

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of)
)
Space Modernization for the 21st Century) SB Docket 25-306
)

**COMMENTS OF THE
NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES**

The National Academy of Sciences, through its Committee on Radio Frequencies (hereinafter, CORF),¹ hereby submits its comments in response to the Commission's *Notice of Proposed Rulemaking* (NPRM) in the above-captioned docket, FCC 25-69 (released October 29, 2025). In these comments, CORF points out text that appears to be inadvertently missing in the Part 100 rules proposed in the NPRM and suggests text insertions to remedy those omissions and continue important protections for radio astronomy that are in the current Part 25 rules.

I. Background: The Importance and Vulnerability of Radio Astronomy Service.

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

As the Commission has long recognized, radio astronomy is a vitally important tool used by scientists to study the universe. It was through the use of radio astronomy that scientists discovered the first planets outside the solar system, circling a distant pulsar. The Nobel Prize-winning discovery of pulsars by radio astronomers has led to the recognition of a widespread

¹ See the Appendix for the membership of the Committee on Radio Frequencies.

population of rapidly spinning neutron stars with surface gravitational fields up to 100 billion times stronger than that on Earth. Subsequent radio observations of pulsars have revolutionized understanding of the physics of neutron stars and have resulted in the first experimental evidence for gravitational radiation, which was recognized with the awarding of another Nobel Prize. Radio astronomy has also enabled the discovery of organic matter and prebiotic molecules outside the solar system, leading to new insights into the potential existence of life elsewhere in the Milky Way Galaxy. Radio spectroscopy and broadband continuum observations have identified and characterized the birth sites of stars in the Milky Way, the processes by which stars slowly die, and the complex distribution and evolution of galaxies in the universe. The enormous energies contained in the enigmatic quasars and radio galaxies discovered by radio astronomers have led to the recognition that most galaxies, including the Milky Way, contain supermassive black holes at their centers, a phenomenon that appears to be crucial to the creation and evolution of galaxies.

Synchronized observations using widely spaced radio telescopes around the world with very-long-baseline interferometry give extraordinarily high angular resolution, far superior to that which can be obtained using the largest optical telescopes on the ground or in space. Indeed, the first image of a supermassive black hole, in the M87 galaxy, and its shadow was obtained by such an array of radio telescopes,² followed most recently by observations of the

² See The Event Horizon Telescope Collaboration, 2019, *The Astrophysical Journal Letters*, 875, L1, <https://doi.org/10.3847/2041-8213/ab0ec7>. See also J. Greene, "The Black Hole Photo Was No Big Surprise Scientists. Here's Why It's Still a Big Deal," *Washington Post*, April 12, 2019, at <https://www.washingtonpost.com/opinions/2019/04/12/black-hole-photo-was-no-big-surprise-scientists-heres-why-its-still-big-deal/>; S. Kaplan and J. Achenbach, "See a Black Hole for the First Time in a Historic Image from the Event Horizon Telescope," *Washington Post*, April 10, 2019, at <https://www.washingtonpost.com/science/2019/04/10/see-black-hole-first-time-images-event-horizon-telescope/>; and D. Overbye, "Darkness Visible, Finally: Astronomers Capture First Ever Image of a Black Hole," ; and D. Overbye, "Darkness Visible, Finally: Astronomers Capture First Ever Image of a Black Hole," *New York Times*, April 10, 2019, <https://www.nytimes.com/2019/04/10/science/black-hole-picture.html>., April 10, 2019, at <https://www.nytimes.com/2019/04/10/science/black-hole-picture.html>.

black hole at the center of the Milky Way Galaxy.³

The critical scientific research undertaken by RAS observers, however, can only be performed with access to interference-free spectral bands. Notably, the emissions that radio astronomers receive are extremely weak: a radio telescope receives less than 1 percent of one-billionth of one-billionth of a watt from a typical cosmic object. Because radio astronomy receivers are designed to pick up such remarkably weak signals, radio observatories are particularly vulnerable to interference from in-band emissions, spurious and out-of-band emissions from licensed and unlicensed users of neighboring bands, and emissions that produce harmonic signals in the RAS bands, even if those human-made emissions are weak and distant.

II. The Proposed Part 100 Is Missing Portions of Rules That Provide Critical Protection to RAS Observations.

It appears that in converting the entire set of Part 25 rules to a new set of Part 100 rules, the proposed Part 100 rule with critical protections for RAS observations at 1610.6–1613.8 MHz [100.283(c)(2)(i)] is missing important text, and an equivalent to the Part 25 rule providing critical protections for RAS observations at 14.47–14.50 GHz [25.228(j)(3) and (4)] is missing in its entirety. Given the diligent conversion to proposed Part 100 of all other Part 25 rules providing protection for RAS observations, these two omissions appear to be inadvertent.⁴

A. The Commission Should Add Text to Proposed Section 100.283(c)(2)(i).

Proposed Section 100.283(c)(2)(i) addresses the protection of RAS observations at 1610.6–1613.8 MHz. This band is widely used by radio astronomers for studying the hydroxyl (OH) molecule that exists in stellar atmospheres and in clouds in the Milky Way. This molecule

³ See The Event Horizon Telescope Collaboration, 2022, *The Astrophysical Journal Letters*, 930, L2, <https://doi.org/10.3847/2041-8213/ac6674>.

⁴ In addition, CORF notes a typo in proposed Section 100.244(a)(1)(ii): “Pile Town, NM” should be replaced with “Pie Town, NM.”

has an important emission line with a rest frequency of 1612.231 MHz, often amplified via maser emission in geometrically compact regions. This emission provides unrivaled information about morphology and magnetic fields in star forming regions. In external galaxies, OH maser emission (possibly redshifted outside the RAS allocation) has also been used as a tool to measure the masses of the supermassive black holes at the galactic centers. In addition, this frequency provides important data regarding certain galaxies (where the lines may be redshifted outside of the RAS allocation) to measure the masses of supermassive black holes at the galactic centers. The 1612.231 MHz line is listed as one of the spectral lines of greatest importance to radio astronomy in Table 1 of the International Telecommunication Union Radiocommunication Sector (ITU-R) Recommendation ITU-R RA.314. Footnote US342 provides that “all practicable steps shall be taken to protect the radio astronomy service from harmful interference” from assignments to active services in this band.

Current Section 25.254 provides in part:

“(b) An applicant for an ancillary terrestrial component in these bands [1610-1626.5 MHz/2483.5-2500 MHz] must demonstrate that mobile terminals shall:

- (1) Meet the requirements contained in § 25.213 to protect radio astronomy service (RAS) observations in the 1610.6-1613.8 MHz band from unacceptable interference;”

Section 25.213 contains extensive provisions for protection of the RAS in the 1610.6–1613.8 MHz band against interference from 1.6/2.4 GHz Mobile-Satellite Service (MSS) systems. This would include the ancillary terrestrial components that are integrated into such satellite systems.

Proposed Section 100.283(c)(2)(i) appears to directly address the same requirement, with largely the same language:

“An applicant for an ancillary terrestrial component in these bands must demonstrate that mobile terminals shall:

- (i) Meet the requirements contained to protect radio astronomy service (RAS)

observations in the 1610.6-1613.8 MHz band from harmful interference;”

However, there is no reference to another rule after “contained,” as is the case with Section 25.254 (“contained in § 25.213”). As a result, not only are specific protection criteria left unreferenced but also the sentence itself seems incomplete. Accordingly, the words “in Section 100.244(a),” the proposed Part 100 rule that appears to be the equivalent of the current Section 25.213,⁵ should be inserted into proposed Section 100.283(c)(2)(i) after the word “contained.”

B. The Commission Should Add a Rule into Part 100 That Is Equivalent to Sections 25.228(j)(3) and (4).

The proposed Part 100 rules in the NPRM appear to contain an equivalent of every rule in current Part 25 that provides protection to RAS, except two: Sections 25.228(j)(3) and (j)(4). These rules address operations of Earth stations in motion (ESIMs) in the 14.47–14.5 GHz frequency band in the vicinity or within radio line of sight of RAS observatories observing in the 14.47–14.5 GHz band and are critical for the protection of such RAS observations.

The 14.47–14.50 GHz band is extensively observed by astronomers studying comets, star formation, interstellar matter, and galactic dynamics. This allocation covers emission of the formaldehyde molecule, and observations at these frequencies provide a sensitive diagnostic of density of the emitting gas. Observation of formaldehyde is valuable in the study of interstellar clouds. Formaldehyde maser emission and absorption have been found in a growing number of galaxies, including our own, and observation of the distribution of formaldehyde clouds helps scientists understand the structure of galaxies.

⁵ Compare: “**§ 100.244 Inter-service coordination requirements for the 1.6/2.4 GHz MSS.**

(a) Protection of the radio astronomy service in the 1610.6-1613.8 MHz band against interference from 1.6/2.4 GHz MSS systems” with

“**§ 25.213 Inter-Service coordination requirements for the 1.6/2.4 GHz Mobile-Satellite Service.**

(a) Protection of the radio astronomy service in the 1610.6-1613.8 MHz band against interference from 1.6/2.4 GHz Mobile-Satellite Service systems.”

The importance of protecting RAS observations in this band is well recognized, both internationally and domestically. The spectral line at 14.488 GHz is listed among those of greatest importance to radio astronomy in Table 1 of ITU-R RA.314. Footnote 5.149 includes 14.47–14.5 GHz as among those in which “administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference.” The same requirement is stated in Footnote US342. Footnote US133(b) requires even more protection from Earth stations aboard aircraft (ESAAs), and specifically cites Section 25.228(j)(3):

“in the band 14.47-14.5 GHz, operations within radio line-of-sight of the radio astronomy stations specified in 47 CFR 25.228(j)(3) are subject to coordination with the National Science Foundation in accordance with the requirements set forth in that rule section.”

Indeed, Footnote 133(b) mandates the existence of Section 25.228(j)(3) or its equivalent.

Commission orders have long recognized the existence and importance of Section 25.228(j)(3) and its prior iterations. In 2018, the Commission consolidated its rules on ESIMs. Therein, it created Section 25.228(j)(3), which states:

“Operations of ESIMs in the 14.47-14.5 GHz (Earth-to-space) frequency band in the vicinity (for ESVs and VMESs) or within radio line of sight (for ESAAs) of radio astronomy service (RAS) observatories observing in the 14.47-14.5 GHz band are subject to coordination with the National Science Foundation (NSF). The appropriate NSF contact point to initiate coordination is Electromagnetic Spectrum Management Unit, NSF, Division of Astronomical Sciences, 2415 Eisenhower Avenue, Alexandria VA 22314; Email: esm@nsf.gov. Licensees must notify the International Bureau once they have completed coordination. Upon receipt of the coordination agreement from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations. Table 1 provides a list of each applicable RAS site, its location, and the applicable coordination zone.”

In the Matter of Amendment of Parts 2 and 25 et al., Report and Order, 33 FCC Rcd. 9327 (2018) at para. 45.

That same Order modified Footnote US133(b) to specifically reference the requirements of Section 25.228(j)(3):

“(b) In the band 14.47-14.5 GHz, operations within radio line-of-sight of the radio astronomy stations specified in 47 CFR 25.228(j)(3) are subject to coordination with the National Science Foundation in accordance with the requirements set forth in that rule section.”

In a subsequent Order establishing the Space Bureau as a replacement for the International Bureau, the Commission not only retained the requirements of Section 25.228(j)(3) [while substituting in references to “Space Bureau” in place of “International Bureau”], it enacted an additional requirement in Section 25.228(j)(4) to protect *future* RAS facilities:

“(4) When NTIA seeks to provide similar protection to future RAS sites that have been coordinated through the IRAC Frequency Assignment Subcommittee process, NTIA will notify the Commission’s Space Bureau that the site is nearing operational status. Upon public notice from the Space Bureau, all Ku-band ESIMs licensees must cease operations in the 14.47-14.5 GHz band within the relevant geographic zone (160 kms for single-dish radio observatories and Very Large Array antenna systems and 50 kms for Very Long Baseline Array antenna systems for ESVs and VMESs, radio line of sight for ESAAs) of the new RAS site until the licensees complete coordination for the new RAS facility. Licensees must notify the Space Bureau once they have completed coordination for the new RAS site and must submit the coordination agreement to the Commission. Upon receipt of such notification from a licensee, the Space Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party opposed the operations.”

In the Matter of Establishment of the Space Bureau et al., Order, 38 FCC Rcd. 608, 652 (2023).

In sum, as recently as 2023, the Commission has recognized the importance of protecting existing and future RAS sites from interference from ESIMs at 14.47–14.50 GHz. Furthermore, the Space Bureau established compliance with Section 25.228(j)(3) as a condition in specific satellite authorization orders. See, for example, *In the Matter of Space Exploration Holdings, LLC Request for Orbital Deployment et. al*, DA 24-222 (released March 8, 2024), at para. 22.I. In the present proceeding, the Commission should ensure that these critical protections are properly translated to the new Part 100 rules.

III. Conclusion

As discussed above, text containing important protections for radio astronomy currently

in the Part 25 rules appears to have been inadvertently omitted from the Part 100 rules proposed in the NPRM. Accordingly, the Commission should ensure that these critical protections are properly translated to the new Part 100 rules. Doing so would serve the public interest in protecting cutting-edge research and in maintaining the integrity of the Commission's satellite rules.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
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