NATIONAL RESEARCH COUNCIL
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Federal Communications Commission
Office of the Secretary

April 8, 1992

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

Re: Gen. Docket No. ____
RM No. 7927

In the Matter of

AMENDMENT OF PARTS 2, 22 & 25
OF THE COMMISSION'S RULES

for an Allocation of Frequencies and
Other Rules for a New Nationwide Hybrid
Space/Ground Cellular Network for
Personal/Mobile Communications Services

Dear Ms. Searcy:

Transmitted herewith by the National Academy of Sciences–National Research Council's Committee on Radio Frequencies 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.

Very truly yours,

Robert L. Riemer

Robert L. Riemer
Senior Program Officer

Enclosure

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List A B C D E

BEFORE THE

Federal Communications Commission

WASHINGTON, D.C. 20554

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Space/Ground Cellular Network for	)	
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COMMENTS OF THE COMMITTEE ON RADIO FREQUENCIES OF THE NATIONAL ACADEMY OF SCIENCES

NATIONAL ACADEMY OF SCIENCES
Dr. Frank Press, President

April 8, 1992

SUMMARY

The Committee on Radio Frequencies ("CORF") of the National Academy of Sciences–National Research Council represents the interests of radio scientists, including radio astronomers, and researchers involved in remote sensing, wildlife telemetry, and meteorological research. In these Comments, the CORF discusses the impact on radio astronomy of the mobile satellite service proposed by CELSAT, Inc., in its Proposal for Rulemaking.

CORF asks for assurance that a method of determining a protection radius around radio astronomy observatories be provided and questions the capability of the frequency assignment subsystem proposed by CELSAT. CORF requests protection against the willful or inadvertent alteration of the output power of user terminals. The Committee maintains that CELSAT's proposal to use the band 2483.5-2500 MHz for space-to-Earth transmissions creates a potential problem for radio astronomy operations at 4990-5000 MHz due to the second harmonic.

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

The National Academy of Sciences, through the Committee on Radio Frequencies ("CORF") of the National Research Council, hereby offers its comments on the above captioned matter.

I. Introduction

CORF's comments are limited to a discussion of the band 1610-1626.5 MHz, proposed for allocation as uplinks, and the band 2483.5-2500 MHz, proposed for downlinks, in the Mobile-satellite service by CELSAT, Inc. in its Petition for Rulemaking.

Use of the band 1610-1626.5 MHz by portable/mobile terminals for Earth-to-space transmissions could cause harmful interference to nearby radio astronomy observatories. Signals in that band from the OH molecule carry unique information that cannot be obtained by other means. Use of the band 2483.5-2500 MHz by satellites for space-to-Earth transmissions creates a potential problem for radio astronomy observatories at 4990-5000 MHz.

The satellite system contemplated by CELSAT would provide service everywhere in the United States, throughout which are located many radio astronomy observatories. One CELSAT proposal is to use the band 1610-1626.5 MHz throughout the United States for Earth-to-space transmissions by Portable/Mobile terminals.

Until recently, the band 1610.6-1613.8 MHz was allocated internationally to Radio Astronomy on a Secondary basis under radio regulation 734. On the initiative of the United States, which, among other administrations, included such a provision in its proposals to the Conference, radio astronomy was raised to Primary status worldwide by the Final Acts of WARC-92. The United States fully supported the change to Primary status and the adoption of Radio Regulation number 733E:

> Harmful interference shall not be caused to stations of the radio astronomy service using the band 1610.6-1613.8 MHz by stations of the radiodetermination-satellite and mobile-satellite services.

This band is important to the radio astronomy community in the United States and the rest of the world for spectral line measurements. The Commission, in Section 25.382(g) of the rules, recognizes the importance of this band; Section 25.382(g) states that "[a]ll authorizations in the Radiodetermination satellite service shall be subject to" Appendix D of the Commission's Report and Order[1/] establishing allocation policies for RDSS. Appendix D establishes restrictions designed to protect radio

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[1/] Report and Order in Gen. Dkt. Nos. 84-689 and 690. In re Amendment of the Commission's Rules to Allocate Spectrum For, and to Establish Other Rules and Policies Pertaining to, a Radiodetermination Satellite Service, 50 Fed. Reg. 39101, 58 RR 2d 1416 (1985).

observatories from RDSS transmissions. Rules should be established as a consequence of this proceeding, specifically designed to protect observatories from MSS systems of the CELSAT type.

CELSAT itself recognizes that portable/mobile terminals in their proposed system, operating in the band 1610-1626.5 MHz, have the potential to cause interference to radio astronomy observatories using the band 1610-1613.8 MHz. CELSAT proposes to avoid such interference by not assigning frequencies below 1614.75 MHZ to portable/mobile terminals in affected areas during periods of radio astronomy observation.

CORF agrees that this method of system operation could prevent interference to radio astronomy, but only if certain conditions could be assured:

- the specified protection radius around observatories must be adequate to protect them from harmful interference from terrestrial and airborne terminals;
- the operation of the frequency assignment sub-system of the control center must be designed to determine, and keep track of, the location of all portable/mobile terminals with sufficient accuracy to prevent the assignment of RA frequencies to terminals within the specified protection radius of an observatory throughout the entire period of operation of such terminals;
- the control center must be able to detect rapidly, and to deal effectively with, portable/mobile terminals operating in the system which have been purposely altered so as to increase their equivalent isotropically radiated power above the design value.

The potential for, and the methods of, reducing the effects of interference to radio astronomy observatories in the band 1610.6-1613.8 MHz, is discussed in more detail in Sections II, III and IV, below.

The second harmonic of satellite transmissions in the band 2483.5-2500 MHz would fall in the band 4967-5000 MHz. The band 4990-5000 MHz is allocated on a Primary basis to radio astronomy and is used extensively for continuum studies.

Filtering should be required in the satellite transmitter to reduce to acceptable levels interference to this radio astronomy band, as discussed in Section V below.

II. Determination of Protection Radius Around Radio Astronomy Observatories

The CELSAT Petition makes reference to the 25 km protection radius around radio astronomy observatories for Geostar terminals but recognizes that a different protection radius may be required for its system:

> The CELSAT emission characteristics and user geographical density are different from those of Geostar and the protection radius may differ from the 25 km value arrived at in the Geostar agreement.

(Petition, Appendix D, footnote 2, page D-7). However, the Petition does not include any calculation or proposal of a radius that CELSAT believes would be adequate to protect observatories from portable/mobile terminals in CELSAT-type systems.

Because of the nature of the Celsat transmissions (i.e. CDMA or "spread spectrum") the determination of the protection radius must take into account the characteristics of all transmissions in the band 1610-1626.5 MHz, that is, by following the methods outlined in CCIR Report 1126.

In the rules to be adopted, a distinction must be made between the protection radius that would be adequate to protect

observatories from terminals operating on the surface of the earth and those operating on board aircraft. The protection radius for the latter might be many hundreds of kilometers.

CELSAT and any other system operators in this band would have to be able to identify positively all terminals aboard aircraft and apply the appropriate protection radius when assigning frequencies to them for uplink transmissions. Alternatively, the operators could adopt the practice of never assigning frequencies in the radio astronomy band to any aircraft terminal.

III. Capability of the Frequency Assignment Subsystem

The CELSAT Petition states that it can modify operations rapidly, on short notice, to accommodate temporary radio astronomy operations at any location, and that it will design the CELSAT system to avoid harmful interference with any existing or future permanent radio astronomy operations within any of its service areas.

This method of operation obviously requires knowledge of the location of every mobile/portable terminal throughout the period it is transmitting. Terminals are to be located by "multilateral position determination":

> In conjunction with receptions of each user signal at several ground or satellite nodes which will always be monitoring the [signalling channel] signal, this provides the basis for CELSAT's position measuring system, capable of position accuracy well within 300 yards."

(Petition, Appendix A, page A-14). While it is reasonable to assume that satellite fix(es) in conjunction with a multiplicity of "ground node" fixes could provide position location of that

accuracy, no description is given of the angle sensing capability of the antenna system of the "ground nodes" which would be necessary for them to determine position.

Furthermore, mobile/portable terminals can often be in regions of the country where no "ground node" would be near enough to receive signals from the mobile terminal, but where the mobile terminal would be close to a radio astronomy observatory and capable of interfering with it. In fact, since radio astronomy observatories are, and will likely continue to be, located in remote and less populous regions of the country, such situations will not be rare. In such cases, the two satellites by themselves will have to be relied on for position determination of the mobile/portable terminals. But with only two satellites, terminal elevation must be known to provide accurate position determination.

In any event, the Petition is silent on the design features of the satellites that would enable them to make such position fixes.

By definition, terminals in mobile-satellite systems are mobile or portable. As such, they can be driven or carried within the protection radius around a radio astronomy observatory during a call, even if they were outside that radius at the inception of the call. Assuming that CELSAT-type systems can determine with sufficient accuracy the geographic location of every user terminal that initiates or responds to a call, a frequency assignment subsystem must prevent the assignment of a frequency in the radio astronomy band to any terminal which is

within the appropriate protection radius (terrestrial or airborne) at the initiation of a transmission, or at any time thereafter if the terminal is carried or driven within the protection radius.

IV. Protection Against Willful or Inadvertent Alteration of User Terminals

The phenomenon of the unauthorized alteration of radio transmitters by users so as to increase significantly their equivalent isotropically radiated power (e.i.r.p.) is not unknown. Such alterations can greatly increase the distances over which an operator can communicate and thereby increase the distance over which interference can be caused to co-channel users.

In addition to having the capability of detecting and disabling such terminals for the protection of its own system, CELSAT and other MSS operators should be required to incorporate such features in their system design to protect radio astronomy.

A separation distance just adequate to protect an observatory from a standard CELSAT user terminal having a power output of one-tenth of a watt would obviously be inadequate to protect that observatory from a 10-watt unit. While the likelihood of a significant increase in e.i.r.p. through inadvertence (e.g., accidental coupling to an antenna of high gain) or equipment malfunction is undoubtedly small, a system designed to detect and cope with intentional power increases can obviously cope with both.

V. CELSAT's Proposal to Use the Band 2483.5-2500 MHz for Space-to-Earth Transmissions Creates a Potential Problem for Radio Astronomy Operations at 4990-5000 MHz.

CELSAT's proposal to use the band 2483.5-2500 MHz for space-to-Earth transmissions in the Mobile-satellite service creates a potential problem for radio astronomy observations, since the second harmonic of those transmissions would fall in the band 4967-5000 MHz. The band 4990-5000 MHz is allocated to radio astronomy on a Primary basis and is used for continuum studies. CORF addressed this potential problem in its comments on the applications of Motorola Satellite Communications, Inc. and Ellipsat Corporation[2/], incorporated herewith by reference. In those comments, CORF stated:

> CCIR Report 224 established the threshold for harmful interference in the 4990-5000 MHz band as -241 dBW/m^2/Hz. CORF recognizes that footnote US74 to the Table of Allocations (47 C.F.R. §2.106) protects radio astronomy in this band from extraband radiation only to the extent that such radiation exceeds the level that would be present if the offending station were operating in compliance with the technical standards or criteria applicable to the service in which it operates.
>
> However, CORF believes that it is feasible, and Ellipsat and any other RDSS operators should be required, to provide adequate filtering in the satellite, in order to reduce interference to this radio astronomy band to below the levels specified in CCIR Report 224.

CORF believes that this same requirement should be applied to MSS systems of the CELSAT type.

[2/] Petition to Deny and comments of the Committee on Radio Frequencies of the National Academy of Sciences, June 3, 1991. In re Applications of Motorola Satellite Communications, Inc. and Ellipsat Corporation, To Construct Satellite Systems to operate in the 1610-1626.5 MHz Band; File Nos. 9-DSS-P-91(87) CSS-91-010 and 11-DSS-P-91(6).

VI. Conclusion

Should the Commission allocate the band 1610-1626.5 MHz to the Mobile-satellite service (Earth-to-space), CORF asks that the following five rules be adopted to protect radio astronomy:

(1) Require the establishment of a protection radius around observatories designated as requiring protection. The radius to protect observatories from interference from terrestrial or airborne mobile/portable terminals should be based on criteria set forth in CCIR Report 224 and be determined using methods outlined in CCIR Report 1126.

(2) Require that any prospective operator whose protection of radio astronomy is based on a determination of the location of user terminals to demonstrate, as a condition of authorization, that the location of such terminals can be determined with sufficient accuracy. In the case of the CELSAT design, CELSAT should be required to demonstrate that two satellite fixes will provide sufficient accuracy to determine when user terminals are within the required protection radius.

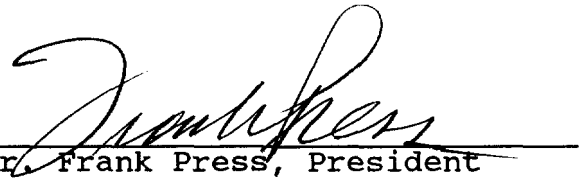
(3) Require that the characteristics and capabilities of its proposed frequency assignment subsystem be adequate and sufficiently reliable to protect observatories from terminals using those frequencies and being carried or driven towards them and operating at less than the protection radius during a call throughout the lifetime of the system.

(4) Require that the characteristics and capabilities of systems be adequate for detecting and coping with unauthorized increases in user terminal e.i.r.p.

And finally, (5) require the use of filtering in satellites using the band 2483.5-2500 MHz, so that the second harmonic of those transmissions reaching the surface of the earth be below the level set forth in CCIR Report 224, that is, -241 dBW/m^2/Hz.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

BY: 
Dr. Frank Press, President

April 8, 1992

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CERTIFICATE OF SERVICE

I, Robert L. Riemer, senior program officer with the National Academy of Sciences—National Research Council, do certify that on April 8, 1992, copies of the "Comments of the Committee on Radio Frequencies" were mailed first-class, U.S. postage prepaid to the following:

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