Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Allocation and Designation of Spectrum for	)	
Fixed-Satellite Services in the 37.5-38.5 GHz,	)	IB Docket No. 97-95
40.5-41.5 GHz, and 48.2-50.2 GHz Frequency	)	RM-8811
Bands; Allocation of Spectrum to Upgrade	)	
Fixed and Mobile Allocations	)	
in the 40.5-42.5 GHz Frequency Band;	)	
Allocation of Spectrum in the 46.9-47.0 GHz	)	
Frequency Band for Wireless Services; and	)	
Allocation of Spectrum in the 37.0-38.0 GHz	)	
and 40.0-40.5 GHz for Government Operations	)	

REPLY 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),[1] hereby submits its Reply Comments in response to comments filed on the Commission's May 31, 2001, Notice of Proposed Rulemaking in the above-captioned docket (NPRM). In these Reply Comments, CORF discusses the flaws in comments opposing the Commission's proposal to provide footnote protection for radio astronomy observations at 42.5-43.5 GHz, and the flaws in comments supporting the allocation of Broadcasting-Satellite Service (BSS) or Fixed-Satellite Service (FSS) downlinks at 42.0-42.5 GHz.

I. Introduction.

In its initial Comments in this proceeding, CORF demonstrated that radio astronomy observations in the 42.5-43.5 GHz band are very important and that, like all such observations, they are very

[1] A roster of the committee membership is attached.

vulnerable to interference from unwanted emissions. CORF expressed particular concern about the potential for harmful interference from BSS and FSS operations in the 42.0-42.5 GHz band. CORF pointed out that the basis for its concern was not that it would be technically impossible for satellite operators at 42.0-42.5 GHz to filter their emissions to the degree required to avoid harmful interference to Radio Astronomy Service (RAS) observations in the immediately neighboring band, but rather that doing so might incur costs greater than commercial operators are willing to accept. As discussed more fully below, the initial comments of satellite operators reinforce CORF's concern. CORF recommends that, to protect the RAS observations from harmful interference, the Commission enact footnote protection of the 42.5-43.5 GHz RAS band, and should delete any satellite downlink allocation from the 42.0-42.5 GHz band.

II. Footnote Protection for the RAS Band Is Necessary and Appropriate.

In its initial Comments, CORF supported the Commission's proposal to enact a new domestic footnote modeled on Footnote S5.551G. Such a footnote is necessary if radio astronomy observations are to continue in the 42.5-43.5 GHz RAS band without harmful interference from satellite downlinks in the neighboring bands. The opposition of several satellite operators to footnote protection is based on incorrect arguments.

For example, TRW, Inc. suggests (in its comments at page 16) that enactment of the Commission's proposed footnote would constitute a "novel form of protection that would set a dangerous precedent . . .." It claims (in its footnote 35) that under ITU radio regulations "[radio astronomy] is protected only at the lowest applicable levels." This assertion is incorrect. It was the ITU itself that enacted Footnote S5.551G, which is the model for the Commission's proposed footnote. Presumably, the ITU would not enact a footnote that is inconsistent with its own regulations. Rather, the enactment reflected a recognition by the ITU that the sensitivity of the RAS to out-of-band interference is substantially greater than the sensitivity of other services. This recognition is based on unambiguous

factual evidence.

TRW also states that ". . . [TRW] has found that the protection criteria in Rec. ITU-R RA.769 are plainly too conservative, as the results of several studies submitted to Task Group 1/7 and Working Party 4A make clear." CORF is aware of documents submitted to ITU-R task groups and working parties that state that satellite operators cannot meet the protection levels in Rec. ITU-R RA.769 in some radio astronomy bands. Some of these documents from satellite operators also question the need for the protection criteria in Rec. ITU-R RA.769 along the same lines as TRW does in its current filing. None of them demonstrates the contention that the levels in Rec. ITU-R RA.769 are too conservative, and as far as CORF can establish, none was developed in collaboration with the radio astronomy community. In particular, no document supporting this argument has been agreed on within TG 1/7, in which both radio astronomers and satellite operators participated. The levels in Rec. ITU-R RA.769 have been tested by much experience. Because of increases in the sensitivity of radio telescopes and other technological improvements that allow longer integration times, CORF believes that, far from being conservative, those levels are several decibels less stringent than would be desirable currently for astronomical observations.

Astrolink International LLC suggests (in its comments at pages 4-5) that there is no support in the record for the out-of-band limits in the Commission's proposed footnote, for two reasons: (1) U.S. radio astronomy observatories allegedly are less susceptible to interference than is assumed by Rec. ITU-R RA.769-1, which forms the basis for Footnote S5.551G; and (2) according to Astrolink, few U.S. observatories make observations at 43 GHz, but the proposed footnote would require protection of all of them. These assertions are incorrect.

Astrolink's first unsupported assertion makes reference to satellite-industry arguments submitted to ITU TG 1/7 that compare a radio-astronomy antenna with a 2-foot antenna such as an offset Cassegrain reflector. There is currently only one operational radio astronomy antenna in the United States with an offset feed. This telescope (the Green Bank Telescope, or GBT, in West Virginia) has been commissioned recently, and its performance has yet to be measured at 43 GHz. All other existing radio

telescopes have significant feed blockage, feedleg blockage, or both, and these effects often produce the strongest sidelobes on an antenna. When tests on the GBT antenna have been completed at 43 GHz, it is anticipated that the far-out sidelobes may indeed be weaker than the antenna patterns that have been used to derive the standard ITU antenna models. If this expectation is realized, then it may be appropriate to take the actual sidelobe pattern into consideration for the GBT—particularly by using the geographical separation of the satellite downlink footprint and the radio telescope as one of the mitigation techniques—in determining the satellite operational schedule.

Radio telescopes differ significantly from Earth stations, most notably in their large size, which imposes certain limitations on them. The comparison with an offset-feed 2-foot dish is not meaningful, because:

1. The 2-foot dish used in these arguments is an offset design with no blockage. Only one radio telescope in the United States has an unblocked aperture.
2. For a large antenna (e.g., a 25-meter dish operating at 7 millimeters wavelength) the sidelobe response 19 degrees from the boresight is dominated by scattered radiation, not the circular-aperture diffraction pattern that alone would cause sidelobe levels to decrease with increasing dish size. Note that Rec. ITU-R S.580-5 gives 29 – log(phi) as a design objective for new, large antennas; this corresponds to sidelobes of –3 dBi at 19 degrees. Rec. ITU-R S.580-5 clearly distinguishes between large and smaller antennas, recognizing that the same performance criteria do not apply to both.
3. The 2-foot dish, to which radio astronomy antennas are compared, presumably has a solid surface, so that no sidelobes are generated by panel gaps or by panel misalignment; being small, it can be manufactured with high precision and is unlikely to suffer significant distortions as a result of gravity, temperature gradients, or wind. All of these sources of distortion become very important for the larger antennas used in the RAS, resulting in a much increased sidelobe level.

4. With a small Cassegrain dish it is economically feasible to under-illuminate the subreflector, which will further reduce the antenna's sidelobes. However, the effectiveness of this approach depends on details of the electromagnetic design. Such a reduction in the gain introduced by under-illuminating cannot be tolerated on a large and expensive radio telescope.
5. Radio telescopes are designed to observe over a very wide range of frequencies, which results in blockage of the surface by a large subreflector and numerous feeds in the vertex area. Satellite Earth stations, by contrast, often are designed to use only one frequency band that enables a design with a single high-gain feed that requires only a small subreflector.

Astrolink's other argument—that most U.S. observatories do not observe in the 43 GHz band—is also incorrect. Table 1 lists the U.S. observatories and antenna sites that regularly use this band. These observatories represent most of the forefront radio astronomy facilities located in the United States.[2]

Lastly, Astrolink suggests at page 3 of its comments that the limits in Footnote S5.551G should not form the basis of the footnote protection proposed by the Commission, since the ITU action is subject to revision at the 2003 World Radiocommunication Conference (WRC-03). But failure to codify the current limits at this time would be unnecessarily harmful to both the RAS and satellite operators. If the current limits are liberalized in 2003, then it will be easy for the Commission to make parallel revisions, and no harm will have been done to satellite interests in the interim. However, if the current limits are retained at WRC-03, then the failure to codify the current limits will likely result in 3 wasted years of planning by the satellite industry to meet a standard less stringent than required. In sum, it is easier for

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[2] The United States also provides substantial support for future radio observatories located in San Pedro de Atacama, Chile, and Sierra Negra, Mexico (and current and future telescopes at the South Pole) that will observe in this band. U.S. astronomers also regularly collaborate with foreign astronomers in carrying out observations in this band with radio telescopes located in Europe, Asia, and Australia.

the Commission (and best for all parties) to relax the requirement in 2 years if the Commission then so decides, rather than to tighten it after 2 years.

Table 1: U.S. Observatories and Antenna Sites Regularly Observing in the 42.5-43.5 GHz Band

Site	Latitude	Longitude	Diameter (meters)	Telescope Type
Socorro, NM	34º 05′ N	107º 37′ W	25	Connected-element array
Green Bank, WV	38º 26′ N	79º 50′ W	100	Single dish
Westford, MA	42º 37′ N	71º 29′ W	36	Single dish
Kitt Peak, AZ	31º 57′ N	111º 37′ W	12	Single dish
Pie Town, NM	34º 18′ N	108º 07′ W	25	VLBI
Kitt Peak, AZ	31º 57′ N	111º 37′ W	25	VLBI
Los Alamos, NM	35º 47′ N	106º 15′ W	25	VLBI
Ft. Davis, TX	30º 38′ N	103º 57′ W	25	VLBI
North Liberty, IA	41º 46′ N	91º 34′ W	25	VLBI
Brewster, WA	48º 08′ N	119º 41′ W	25	VLBI
Owens Valley, CA	37º 14′ N	118º 17′ W	25	VLBI
St. Croix, VI	17º 45′ N	64º 35′ W	25	VLBI
Hancock, NH	42º 56′ N	71º 59′ W	25	VLBI
Mauna Kea, HI	19º 48′ N	155º 27′ W	25	VLBI

NOTE: A central location is denoted for the 27 antennas that compose the Very Large Array near Socorro, New Mexico. The 10 telescopes used in very long baseline interferometry (VLBI) observations are each listed.

III. Allocation of the 42.0-42.5 GHz Band to a Satellite Service Will Likely Result in Harmful Interference to RAS Observations.

In its initial Comments, CORF supported the Commission's proposal to delete the BSS allocation from the 42.0-42.5 GHz band, and CORF opposed the allocation of the 42.0-42.5 GHz band to the FSS. The comments of certain satellite operators opposing the deletion are flawed.

Astrolink, on pages 6-7, states that the Commission should not delete the current 42.0-42.5 GHz BSS allocation. Astrolink argues that since the power flux-density (PFD) limit in the proposed footnote should provide the required protection to RAS observations, this limit should be sufficient without deleting the neighboring allocation. The ironic flaw in this approach is that in pages 4-6 of its comments,

Astrolink advocates *reducing* the PFD limit in the proposed footnote, an action that, if adopted, would undercut the premise of its argument against deletion of the allocation.[3]

TRW suggests (pages 15-16) that not allocating the 42.0-42.5 GHz band to FSS conflicts with the U.S. position at WRC-97 and WRC-00. But TRW has made an extensive showing (pages 17-18) that satellites in the 42 GHz band "will not be able to meet" the requirements of Rec. ITU-R RA.769, or even Footnote S5.551G, as applied to 43 GHz RAS observations. While CORF believes that there are many flaws in this showing, it may be the case that compliance with the required protections, while technically achievable, is not currently commercially feasible. If so, clearly the proper policy is not to ignore the internationally mandated protections for the RAS, but rather to allocate the spectrum to satellite operators in a band where they can comply with the operational requirement to protect their spectral neighbors. The Commission's proposal to delete the BSS allocation from the 42.0-42.5 GHz band wisely recognizes the substantial difficulty that satellite operators would have in meeting required out-of-band limits while transmitting in the 42.0-42.5 GHz band.

IV. Conclusion.

CORF supports the Commission's proposal to add a footnote based on the limits in Footnote S5.551G to protect the RAS at 42.5-43.5 GHz. Such a footnote is essential to protection of RAS

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[3] CORF believes that *both* footnote protection and deletion of the 42.0-42.5 GHz satellite allocation are necessary to prevent harmful interference to RAS observations, since even in the absence of downlinks in the 42.0-42.5 GHz band, out-of-band emissions from broadband satellite downlinks *below* 42 GHz could easily reach into the 42.5-43.5 GHz band. However, if the "either/or" approach is taken, then CORF strongly supports the enactment of the proposed footnote, relying on the Commission to enforce the limits therein.

observations in this band. CORF also supports the proposal to delete the BSS allocation in the 42.0-42.5 GHz band, and CORF opposes allocation of that band to the FSS.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

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CERTIFICATE OF SERVICE

I, Nelson Quiñones, a project assistant in the Board on Physics and Astronomy of the National Academy of Sciences, do hereby certify that a true copy of the foregoing *Reply Comments of the National Academy of Sciences' Committee on Radio Frequencies* was sent this 3rd day of October, 2001, via United States First Class Mail, postage prepaid, to the following:

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