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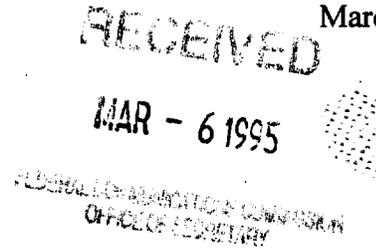
2101 Constitution Avenue Washington, D.C. 20418

BOARD ON
PHYSICS AND ASTRONOMY

(202) 334-3520
FAX: (202) 334-2791
INTERNET: BPA@NAS.EDU

March 6, 1995

Ms. Donna R. Searcy
Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554



Re: IC Docket No. 94-31

In the Matter of
Preparation for International
Telecommunication Union
World Radiocommunication
Conference

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Dear Ms. Searcy:

Transmitted herewith by the National Academy of Sciences, through the Committee on Radio Frequencies of the National Research Council, are an original and nine (9) copies of its comments 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

Enclosure

cc: Members of CORF
Mr. Paul J. Feldman
Mr. Richard Gould
Dr. Donald C. Shapero

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

NATIONAL ACADEMY OF SCIENCES
Bruce Alberts, President

March 6, 1995

Direct correspondence to:

Dr. Robert L. Riemer
HA-562
National Research Council
2101 Constitution Ave., NW
Washington, D.C. 20418
(202) 334-3520

With copies to:

Paul J. Feldman, Esq.
Fletcher, Heald & Hildreth
1300 North 17th Street
11th Floor
Rosslyn, VA 22209
(703) 812-0403

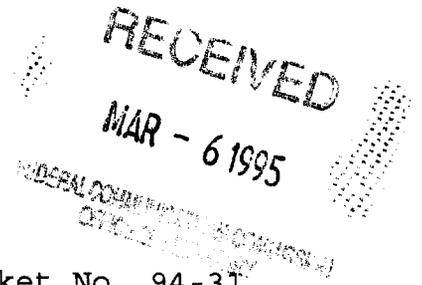
and

Mr. Richard G. Gould
Telecommunications Systems, Inc.
1629 K Street, NW, Suite 600
Washington, DC 20006
(202) 223-4449

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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554



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

The National Academy of Sciences, through the National Research Council's Committee on Radio Frequencies ("CORF"), hereby submits its comments in response to the Commission's *Second Notice of Inquiry* ("Second NOI") in the above-captioned proceeding. CORF represents the interests of the radio astronomy service, the Earth exploration-satellite service, the space research service, and other users of the radio spectrum engaged in scientific research.

I. Introduction

CORF is present in this proceeding because radio astronomy operations at numerous frequencies are protected on a co-primary basis both internationally and in the U.S. Table of Allocations. As the Commission has long recognized, while the radio astronomy service ("RAS") has produced unique and tremendously valuable information about our universe, it is also uniquely vulnerable to

interference from both in-band and unwanted emissions since the signals received from the cosmos are extraordinarily weak-- usually less than a *trillionth* of a watt. Accordingly, the Commission has recognized the special need to protect this passive service, generally, as well as in the context of service and allocation rules for the mobile satellite service ("MSS").¹

In the *Second NOI*, the Commission seeks comments on proposals intended to "facilitate implementing competitive MSS operations by easing international technical and regulatory restraints and providing additional spectrum allocations." *Id.* at para. 6. CORF recognizes the value of a competitive MSS industry and has worked with (and is committed to continuing to work with) MSS operators to reduce "technical and regulatory constraints" as much as possible without countenancing substantial harm to radio astronomy and other passive users of the spectrum. However, CORF urges the Commission to modify some of its proposals in this proceeding to protect the RAS from potentially devastating harmful interference from MSS operations. These minor modifications will have no major impact on the viability of the MSS, but failure to make the suggested

¹See, e.g., MSS Allocation Report and Order, 9 FCC Rcd 536 (1994) at para. 18; and MSS Service Rules Report and Order, 9 FCC Rcd 5936 (1994) at paras. 100-121.

modifications could needlessly undercut protections to the RAS enacted in prior proceedings. The rules containing these protections not only are in the public interest but also constitute finely balanced compromises negotiated at length between representatives of the RAS and proposed MSS operators.

II. CORF Recommendations Regarding Mobile Satellite Service Issues

A. MSS Below 1 GHz

In paragraph 19 of the *Second NOI*, the Commission proposes that the 149.9-150.05 MHz band be allocated to the MSS generically as given in Proposal No. 2/L-LEO. This band is adjacent to the band 150.05-153 MHz, which is allocated to the RAS in Region 1 and in Australia and India. Many of the observatories in those countries have highly specialized programs and capabilities. In particular, India's Giant Meterwave Radiotelescope (GMRT) in Poona will have unique capabilities for studies of the early universe that are not replicated anywhere else in the world and that are of special interest to U.S. scientists.

Although the band 150.05-153 MHz is not allocated to the RAS in Region 2, this does not mean that the band is unimportant to radio astronomers in the United States and throughout the Western

Hemisphere. This allocation satisfies an important scientific requirement to sample continuum radiation at approximately octave intervals (doublings) in frequency and is the longest wavelength essentially free from ionospheric effects, e.g., scintillation. Pulsars and many continuum sources reach their maximum flux density value near this part of the spectrum. Pulsars actually have great practical significance for accurate timekeeping standards. Meter-wavelength studies of continuum sources tell us a great deal about synchrotron radiation mechanisms. In addition, this band can be used for study of the spectral-line recombination radiation from hydrogen, helium, and carbon atoms in our own Galaxy, and the very highly red-shifted hydrogen-line radiation from the early universe.

Since the band was heavily used and is still being intensely used by the fixed and mobile services in the Americas, it has not been possible to allocate it to the RAS in Region 2. Therefore, astronomers in the Western Hemisphere regularly use observatories in parts of the world where observations in this band are protected by an allocation. Foreign observatories so used include those in Europe and Australia, and especially the United Kingdom and India (including the GMRT).

Unfortunately, the Commission's proposal to broaden the present worldwide Earth-to-space land mobile satellite service

(LMSS) allocation to a generic MSS (also Earth-to-space) could include transmitters on aircraft. Such uses would cause interference to the RAS from much greater distances.

For the sake of comparison, it should be noted that the report of the MSS Above 1 GHz Negotiated Rulemaking Committee recognized that in-band and unwanted emissions from aeronautical stations in the band 1610-1626.5 MHz could cause interference to radio astronomy observatories over much greater distances than from mobile Earth terminals on the Earth's surface--even considerably beyond the horizon, if tropospheric refraction propagation and other propagation modes, e.g., meteor and auroral reflections, are taken into account. The Negotiated Rulemaking Committee recommended that, as a first approximation, protection zones around observatories should be based on the line-of-sight distance to the horizon at the altitude of the aircraft. This recommendation was incorporated in the Commission's *Big LEO Report and Order*. See Docket No. 92-166, Appendix B, new Section 25.213 (a)(1)(iv).

The problem will be much more difficult to overcome at the VHF frequencies under consideration here: at these lower frequencies, unwanted emissions into the RAS band beginning at 150.05 MHz will be hard to reduce because filtering of MSS transmitters will be much less effective and more complex (due to

higher insertion loss, greater weight and volume) and therefore, more costly. Moreover, roll-off from filtering is slower (i.e., less effective) when the percentage of frequency difference is small, as is the case at these lower, VHF frequencies.

In sum, since the potential for interference on these VHF frequencies to radio astronomy observatories from high-flying aircraft will occur frequently and over extremely large areas, aeronautical stations should not be allowed to use the band 149.9-150.05 MHz. Therefore, if the allocation to the LMSS is changed to a generic MSS allocation, the phrase "except Aeronautical Mobile" should be made part of the allocation.²

²The concerns set forth above regarding the proposed change of allocation from LMSS to generic MSS in the 150 MHz band apply equally to proposals in paras. 32-33 regarding the 1660-1660.5 MHz band, except that the airborne interference will, a fortiori, be significantly worse since it will be in-band. Therefore, as recommended above, if the allocation to LMSS in the 1660-1660.5 band is changed to a generic MSS allocation, the phrase "except Aeronautical Mobile" should be made part of the allocation.

B. MSS Between 1 and 3 GHz

In paragraph 23 of the *Second NOI*, the Commission proposes to clarify footnote RR 731 to reflect that the effective isotropically radiated power (e.i.r.p.) limit be expressed in terms of a "mean" rather than a "peak" value. CORF believes that the use of a reference bandwidth, 4 kHz in this case, implies that mean power is intended. Throughout the Radio Regulations, the reference bandwidth used in specifying e.i.r.p., power flux density (p.f.d.), and other measurements is typically the smallest bandwidth used by the interfered-with service, and therefore, the one over which the interfering power may be spread without causing unacceptable interference.

With regard to time averaging, CORF recommends a one-quarter second averaging time. This will permit flexibility in use of peak-to-average power ratios in the range 1 to about 1000, the latter limit being set by twice the Nyquist sampling rate of a 4 kHz bandwidth.

In paragraphs 24-27 of the *Second NOI*, the Commission considers the proposals of MSS operators that RR 733E be suppressed. CORF is supportive of that portion of paragraph 27 which states that the Commission does not propose to suppress RR 733E; however, CORF is very concerned by the concluding phrase of that sentence--"at this time"--which implies that the

Commission might still recommend that the United States propose suppression of this important Radio Regulation at 1995 World Radiocommunication Conference (WRC) or at a future WRC. CORF is also concerned over the Commission's alternative suggestion "to suppress RR 733E and propose a new international footnote that incorporates the RAS protection rules embodied in the *Big Leo Report*." Similarly, CORF is concerned that while footnote 33 to the *Second NOI* confirms the Commission's intent to protect the RAS in the 1610.6-1613.8 MHz band, that footnote also expresses disagreement with CORF's inference that the Commission previously reaffirmed its intention to retain RR 733E.

It is important to note that footnote 33 cites paragraphs 101-109 of the *MSS Service Rules R&O*: paragraphs that deal only with protection of the RAS from in-band interference. Protection of the RAS from out-of-band interference is dealt with in paragraphs 110-113. There, the *R&O* recognizes "that MSS uplink operations in the 1613.8-1626.5 MHz portion of the band could cause unacceptable out-of-band interference into operations at 1610.6-1613.8 MHz." (See 9 FCC Rcd at 5979.)

The *R&O* considered the views of the MSS parties and the several alternative methods suggested by CORF for protecting the RAS from these unwanted emissions, and it concluded that Big LEO licensees would not be unduly burdened by protecting the RAS

observations from these unwanted emissions, noting that less than one percent of MSS customers would be affected, and that even that small number would not be denied communications: those customers would simply be assigned another uplink channel by the MSS network control center.

The R&O then concluded consideration of the problem of protecting the RAS from these unwanted emissions by stating (at 9 FCC Rcd at 5981):

We do not believe that the CORF proposals [to protect RAS from out-of-band, uplink MSS emissions throughout the 1613.8-1626.5 MHz band] relegate the MSS to co-primary or even lower status . . . [t]herefore we adopt CORF's proposals to protect RAS during observations, from out-of-band emissions caused by Big LEO systems.

This protection of the RAS on a domestic basis that the Commission has affirmed is, in essence, identical to the protection of the RAS on an international basis that is embodied in RR 733E.

The Commission seeks comments as to whether a different, ideally more specific, Radio Regulation can be substituted for RR 733E. CORF disagrees that such a substitution is possible. If all the U.S. and foreign Big LEO systems that will ever be

placed in operation were to have the same technical and operational characteristics, and therefore, the same interference potential, more specific criteria could be incorporated in the Radio Regulations than is now embodied in the broad protective language of RR 733E. But systems are not going to be identical, or even similar, as evidenced by the diverse parameters of the current Big LEO system applicants. In such circumstances, the determination of whether interference will be caused to the RAS by a prospective MSS system only can be made on a case-by-case basis. With the broad protection afforded by RR 733E in place, negotiations between the prospective operator and the radio astronomy community can take place.

For example, the actual performance of the transmitter filters and the resulting emission spectra will determine how much frequency separation and how much distance separation are required to protect a specific radio astronomy observatory from emissions from mobile Earth stations in a particular Big LEO system. Similarly, the actual transmitter characteristics will determine how much frequency separation (from the RAS band) is required to protect observatories from space-to-Earth satellite transmissions in the 1613.6-1626.5 MHz band. Of course, the Commission remains the final authority to ensure that these

coordinations will be conducted in good faith and that reasonable calculation methods and interference criteria will be employed.

Therefore, CORF believes that the best way to carry out the Commission's stated intention to protect the RAS in the band 1610.6-1613.8 MHz is to retain RR 733E unchanged. Furthermore, it would be inconsistent--and would represent poor international policy--for the United States to prohibit its MSS licensees from causing interference to the RAS in the United States by means of their unwanted emissions, and then propose suppression of a Radio Regulation that now prohibits those same systems from causing harmful interference to radio astronomy observatories elsewhere in the world. Removing the protection of RR 733E would permit future foreign Big LEO systems to interfere with the RAS in the United States because foreign systems would not be bound by the domestic rules that protect U.S. radio astronomy from FCC-licensed MSS systems.

Without RR 733E, the RAS would have only the weak protection of RR 734 from the emissions of other services in the 1610.6-1613.8 MHz band, and no protection from the unwanted emissions of services in the 1610-1610.6 and 1613.8-1626.5 MHz bands. CORF therefore strongly recommends retention of RR 733E in its present form.

In paragraphs 28-31 of the *Second NOI*, the Commission seeks comments on a proposal to revise RR 753F by striking the reference to RR 2566 and providing increased p.f.d. limits that are specific to RR 753F. CORF is concerned that the higher p.f.d. levels that would be permitted worldwide in the band 2483.5-2500 MHz under the Commission's proposal would inevitably result in greater interference from unwanted, second-harmonic emissions into the 4990-5000 MHz band, which is allocated exclusively to the RAS worldwide. To reduce the likelihood of such harmful interference, CORF proposes that a cautionary note be incorporated in the proposed modified Footnote RR 753F:

Administrations are urged to take all practicable steps to prevent interference to the radio astronomy service from emissions in the 2483.5-2500 MHz band, especially those caused by second-harmonic radiation that would fall into the 4990-5000 MHz band allocated exclusively to the radio astronomy service worldwide.

In paragraph 35 of the *Second NOI*, the Commission seeks comments on a proposal regarding sharing of the 1675-1710 MHz band between the meteorological satellite service and the MSS. In spite of the potential for interference between the MSS and the Earth exploration-satellite service and meteorological

activities, the 1675-1710 MHz band is currently allocated in Region 2 not only to downlinks of meteorological satellites ("MetSats")--with the 1675-1700 MHz segment of that band also allocated to meteorological aids ("MetAids")--but also on a co-primary basis with the MSS and the Earth exploration-satellite service.

Paragraph 34 of the NOI notes that footnote RR 735A requires that the MSS shall not cause interference or constrain the development of meteorological satellites operating in the 1675-1710 MHz band. If it is assumed that most of the transmissions between MetSats and the Earth involve fixed Earth stations, it appears reasonable that appropriate measures can be taken to avoid interference through cooperative agreements between the different services. If current ITU-R studies now under way conclude that sharing is indeed possible, then these different services can use the band and RR 735A can be retained to continue the current protections to the MetSat service.

The present allocation and the proposed modification of RR 735A can have a serious impact on MetAids. MetAids in this context means radiosondes, which, typically, are balloon-borne instruments for measuring profiles of temperature, humidity, and winds in the atmosphere. The transmitters operate at a nominal frequency of 1680 MHz but are subject to frequency drift during

the ascent through the atmosphere. Radiosondes are operated in both operational and research modes.

In research applications such as cloud physics studies, radiation and climate studies, sensor evaluation, and so on, radiosondes are often employed as a source of ground-truth for passive remote sensors that measure atmospheric water substance and cloud base temperature and for active sensors such as wind profilers and cloud radars.

In these experiments, which are typically done on campaigns of several week's duration, radiosondes are often released as frequently as every three or four hours. Launch sites may vary during the course of the experiment. As a result, the potential for interference from MSS ground stations operating in the 1680 MHz band is greater than in the operational case. At the same time, the research operating mode makes cooperative efforts in minimizing interference difficult if not impossible to implement.

In sum, although the possibility of sharing is being examined by International Telecommunication Union working groups, the outcome of these studies is still in doubt. Until we have reliable information that defines quantitatively the ability of radiosondes to tolerate interference, the current allocation, including footnote RR 735A, should be retained.

Lastly, footnote 95 of the *Second NOI* states that in spite of the recommendations of the Industry Advisory Committee, the 2300-2310, 2390-2400, and 2402-2417 MHz bands "are not likely candidates for U.S. proposals for MSS [space-to-Earth] allocations." Several reasons are given, including the concern expressed by the National Telecommunications and Information Administration (NTIA) of the Department of Commerce over possible effects on planetary radar research being conducted at Arecibo, Puerto Rico, at 2380 MHz. CORF shares the concern of the NTIA and supports the Commission's decision in the *First Report and Order* in ET Docket No. 94-32, and in other proceedings, to not allocate these bands to the MSS because of the interference that could be caused to this important work. There is no basis for taking a contrary approach in this proceeding.

III. Conclusion

Allocations of spectrum can and should be made for commercial uses of the spectrum, but such uses should not interfere with critical radio astronomy research and other important passive uses of the spectrum. CORF appreciates that the Commission has, in prior proceedings, recognized the importance of radio astronomy and other passive research and taken actions specifically protecting the RAS from interference

from the MSS. CORF believes that some of the proposals in this proceeding would undercut or be inconsistent with the protections recently enacted in the MSS proceedings.

Accordingly, CORF supports many of the proposals in the *Second NOI*, as long as the Commission enacts certain minimum protections for passive users. These protections are not likely to substantially burden commercial use of the proposed bands.

Respectfully submitted,
NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

By:



Bruce Alberts
President

March 6, 1995

Direct correspondence to:

Dr. Robert L. Riemer
HA-562
National Research Council
2101 Constitution Ave., NW
Washington, D.C. 20418
(202) 334-3520

With a copy to:

Paul J. Feldman, Esq.
Fletcher, Heald & Hildreth
1300 North 17th Street
11th Floor
Rosslyn, VA 22209
(703) 812-0403

and

Mr. Richard G. Gould
Telecommunications Systems, Inc.
1629 K Street, NW, Suite 600
Washington, DC 20006
(202) 223-4449