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

In the Matter of	)	
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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 Frequencies[1] (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.

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

[2]CORF 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

[3]Current 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 dBW/m^2/(100 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.

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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 O_2 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

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