 GHz Bands

CORF recognizes that the Commission may conclude that, regardless of the argument made in Section II above, for other reasons, airborne or space-borne use of the 47 GHz band should be authorized prior to WRC-00. In such a case, it would be best for all parties to have spurious or out-of-band limits in place prior to construction of HAPs and other facilities transmitting in the 47 GHz band. Enactment of such limits after construction of HAPs could lead to the unfortunate situation of a fait accompli being presented to the Commission in the form of HAPs that do not meet Commission interference limit standards, but for which it is allegedly "too late" or too expensive to change production, or technically infeasible to modify equipment that has already been launched into the stratosphere.

The Commission proposes that licensees in the 47 GHz band must attenuate the power below the transmitter power (P) by at least $43 + 10 \log_{10}(P)$ or 80 decibels, whichever is less, for any emission on frequencies outside the licensee’s authorized channel. As shown in the technical portions of Appendix B, attached hereto, the emission limits proposed in the NPRM will result in harmful interference to the Radio Astronomy Service observations in the 48.94-49.04 and 42.5-43.5 GHz bands. Appendix B considers the effect of a HAP operating over the Albuquerque, New Mexico, area on the National Radio Astronomy Observatory’s Very Large Array (NRAO/VLA), which is located near Socorro, New Mexico, and operates in the above radio astronomy bands.[FOOTNOTE 3: Although not used in the example, the NRAO’s Very Long Baseline Array has antennas located at Los Alamos and Pie Town, New Mexico,

that operate at 43 GHz.] The interference produced by the HAP would exceed by nearly 40 dB the harmful interference levels given in ITU-R Recommendation RA.769-1 on "Protection Criteria Used for Radioastronomical Measurements". Accordingly, CORF proposes that the requirements for out-of-band emissions in the bands 42.5-43.5 GHz and 48.94-49.04 GHz be specifically set to the more stringent levels consistent with Recommendation ITU-R RA.769-1 (see Appendix B). This would result in an attenuation requirement of $83 + 10 \log_{10}(P)$ in the 48.94-49.04 GHz and 42.5-43.5 GHz radio astronomy bands.

IV. Conclusion

The Commission should forbear from enacting rules on out-of-band and spurious emission limits on airborne and space-borne users of the 47 GHz band until such matters are addressed at WRC-00. Until such time, aeronautical and space-borne uses of the 47 GHz band should not be authorized. However, if the Commission decides to enact interference limits prior to international resolution, the limits must be significantly more stringent than those proposed in the NPRM, in order to protect radio astronomy observations in nearby bands from harmful interference.

Respectfully submitte

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NATIONAL ACADEMY OF SCIENCES’

COMMITTEE ON RADIO FREQUENCIES

By: _____

Bruce Alberts

President

September 21, 1998

Attachments:

Appendix A: CORF Membership

Appendix B: Illustration of Potential Interference from High Altitude Platforms Operating in the 47.2 GHz and 47.9 GHz Bands to a Radio Astronomy Station Operating in the 42.5-43.5 GHz and 48.94-49.04 GHz Bands, communication from William Brundage, NRAO-VLA to Paul Steffes, Chair, CORF.

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