

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

National Academy of Sciences
National Academy of Engineering
Institute of Medicine
National Research Council

DOCKET FILE COPY ORIGINAL

September 30, 1999

Ms. Magalie Roman Salas, Esq.
Secretary
Federal Communications Commission
(Delivered to TW-A325, 12th Street Lobby)
The Portals
445 Twelfth Street, SW
Washington, D.C. 20554

RECEIVED

SEP 30 1999

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

In the Matter of)	
)	
Amendment of Part 2 of the Commission's)	ET Docket No. 99-261
Rules to Allocate Additional Spectrum to)	
the Inter-Satellite, Fixed, and Mobile Services)	
and to Permit Unlicensed Devices to Use)	
Certain Segments in the 50.2-50.4 GHz and)	
51.4-71.0 GHz Bands)	

Dear Ms. Salas:

Transmitted herewith by the National Academies, through the Committee on Radio Frequencies of the National Research Council, are an original and five copies of its Motion to File Late Comments in the above-referenced proceedings. If additional information is required concerning this matter, please communicate with this office. in the above-referenced proceedings. If additional information is required concerning this matter, please communicate with this office.

Sincerely yours,

Robert L. Riemer
Senior Program Officer

cc: Members of CORF
Mr. Paul J. Feldman
Dr. Tomas Gergely
Dr. Donald C. Shapero

No. of Copies rec'd 044
List ABCDE

Board on Physics and Astronomy

2101 Constitution Avenue, NW, Washington, DC 20418

Telephone (202) 334 3520 Fax (202) 334 3575 Email bpa@nas.edu national-academies.org/bpa

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

RECEIVED

SEP 30 1999

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

In the Matter of)
)
Amendment of Part 2 of the Commission's) ET Docket No. 99-261
Rules to Allocate Additional Spectrum to)
the Inter-Satellite, Fixed, and Mobile Services)
and to Permit Unlicensed Devices to Use)
Certain Segments in the 50.2-50.4 GHz and)
51.4-71.0 GHz Bands)

MOTION TO LEAVE TO FILE AND COMMENTS
OF THE NATIONAL ACADEMIES'
COMMITTEE ON RADIO FREQUENCIES

The National Academies, through the National Research Council's Committee on Radio Frequencies¹ (hereinafter, CORF), hereby submits Comments in response to the Commission's July 23, 1999, Notice of Proposed Rulemaking in the above-captioned docket (NPRM).² In these Comments, CORF generally supports the Commission's proposals in the NPRM as likely to lead to improvement of the operation of passive sensors in the Earth Exploration Satellite Service (EESS). CORF suggests, however, that the Commission be mindful of the need to protect future space-based radio astronomical observations at certain specific frequencies in the 56-62 GHz band.

I. Introduction: The Importance of Radio Astronomy Service (RAS) and Earth-Exploration Satellite Service (EESS) Observations in the 50-70 GHz Band, and the Unique Vulnerability of Passive Services to Out-of-Band and Spurious Emissions.

CORF has a substantial interest in this proceeding, as it represents the interests of the scientific users of the radio spectrum, including users of the RAS and EESS bands. Both RAS and EESS 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. Through the use of radio astronomy, scientists have in recent years 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.

¹The roster of the CORF membership is listed in the Appendix.

²CORF hereby moves for leave to file these Comments after the filing deadline. CORF believes this late filing will not prejudice any parties, since there is still significant time for such parties to review and comment on the matters set forth herein. Most importantly, CORF believes that these Comments contain significant and substantial information that will contribute to reasoned decision making in this proceeding.

Observations of supernovas have witnessed the creation and distribution of heavy elements essential to the formation of planets like Earth, and of life itself.

The EESS represents both a critical and a unique resource for monitoring the global atmospheric and surface state, operationally and experimentally. Passive and active satellite-based microwave remote sensing measurements represent the only practical approach to obtaining uniform-quality atmospheric and surface data encompassing the most remote oceans as well as densely populated areas of Earth. EESS data have contributed substantially to the study of meteorology, atmospheric chemistry, oceanography, and global change. Currently, instruments operating in the EESS bands provide regular and reliable quantitative atmospheric, oceanic, and land measurements to support an extensive variety of scientific, commercial, and government (civil and military) data users. Applications of the data include aviation forecasts, hurricane and severe storm warning and tracking, seasonal and interannual climate forecasts, decadal-scale monitoring of climate variability, medium-range forecasting, and studies of the ocean surface and internal structure, as well as many others.

These current benefits of scientific research, obtained through years of work and substantial federal investment, as well as future benefits, must be protected.

As passive users of the spectrum, radio astronomers and Earth scientists 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.

Furthermore, the emissions that radio astronomers observe 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 remarkably weak signals, such facilities are 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. Similarly, the emissions received by passive EESS radiometers in Earth orbit are weak by comparison with emissions from other services.

As recognized in note 9 of the NPRM, passive scientific observations in the 50-71 GHz band are significantly affected by the impact of the presence of oxygen and water vapor in Earth's atmosphere. Yet, it is because these unique molecular oxygen resonance frequencies are located in this band that EESS observations there are of the utmost importance to weather forecasting and climate studies. In addition, as discussed further below, it is anticipated that important space-based astronomical observations of oxygen will be made in the near future, and such observations at frequencies between 56 and 62 GHz would be vulnerable to interference from inter-satellite service (ISS) transmission.

II. CORF Supports the Commission's Proposal, But Notes Concerns Regarding the Impact on Future Space-Based Radio Telescope Observations at Certain Frequencies.

CORF believes that the proposal in the NPRM would generally serve the public interest. The Commission should be mindful of the following points, however.

One frequency band (51.4-52.6 GHz) previously allocated on an exclusive basis for passive sensor use is less important to EESS and can be relinquished in favor of fixed and mobile services, as part of a realignment of frequencies that protects EESS observations at other frequencies.³ CORF would like to emphasize the importance of interference-free observations in

³Current on-orbit sensors and/or sensors awaiting launch will utilize spectrum immediately adjacent to (above and below) the 51.4-52.6 GHz band for near-surface temperature estimates and surface corrections to temperature profiling algorithms. The 51.4-52.6 GHz band represents a region where the temperature weighting functions typically begin to peak just above the surface rather than at the surface. The 51.4-52.6 GHz band is less important than the immediate adjacent band segments owing to the mixing of sensitivity to the surface and to the atmosphere just above

the region of 50-70 GHz for “all weather” three-dimensional temperature sounding. Utilization of passive microwave observations in the 50.2-50.4 and 52.6-59.3 GHz bands has contributed to significant progress for weather prediction and climate monitoring and will continue to be a major resource in the future provided that uncorrupted measurements in these bands remain possible.

Studies have shown that numerical weather prediction models are very sensitive to missing or corrupted temperature data. However, studies by the Radiocommunication Sector of the International Telecommunication Union have shown that sharing with terrestrial fixed and mobile services is feasible above 55.78 GHz due to the high atmospheric attenuation that exists. However, at lower frequencies, undesirable constraints would be required on the fixed and mobile services, and the meteorological community would still receive interference that could affect weather forecasts and give false results to measurements of terrestrial warming.

Other studies have shown that operation of inter-satellite links in planned networks of non-geostationary-orbit (NGSO) fixed and mobile satellites can cause excessive interference to passive sensors in the 54.25-58.2 GHz band previously shared by the EESS and Space Research services on a primary basis with the ISS. These studies have shown, however, that inter-satellite links between satellites in GSO will not cause excessive interference to passive sensors provided that a power flux density (PFD) limit is instituted to protect the sensors. Sharing is feasible between passive microwave sensors and GSO ISS links provided that the PFD at altitudes of 1,000 km or less above Earth's surface produced by emissions from a space station do not exceed $-147 \text{ dBW/m}^2/(100 \text{ MHz})$ for all angles of arrival. This emission limit must be strictly followed, however.

In sum, given compliance with emission limits, the proposed realignment of allocations within the 50.2 to 71.0 GHz range should provide an interference-free environment for passive spaceborne sensor measurements of the atmosphere, while satisfying the requirements of the fixed, mobile, and inter-satellite services in this frequency range.

In regards to the RAS allotments to allocations at issue in this proceeding, CORF agrees that, due to atmospheric absorption, terrestrial radio astronomy observations are not made in the 51.4-54.25, 58.2-59, and 64-65 GHz bands. Accordingly, CORF does not oppose deletion of these allocations. However, CORF brings to the Commission's attention the fact that space-based observations of the oxygen molecule in cosmic molecular clouds are an important and imminent goal of scientific research, and such observations at frequencies between 56 and 62 GHz would be vulnerable to interference from ISS transmission.

Oxygen is the third most abundant element in the universe, and the most abundant of the “heavy” elements from which planetary bodies are made. However, about three-quarters of oxygen exists in as yet unidentified forms. One such form could be molecular oxygen, O_2 , which has not yet been measured in astrophysical environments using radio frequencies because of intense absorption from O_2 in Earth's atmosphere. Measurement of interstellar O_2 is a goal for ongoing and future space-based observation missions such as NASA's Submillimeter-Wave Astronomy Satellite (SWAS), the Canadian-Swedish-Finnish-French ODIN astronomy/aeronomy mission, the European Space Agency's Far-Infra-Red and Submillimeter Telescope (FIRST), and the proposed Advanced Radio Interferometry between Space and Earth (ARISE) mission. The U.S. ARISE mission (targeted for launch in approximately 10 years) in particular will have the capability of measuring key O_2 transitions that lie between 56 and 62 GHz.

the surface. Therefore measurements in a less opaque region immediately below 51.4 GHz, which respond much more strongly to surface emission than to the lower atmosphere temperature, may be used essentially to correct for the residual surface contributions to measurements immediately above 52.6 GHz, producing an accurate estimate of atmospheric temperature. However, it is possible that EESS measurements in the “transition region” of 51.4-52.6 GHz could be of benefit when assimilated with other observations adjacent to the band.

Because of the intense opacity of Earth's atmosphere, space-based observations would not be affected by unlicensed and fixed or mobile terrestrial devices operated on or near Earth's surface. However, ISS operations (and airborne unlicensed or mobile operations) in these bands could cause problems for space-based radio telescopes. The transitions that lie in the lower part of the O₂ rotational excitation energy ladder, and the proposed ISS bands in which they lie, are as follows:

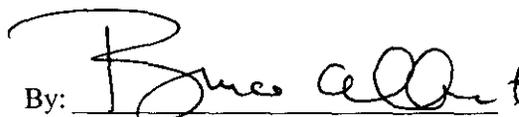
Frequency (GHz)	Excitation (K)	Band Allocation
56.265	3.0	Gov. and non-gov. GSO with PFD limit
62.486	23.4	Gov. GSO and NGSO
58.447	23.6	Passive services
59.591	60.6	Gov. GSO and NGSO
60.306	60.7	Gov. GSO and NGSO
60.435	114.5	Gov. GSO and NGSO
59.164	114.6	Gov. GSO with PFD limit

Accordingly, in response to the Commission's inquiry in paragraph 21 of the NPRM, CORF urges the Commission to consider providing footnote protection to 50 MHz bands centered on the frequencies listed above. Such footnotes should limit assignment of these particular frequencies where possible, and where necessary, assign the frequencies at the bottom of the list (with higher excitation energy) before those at the top of the list.

III. Conclusion

CORF supports the Commission's proposals in this proceeding. However, the Commission should also consider the additional footnote protection suggested above.

Respectfully submitted,
 NATIONAL ACADEMIES'
 COMMITTEE ON RADIO FREQUENCIES

By: 
 Bruce Alberts
 President

September __, 1999

Direct correspondence to:
 Paul J. Feldman, Esq.
 Fletcher, Heald & Hildreth, PLC
 1300 North 17th Street
 11th Floor
 Rosslyn, VA 22209
 (703) 812-0400

With a copy to:
 Dr. Robert L. Riemer
 HA-562
 National Research Council
 2101 Constitution Ave., NW
 Washington, DC 20418
 (202) 334-3520

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

National Academy of Sciences
National Academy of Engineering
Institute of Medicine
National Research Council

COMMITTEE ON RADIO FREQUENCIES

Terms expire at the end of the month and year indicated.

Paul Steffes, **Chair** 6/01
School of Electrical and Computer
Engineering
Georgia Institute of Technology
Atlanta, GA 30332-0250
Phone: 404-894-3128
Fax: 404-894-5935 or 4641
Email: ps11@prism.gatech.edu

Darrel Emerson 12/01
National Radio Astronomy Observatory-
Tucson
Campus Building 65
949 N. Cherry Ave.
Tucson, AZ 85721
Phone: 520-882-8250
Fax: 520-882-7955
Email: demerson@nrao.edu

Charles C. Eriksen 12/02 (pending)
School of Oceanography
University of Washington
Box 357940
Seattle WA 98195-7940
Phone: 206-543-6528
Fax: 206-685-3354
Email: charlie@ocean.washington.edu

Michael J. Klein 12/01
Jet Propulsion Laboratory
303-402
4800 Oak Grove Dr.
Pasadena, CA 91109-8099
Phone: 818-354-7132
Email: michael.j.klein@jpl.nasa.gov

Thomas Kuiper 6/01
Jet Propulsion Laboratory
169-506
4800 Oak Grove Drive
Pasadena, CA 91109-8099
Phone: 818-354-5623
Fax: 818-354-8895
Email: kuiper@jpl.nasa.gov

David B. Kunkee 12/02
The Aerospace Corporation
PO Box 92957, MS M4-927
Los Angeles, California 90009-2957
Phone: 310-336-1125
Email: kunkee@seal.aero.org

Mark McKinnon 6/00
National Radio Astronomy Observatory-
Green Bank
P.O. Box 2
Green Bank, WV 24944
Phone: 304-456-2212
Email: mmckinno@nrao.edu

Ram M. Narayanan 6/00
Department of Electrical Engineering
242N, WSEC
University of Nebraska-Lincoln
Lincoln, NE 68588-0511
Phone: 402-472-5141
Fax: 402-472-4732
Email: rnarayanan@unl.edu

Karen M. St. Germain 12/02
Remote Sensing Division, Code 7223
Naval Research Laboratory
4555 Overlook Avenue, SW
Washington, DC 20375
Phone: 202-767-3443
Fax: 202-767-9194
Email: karen.stgermain@nrl.navy.mil

Board on Physics and Astronomy

2101 Constitution Avenue, NW, Washington, DC 20418

Telephone (202) 334 3520 Fax (202) 334 3575 Email bpa@nas.edu national-academies.org/bpa

NRC Staff

Donald C. Shapero, Director
Email: dshapero@nas.edu

Robert L. Riemer, Associate Director
Email: rriemer@nas.edu

Board on Physics and Astronomy
The National Academies
2101 Constitution Avenue
Washington, DC 20418
Phone: 202-334-3520
Fax: 202-334-3575
Email: bpa@nas.edu

Consultants

Paul Feldman
Attorney at Law
Fletcher, Heald and Hildreth
11th Floor
1300 North 17th Street
Rosslyn, VA 22209
Phone: 703-812-0400
Fax: 703-812-0486
Email: feldman@fhh-telcomlaw.com

John Kiebler
14520 Dowling Drive
Burtonsville, MD 20866
Phone: 301-384-9615
Fax: 301-901-9207
Email: jkiebler@cpcug.org

A. Richard Thompson
National Radio Astronomy Observatory
520 Edgemont Road
Charlottesville, VA 22903
Phone: 804-296-0285
Fax: 804-296-0278
Email: athomps@nrao.edu