User Location	Percent Population (%)	Duty Cycle (%)	Weighted Duty Cycle
Outdoor	30	100	0.30
In Car	30	25	0.08
In Building	40	18	0.07
		Sum =	**0.45**
	Average Vocoder Power Reduction (dB) =		*-3.5*

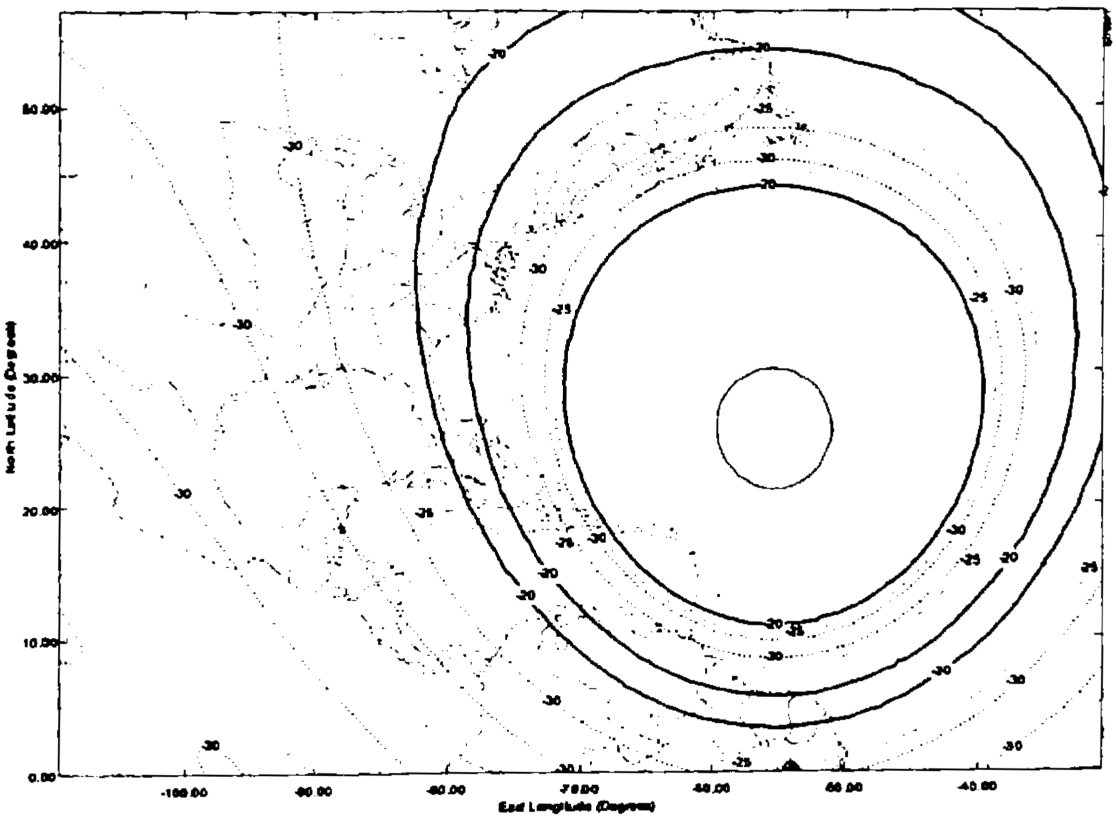
Area No.	Size Sq. Deg.	Relative Size	Discrimination dB	Weighted Discrimination
1	0.19	0.005	-22.5	0.000027
2	0.2	0.005	-27.5	0.000009
3	0.88	0.023	-30.0	0.000023
4	0.71	0.018	-27.5	0.000032
5	2.63	0.068	-22.5	0.000380
6	3.83	0.098	-19.0	0.001238
7	4.67	0.120	-22.5	0.000674
8	2.05	0.053	-27.5	0.000094
9	23.78	0.611	-30.0	0.000611
Sum	38.94	1.000		0.003088
Average Antenna Discrimination (dB) =				-25.1

[89] Inmarsat Comments, Technical Annex, at 4.

[90] ***See*** MSV Nov. 4, 2002 *Ex Parte* Letter at 5

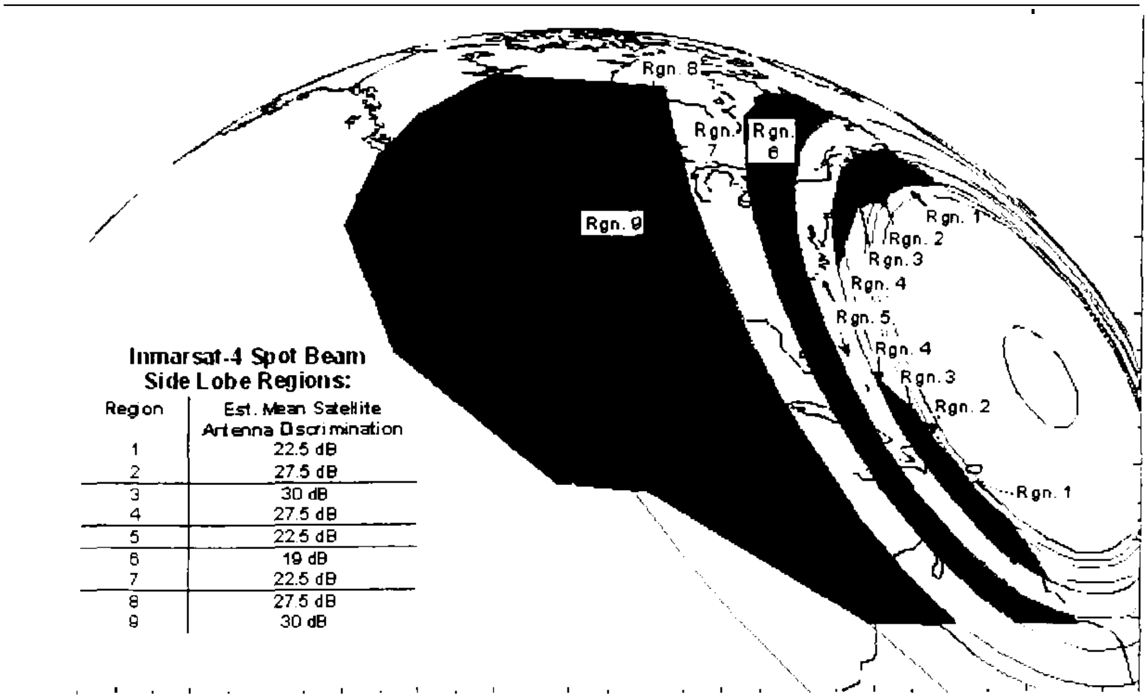
MSV has stated that an Inmarsat antenna discrimination greater than 25 dBi would be required to share with MSV's MSS. MSV calculated that a fully loaded MSV MSS system would increase the delta T/T **of** the Inmarsat receiver by about 30% for this beam.[91] Lnmarsat asserts that the beam under discussion is one that it expects to be able to share spectrum with MSV MSS operations in the absence of ATC. This would imply that an Lnmarsat antenna discrimination greater than *25* dBi would be required to share with MSV's MSS. Only the antenna beams that can operate co-frequency with the MSV **MSS** interference are candidates for operating co-frequency with ATC. Therefore, the minimum Inmarsat discrimination towards MSV ATC coverage considered in co-frequency ATC analyses is *25* dB.

Figure 1.11 A Inmarsat Gain Roll-Off For Selected Inmarsat-4 Antenna Beam



[91] *See* MSV Nov. 4. 2002 *Ex Parte* Letter at 5

Figure l.ll.B **Gain Discrimination** Regions for Selected Inmarsat-4 Antenna Beam



1.12 Saturation levels in **Inmarsat** Receivers

lnmarsat contends that a saturation value of -90 dBm should be used for its receivers.” MSV contends that it has made measurements on an Inmarsat Mini-M receiver that showed that saturation did not occur until the input power reached about -45 dBm, some 45 dB higher than -90 dBm.[93] Additionally, some parties have quoted the Radio Technical Committee on Aeronautics **(RTCA),** which has a standard for -50 dBm for airborne terminals?

GMDSS and AMS(R)S services are provided by Inmarsat and therefore its receivers should have similar performance characteristics. ARINC Characteristics **741** provides specifications on desensitization thresholds for AMS(R)S receivers. ARINC 741 specifies the gain of the front end (comprising the low noise amplifier **(LNA)** and diplexer) **as** being between 53 dB and 60 dB inclusive. In the same document. the **I** dB compression point occurs **at** a minimum front-end output level of 10 dBm. The saturation resulting in desensitization is attributed to the **LNA.** The worst-case front-end input level leading to desensitization is –50 dBm.

Given these potential values for saturation. we feel that the use of -50 dBm for airborne terminals and -60 dBm for mass-produced terrestrial receivers is reasonable.

[92] *See* Inmarsat Comments. Technical App.. Table 3.3-2, dated October 22, 2001. The actual **term** that appears in the Table is -120 dBW, which **is** equivalent to -90 dBm.

[93] *See* MSV Reply. Technical App. at 14.

[94] *See* Boeing April 8. 2002 *Ex Parte* Letter at 10

1.13 MSV MSS Frequency Reuse Factor

MSV states that its next-generation satellite will have approximately 200 beams and will use a 7 cell frequency plan. This, it argues, yields a (200/7 = 28.6) 28 fold frequency reuse factor, allowing it to reuse each frequency 28 times within the satellite coverage area. Inmarsat provides a statistical analysis that, using a number of assumptions, shows that the MSV frequency reuse factor is closer to 8 or 10.[95] The Inmarsat analysis makes the following assumptions:

- The MSV antenna beams are each assigned a number from F-1 to F-7 which is a typical 7 cell reuse plan.
- All the beams are equal in size.
- Traffic volume is distributed exponentially and randomly from beam to beam.
- The bandwidth assigned to any beam is determined by the maximum traffic of any of the beams of the same F number. (In other words, all F-1 beams will be assigned the necessary bandwidth to handle the highest level of traffic in the F-1 beam).

Inmarsat then **sum** the total traffic assigned to all of the beams (calling it the "gross spectrum" or 100.2 MHz) and divides it by the sum of the maximum bandwidths assigned to the individual F1 to F7 cells (calling this the "net spectrum" or 12.0 MHz). Inmarsat then concludes that the frequency reuse is actually (100.2/12.0 =) eight. The study does not. however, take into accounr the fact that both the beam sizes and frequency assignments would be optimized to maximize revenue. This means that, for example, the **F-I** beam directed near Arizona wouldn't necessarily have the same assigned bandwidth as the F-1 beam covering Philadelphia. Nor, would it necessarily be the same size beam. The major factor in optimizing the beam size and frequency assignments is the potential for interference from the closest beams with overlapping frequency assignments. Therefore. the ability to optimize beam size and frequency use within a multi-beam antenna is not unlimited. The result of this optimization will be an increase in the ratio of traffic to assigned bandwidth throughout the MSS system. increasing the effective frequency reuse of the satellite above Inmarsat's example. While a reuse of 8 or 10 is considered too small, a reuse factor of **28** would occur only with a completely balanced. homogenous, traffic pattern across the United States. The **MSS** traffic can not be expected to be totally balanced. We expect that a frequency reuse factor on the order of 20 would be a more appropriate value to use in our analysis

In addressing MSV's reuse of **MSS** frequencies for ATC operations, Inmarsat also argued that, based upon its assessment of MSV's beam roll-off utilization and satellite pointing capabilities, MSV would require additional spectrum beyond that used for its MSS operations." Inmarsat based its argument on certain assumptions on the placement of MSV's ATC base stations with respect to the -10 dB beam contour and on MSV's antenna-pointing accuracy.[97] Satellite pointing errors on the order of those used by MSV are technically feasible. We do not find Inmarsat's arguments persuasive.

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[95] *See generally* Inmarsat **May** 10. 2002 *Ex Parte* Letter. Attach. at i-v.

[96] ***See*** Inmarsat **May** 21, 2002 ***Ex Parte*** Letter. Attach. at 1-12.

[97] Specifically. MSV claims that satellite pointing errors of 0.04 degrees in roll and 0.05 degrees in pitch are possible. Inmarsat adds 0.15 degrees simultaneously in all directions io **its** description of ihe MSV's beam patterns. *See* Inmarsat May 21, 2002 *Ex Parte* Letter at 5.

1.14 Number of MSV ATC Terminals to be used in Interference Analysis

The maximum number of ATC transmitters that can be simultaneously active is an important parameter in determining the potential interference to other systems. MSV proposes to limit the number of transmitting ATC users on its own network by measuring the increased noise-floor of its satellite receiver and to adhere to a maximum increase in the satellite noise floor of *0.25* dB. Inmarsat contends that not only is it very difficult to reliably measure this small increase in noise at the satellite, but MSV MES operating with other MSV satellite antenna beams will obscure the ATC MT measurement. We agree that, without special techniques that no party has explained or demonstrated, it will be very hard to measure reliably the stated increase in the MSV satellite receiver noise floor.

An alternative to measuring the increase in satellite noise floor would be to limit the number of ATC users that correspond to the *0.25* dB increase in the MSV noise floor. The **ATC** users transmit in the satellite receiver frequency band, so the increase in noise floor is directly attributable to the number of simultaneously transmitting ATC users. The difficulty is that the classic method of regulating the number of users would be to issue a blanket license for a specific number of ATC user terminals and, unfortunately, the ratio of the number **of** simultaneously transmitting users to total number of users is unknown for this new application. However, each transmitting user terminal must be associated with a base station carrier transmission. Therefore, it is possible to relate the number of base station carriers operating on a specific frequency to the maximum number of simultaneously transmitting users and, indirectly, limit the associated increase in satellite receiver noise floor.

Table **1.14.A** provides a calculation of the maximum number of the simultaneous user transmitters required to increase the MSV satellite noise floor by *0.25* dB, and the corresponding maximum number base station carriers. Since this approach assumes that 100% **ATC** system occupancy results in a *0.25* dB satellite noise floor increase, it does not allow **for** any amount of excess capacity that would be designed into a system under realistic peak load conditions. **As** a result, it will lead to a lower bound estimate on the number of base stations required to maintain an increase in **MSV** satellite noise floor of 0.25 dB. That is, under realistic loading conditions, MSV could deploy more base stations and reasonably expect lo maintain the *0.25* dB ATC system limit. However. the values calculated in Table 1.14.A will protect the other MSS systems from unacceptable interference.

Table 1.14.A Calculation of Number of MSV ATC Base Stations

Term	Units	Value
Calculation of Maximum Allowable Interference		
MSV Satellite Gain	(dBi)	41
Satellite Receive Noise Temperature	(K)	450
Satellite Noise Density (No)	(dBW/Hz)	-202.1
Allowable Degradation in Beam using Frequency F1	(dB)	0.25
Maximum Degraded Noise Floor (No+Io)	(dBW/Hz)	-201.8
Maximum Allowable Interference Density (Io)	(dBW/Hz)	-214.3
Calculation Interference Received from One MT		
MT Peak EIRP	(dBW)	0.0
MT Bandwidth	(kHz)	200
MT EIRP Density	(dBW/Hz)	-53.0
Average Free Space Loss	(dB)	188.3
Average Outdoor Blockage to MSV Satellite	(dB)	0.5
MSV Average Satellite Antenna Discrimination	(dB)	10
Power Control Factor	(dB)	20.0
Vocoder Factor	(dB)	3.5
Polarization Isolation	(dB)	1.4
Voice Activity Factor for MT	(dB)	1.0
Received Interference Power Density per User	(dBW/Hz)	-236.7
Calculation of Allowed Simultaneous Users per Beam		
Total Allowed Interference Density (from above)	(dBW/Hz)	-214.3
Individual Average MT Interference Density (from above)	(dBW/Hz)	-236.7
Simultaneous Users on Frequency F1	(dB)	22.4
Simultaneous Users on Frequency F1	(#)	173
Number of Base Station Carriers on F1	(#)	173
Approximate Number of Beams over CONUS using F1	(#)	10
Number Base Station Carriers in CONUS on F1	(#)	1725

MSV has stated that it would implement a GSM-like 8 slot TDMA ATC system. Assuming this type of system is implemented. each base station carrier will have one MT, and only one MT. transmitting to it at any time. Table 1.14.A provides a calculation of the number of base stations that may operate on a specific frequency while providing a 0.25 dB increase in the noise level of an MSV satellite receiver on that frequency. Assuming one MT per base station carrier. the resulting number of base station carriers that would be permitted to operate would be about 1725 per 200 kHz of bandwidth assigned to MSV.

In some of its analyses, MSV assumed a total of 90.000 MTs transmitting simultaneously in addition to the assumed 2000 MTs transmitting on a single frequency. This means that it has assumed a total of (90,000/2000 =) 45 separate 200 kHz ATC channels in use. This further assumes a total of (45 * 200 kHz =) 9 MHz of spectrum devoted to ATC downlink and another 9 MHz of ATC uplink. The amount of spectrum actually available to MSV for ATC is the same as the MSV spectrum negotiated between the other L-band MSS operators for MSS operations up to its licensed limit. Since this spectrum is expected to vary annually in accordance with the L-band MOU. we cannot say determine how many ATC channels will exist at any one time. Additionally. as discussed above, we find that the maximum number of MTs on a single channel should be about 1725 as opposed to MSV's number of 2000. This implies that the total number of ATC MTs could vary from the number 90,000 assumed by MSV. For the purposes of assessing the potential for interference to other systems, some number of simultaneously transmitting MTs will have to be assumed. We use MSV's value of 90,000 while noting that the total number of simultaneously transmitting MTs could. in fact, be less.

As shown in Table 1.14.A, limiting the number of simultaneously transmitting MTs to about 1725 will limit the noise increase at the MSV satellite receiver to 0.25 dB. This number of base station carriers, or equivalently, the number of MTs on a channel. is predicated on three important assumptions:

1) that the licensee will implement a vocoder that can be used to reduce the time-averaged EIRP of the MT when operated at high peak EIRPs (see section 1.10);
2) that the licensee will not substitute other MT transmissions in the TDMA time slots left empty by the reduction in MT duty cycle that results from use of the vocoder; and.
3) that the ATC cells will be designed so that. at a minimum, 18 dB of structural attenuation margin is reserved within the link budget (see section 1.2).

If these conditions are not met then the number of allowable BS carriers should be reduced.

2.0 Intra-Service Interference Analyses

Inmarsat and MSV currently share the L-band spectrum with three other GSO MSS systems visible from the United States. MSV, the United States satellite operator; Inmarsat, a United Kingdom company; and TMI, a Canadian company. are authorized to serve end users in the United States. Mexico and Russia are also parties to the Mexico City Memorandum of Understanding. Sharing between these systems is accomplished by their use of geographic and frequency separation. In the geographic regions served by both Inmarsat and MSV, the satellites use different frequencies (i.e., frequency separation). Where the two systems serve different geographic areas of the United States. the two systems may use the same frequencies (i.e., through geographic separation). An additional MSS system. operated by the Japanese, has requested to join the multilateral coordination to gain access to these same frequency bands.

2.1 Potential Interference from ATC Operations to Inmarsat Satellite Receivers

Inmarsat indicates in its comments that it expects high levels of interference to its satellite receivers from MSV's ATC MTs and base stations. Inmarsat contends that its currently operating Inmarsat-3 and its future generation system. the Inmarsat-4 network. will be affected by MSV's ATC operations. MSV maintains that any increase in noise to Inmarsat's systems should be compared with the interference that is produced by MSV's currently operating MSS system. NTIA analyzed the potential for interference to an Inmarsat satellite receiver due to its use of Inmarsat to support GMDSS and AMS(R)S operations.[98] NTIA used a number of different assumptions we have. For example, NTIA assumed a polarization loss factor of 0 dB, a transmit power control factor of 3 dB and a shielding loss of 10 dB. Our assumptions are discussed in Subsection 1. As a result of the use of different assumption, we disagree with the NTIA calculation.

[98] *See* NTIA Nov. 12.2002 *Ex Parte* Letter. Encl 4 at 1-7.

The first of the following analyses evaluates the ratio of interference from MSV's current MSS traffic and compares it to the potential ATC interference to Inmarsat's current and future satellite networks. The second analysis, contained in section 2.1.2, uses a less complex approach to determine the expected increase in the noise floor of the Inmarsat-3 and Inmarsat-4 satellites.

2.1.1 Calculation of Interference to Inmarsat Satellites

Adjacent Band Analysis. Table 2.1.1.A calculates the amount of noise received by Inmarsat's satellite receivers assuming both the MSV and Inmarsat satellite systems are providing service to the same geographic region in different sub-bands of the L-band (i.e. they are sharing the L-band using frequency separation). The amount of noise produced by the current MSV MSS system is compared to future MSV MSS and ATC operations. The results of this analysis are summarized in Table 2.1.1.B.

Table 2.1.1.A - Comparison of Current Operations and Future MSS and ATC Terminal Usage on Inmarsat-3 and Inmarsat-4 for Adjacent Band Situation

		Inmarsat 3			Inmarsat 4		
		Current	**MSS**	**ATC**	**Current**	**MSS**	**ATC**
Inmarsat G/T	(dB/K)	-1.45	-1.45	-1.45	12.87	12.87	12.87
Noise Temp	(K)	700	700	700	650	650	650
Noise Density (No)	(dBW/Hz)	-200.2	-200.2	-200.2	-200.5	-200.5	-200.5
MT EIRP	(dBW)	16	5	0	16	5	0
Bandwidth	(kHz)	6	50	200	6	50	200
MT EIRP Density	(dBW/Hz)	-21.8	-42.0	-53.0	-21.8	-42.0	-53.0
Inmarsat Gain	(dBi)	27	27	27	41	41	41
Max OOB	(dBW/Hz)	-79.5	-103	-103	-79.5	-103	-103
Propagation Loss	(dB)	188.7	188.7	188.7	188.7	188.7	188.7
Outdoor Blockage	(dB)	0.0	0.0	3.1	0.0	0.0	3.1
Power Control Factor	(dB)	0.0	2.0	20.0	0.0	2.0	20.0
Vocoder Factor	(dB)	0.0	0.0	3.5	0.0	0.0	3.5
Voice activity	(dB)	0.0	3.0	1	0.0	3.0	1
Polarization Isolation	(dB)	0.0	0.0	1.4	0.0	0.0	1.4
Received Power	(dBW/Hz)	-241.2	-269.7	-293.1	-227.2	-255.7	-279.7
Received I	(K)	0.055	0.000	$3x10^{-7}$	1.38	0.002	0.00001
Delta-T/T per MT	(%)	0.008	0.00001	$4x10^{-8}$	0.21	0.0003	$1x10^{-6}$
Max No. MT Carriers[99]	(#)	1800	1800	90000	1800	1800	90000
No. Beams Over CONUS	(#)	4	4	4	100	100	100
Sum delta-T/T	(%)	14.1	0.02	0.0004	382	0.54	0.11
Total delta-T/T per Inmarsat Beam	(%)	3.5	0.005	0.001	3.82	0.005	0.001

The impact of future MSV operations, both ATC and **MSS,** on current and future Inmarsat satellites will be significantly less than the current sharing situation in the L-band. Table 2.1.1.B compares the percentage of increased noise that would be received by the currently operating Inmarsat satellites and its future generation system. Inmarsat-4, from the **MSV** system as it currently configured to operate and its proposed ATC operations when sharing through frequency separation is implemented.[100]

[99] See MSV Jan 11, 2002 *Ex Pone* at 22 (providing estimate of full? loaded MSS system)

[100] See MSV Jan. 10, 2002 *Ex Parte* Letter at 22

Table 2.1.1.B – Comparison of Inmarsat Received Interference to Current Interference with Frequency Separation

Ratio of Future ATC Noise to Current MSS Noise	0.03%	0.03%
Ratio of Future MSS Noise to Current MSS Noise	0.14%	0.14%
(Ratio Future Total [MSS+ATC] Noise to Current MSS Noise	**0.17%**	0.17%

In sum, the results contained in the table indicate that, for Inmarsat-3, the expected noise increase due to the MSV ATC will be only 0.03% of the noise increase it is currently experiencing from MSV's MSS system. The combined noise increase from MSV's ATC and future MSS operations would be less than one quarter of one percent (0.17%) of the current MSV operations. The same ratio of future ATC noise to current MSS system noise and future ATC plus MSS noise to current MSS system noise apply to the Inmarsat-4 satellite. One of the conclusions that can be drawn from this table is that the interference to the future generation of Inmarsat satellites is lower if the next generation of MSV satellite is implemented.

It should also be noted that the noise increase. in the out-of-band case treated in Table 2.1.1.A. for both the Inmarsat-4 satellite and the Inmarsat-3 receiver is the same value (i.e., 0.001%).

Adjacent Beam Analysis. Table 2.1.1.C calculates the amount of noise received **by** Inmarsat's satellite receivers assuming both the MSV and Inmarsat satellite systems are providing service to different, but adjacent, geographic regions on the same frequency (i.e., they are sharing the L-band using geographic separation). The amount of noise produced by the current MSV MSS system is compared to future MSV MSS and ATC operations. The results of this analysis are summarized in Table **2.1.1.D.**

Table 2.1.1.C - *Comparison of* Current Operations and Future MSS and ATC Terminal Usage on Inmarsat-3 and Inmarsat-4 for Adjacent Beam Situation

Parameter	Units	Inmarsat 3			Inmarsat 4		
		Current Terminal	MSS Terminal	ATC Terminal	Current Terminal	MSS Terminal	ATC Terminal
Inmarsat G/T	(dB/K)	-1.45	-1.45	-1.45	12.87	12.87	12.87
Noise Temp	(K)	700	700	700	650	650	650
Noise Density (No)	(dBW/Hz)	-200.2	-200.2	-200.2	-200.5	-200.5	-200.5
MT EIRP	(dBW)	16	5	0	16	5	0
Bandwidth		6	50	200	6	50	200
MT EIRP Density	(dBW/Hz)	-21.8	42.0	-53.0	-21.8	-42.0	-53.0
Required OOB Reduction	(dBW/Hz)	0.0	0.0	0.0	0.0	0.0	0.0
Max OOB	(dBW/Hz)	-21.8	-42.0	-53.0	-21.8	42.0	-53.0
Relative Power Density	(dB)	0.0	-20.2	-31.2			
Inmarsat Gain	(dBi)	27	27	27	41	41	41
Propagation Loss	(dB)	188.7	188.7	188.7	188.7	188.7	188.7
Antenna Discrimination	(dB)	22	22	22	25	25	25
Outdoor Blockage	(dB)	0.0	0.0	3.1	0.0	0.0	3.1
Power Control	(dB)	0.0	2.0	20.0	0.0	2.0	20.0
Vocoder Factor	(dB)	0.0	0.0	3.5	0.0	0.0	3.5
Voice activity	(dB)	0.0	3.0	1.0	0.0	3.0	1.0
Polarization Isolation	(dB)	0.0	0.0	1.4	0.0	0.0	1.4
Received Power	(dBW/Hz)	-205.5	-230.7	-265.7	-194.7	-219.7	-254.7
Received I	(K)	205	0.6	0.0002	2581	7.8	0.002
Delta T/T One carrier	(%)	29.3	0.1	0.00003	397	1.2	0.0004
Max # Co-freq Carriers	(#)	2	20	1725	2	20	1725
Total Delta T/T	(%)	58.6	1.8	0.05	794.1	23.9	0.7

The impact of future MSV operations. both ATC and MSS. on current and future Inmarsat satellites will be significantly less than the current sharing situation in the L-band. Table 2.1.1.D compares the percentage of increased noise that would be received by the currently operating Inmarsat satellites and its future generation system, Inmarsat-4. from the MSV system as it currently operates and its proposed ATC operarions when sharing through geographic separation is implemented.

Table 2.1.1.D – Comparison of Inmarsat Received Interference to Current Interference with Geographic Separation

For Adjacent Beam Situation	Inmarsat-3	Inmarsat-4
Ratio of Future ATC to Current MSS Noise	0.08%	0.08%
Ratio of Future MSS to Current MSS Noise	3.02%	3.02%
Ratio Future Total [MSS+ATC] to MSS Current	3.106	3.10%

[101] This is a conservative assumption because, according to MSV, approximately 20 MSV satellite beams cover the ocean or the Gulf of Mexico and are not associated with land areas. *See* MSV *Ex Parte* Jan. 11, 2002 at 14. Theretore ATC could nor be implemented in rhese beams.

2.1.2 Alternative Approach to Estimating Increase io delta-T/T in the Inmarsat Satellites

Another approach to assess the level of interference that would be caused by **MSV's ATC** system to Inmarsat's satellites is to evaluate the change in the noise temperature of the lnmarsat system based on **MSV** limiting its self-interference noise increase to 0.25 dB. For this approach. we assume **that** a number of parameters **are** the same for both satellite **system.** These parameters include: propagation loss, polarization isolation. main beam gain, outdoor blockage. power control, voice activation, and vocoder factor.

Table 2.1.2.A calculates the interference that would be caused to the lnmarsat system. based on **MSV's** intra-system interference target of 0.25 dB, and based on the following other assumptions: the average **MSV** antenna discrimination to its own MTs **will** be **10 dB**;[102] for the out-of-beam case (i.e., co-frequency use in adjacent geographical regions) the Inmarsat-3 satellite has 22 dB of antenna discrimination toward the **MSV** ATC users and the Inmarsat-4 satellite has 25 dB of antenna discrimination; and for the out-of-band case (i.e., coverage of the same geographical regions by using frequency separation) the **MSV ATC** terminals have 50 dB of out-of-band attenuation.[103] The results of the calculations in Table 2.1.2.A are summarized in Table 2.1.2.B.

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[102] MSV Jan. 10,2002 ***Ex Panr*** Letter at 21

[103] Inmarsat maintains that the Inmarsat-4 satellite, with a maximum spot beam **pain** of 41 dBi, will only have 20 dB of discrimination toward MSV's ATC *transmitter*. **See** Inmarsat Comments, Technical Annex. § 3.1. However, the Inmarsat-3 satellite **that** has a **spot** beam maximum gain of 27 dBi will have 22 dB of discrimination. Based upon the calculation in Section 1.1I, we use a *25* dB discrimination value for the Inmarsat-4 adjacent beam discrimination. **As** shown in Table 2.1.2.A, the resulting "Total Delta T/T" changes from 0.25% with *an antenna* discrimination *o f 3 dB to 2.1%* with *an* antenna discrimination *of* 20 dB. This is still significantly below the 6% used to trigger inter-satellite coordination. Additionally, the difference in blockage between the MSV satellite and Inmarsat satellite has not been taken into account in this conservative analysis. Adding this factor will reduce the impact of ATC transmissions on Inmarsat's satellites.

Table 2.1.2.A: Calculation of the Increase in Noise Floor of Inmarsat Satellites

Parameter	Units	MSV MT	nmarsat I3 Case 1 In-band	Inmarsat I4 Case 1 In-band	Inmarsat I3 Case 2 In-beam	Inmars: I4 Case 2 In-bear
Satellite Rec. Noise Temp.	(K)	45(	700	650	700	6:
Satellite Noise Density (No)	(dBW/Hz)	-202.				
Allowed Degradation	(dB)	0.2:				
Allowed No+Io	(dBW/Hz)	-201.1				
Allowed Interference Den. (Io)	(dBW/Hz)	-214.:				
Effective MSV User Power	(dBW/Hz)			-57.0	-57.0	-57
Satellite Gain	(dBi)	41.(		41.0	27.0	41
Relative Loss	(dB)	188.:		188.7	188.7	I88
Relative Sat Antenna Discrimination	(dB)	10.(		25.0	0.0	0
Relative Spectrum Roll-Off	(dB)	0.(		0.0	*50.0*	***50***
Effective MSV User Power	(dBW/Hz)	-57.(				
Inmarsat Interference Per MSV Beam	(dBW/Hz)		240.7	-229.1	-268.7	-254
No. Inmarsat Beams per MSV Beam	(#)				25	
No. of Co-Frequency Beams				29		
Inmarsat Interference	(dBW/Hz)			-215.2	-254.8	-250
Inmarsat Interference	(K)			21.97	0.002	0.0(
Total Delta-T/T	(%)	5.9	0.25	3.4	0.00031	0.0(

The analysis in Table **2.1.2.A** first calculates the total ATC MT power density on the surface of the Earth that would be required to increase the **MSV** noise floor by *0.25* dB, the amount that **MSV** indicated as its intra-system interference target That MT power density is then used to calculate the resulting increased noise floor of the Inmarsat satellites. In calculating the increase in noise floor of the Inmarsat satellites, the factors that are taken into account are the differences in the antenna gain between the **MSV** and Inmarsat systems and the out-of-band roll-off of the ATC MTs. Inmarsat contends that there would be little or no difference in the amount of outdoor signal blockage between the ATC user and Inmarsat's satellites and the ATC user and MSV's satellite. Though we disagree with this contention (see section 1.2), this analysis assumes the blockage between the ATC user and the **MSV** satellite is identical to the blockage between the ATC user and the Inmarsat satellite in order to be conservative. It should be noted, however. that the Inmarsat satellites will be seen **by** the ATC user at an average elevation angle *lower* than the

[104] The value of 29 co-frequency MSV beams assumes that the MSV satellite has 200 independent beams and uses a 7-fold frequency reuse plan. We address this value in more detail in **Secuon** I. **I3** and use **a** value of29 here because it is conservative.

	Inmarsat-3 Delta-T/T	Inmarsat-4 Delta-T/T
Adjacent Band	0.0003%	0.001%
Adjacent Beam	0.25%	3.38%

[105] Receiver "overload" or "saturation" occurs when the input total power is sufficient to drive the receiver from its normal, operational linear state, into a non-linear state. The resulting non-linear state provides distortion of the desired input signals and, for severe overload, the inability of the receiver to operate.

Inmarsat claims that an MSV base station. when seen at a distance of 100 meters, will produce a signal 60 dB higher than that which would saturate or overload one of its MES receivers. This claim is based upon a number factors:

(1) Inmarsat assumes that MSV will use *25* carriers per cell[106] while MSV states that the maximum carriers per cell in its design is only three;[107]

(2) Inmarsat argues that its MES will "overload" or saturate when exposed to –120 dBW of interfering power.[108] This number converts to –90 dBm. MSV provided measurements of an Inmarsat Mini-M terminal which indicated that saturation did not occur until the input power reached about –45 dBm (about 45 dB higher than Inmarsat's stated value).[109] A value of –60 dBm is used in this analysis. The -60 dBm value is still considerably more conservative than the -45 dBm threshold measured by MSV;

(3) Inmarsat assumes that the gain of the MSV base station antenna would be **0** dBi when an **MES** terminal *is* 100 m from a base-station antenna. In practice, the antenna would typically be on a tower or building and the angle from the base-station antenna main-beam to the MES receiver would be on the order of 25 degrees. MSV uses a gain discrimination value of –12.5 for this situation. An ITU-R Recommendation incorporated in Inmarsat's comments indicates that this value could be **as** low as **–24 dB**.[110] The –12.5 dB value supported by MSV is therefore much more conservative; and

(4) Inmarsat assumes free-space loss between the base station and the **MES** receiver (i.e., at 100 m there would be a 76 dB loss). This free-space loss calculation is close to the calculated free-space-loss if the antenna were on a 30-meter tower and the **user** stands 100 m away from the tower. MSV uses the WI propagation model that. it states, predicts **94** dB of loss for the same case.[111] Other urban propagation models give a range of expected loss from 80 to **97** dB.[112] A value of 86 dB is used in the following analysis, when assuming operations in an urban environment.[113] For non-urban environments free-space propagation is assumed.

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106 Inmarsat Comments, Technical **Annex** at 9.

107 MSV Reply, Technical App. at 17.

108 Inmarsat Comments, Technical **Annex** at 8

109 **See MSV** Reply, Technical App. at 14

110 ***See supra*** § 1.8, Fig. 1.8.A.

111 The "WI model" refers **to** the Walfisch-Ikegami propagation model. The WI model addresses radio propagation in urban and suburban areas.

112 *See* National Institute of Standards and Technology. Wireless Communications Technology Group. *General Purpose Calculator for Outdoor Propagation Loss*, *available at* <http://w3.antd.nist.gov/wctg/manet/prd_propcalc.html> (last visited. Jan. 30. 2003) (offering propagation software).

113 *See supra* § 1.6

By factoring for three vs. 25 carriers per MSV cell. using –60 dBm as the Inmarsat **MES** overload threshold, and taking into account the antenna pattern to which Inmarsat referred in its comments, any signal propagation loss greater than 86 dB from the base station to the lnmarsat MES should be sufficient to protect the Inmarsat receiver from overload interference. **All** of the propagation models, except the WI line-of-sight model. predict a loss greater than 86 dB. The actual **loss** is a strong function of the surrounding environment and the propagation model used. Since all of the urban and city propagation models predict a loss significantly higher than the free-space model proposed by Inmarsat, we conclude that Inmarsat's MES should not experience overload in the presence of ATC base stations in urban areas.

The following table, Table 2.2.1.1.A, shows the three link budgets used by Inmarsat, MSV and **us** in our respective analyses. Our link budget shows a positive margin against a conservative saturation value of –60 dBm. This should be sufficient to prevent saturation in a reasonably constructed MSS terminal.

Table 2.2.1.1.A Link Budgets **Examining Possibility of** Saturation **of** lnmarsat **Mobile** Earth **Stations (MES)** in Urban Areas

Parameter	Units	lnmarsat	**MSV**	**Staff**
		19.1	19.1	19.1
Total BW per Sector (**3** carriers)	(MHz)	5	0.6	0.6
Max. No. Carriers per Sector	(#)	25	3	**3**
Distance	(m)	100	100	100
BS to MES Propagation Loss	(dB)	76.0	95.5	86
Power Control	(dB)	6.0	6.0	5.2
Voice Activation	(dB)	4.0	4.0	4.0
Polarization Isolation	(dB)	3.0	8.0	8.0
lnmarsat Gain to BS	(dB)	*0.0*	0.0	0.0
BS Gain to lnmarsat	(dB)	0.0	-12.5	-12.5
Received Interference	(dBW)	-55.9	-102.1	-91.8
Saturation level	(dBW)	-120	-75	-90
Saturation Level	(dBm)	-90	-45	-60
Margin	(dB)	-64.1	27.1[114]	1.8

Realizing that urban and city propagation models predict a loss significantly higher than the free space model. overload interference from ATC base stations to lnmarsat MES in an urban environment is not expected to be problematic. It is possible. however. that in limited urban situations, the loss between an lnmarsat terminal and a base station may be less than the 86 dB mentioned above. This is expected to occur rarely, but could cause occasional, limited periods of saturation in lnmarsat terminals operating in these areas. This must be considered in light of the already limited usage of L-band terminals in urban settings due to line-of-sight interruption between the Inmarsat terminals and the satellite due to building. trees and other obstructions. If, hypothetically, **an** Inmarsat terminal **in** an urban environment would be saturated while being within 100 meters of an ATC base station and the radius of the ATC cell was 1 km. then the percentage of restricted area operation for the Inmarsat terminal would be given by the ratio of

114 We note that we could not reproduce MSV's calculated the received signal power level *of–101.9* dBW or the resulting margin of 26.9 dB

the area of restricted operations to that of the ATC cell or ($100^2/1000^2$ = 0.01 or) 1%. For a 6 **km** cell radius cell the ratio is 0.03%. Therefore, the increase in the area in which an Inmarsat terminal might have difficulty in communicating with the satellite could **be** slightly increased. This should be compared with the increase in urban area served by an MSS system using ATC, which would be the majority of the urban area.

It should be stressed that in an urban environment, it will be possible in most instances to operate an Inmarsat MES well within 100 meters of an ATC base station. In many locations, the Inmarsat terminal will be shadowed from the base station due to buildings and other man-made objects, and the loss between the Inmarsat terminals and the base station will be higher than indicated above. In an urban environment, particularly at ranges beyond 100 meters. the path loss between the ATC base station and the Inmarsat terminal should be greater than predicted by the free space model and the Inmarsat terminal should not suffer overload. Furthermore, we believe that the saturation level we have selected for the Inmarsat terminal is quite conservative in estimating the potential for interference.

2.2.1.2 Protection of Inmarsat Terminals in Urban Areas – Out-of-Band Interference
Inmarsat expressed its concern about the possibility of out-of-band interference from an MSV ATC base station to Inmarsat's MES receivers. The details of both Inmarsat's and MSV's analyses are contained in Table 2.2.1.2.A, below. Table 2.2. I.2.A also contains, in the last column, the values that would result from the assumptions we made in Section 1 of this Appendix. The basic differences in the analyses are as follows:

(1) MSV states that Ericsson, MSV's ATC-equipment manufacturer, has committed to a specific out-of-band suppression level of -57.9 dBW/MHz (-1 18 **dBW/Hz**)[115] for the base stations. whereas Inmarsat uses a value of –27 **dBW/200** kHz (-80 **dBW/Hz**)[116] creating a difference of almost 40 dB in the assumed radiated power:
(2) Inmarsat assumes that there is no antenna gain discrimination from the ATC base station to the Inmarsat terminal. As discussed above and in section 1.8, this term should be between MSV's proposed value of –12.5 dB and –24 dB, the lowest possible value according to Figure 1.8.A;
(3) The propagation loss between the transmitter and receiver in an urban environment is also a factor and is similar to the overload analysis, above; and
(4) MSV assumes an **8** dB polarization isolation factor[117] and Inmarsat proposes a **3** dB polarization factor.[118] MSV substantiated the 8 dB factor through both theory and measurement.

115 *See* **MSV Jan.** 11, 2002 *Ex Parte* Letter **at** 26; MSV Comments. *Ex.* E at 1-8.

116 Inmarsat Comments, Technical Annex, Table 3.4-1

117 *See, e.g.*, MSV Jan. 11, 2002 *Ex Parte* Letter at 27; MSV May 1, 2002 *Ex Parte* Letter at ***4***

118 Inmarsat Comments, Technical Annex. at 20.

Table 2.2.1.2.A: Potential Out-of-Band Interference from MSV ATC Base Stations to Inmarsat MES

Parameter	Unit	Inmarsat Value	MSV Value	staff Value
BS In-band EIRF per *200* kHz	(dBW)	19.1		
OOB Attenuation (re Inmarsat)	(dB)	46.1		
Assumed EIRP Toward MES	(dBW)	-27.0		
OOB Power to Ant. Re MSV/Ericsson	(dBW/MHz)		-57.9	
BW Conversion (dBMHz/200 kHz)	(dB)		7.0	
Power to Ant. In Inmarsat band	(dBW/200 kHz)		-64.9	**-64.9**
BS Main beam Gain	(dBi)		16.0	16.0
BS ant discrimination to MES	(dB)	0.0	-12.5	-12.5
EJRP Towards *MES*	(dBW/200 kHz)	-27.0	-61.4	-61.4
Distance lo Antenna	(m)	100.0	100	100
Free space loss	(dB)	-76.0		
WI non-line of sight	(dB)		-95.5	
Average of FSL/WI				-86
Power Control	(dB)	6.0	6.0	5.2
Voice Activity	(dB)	4.0	4.0	1.8
Polarization Isolation	(dB)	3.0	8.0	8.0
Gain Inmarsat **MES** to BS	(dB)	0.0	0.0	0.0
Sum of Attenuation factors	(dB)	89.0	113.5	101.0
Received Int.	(dBW/200 kHz)	-1 16.0	174.9	-162.4
Received Power Spectral Density	(dBW/Hz)	-169.0	-227.9	-215.4
MES Receive Noise Temp	(K)	150.0	290.0	290.0
MES Noise Power	(dBW/Hz)	-206.8	-204.0	-204.0
Increase in Noise	(%)	611.672	0.4	7.2
	(dB)	37.9	-23.9	-1 1.41

Taking all of the above factors into account leads to the conclusion that an Inmarsat MES would experience a noise increase of about 7% as opposed to the 600,000% predicted by Inmarsat.[119] The interference-to-noise ratio (I/N) that corresponds to delta T/T of 7% is -11 dB. This means that the interference power will be, at most, less than 1/10[th] of the noise power of the receiver. Funhermore. the lnmarsat **MES** receiver performance should not be adversely affected by the MSV base station because the small transient degradation experienced by the mobile terminals would occur for only a short amount time due to the mobile use of the terminal.

2.2.1.3 Protection of lnmarsat Terminals in Open Areas

[119] Inmarsat claims that the resulting increase in noise will be 600,000%. *See* Inmarsat Comments, Technical Annex at *20*.

Table **2.2.1.3.A** assumes both the Inmarsat receiver and MSV Base Station **are** operating in an urban environment. Areas such as airports and harbors and waterways offer large building-free areas where the signal propagation from the base station to the receiver is best characterized by free space propagation. The following paragraphs examine possible interference to Inmarsat and other terminals operating around airports and on waterways. The terminal used for this analysis is similar to the Inmarsat Mini-M terminals, which have a **maximum** of 6 dB of gain. Because of the broad antenna beam width associated with the Mini-M terminal, we have assumed that two ATC base stations are in rhe terminal's main beam.

Inmarsat Terminals in Airports. Table 2.2.1.3.A calculates the required distance between the MSV base station and an Inmarsat receiver to avoid saturation. An Inmarsat terminal utilizing a relative low gain antenna. such **as** the Mini-M terminal, is assumed. The resulting distance, 470 m. is approximately 1550 ft. The power flux density. equivalent to a -60 dBm received signal. for a single base station according to the assumptions in Table 2.2.1.3.A. is -73.0 dBW/m^2 in **200** kHz.

Table 2.2.13.A Required Seoaration between lnmarsat Receiver and MSV Base Station (Free Space Propagation)

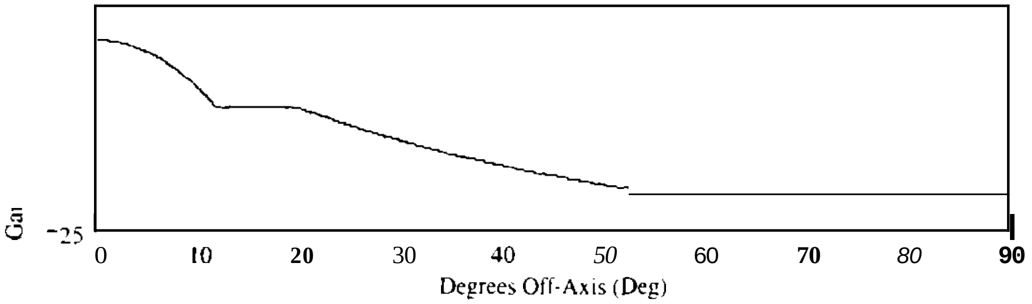
Parameter	Units	Value
Base Station EIRP	(dBW/200 kHz)	19.1
Total BW per sector (3 carriers)	(MHz)	0.6
Max carriers per sector	(#)	3
Number of Base Stations Visible	(#)	2
Distance	(m)	470
BS to MES Loss	(dB)	89.4
Polarization Isolation	(dB)	8.0
Voice Activation	(dB)	1.4
Power Control	(dB)	5.2
BS Gain to Inmarsat	(dB)	-12.5
Inmarsat Gain to BS	(dB)	0
Received Level	(dBW)	-90.0
Assumed Saturation level	(dBW)	-90.0
Margin	(dB)	0.0

2.2.2 Protection of GMDSS/Inmarsat Receivers from ATC Base Stations

Inmarsat terminals may also be located in harbors and on waterways. The frequency band 1530-**1544** MHz is allocated to the GMDSS. This international application is connected to and required by international treaty resulting from the Safety of Life at Sea (SOLAS) Convention. lnmarsat receivers often operate within the GMDSS service. In harbors and on navigable waterways, lnmarsat terminals with larger antennas such as the lnmarsat-B terminals, will likely be used. Table **2.2.2.A** shows the elevation angle of the highest operational Inmarsat satellite as seen from a number of United States cities. As can be seen in the Table, there is always an Inmarsat satellite visible above 30 degrees elevation. Figure 2.2.2.A presents the discrimination pattern fora 21 dBi gain lnmarsat terminal. This Figure **was** developed using Recommendation ITU-R M.694 which contains a reference radiation pattern for **MSS** shipboard antenna operating around 1.5 to 1.6 GHz. The figure shows that the gain discrimination at 30 degrees is 13.2 dB.

City	Inmarsat AORW	Inmarsat POR	Highest Elevation
Washington, DC	40.7	**11.2**	40.7
Boston, **MA**	38.1	5.3	
Miami. FL	48.4	16.9	
Dallas, TX	30.6	29.0	
Denver, **CO**	20.8	**30.4**	
Bismarck, **ND**	32.3	18.0	
Seattle. **WA**	7.4	37.2	37.2
San Francisco. **CA**	8.5	41.9	**41.9**
San Diego, **CA**	14.0	43.7	43.7

Figure 2.2.2.A Inmarsat-B Antenna Discrimination Pattern



In order to analyze the impact of **ATC** base stations on a GMDSS receiver, two cases will be considered: I) receiver saturation (or desensitization) and 2) out-of-band interference. The scenario used in each analysis involves an **ATC** base station transmitter with an antenna height **of** 30 meters and a GMDSS receive antenna that has a height of 7 m. The analysis will consider a 1500 meter separation distance between the **ATC** base station and the GMDSS receiver. The Inmarsat B antenna shown in Figure 2.2.2.A will **be** used to determine the GMDSS receive antenna gain. The base station antenna is assumed to be tilted down at a 5 degree angle. is viewed at about 5 degrees off-axis and a minimum of about 5 dB gain back-off from the antenna mainbeam exists.

NTIA analyzed the effect of ATC base stations on GMDSS terrestrial receivers in a manner significantly different than the approach used in the following paragraphs.[120] NTIA calculated the maximum EIRP that a base station could transmit without causing interference to a shipboard GMDSS receiver under the condition that the GMDSS receiver was located at a worst case distance from the base station. This worst case distance was determined by calculating the highest PFD, at the assumed height of the GMDSS receive antenna, using a base station antenna pattern at two different antenna heights. We disagrre with NTIA that limiting the BS EIRP is the most useful approach. When necessary. we prefer to determine a separation distance between the BS and the possible location ***of*** a ship carrying a GMDSS receiver that will still protect GMDSS operauons.

[120] *See* NTIA Nov 12, 2002 *Ex Parte* Letter. Encl. 3 at 1-12

2.2.2.1 GMDSS/Inmarsat Receiver Saturation

As discussed earlier, a value of -60 dBm (-90 dBW) will be used in this analysis for the desensitization threshold. Table 2.2.2.1.A provides the link calculation for GMDSS receiver desensitization,

Table *2.2.2.1.A* GMDSS Receiver Saturation Calculation

Parameter	Units	Value
ATC BS Antenna Height	(m)	30
GMDSS Antenna Height	(m)	7
Horizontal Distance Between ATC BS and GMDSS	(m)	1500
Slant Range	(m)	1500.2
Frequency	(MHz)	1540
ATC BS Peak EIRP per Carrier	(dBW/200 kHz)	19.1
Camers per Sector (3)	(dB)	4.8
ATC BS Peak EIRE' per Sector	(dBW)	23.9
ATC BS Antenna Gain Back-off	(dB)	-5.0
ATC BS Power Control	(dB)	-5.2
Polarization Loss	(dB)	-8.0
ATC BS Voice Activation	(dB)	-1.8
GMDSS Antenna Gain	(dBi)	21.0
GMDSS Antenna Discrimination	(dB)	-13.2
Propagation Loss	(dB)	-99.8
Received Power	(dBW)	-88.1
GMDSS Receiver Desensitization	(dBW)	-90
Margin	(dB)	-1.9

The link calculation in Table 2.2.2.1.A shows a margin of –1.9 dB. The calculated received power level at the GMDSS receiver input is –88.1 dBW compared to the saturation threshold of -90 dBW. Because of the expected range in signal levels for saturation (-80 to -90 dBW) and the possibility of additional propagation loss above free space, the GMDSS receiver should be protected for the EIRP of 19.1 dBW and a separation distance of 1.5 **km.**

2.2.2.2 Out-of-Band Interference to GMDSS/Inmarsat Receivers

The GMDSS receiver system noise level is used to assess the potential of interference from the out-of-band emissions of ATC base stations. The GMDSS receiver system noise level is calculated using the following equation:

$$N = -172.1 \text{ dBm/Hz}^{[121]} + 10 \text{ Log } (BW_{GMDSS}) -30$$

For a GMDSS receiver bandwidth of 15 kHz, rhe system noise level is **–160.3** dBW/15 kHz. Table 2.2.2.3.A provides the link calculation for GMDSS receiver out-of-band interference.

[121] RTCA/DO-210C. *Minimum Operational Performance Standards for Aeronautical Mobile Satellite Services (AMSS)*, 26 (Jan. 16, 1996).

Table 2.2.2.2.A Out-of-Band Interference *to* GMDSS Receiver Calculation

Parameter	Units	Value
ATC BS Antenna Height	(m)	30
GMDSS Antenna Height	(m)	7
Horizontal Distance Between ATC BS and GMDSS	(m)	1500
Slant Range	(m)	1500.2
Frequency	(MHz)	1540
ATC BS Out-of-Band Power to Antenna	(dBW/200 kHz)	-64.9
Carriers per Sector (3)	(dB)	4.8
ATC BS Mainbeam Antenna Gain	(dBi)	16.0
ATC BS Antenna Gain Back-off	(dB)	-5.0
ATC BS Voice Activation	(dB)	-1.8
ATC BS Power Control	(dB)	-5.2
ATC BS Effective EIRP in GMDSS Band	(dBW/200 kHz)	-56.1
Propagation Loss	(dB)	-99.8
Polarization Loss (BS-LHCP. Inmarsat-RHCP)	(dB)	-8.0
GMDSS Mainbeam Antenna Gain	(dBi)	21
GMDSS Antenna Discrimination	(dB)	-13.2
Receiver Bandwidth Correction	(dB)	-11.2
Received Interference Power in GMDSS Receiver	(dBW)	-167.3
GMDSS Receiver Noise Level	(dBW)	-160.3
Margin	(dB)	*7.0*

As shown in Table 2.2.2.2.A, for an ATC BS out-of-band emission level of -64.9 dBW/200 kHz[122] and a 1.5 km (0.9 mile) separation distance, the interference level in the GMDSS receiver is 7 dB below the system noise. This would result in an increase of the system noise by 0.8 dB and should provide adequate protection for GMDSS receivers. However, in order to ensure that the -64.9 dBW/200 kHz out-of-band emission level in the GMDSS band is maintained, the MSS operator providing the ATC should be required to reduce its emissions below the **-64.9** dBW/200 kHz used in the analysis. One reference states that the emission for a GSM TDMA signal is down 40 dB at the adjacent TDMA carrier frequency.[123] That is, the emission *is* down 40 dB at a separation of 200 kHz from the carrier. To obtain the out-of-band emission level of 44.9 dBW/200 kHz, significantly more than 40 dB of attenuation is required. How this requirement is satisfied is the responsibility of the MSS operator providing ATC.

Table 2.2.2.2.A shows a link calculation with the base station located 1.5 km from the waterway in which the Inmarsat-B terminal equipped ship is located. At 1.5 km, the BS antenna, which is tilted down at a 5 degree angle. is viewed at about 5 degrees off-axis and with a minimum of about *5* dB gain back-off from the antenna mainbeam. Because the beamwidth of the Inmarsat-B terminal is significantly less than that of the Mini-M terminal, we assume that only a single base station will be operating near the main beam.

[122] This is taken to be that same level as -57.9 dBW/MHz dtscussed in MSV's **Jan.** IO. 2002 *Ex Parte* Letter. MSV staled that Ericsson, its ATC equipment manufacturer, has committed IO the specific out-of-band suppression level of -57.9 dBW/MHz.

[123] Dr. Jerry D. Gibson, ed.. The Mobile Communications Handbook. 410 (CRC Press. 1999).

If the base station is located 1.5 km from the waterway, and has clear visibility to the waterway. Table 2.2.2.2.A shows that the Inmarsat-B terminal receiver should have no difficulty in operating. Additionally, with the base station *1.5* km from the waterway, it will appear to be less than 1.2 degrees above the horizon and the propagation loss in most situations will be greater than free space loss. We conclude that a 1.5 km separation between the BS and constricted. navigable waterway should be sufficient to protect an Inmarsat receiver on a ship.

An alternative method to protect the Inmarsat-B type of terminal on a waterway would be to constrain the PFD produced by **a** base station to be less than that required to saturate an Inmarsat-B terminal. Table 2.2.2.2.B shows that a PFD equal to **-64.6** dBW/m^2 in 200 kHz with the mainbeam of the antenna coupled into the Inmarsat-B terminal would produce a received power of -60 dBm (the assumed saturation level of the receiver). Therefore, a requirement either to constrain base stations to maintain a 1.5 km distance from navigable, constricted waterways or to illuminate the edge of the waterway with a PFD no greater than **-64.6** dBW/m^2 in 200 kHz with the base station antennas tilted at -5 degrees from the horizontal should protect the Inmarsat terminals on ships from interference.

Table 2.2.2.2.B Derivation of Received Power at Suggested PFD Limit

Inmarsat-B Gain	(dBi)	21.0
Antenna Discrimination		-13.2
Isotropic Area	(dBm^2)	-25.2
Polarization Isolation		-8.0
Received Power LHCP	(dBW/200 kHz)	-90.0
Conversion to dBm	(dB)	30.0
Received Power LHCP	(dBm)	-60.0

The above analyses indicate that it is possible to protect Inmarsat receivers in open areas such as around airports and harbors by placing limits on the installation of MSV ATC base stations. Specifically, if the base station is no closer to an airport than 470 meters or has a PFD below -73.0 dBW/m^2 in 200 kHz at the edge of the airport runways and stand areas and the base station is installed at least 1.5 *km* from a harbor or navigable waterway or has a PFD below *-64.6* dBW/m^2 in 200 kHz at the edge of the navigable waterway or harbor, then the potential interference to these types of Inmarsat terminals would be significantly reduced if not eliminated.

2.2.3 Potential Interference to Airborne AMS(R)S/Inmarsat Terminals

The frequency band 1545-1555 MHz is allocated to the aeronautical mobile satellite en-route service (AMS(R)S) in the space-to-Earth direction. AMS(R)S is reserved for communications relating to safety of flights (see Provisions No. 1.36, 1.59, 5.37A, and Article **44** of the international Radio Regulations). Inmarsat receivers are often used in the AMS(R)S service. In order to analyze ***the*** impact ***of*** **ATC base** stations on AMS(R)S receivers, two cases will be considered: 1) out-of-band interference and 2) receiver desensitization. **As** discussed earlier, the threshold of -50 dBm is used for the receiver-desensitization analysis. **An** interference threshold based on 6% of the total noise corresponding to an interference-to-noise ratio (I/N) of −12.2 dB is used for the out-of-band analysis.[124]

NTIA analyzed the effect of **ATC** BS on AMS(R)S terrestrial receivers in a manner significantly different than the approach used in the following paragraphs.[125] NTIA calculated the maximum number of BS base stations that would be required to cause interference to an airborne AMS(R)S terminal. NTIA assumed that the AMS(R)S terminal would be located *270* meters above the **BS.** We disagree with **NTIA** that this static model provides a reasonable description of the way an aircraft receiver would operate and choose. instead. to use a Monte Carlo approach as described below.

2.2.3.1 Potential Interference to Airborne AMS(R)S Receivers
Inmarsat performed an analysis to assess the possibility of an airborne Inmarsat terminal experiencing out-of-band interference from the aggregate of a large number of MSV **ATC** base stations that could be visible from a worst case altitude of 302 m (1000 ft). From 302m, a circular area approximately 100 miles from edge-to-edge would be visible to the aircraft.[126] Inmarsat's analysis conservatively assumes that there would be 1000 base stations in this area. Inmarsat also disagrees with MSV that the base station antennas will have significant overhead antenna discrimination to the aircrah. Inmarsat refers to Recommendation **ITU-R** F.1336[127] **as** evidence that, at best. an isolation of only about 10 dB is available from the L-band base-station antennas at high elevation angles. MSV claims that a maximum isolation of 40 dB is achievable. **As** discussed more fully in Section **1.8.** we agree with **MSV.**

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124 *See* Recommendation ITU-R M.1234. *Permissible Levels of Interference in a Digital Channel ofo Geostationary Sarellire Nenvork in the Aeronautical Mobile-Satellite (R) Service (AMS(R)S) in the Bands 1545 to 1555 MHz and 1646.5 to 1656 MHz and its Associnrrd Feeder Links Caused by Other Networks of this Service and the Fixed Satellite Service* (1997). *available at* < http://www.itu.int/rec/ recommendation.asp?type=items&lang=e&parent=R-REC-M.1234-0-199702-I > (last visited, Feb. 1, 2003).

125 NTIA Nov. 12.2002 *Ex Parte* Letter. Encl. 3 at 1-12

126 Assuming an MSV base station antenna height of 30 meters

127 See Recommendstion ITU-R F. *1336. Reference Radiation Patterns Of Omnidirectional, Sectoral And Oilier Antennas In Point-To-Multipoint Systems For Use In Sharing Studies In The Frequency Range From 1 GHz To About 70 GHz, available at* <http://people.itu.int/~meens/pt2/RR/> (last visited. Feb. 4, 2003).

Table 2.23.1.A: Potential Interference to lnmarsat Airborne Receiver from ATC Base Stations

Item	Units	MSV	Monte Carlo Approach
EIRP per Carrier	(dBW)	19.1	
Bandwidth	(kHz/ch)	200	
EIRP density/carrier	(dBW/Hz)	-33.9	
Spurious EIRP density	(dBW/Hz)	-101.9	-101.9
Assumed Spurious Limit	(dB)	-68.0	-68.0
Carriers per sector	(#)	3.0	3.0
Voice activation	(dB)	4.0	4.0
Power control	(dB)	6.0	5.2
Polarization	(dB)	8.0	0.0
Spurious Emission average	(dBW/Hz)	-115.1	-106.3
Gain Disc. Inmarsat MES to Base Station	(dB)	0.0	*0.0*
Calculated Isolation	(dB)	-101.6	-105.I
Received interference power	(dBW/Hz)	-216.7	-211.4
Receiver Noise Temperature	(dBK)	25.0	**25.0**
Receiver Noise Temperature	(K)	316.2	316.2
Receiver Noise Density	(dBW/Hz)	-203.6	-203.6
Interference Temperature	(T)	15.5	52.1
Delta-T/T	(%)	4.9	16.5
Interference to Noise Ratio (Io/No)	(dBW/Hz)	-13.1	-7.8

Table 2.2.3.1.A addresses the details of the potential for interference to aircraft earth stations operating with the Inmarsat system. The calculations in the table are based on MSV's less complex, hut still conservative approach. The key assumption made by MSV was thar it will have 68 dB of our-of-band suppression in the lnmarsat band (see *italicized* entry in the table). As mentioned above, we independently verified. via a MathCad model, the isolation factor in the right-most column using a random ATC base station distribution. Our calculated value matches very closely the value used by MSV (i.e. 101.6dB for MSV versus 105.I dB for the MathCad model). We include the model as an attachment to this appendix. Note that no antenna discrimination was used for the Inmarsat antenna even though an airborne satellite antenna would be expected to have some. and perhaps a significant amount of shielding from terrestrial transmissions. The approach taken here **is** conservative.

In this case, Table 2.2.3.1.A shows that the worst case I/N is about –8 dB, which is 4 dB above the AMS(R)S receiver interference criteria of an I/N of –12.2 dB. Based on the analysis, to protect AMS(R)S receivers from ATC base station operations, the assumed spurious emission level could be reduced by 4 dB to -72 dB. However. hased on the antenna specifications for AMS(R)S antennas the gain in the direction of the base station will be negative, which would provide additional isolation than that calculated in the analysis. Additionally, while no polarization discrimination is used in the analysis. the probability of having no polarization discrimination is remote. The situation improves dramatically as the aircraft altitude is increased. Therefore, this situation should cause no problems to AMS(R)S operations.

2.2.3.2 Overload of Airborne AMS(R)S/Inmarsat Terminals

The possibility of an airborne AMS(R)S/Inmarsat terminal being overloaded by ATC base stations was also evaluated. The analysis of potential saturation of airborne Inmarsat terminals assumes, again, a conservative 1000 base stations being visible from a 302 m (1000 ft.) altitude

Table 2.2.3.2.A Evaluation of Potential for AMS(R)S Airborne

Parameter	Units	MSV Value	Our Analysis
BS EIRP per carrier	(dBW)	19.1	19.1
Carriers per sector	(#)	3.0	3.0
Voice activation	(dB)	4.0	4.0
BS Power Control	(dB)	6.0	5.2
EIRP per sector	(dBW)	13.9	14.7
Polarization Isolation	(dB)	8.0	0.0
Gain Discrimination MES to Base Station	(dB)	0.0	0.0
Loss Factor from OOB analysis	(dB)	-101.6	-105.1
Effective power per Sector @ A/C	(dBW)	-95.1	-90.4
Power at A/C Receiver	(dBm)	-65.7[128]	-60.4
Overload Level	(dBm)	-50.0	-50.0
Margin	(dB)	15.7	10.4

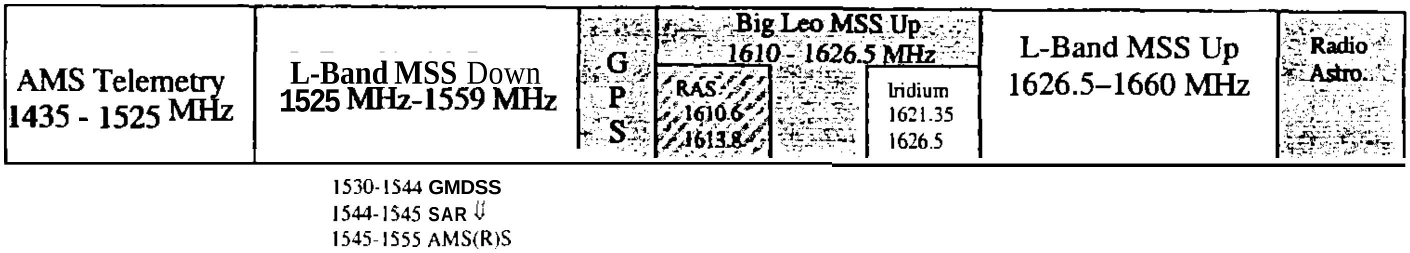
The analysis shown in Table 2.2.3.2.A indicates that there exists a margin of 10 dB against receiver overload or saturation. Additionally. as indicated for the out-of-band case, as the altitude of the aircraft is increased. for example to 5000 ft, the margin against overload increases dramatically by approximately 9 dB to a total margin of 19 dB. Given the conservative nature of the model (e.g. antenna models, 1000 base stations, very low aircraft altitude, omnidirectional aircraft antenna, and no terrain shielding), overload from ATC base stations should not be an issue.

3.0 Inler-Service Interference Analvses

Several services are allocated in and adjacent to the 1525-1559 MHz and 1626.5-1660.5 MHz L-band MSS spectrum. Within the 1626.5-1660.5 MHz and 1525-1559 MHz bands. the Aeronautical Mobile Satellite, en-route Service (AMS(R)S), aeronautical terrestrial service, and Global Maritime Distress and Safety System (GMDSS) are allocated spectrum. Above 1660 MHz, the Radio Astronomy Service is allocated spectrum in the L-band. Within the 1525-1559 MHz band. Search and Rescue Satellite (SARSAT) downlinks operate in the 1544-1545 MHz band. Systems operate adjacent to the L-band spectrum as well. Below the 1626.5 MHz band. Big LEO MSS systems operate in the MSS allocation from 1610-1626.5 MHz. Below the 1525 MHz band edge, Mobile Aeronautical Telemetry systems operate in the 1435-1525 MHz allocation. Above the 1559 MHz band edge, GPS operations in the 1559-1610 MHz Radionavigation Satellite Service (RNSS) allocation. Figure 3.0.A is provided to show the various service allocations located adjacent to and within the L-band MSS allocations where MSV proposes to operate its ATC system.

[128] MSV actually calculates this value as –60 7 dB. *See* MSV Jan. 10, 2002 *Ex Parte* Leuer at 28

Figure 3.0.A: L-Band Service Allocations



3.1 AMS(R)S and GMDSS Operations Conditions

Communications systems operating in the frequency hands occupied by the AMS(R)S and GDMSS services must meet certain operating conditions. The following paragraphs address these conditions.

AMS(R)S Operating Conditions. Footnote US308 to the United States Table of Allocations provides priority to AMS(R)S systems in the upper L-band.[129] MSS operators authorized to provide MSS in the upper L-band are subject to meeting several conditions on their **MES** and Land Earth Stations (Gateways).[130] MSV's ATC operations could be required to protect AMS(R)S under the same conditions that apply to MSS systems operating in the upper L-band, in order to comply with footnote US308. MSV demonstrates in its comments how its ATC system would comply with the priority and preemption requirements with which MSS system must comply under US308. MSV asserts that its ATC network will possess inherent features for handling priority communications.[131] Specifically, MSV's ATC system will be capable of prohibiting entire populations of mobile terminals from accessing its system.[132] In addition to being capable of giving priority to AMS(R)S, the MSV system will also be capable of preempting active channels automatically and immediately (i.e., in less than one second. the MSV gateway would be able to allocate the preempted resource(s) to the AMS(R)S). Terminals would be preempted from providing MSS and ATC in the upper L-band through MSV's ability to simultaneously preempt corresponding satellite and terrestrial resources by the use of a centralized and common control facility for space and ground assets.[133] Based on MSV's explanation of its proposed ATC system, it appears to be able to meet the priority and preemption requirements that its current MSS system is obligated to meet and that its ATC system would therefore be capable of complying with US308.

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[129] *See* 47 C.F.R. § 2.106, n.US308.

[130] *See, e.g.*, ***Application of AMSC Subsidiary Corporation** for a **Blanket License** to **Construct** and **Operate** up to 200,000 L-band Mobile Earth Stations*, Order and Authorization. File No. 2823-DSE-P/L-93, 1995 WL 109123, 12 & 18 (1995).

[131] MSV Comments, Technical App. at 7-11

[132] MSV Comments, Technical App. at 7-11

[133] MSV Comments, Technical App. at 7-11

In the *Flexibility Norice,* the Commission noted that. according to Footnote US309, terrestrial stations are permitted to operate in the frequencies allocated to the AMS(R)S.[134] The Aviation Industry Parties and MSV do not take issue with US309 with respect to potential interference that could be caused to stations operating under the footnote allocation, but rather MSV contends that the footnote supports its claim that it is possible to have a footnote allocation for ATC similar to aeronautical terrestrial stations.[135] The regulatory issue of how lo incorporate ATC in the Table of Allocations is not addressed in this Appendix.

GMDSS *Operating Conditions.* Footnote US315 to the United States Table of Allocations provides priority to the GMDSS in the lower L-band.[136] MSS operators authorized to provide MSS in the lower L-band are subject to meeting several conditions on their METs and Land Earth Stations (Gateways).[137] MSV's ATC operations could be required to protect GMDSS under the same conditions that apply to MSS systems operating in the lower L-band, in order to comply with footnote US3 15. MSV demonstrates in its comments how its ATC system would comply with the priority and preemption requirements that its MSS system must comply with according to US315. MSV asserts that its network will possess inherent features for handling priority communications.[138] Specifically, MSV's ATC system will be capable of prohibiting entire populations of mobile terminals from accessing its system.[139] In addition to being capable of giving priority to GMDSS, the MSV system will also be capable of preempting active channels automatically and immediately (i.e. in less than one second. the **MSV** gateway would be able to allocate the preempted resource(s) to the GMDSS). Terminals would be preempted from providing MSS and ATC in the lower L-band through MSV's ability to simultaneously preempt corresponding satellite and terrestrial resources by the use of a centralized and common control facility for space and ground assets.[140] Based on MSV's explanation of its proposed ATC system, it appears IO be able to meet the priority and preemption requirements that its current MSS system is obligated to meet and that its ATC system would therefore be capable of complying with US315.

3.2 Systems Operating within the **1626.5-1660.5 MHz** Portion **of** the L-Band Spectrum

The Radioastronomy Service (RAS) is allocated spectrum in the 1660-1660.5MHz portion of the L-band to conduct scientific observations. RAS observatories are not located in urban or heavily populated areas; they are typically located in remote areas to avoid receiving noise caused by

[134] *Flexibility Notice* 16 FCC Rcd at 15538, ¶ 12 *n.17*

[135] Indeed. there are no terrestrial stations operating in conjunction with AMS[R]S systems currently in operation that could receive interference. *See* AIP Comments at 4-5 and 7.

[136] *See* Footnote US315 to the U.S. Table of Frequency Allocations. Section 2.106 of the Commission's Rules.

[137] *See L-Band MSS Rules* ***Order,*** 17 FCC Rcd at 2717-23, ¶¶ 30-45

[138] MSV Comments, Technical App at 7-11

[139] MSV Comments. Technical App. at 7-11

[140] MSV Comments. Technical App. at 7-11

radio frequency transmitters.[141] The ITU has conducted studies and recommended appropriate protection requirements for RAS stations.[142] Consistent with the ITU studies, ATC operators could be required to take all practicable steps to avoid interference to United States RAS observations in the 1660-1660.5 MHz band, consistent with Recommendation ITU-R RA.769-1 of the international Radio Regulations.

3.3 Systems Operating within the 1525-1559 MHz Band Portion of the L-Band Spectrum

Search and Rescue Satellite (SARSAT) downlink operations exist in the 1544-1545 MHz band in accordance with Footnote 5.356 of the International Radio Regulations.[143] SARSAT uplink transmissions are located around 406 MHz from Emergency Position Indicator Radio Beacon (EPIRB) transmitters that are downlinked in the 1544-1545 MHz band to various earth station receivers located in the United States. The locations of these Earth stations are listed below in Table 3.3.A.

Table 3.3.A: Locations of SARSAT Receive Earth Stations

Location	Latitude	Longitude	Nearby Local
Alaska	64.9933 N	-147.5237 E	Fairbanks
California	34.6624 N	-120.5514 W	Vandenberg AFB
Florida*[144]	TBD	TBD	TBD
Guam	13.5783 N	144.9391 W	Guam
Hawaii	21.526 N	-157.9964 W	Oahu
Maryland	38.9955 N	-76.8513 W	NASA GSFC
Maryland	38.8510 N	-76.9310 W	Suitland
Puerto Rico**	18.4317 N500	-66.1922 W	Puerto Rico
Texas**	29.5605 N1	-95.0925 W	NASA Huston

(Note: In Table 3.3, a single "*" denotes a future SARSAT site and a double "**" denotes a site that is to be decommissioned.)

MSV is not authorized to provide MSS in the 1544-1545 MHz band so the potential for interference is strictly an out-of-band case. It is also noted from Table 3.3.A that some of the SARSAT earth stations are located in or near urban areas where ATC base stations would be located. In Table 3.3.B, we analyze the potential for interference between transmitting ATC base

[141] 47 C.F.R. § 25.213(a)(1)(i), (ii) (listing RAS sites located in the United States).

[142] *See* Recommendation ITU-R RA.769-1, *Protection Criteria Used for Radioastronomical Measurements, available* at <http://people.itu.int/~meens/Pt2/Rec/RA769-1.pdf> (last visited, Feb. 1, 2003).

[143] *See* International Radio Regulations S5.356. S5.356 states that the use of the band 1544-1545 MHz by the mobile-satellite service (space-to-Earth) is limited to disrress and safety communications). *See* Article S31). *See also* 47 C.F.R. § 2.106.

[144] There are several possible sites in Miami under consideration for a new local user terminal (LUT) location; however, the final decision has not been made. The LUT sires in Texas and Puerto Rico will be eliminated once the Miami LUT site is operational. There is also a possibility on a new LUT site at the Goddard Space Flight Center in Greenbelt. MD.

stations operating in bands adjacent to the receiving SARSAT earth stations. We base our analysis on the MSV ATC base stations king capable of meeting an out-of-band emission level of -57.9 dBW/MHz as in our other interference analyses.

Table 3.3.B: Analysis of SARSAT Avoidance Distance

Item	Units	Value	Comment
Nominal Center Frequency	(MHz)	1554.5	
Polarization			Note 1
Elevation Angle	(Degrees)	0	Note 2
Antenna Diameter	(m)	1.8	
SARSAT Gain (typical)	(dBi)	26.1	
SARSAT (G/T)	(dB/K)	4.0	
SARSAT Noise Temperature	(dBK)	22.1	
Receiver Noise Power	(dBW/Hz)	-205.9	
Allowable I/N	(dB)	-11.32	
Maximum Allowable Io	(dBW/Hz)	-217.2	
Receive Gain	(dBi)	26.7	
Isotropic Area	(dBm^2)	-25.3	
Receive Antenna Effective Area	(dBm^2)	1.5	
Allowable Power Flux at Antenna	(dBW/m^2 Hz)	-218.6	
MSV OOB Emission	(dBW/MHz)	-57.9	
MSV BS peak Antenna gain	dBi	16.0	
BS Gain Reduction Toward Horizon	dB	5.0	
Three BS Carriers	dB	**4.8**	
Power Control	dB	-2.3	
Voice Activation	dB	-1.8	
Polarization Discrimination	dB	0	
Peak Out-of-band Emission	dBW/MHz	-49.1	
MSV OOB Emission Density	(dBW/Hz)	-109.1	
Required Loss	(dBm^2)	134.8	
Maximum Interference Distance	(km)	85.6	
Maximum Interference Distance	(mi)	51.4	

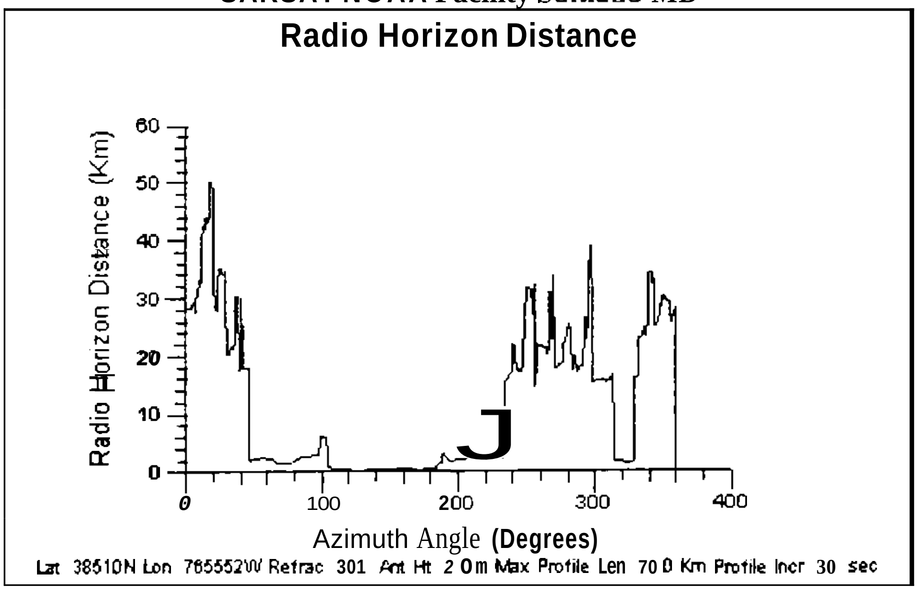
Note 1: SARSAT System uses both Rt P and LHCP
Note 2: SARSAT receivers typically poinr to the horizon awaiting an oncoming NGSO satellite.

As calculated in Table 3.3.B, if the ATC bise station is located more than 85.6 km from the SARSAT receivers. inferference is not expected to occur. This is based on the worst case scenario of the main-beam coupling between the SARSAT receive antenna and the ATC base station transmitting antenna using free-space loss. Path profiling (i.e. selecting locations for ATC base stations where main-beam coupling would be less likely to occur) would further reduce this distance.

NTIA has analyzed the same situation and come to the conclusion that an ATC **BS** within 30 km of a SARSAT station should be coordinated.[145] The approach used by **NTIA** assumed a number of additional technical factors. including: 15% of the interference budget of the SARSAT system was devoted to ATC and an irregular terrain model (ITM) was used to determine coordination distance.[146] The NTIA analysis shows that a coordination distance of 27 km is necessary. We choose to use a 27 km coordination distance.

The following figures show the distance to the radio-horizon for the two SARSAT stations located in the Washington, D.C. area.[147] While the radio-horizon extends beyond the distance calculated **in** Table **3.3.B** along some azimuths, in general. it is much closer than the maximum interference distance. This should make coordination of the BS and SARSAT operations possible at distances much less than 27 km in many cases.

Figure 33.A Distance to Horizon for SARSAT NOAA Facility Suitland MD



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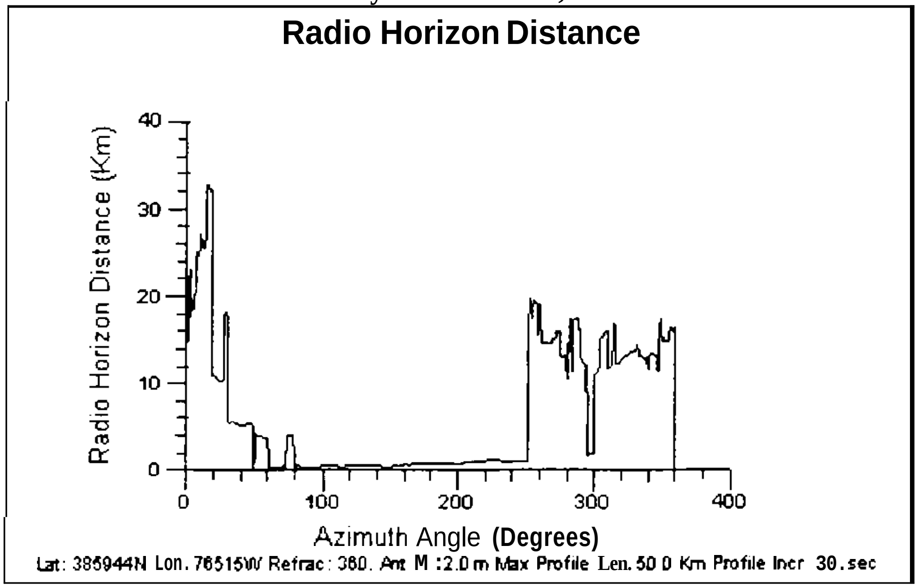
145 *See* NTIA Nov. 12, 2002 *Ex Parte* Letter. Encl. 5

146 The Institute for Telecommunication Science Irregular Terrain Model (ITM). For additional information. *see* NTIA Report 82-100. *A guide to the Use of ITS Irregular Terrain Model in the Area Prediction Mode* (April. 1982).

147 These figures were generated using the software package "HORIZON" available from the NTIA Microcomputer Spectrum Analysis Models webpage http://ntiacsd.ntia.doc.gov/msam/.

Figure 3.3.B Distance to Horizon for SARSAT Facility NASA GSFC, Greenbelt MD



If any ATC base station is intended to be placed within the maximum interference distance of 27 km from one of the locations listed in Table 3.3.A. the operator should provide the Commission with sufficient information so that the Commission can coordinate the ATC BS with SARSAT operations. This should be done on a case-by-case basis prior to operation to avoid possible unacceptable interference to SARSAT operations.

3.4 Systems Operating Adjacent to the 1626.5-1660.5 MHz Portion of the L-Band

MSV's ATC MTs will transmit to ATC base station receivers in the 1626.5-1660.5MHz frequency band. Below the 1626.5MHz band, the Iridium and Globalstar Big LEO systems operate in the 1610-1626.5MHz band. Big LEO MSS **MES** emissions are limited by national and international regulations to an EIRP density limit of –15 dBW/4kHz in pans of the band where airborne electronic aids to air navigation are being developed, and **–3** dBW/4kHz elsewhere in the band.[148] Additionally, section 25.202(f) of the Commission's rules applies an out-of-band emission mask to Big LEO MSS MES emissions within the 1610-1626.5 MHz band. Given these two parameters, Big LEO **MES** emissions are limited to out-of-band power densities of (-3-43 =) -46 dBW/4KHz to (-15-43 =) –58 dBW/4kHz within the 1610-1626.5MHz band.

The peak EIRP of **MSV's** ATC mobile terminal is 0 dBW with a bandwidth of 200 kHz. These parameters produce an in-band EIRP density of –17 dBW/4kHz. Using the same section 25.202(f) out-of-band emission mask that applies to Big LEO terminals yields a maximum ATC MT emission level of *4 0* dBW/4kHz in the Big LEO Band. This value is 2 dB lower than the more restrictive then the Big LEO MES out-of-band requirements to protect other Big LEO operations. Out-of-band emissions from the MSV ATC MTs. therefore, should not interfere with Big LEO systems operating in the adjacent spectrum.

[148] ***See*** Footnote 5.364 to the ITU Radio Regulations, Article 5, Table of Frequency Allocations; **see *also*** 47 C.F.R.§ 2.106.

3.5 Systems Operating Adjacent to the 1525-1559 MHz Portion of the L-Band

Mobile Aeronautical Telemetry (MAT). Mobile Aeronautical Telemetry (MAT) system operate below 1525 MHz. The Aerospace & Flight Test Radio Coordinating Council (AFTRCC) is concerned about the potential for interference that MSV ATC base stations could cause to MAT operations adjacent to the L-band. MSV asserts that. under the worst case scenario, there would be no interference to a MAT receiver from an ATC base station if the ATC base station is located at least 0.9 km from the MAT receiver.[149] We have evaluated MSV's calculations and agree with the assumptions and results of MSV's analysis. However. the proper coordination distance for this case should be based on radio line of sight. MSS operators should take all practicable steps to avoid locating ATC base stations within radio line of sight of MAT receive sites in order to protect United States MAT system consistent with Recommendation ITU-R M. 1459. MSS ATC base stations located within radio line of sight of a MAT receiver must be coordinated with AFTRCC for non-Government MAT receivers on a case-by-case basis prior to operation. For government MAT receivers, the licensee will supply sufficient information to the Commission to allow coordination to take place. A listing of current and planned MAT receiver sites can be obtained from AFTRCC for non-Government sires and through the FCC's IRAC Liaison for Government MAT receiver sites.

Global Positioning System (GPS). The Global Positioning System operates above 1559 MHz. MSV demonstrates in its comments that its ATC base stations will be capable of meeting the -70 dBW/MHz and –80 dBW for discrete spurious emissions measured in 700 Hz, which is required of other radio transmitters operating near the spectrum used by GPS.[150] Based on MSV's proposal to operate its ATC base stations with a transmit power of 23 dBW EIRP per sector, and 1.2 MHz of frequency separation between the ATC base station and the GPS band, MSV's equipment manufacturer, Ericsson. is committed to meeting the out-of-band emission attenuation requirements. Based on the information provided by MSV, it appears that MSV's base stations will be capable of meeting the -70 dBW/MHz (and –80 dBW for discrete spurious emissions) out-of-band emission levels in the RNSS allocation as required by other transmitters currently operating in frequency bands adjacent to GPS operations. This conclusion is supponed by an ***ex pane*** agreement that was submitted to the FCC, jointly, by the GPS Industry Council and MSV on July 17, 2002.

The MSV/GPS Industry Council agreement specifies that the MSV ATC base stations will "[u]se filtering to achieve -100 dBW/MHz, or lower" emissions in the [1559-1605 MHz] frequency band. Also, the *ex parte* filing states that the ATC Terminals will "[u]se filtering to achieve -90 dBW/MHz, or lower, in [the] short-term" and will 'migrate to -95 dBW/MHz, or lower, for new terminals in 5 years (from the date MSV service is operational)" for emissions in the [1559-1605 MHz] frequency band. The emission limits contained in the GPS Industry Council/MSV agreement are significantly lower than those currently required for the protection of the GPS L1 signal by other radio frequency transmitters.

One scenario not specifically addressed by the MSV/GPS Industry Council agreement is that of the potential interference to GPS time-base receivers commonly used in cellular networks. These receivers are typically located on the cellular transmit rowers and supply timing information to

[149] MSV Jan 11. 2002 *Ex Parte* Letter at 29

[150] *See GMPCS Order* 7 FCC Rcd at 8930.7 88

the local phone cell. Because of the possible close proximity of the MSV base station transmit antenna to a cellular time-base receiver of another system, particularly if they are on the same Lower, MSV should take necessary steps to avoid causing interference to receive equipment occupying the same tower.

Annex 1 lo Appendix C2
MathCad Program for Evaluating Potential Saturation of Airborne MSS Receivers in the L-Band

The following examines an airborne receiver receiving potential interference from a number of ATC base stations. The base stations are distributed randomly over an area visible to the aircraft. The airborne receiver has an omnidirectional antenna of Gac. The base station has a Gbs antenna which is oriented with a angle of theta to the horizon and a random azimuth.

some necessary functions

$dB(x) := 10 \cdot \log(x)$ $\quad r2d := \frac{180}{\pi}$ $\quad d2r := \frac{\pi}{180}$

$real(x) := 10^{\left(\frac{x}{\;}\right)}$

$freq := 1.550$ $\quad \left(\frac{0.3}{freq}\right)^2$ $\quad iso = -25.256$

function atan2(x,y) returns the angle (0 to 360 degrees in radians) given x and y values

$$atan2(x,y) := \begin{array}{|l} ans \leftarrow \frac{\pi}{2} \cdot sign(x) \quad \text{if } y = 0 \\ ans \leftarrow atan\left(\frac{x}{y}\right) \quad \text{otherwise} \\ ans \leftarrow \pi + ans \quad \text{if } y < 0 \\ ans \leftarrow 2 \cdot \pi + ans \quad \text{if } x < 0 \wedge y > 0 \\ ans \end{array}$$

```
spread_cir(num, dist) := | i ← 0
                         | while i ≤ num
                         |   | xa ← (1.0 − rnd(2.0))·dist
                         |   | ya ← (1.0 − rnd(2.0))·dist
                         |   | da ← √(ya² + xa²)
                         |   | if da ≤ dist
                         |   |   | az ← atan2(xa, ya)
                         |   |   | out[i,0] ← az
                         |   |   | out[i,1] ← da
                         |   |   | i ← i + 1
                         | out
```

Function spread_cir generates random points over a circularly shaped area and returns the distance and azimuth of the point from a central point. Distance is returned in the input units of the argument 'dist'. Az is returned in radians. 'Num" is the number of required randomly located points. This function requires the 'atan2(x,y)' function. The returned array 'spread_cir' is a two column array. The first column (subcript n,0) is the azimuth. The second (subscript n,1) is the distance. The variable 'n;' is the running index.

Base Station Antenna Discrimination Pattern and Aircraft Gain Pattern

Base station parameters

Parameter used in defining antenna discrimination pattern

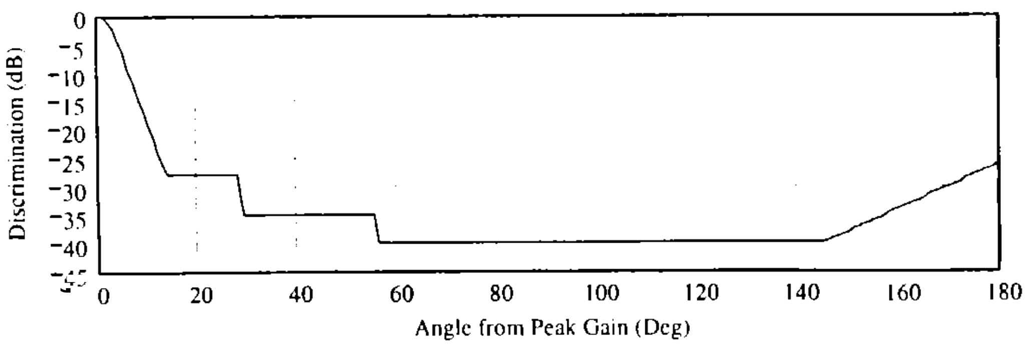
$G_0 := 12$

$\theta 3 := 107.6 \cdot 10^{(-0.1 \cdot G_0)}$ $\qquad \theta 3 = 6.789$

$$Gbs1(\theta) := \begin{array}{|l} g \leftarrow -12 \cdot \left(\frac{\theta}{\theta 3}\right)^2 \text{ if } 0 \le \theta < 4 \\ g \leftarrow -(\theta - 4) \cdot 2.5 - 4.166 \text{ if } 4 \le \theta < 13.5 \\ g \leftarrow -28 \text{ if } 13.5 \le \theta < 29 \\ g \leftarrow -35 \text{ if } 29 \le \theta < 56 \\ g \leftarrow -40 \text{ if } 56 \le \theta < 145 \\ g \leftarrow -40 + 14 \cdot \frac{(\theta - 145)}{35} \text{ if } 145 \le \theta \le 180 \\ g \end{array}$$

$Gbs1(0) = 0$

$\theta := 0..180$



Tilt angle of base station ant

$tilt := -5$

Aircraft Gain Patterns

$Gac1(\phi) := 0$

Geometric constants and parameters

$Re := 6378 \cdot 1000$ Earth radius meters

$hbs := 30$ height of base station antenna in meters

$hac := \frac{1000}{5280} \cdot 1.609 \cdot 1000$ $hac = 304.735$ height of aircraft meters

$\zeta := acos\left(\frac{Re}{Re + hbs}\right)$ Central angle. base station *to* limb in radians

$\zeta \cdot r2d = 0.176$ degrees $\zeta \cdot \frac{Re}{} = 19.562$

$\xi := acos\left(\frac{Re}{Re + hac}\right)$ Central angle, aircraft to limb in radians

$\xi \cdot r2d = 0.56$ degrees $\xi \cdot \frac{Re}{1000} = 62.346$

$mdist := (\zeta + \xi) \cdot Re$

$\frac{mdist}{1000} = 81.908$ radius of area in which base stations can be seen by aircraft (km)

$\frac{mdist}{1.609 \cdot 1000} = 50.906$ miles $(\zeta + \xi) \cdot r2d = 0.736$

General model parameters

$m := 1000$ number of base station in view of aircraft

$t := 100$ number of trials of 'm' base stations atten =

Program	Comment
	set loop lor number of trials (t)
um_var ← 0	zero out variable to cumulate answer
'or $i \in 0..m$	'lor loop' lor number base stations in given trial
staloc ← spread_cir(1, mdist)	place BS at random distance 'staloc'(see 'spread−cir' function)
$cent \leftarrow \frac{staloc_{0,1}}{Re}$	calc. geocentric angle from a/c to staloc (rad)
$dist \leftarrow \sqrt{(Re + hhr)^2 + (Re + hac)^2 - 2\,(Re + hhs)\,(Re + hac)\cos(cent)}$	calc. distance from a/c to base station (m)
$arg \leftarrow \frac{Re + hac}{dist}\sin(cent)$	calc. look angle base station ant. to a/c (rad)
$arg \leftarrow sign(arg)$ if $arg \geq 1.0$	check lor over flow of argument before taking 'acos'
bs2ac ← acos(arg)	
bs2ac_tilt_deg ← bs2ac·r2d − tilt	calc. gain discrimination of base station antenna towards a/c laking into account antenna tilt
bsgaindisc ← Gbs1(|bs2ac_tilt_deg|)	
$ac2bs \leftarrow \frac{\pi}{2} - bs2ac - cent$	calc. aircraft lo base station look angle (ac2bs)
ac2bs_ant ← π − ac2bs	assume a/c anlenna is looking up and calc. off-axis angle (ac2bs_ant=180-ac2bs)
ac2bs_ant_deg ← ac2bs_ant·r2d	
acgain ← Gac1(|ac2bs_ant_deg|)	get gain from a/c to base station (acgain)
$ggrr \leftarrow bsgaindisc + acgain + dB\left(\frac{1}{4\cdot\pi\cdot dist^2}\right)$	bts to a/c gain disc x ac to bs gain x spreading loss (in dBs)
cum_var ← cum_var + real(ggrr)	cumulate gains x loss as real values
$um_j \leftarrow dB(cum\_var) + iso$	finished 'lor loop' - convert real to dB and add isotropic anlenna area to gel sum of antenna gains and losses lor m stations in view of aircraft
um	

$$ave := dB\left(\frac{1}{t+1}\cdot\sum_{i=0}^{t} real(atten_i)\right)$$

'ave' is the average expected coupling loss between all of the base stations and the aircraft receiver. The aircralt gain, path loss and transmitter discriminalion summed across all of the base stations are accounted for. The min and max are the highest and lowest values across all of the trials. Adding the transmit EIRP and other non-geometrically based gains and losses will yield the power received by Ihe aircraft receiver.

$ave = -105.461$

$min(atten) = -105.836$

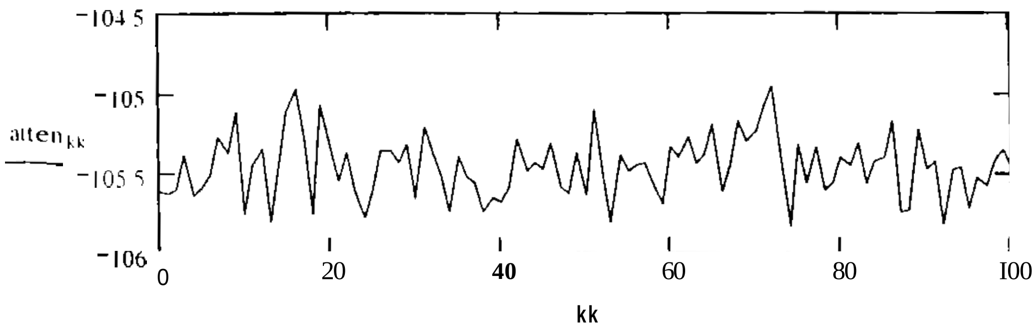
$max(atten) = -104.956$

$m = 1 \times 10^3$ $hac = 301.735$

$t = 100$ $hbs = 30$

$kk := 0..t$

$mdist \cdot \frac{1}{1000} = 81.908$ km



atten =

	0
0	105.617
1	-105.63
2	105.604
3	105.399
4	105.645
5	105.589
6	105.522
7	105.282
8	105.377
9	105.122
10	-105.76
11	105.456
12	105.358
13	105.806
14	105.468

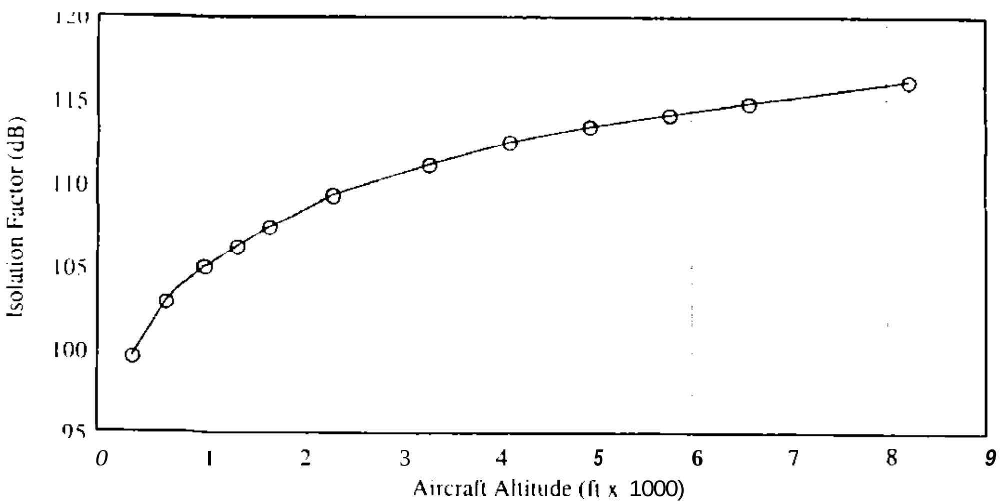
This plot looks at the change in isolation between the aircralt and the base station as a function of the aircraft altitude,

$$\text{liei} := \begin{pmatrix} 100 & -99.47 & 0 \\ 200 & -102.87 & 0 \\ 304.7 & -104.99 & 0 \\ 400 & -106.235 & 0 \\ 500 & -107.479 & 0 \\ 700 & -109.191 & 0 \\ 1000 & -111.024 & 0 \\ 1250 & -112.328 & 0 \\ 1500 & -113.282 & 0 \\ 1750 & -114.077 & 0 \\ 2000 & -114.795 & 0 \\ 2500 & -116.062 & 0 \end{pmatrix}$$

$k := 0 .. 11$

$$hei_{k,2} := \left(hei_{k,1} - hei_{1,1}\right)$$

$$hei_{k,0} := \frac{liei_{k,0}}{1000} \cdot \frac{1}{1.609} \cdot \frac{5280}{1000}$$ convert altitude to (lt x 1000)



hei =

	0	1	2
0	0.328	-99.47	3.4
1	0.656	-102.87	0
2	1	-104.99	-2.12
3	1.313	-106.235	-3.365
4	1.641	-107.479	-4.609
5	2.297	-109.191	-6.321
6	3.282	-111.024	-8.154
7	4.102	-112.328	-9.458
	4.922	-113.282	-10.412
	5.743	-114.077	-11.207

APPENDIX C3 – TECHNICAL EVALUATION OF BIG LEO ATC PROPOSALS

1.0 Introduction

This Appendix reviews the potential interference of various scenarios with the respect to Big LEO ATC operations in 1610-1626.5 MHz and 2483.5-2500 MHz Big LEO uplink and downlink bands, respectively. The Appendix describes, in Section 2, the assumptions used in the various analyses contained in this Appendix. Section 3 discusses the intra-system sharing between the two operating Big LEO systems. Finally. Section 4 discusses inter-system sharing between a Big LEO ATC system and other communication systems that could potentially be affected by interference resulting from the ATC operations.

The specific sharing analyses contained in this Appendix are:

Big LEO Uplink Band (1610-1626.5 MHz)

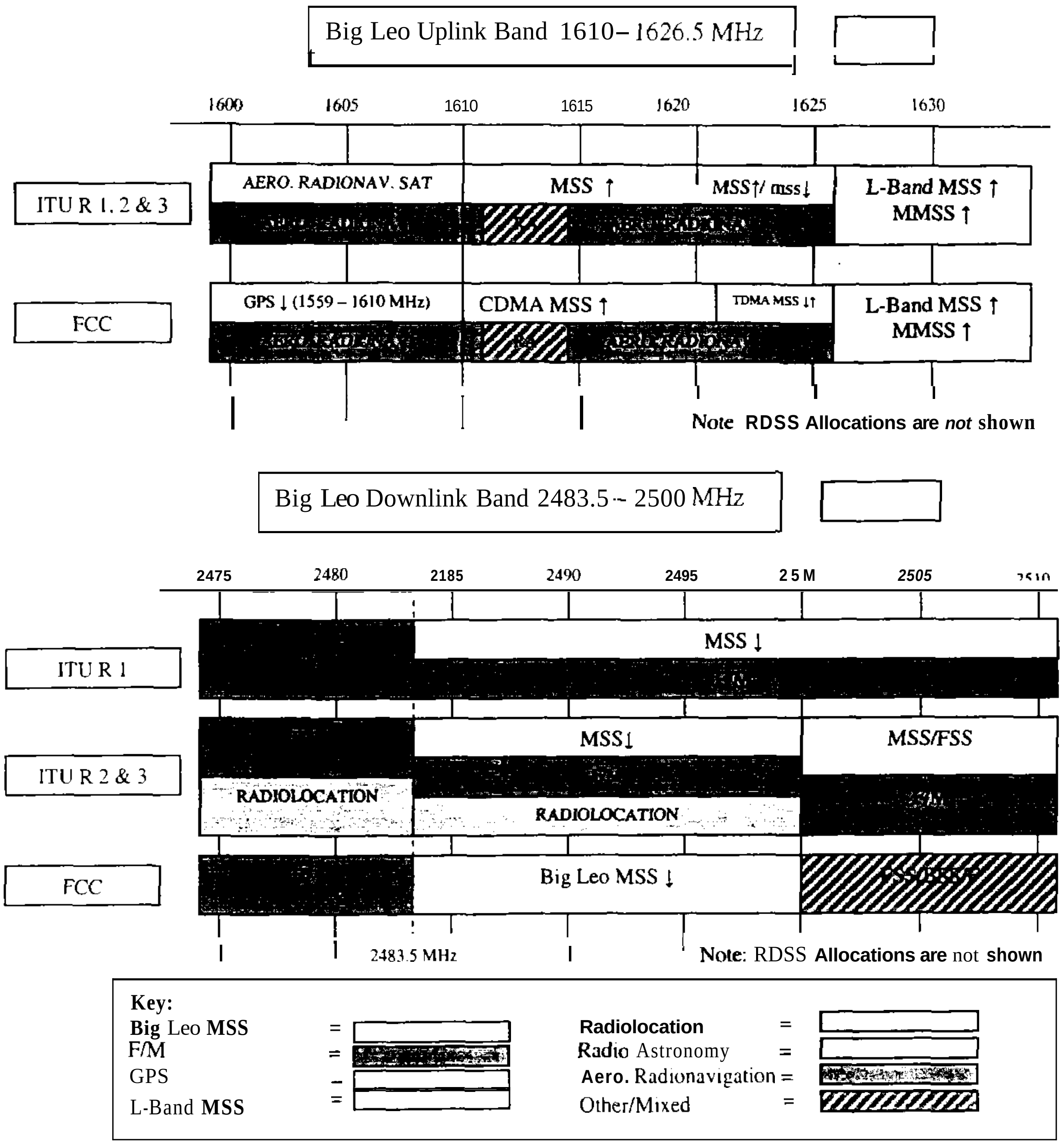
- Limitations on ATC Mobile Terminal (MT) out-of-band emission levels to protect out-of-band, inter-service systems; and
- Limitations on ATC MT out-of-band emission levels to protect out-of-band. intra-service systems.

Big LEO Downlink Band (2483.5-2500 MHz)

- Potential out-of-band interference from Big LEO ATC base stations operating in the downlink band (2483.5-2500 MHz) to ENG channels A8 (2450 – 2467 MHz) and A9 (2467-2483 MHz);
- Potential out-of-band interference from Big LEO ATC base stations operating in the downlink band to fixed and mobile (Part 90 and 101) licensed systems;
- Potential out-of-band Interference from Big LEO ATC base stations operating in the downlink band to ITFS/MMDS (Instructional Television Fixed Services/ Multi-channel Multi-point Distribution Service) above 2500 MHz;
- Potential out-of-band Interference from Big LEO ATC base stations operating in the downlink band to unlicensed 802.11b devices. and
- Potential in-band interference to (grandfathered) BAS, fixed and mobile systems in the 2483.5 – 2500 MHz band.

Figure 1.0.A shows the radio services allocated in the spectrum near the Big LEO uplink and downlink bands from both the ITU and the FCC Allocation Tables.

Figure 1.0.A Current Big LEO Table Allocations



2.0 Assessment of Assumptions used in Technical Analvsis

2.1 Out-of-Band Emissions *of* ATC Operations

Globalstar's ATC system proposal is based on either the *IS-95* or the CDMA-2000 standard.[151] Table 2.0.A presents the pertinent characteristics of the IS-95 and CDMA-2000 terrestrial PCS systems.

Table 2.1.A Characteristics of Candidate Big LEO ATC systems

Item	Units	IS-95 Characteristics	CDMA-2000 Characteristics
Mobile Terminal			
EIRP	(dBW)	0.2-1.0	0.1
Bandwidth	(MHz)	1.23	1.25
Out-of-Band Emission Level		>900kHz -42 dBc/30 kHz >1.98 MHz -54 dBc/30 kHz	
Receiver Sensitivity	(dBW)	-134	-134.0
Interference Threshold	(dBW)	-138.9	-140.0
Base Station			
EIRP	(dBW)	32.0	27.0
Antenna Gain	(dBi)	19.0	17.0
Out-of-Band Emission Level		>750 kHz -45 dBc/30 kHz >1 98 MHz -60 dBc/30 kHz	
Receiver Sensitivity	(dBW)	-147.0	-149.0
Interference Threshold	(dBW)	-136.3	**-144.0**

3.0 Intra-Service Sharing Interference Analvsis

3.1 Intra-Service Sharing 1610-1626.5 MHz

Figure 1.0.A shows the allocations in the Big LEO uplink band. The MSS allocation from 1610 MHz to 1621.35 MHz is occupied by Big LEO systems utilizing direct sequence spread spectrum techniques. Globalstar is the only Big LEO system operating in this portion of the MSS uplink band. Therefore, the intra-service considerations are internal to the Globalstar system. Globalstar stated that it would assign separate frequencies to MSS and ATC operations varying the assignments on **a** timed basis.[152] The ATC services, which would be limited to relatively few cities, could cause co-frequency **MSS** services to be unavailable in areas of the United Stales where the satellite beam coverage included a co-frequency ATC city. These restricted frequency MSS areas would vary as satellites move in orbit and the coverage area changes. Globalstar also indicates that dynamically assigning some frequencies to ATC in selected cities while assigning different frequencies to the MSS operations will reduce the loss of the MSS coverage area. They

[151] Globalstar May 29, 7002 *Ex Pone* Letter. Attach **A** 31 2-3

[152] *See* Globalstar June 27, 2002 *Ex Parte* Letter at 2.

also indicate that MSS operators could reserve some spectrum for MSS-only operations. Thus the inter-service sharing is managed within the Globalstar system.

The 1621.35 MHz to 1626.5 MHz band is occupied by Big LEO systems using TDMA transmission techniques. Iridium is the only Big LEO system occupying this band. At the time the *Big LEO* ***Service Rules Order*** was released. the Commission declined to address comprehensively the issue of emission limits between MSS systems due to the early development of a regulatory structure conductive to the rapid and successful deployment of the Big LEO's services.[153] The Commission did, however. adopt a band arrangement to accommodate these and additional Big LEO MSS systems. as well as maximum MT EIRP levels and out-of-band emission levels.[154] The same band plan, power and out-of-band emission levels for MSS ATC will provide for continued MSS use of the 1610-1626.5 MHz band with ATC operations.

3.2 Intra-Service Sharing 2483.5-2500 MHz

The MSS downlink allocation from 2485.3 MHz – 2500 MHz is occupied solely by Globalstar. Therefore, the intra-service considerations are intsrnal to the Globalstar system.

4.0 Inter-Service Sharing Interference Analysis

4.1 Inter-Service Sharing 1610-1626.5 MHz

4.1.1 Limitations on ATC MT Out-Of-Band Emission Levels to Protect Adjacent Band Systems

Global Positioning System (GPS). Out-of-band emission levels for ATC MT transmitters are required to protect Radionovigation Satellite Service (RNSS) systems such as GPS and L-band Mobile Satellite Service (MSS) systems such as Inmarsat from potentially unacceptable interference. This specific interference issue has been resolved for Big LEO MSS systems that have MSS Mobile Earth Station (MES) that operate in accordance with Recommendation in ITU-R M.1343.[155] ITU-R **M.1343** recommends the maximum unwanted emissions outside the band 1610-1626.5 MHz for an MSS MES. **An** excerpt from ITU-R M.1343 is provided below in Table 4.1.1.A.

Table 4.1.1.A Out-of-Band Emissions into GPS Band

Frequency (MHz)	Carrier-on	
	EIRP (dBW)	Measurement Bandwidth
1590-1605	-70[156]	1 MHz
1605-1610	-70 at 1605 MHz. linearly	1 MHz

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[153] *Big LEO* ***Service Ruler Order,*** 9 FCC Rcd at 5962, ¶ 63

[154] *See* 47 C.F.R. §§ 2.106. 25.202(f)

[155] International Telecommunications Union. *Essential Technical Requirements of Mobile Earth Stations for Global Non-Geostationary Mobile Satellite Service Systems in the Band 1-3 GHz*, Recommendation ITU-R M.1343 (1997).

[156] This value is subjecr to further study in ITU-R according to Recommendation ITU-R M.1343.

	intemolated in dB/MHz to -10 at 1610 MHz[157]	
1628.5-1631.5	-45	1 MHz
1631.5-1636.5	-50	1 MHz
1636.5-1646.5	-55	1 MHz
1646.5-1666.5	-60	1 MHz

The proposed Big LEO ATC MTs are capable of meeting the recommended out-of-band emission levels of the Big LEO MSS systems contained in Table 4.1.1.A.[158] The Commission requires Big LEO MSS systems to meet these same levels in order to protect inter-service operations in adjacent frequency bands.[159] The same out-of-band emission levels should apply to Big LEO ATC MTs to ensure the same level of protection to these inter-service systems.

*Radioastronomy **Service** (RAS).* Additionally, the Commission in its 1996 Big LEO MO&O ruled that harmful interference shall not be caused to stations of the radio astronomy service using the band 1610.6-1613.8 MHz by stations of radiodetermination satellite[160] and mobile-satellite services.[161] The Commission's rules require that mobile earth stations have position-determination capabilities[162] to ensure compliance with out-of-band emission limits for MSS MES in areas around **known** RAS sites. The limits require that MES licensed in the 1610-1626.5 MHz band produce power **flux** densities that do not exceed. at the RAS, the power flux density that would be produced by a **MES** operating in the 1610.6-1613.8 MHz bands at the edge of the site's protection zone.[163] In order to continue protection to RAS observations in this frequency band, the MSS ATC network should be capable of providing the same level of protection. Specifically, the **MSS** ATC systems could be required to meet the same out-of-band emission and position determination requirements as Big LEO **MSS** systems to respect the fixed-radius

(Continued from previous page)
157 According to the ITU, appropriate protection of GNSS needs to be considered, recognizing the current operation and phased transition of the GLONASS system into the new frequency plan. The Russian Federation states that the level of -70 dBW/MHz shall be used to provide protection of GLONASS receiver operations and that a level of -37 dBW/MHz at 1610 MHz, linearly interpolated to –70 dBW/MHz at 1607.5 MHz, is sufficient to protect GLONASS wideband operations in the final GLONASS frequency plan.

158 In the technical statement filed by Globalstar on 5/29/02, Globalstar stated its ATC system has typical out of channel EIRP of -42 dBW/30khz with 1.98 MHz offset, which is -26 dBW/1MHz.

159 *See GMPCS Rrporr and Order*, 17 FCC Rcd at 8927-28, ¶¶ 60-63

160 There is no radio determination satellite system currently operating in the 1.6GHz band.

161 *Big LEO Memorandum Opinioti und Order*, 11 FCC Rcd at 12866, ¶ 15

162 Position-determination equipment allows a mobile terminal to calculate, based on signals received from multiple satellite or ground-based stations, its geographic location and altitude. This information can then be used to determine if the mobile terminal is within the protected radio astronomy zone, and. if it is, to avoid transmitting signals that would cause harmful interference. In addition to GPS, the satellite-based global position system, and LORAN, a terrestrially based position determination system, Big LEO satellites may **also.** depending on system design. act **as a** source of position determination information for mobile terminal\.

163 For MSS operations outside of the United Slates. the stations will observe limits set by the ITU RR Article 5.364.

protection zones for radio astronomy sites listed in section 25.213 of the Commission's rules and not operate within those zones during periods of radioastronomy observations. This would significantly mitigate any potential interference caused to the RAS from **MSS** ATC MT operations.

4.2 Inter-Service Sharing 2483.5-2500 MHz

4.2.1 Potential Interference from Big LEO Base Stations to Fixed and Mobile Stations Operating in the 2483.5-2500 MHz Band

Over 700 fixed terrestrial stations, including temporary fixed (transportable) stations, were licensed and operating in the United States in the 2483.5-2500 MHz band as of 1994.[164] These stations are primarily used as links in microwave relay systems serving petroleum companies and as broadcast auxiliary links. Since 1985, however, the Commission has prohibited any further terrestrial licensing in this band but has permitted the existing stations licensed as of July 25, 1985 to be "grandfathered" in the 2483.5-2500 MHz band subject only to license renewal.[165] In the *Big LEO Report and Order,* the Commission recognized that mutual interference was possible between the fixed and mobile systems and the **MSS** mobile earth terminal receivers, on the one hand, and the satellite downlinks operating in excess of the prescribed pfd levels and the fixed and mobile receivers on the other hand.[166] In the *RDSS Allocation Order,* we recognized that fixed and temporary-fixed operations are unlikely to pose a serious interference threat to RDSS.[167] However, we acknowledged that coordination would be somewhat more difficult when temporary-fixed stations are involved since **RDSS** licensees would not have exact information regarding the location of these stations. Therefore, we required temporary-fixed licensees in this band to notify RDSS licensees directly whenever the station is moved to a new location. We also recognized that a similar interference environment is present with **MSS** operations. Consequently, we modified the Commission's rules to extend the notification requirement for grandfathered temporary-fixed licensees to **MSS** licensees as well as RDSS licensees.[168]

The operation of ATC base stations in the 2483.5-2500 MHz band could potentially cause interference to the grandfathered fixed and temporary-fixed stations in this band. Additionally. there is a potential for interference from the grandfathered fixed and temporary-fixed stations to

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[164] Big *LEO Service Rules Order,* 9 FCC Rcd at 5992. ¶ 145

[165] *Allocating Spectrum for* and *Establishing Other Rules* and Policies *Pertaining to a Radiodetermination Satellite Service,* 50 Fed. Reg. 39101.39104, ¶ 20 (1985) *(RDSS Allocation Order);* **see** also 47 C.F.R. §§ 90.20(c)(3)(73), 90.35 (c)(74), 90.103(b)(9) and 101.147(f)(2).

[166] Big *LEO Service* Rules *Order,* 9 FCC Rcd at 5992. ¶ 146

[167] *RDSS Allocation Order,* 50 Fed. Reg. at 39104. ¶¶ 18-20

[168] Under 47 C.F.R. § 101.4(a), all systems subject to parts 21 and 94 as of July 31. 1996 that are licensed or which are proposed in an application *on file as of July* 31. 1996 are subject to the requirements under part **94** as contained in the Code of Federal Regulations edition revised as of October 1, 1995 and amended in the Federal Register through **July** 31. 1669, as applicable. indefinitely. *See* 47 C.F.R § 94.61(b)(4) (1995). Note that 47 C.F.R. § 94.61(b)(4) (Oct. 1. 199.5) states that grandfathered temporary fixed licensees are required to notify directly each RDSS and MSS licensees concerning present and propoaed locations of operations.

the ATC MTs. With the rules mentioned in the previous paragraph requiring the MSS operators to be notified of any move of a temporary-fixed station, we find that all of the information is available to the MSS operators to coordinate their base stations. We therefore require the MSS ATC operator lo coordinate the placement of its base stations with the grandfathered fixed and temporary-fixed stations in this band.

4.2.2 Potential Out-Of-Band Interference from Big LEO ATC Base Stations Below the MSS Downlink Band (2483.5-2500 MHz)

Electronic News Gathering (ENG) Channels A8 (2450 – 2467 MHz) and A9 (2467-2483 MHz). The Society of the Broadcast Engineers (SBE) commented that MSS ATC base stations will cause out-of-band interference and brute force overload to ENG equipment operating in TV BAS ENG Channels A8 and A9 in the 2483.5-2500 MHz band.[169] Currently, 405 TV BAS licenses are issued nationally in the range 2450 MHz to 2483 MHz. There are 87 licensed facilities used for TV inter-city relay, 297 TV pickup licenses. 19 TV studio transmitter links, and 2 TV translator relay licenses. SBE also claims that ENG channel A10 (2483-2500) is operating at the same frequency as the Big LEO space-to-eanh (downlink) component. However, our records indicate that there are no grandfathered BAS facilities licensed in the 2483.5 – 2500 MHz Band. However, because ENG did. at one time, operate on Channel A10. it is possible that equipment exists that has front end filters that do not isolate the ENG receiver from transmissions in the 2483.5-2500 MHz band. This would constitute a co-frequency situation as discussed in Section 4.2.1. This Section is limited to potential interference to ENG from ATC base stations out-of-band interference.

The proposed Big LEO ATC base station has a typical in-band transmitter power of 20 W.[170] Furthermore. the proposed out of channel emission for the ATC base station is approximately -45 dBc with frequency offset between 750 KHz and 1.98 MHz from the center; and -60 dBc with frequency offset 1.98MHz or more. In areas of frequency congestion, the BAS receive stations operating in the 1990-2110 MHz band are required to use Category A antennas, which have 3 dB beam widths of 5 degrees and minimum front-to-back ratios of 38 dB.[171] An antenna with a beam width of 5 degrees would have a gain of approximately 30 dBi. It is assumed that stations operating just below 2485.3 MHz would use similar equipment. The BAS receiver is also assumed to have a sensitivity of **-86** dBm and that a 10 dB DIU ratio is acceptable in this adjacent band situation."'

Table 4.2.1.A calculates the required separation distance to provide protection to a BAS receiver under two conditions:

- main-beam to main-beam coupling between the ATC base station transmitter and the BAS receiver with a frequency separation of 0.75 MHz, and
- main-beam coupling between the ATC base station transmitter and the back-lobe of a BAS receiver with a frequency separation of 2.0 MHz.

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[169] SBE Comments at 10.

[170] Globalstar May 29. 2002 *Ex Parte* Letter at 3

[171] *See* 47 C.F.R § 71.641.

[172] The DIU ratio is taken from on SBE's *Ex Parte* comments filed in ET docket OS-143. August 7. 2001

Table 4.2.1 .A calculates the out-of-band emission from the base station and the interference threshold for the **BAS** station. The difference between the two values **is** the required isolation that must exist between the transmitter and receiver to prevent interference from occurring. Table 4.2.1.A uses free space propagation. In urban environments. more sophisticated propagation models would probably identify greater path loss and the corresponding reduction in the required separation distance between the base station and BAS receiver. However, since the free-space model is the worst-case model, we take the more conservative approach in our analysis.

The results of Table 4.2.1.A show that under main-beam to main-beam coupling conditions a required separation distance of more then 4 **km** can result. The Table also indicates that it may be possible to have **a** very small separation distance by situating the base station in the back lobe **of a** fixed BAS antenna and/or incorporating some frequency separation between the BAS channel A09 and the base station transmit frequency.

Table 4.2.1.A BAS versus Big LEO ATC Interference Calculation

Item	Units	Main-Beam Value	Back-Lobe Value
IS-95 System			
Frequency	(GHz)	2.483	2.483
ATC Emission Bandwidth	(MHz)	1.23	1.23
BAS Channel Bandwidth	(MHz)	16.5	16.5
ATC Transmit Power	(W)	20.0	20.0
ATC Transmit Gain	(dBi)	19.0	19.0
ATC EIRP	(dBW)	32.0	32.0
Frequency Separation	(MHz)	0.75	2.0
OOB Reduction	(dBc)		-60.0
OOB Emission	(dBW)	-13.0	-28.0
BAS Receiver			
Assumed Sensitivity	(dBm)	-86.0	-86
Required D/U	(dB)	10.0	10.0
Receive Antenna Gain	(dBi)	30.0	-8.0
Area of Isotropic Antenna	(dBm^2)	-29.3	-29.3
Interference Threshold @ Anten	(dBW/m^2)	-96.7	-58.7
OOB Emission (From Above)	(dBW)	-13.0	-28.0
Required Isolation	(dBm^2)	83.7	30.7
Required Distance (Free Space Loss)	(km)	4.3	0.01

From a spectrum efficiency standpoint. Big LEO ATC operators should implement the least amount of frequency offset necessary to avoid causing unacceptable interference to BAS receivers. It appears from our analysis that coordination of the ATC base stations to protect BAS operations in Channel A09 is possible.

Wireless Services in 2450-2483.5 MHz Band. The FCC actively licenses several services in the 2450-2483.5 MHz band allocated for shared fixed. base. or mobile use under Pan 90 (Public

Safety Pool, Industrial/Business Pool. and Radiolocation Service) and Pan 101 (Fixed Microwave Service) in addition to Part 74 (Television Broadcast Auxiliary Service). Licenses in this band are used significantly by television stations that operate ground-based and airborne video equipment and also by public safety agencies that are increasingly using the band for live airborne video and for other public safety functions requiring video links. The analysis of the separation distances for BAS protection versus Big LEO ATC base stations presented earlier in this section would pertain directly to the BAS uses licensed under Pan 14 to the extent that these Part 90 and Part 101 uses are similar to Pan 74. Part 74 and 101 users coordinate their use of the band. Some of these uses are known to be lower power video links. The impact of the ATC base stations on such links could be examined if license information were available in a prior coordination process. Pan 90 users are not required to coordinate. although the FCC encourages their participation in a collaborative coordination effon. ATC operators will be required to take measures to protect against all types of interference to the existing users in this shared band.

Unlicensed 802.***11b Devices.*** Although Industrial. Scientific and Medical **(ISM)** equipment is not subject to any protection from current MSS downlink operations. our research indicates that most 802.11b manufacturers build out-of-band signal rejection features into their hardware. Specifically. in the United States, 802.11b devices operate on channel frequencies ranging from 2412 MHz to 2462 MHz. Lucent Technologies, for example, has also shown in a laboratory test conducted in 1998 that its WaveLAN wireless card can reject up to 35dB when an interfering channel is 25 MHz away.[173] Due to the location the upper band edges of unlicensed 802.11b devices (i.e., 2462 MHz), unlicensed 802.11b devices operating in the United States should have enough signal rejection capability to reject Big LEO ATC base station transmissions.

4.2.3 Potential Out-Of-Band Interference from Big LEO ATC Base Stations Operating Above the MSS Downlink Band (2483.5-2500MHz)

Instructional Television Fixed Services/Multi-Channel Multi-point Distribution Service *(ITFS/MMDS).* SBE indicated that there is a potential for ATC transmissions to interfere with ITFS/MMDS receivers operating above 2500 MHz.[174] In order to calculate the required separation distance between Big LEO ATC transmitters and an ITFS/MMDS receiver operating in the adjacent frequency band, the maximum undesired ATC power flux density that would cause interference to a ITFS/MMDS receiver is first determined. Next. the distance between the ATC transmitter and the ITFS/MMDS receiver is calculated at the point where the received power flux density at the ITFS/MMDS receiver is equal to or less than the level that would cause it unacceptable interference. According to the proposed base station data provided by Globalstar, ATC base stations would have a maximum out-of-band EIRP of -40 dBW.[175] The maximum undesired signal power flux density for an ITFS/MMDS station is -129 dBW/m^2 for a 1.25 MHz interfering signal.[176] The minimum required separation distance between an ITFS/MMDS receiver and a Big LEO ATC base station can be calculated by using the following formula:

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173 WaveLAN Technical Bulletin 003/A, Lucent Technologies, (Nov. 1998).

174 SBE Comments at 10

175 *See Interim Report on the Spectrum Study of the 2500-2690 MHz Band. supra,* at A60 n.2. Typical out-of-hand EIRP for an IS-95 system. the alternative CDMA2000 mentioned by Globalstar is expected to have a lower out-of-band emission. Therefore, -40 dBW can be used as the worst case scenario.

176 The bandwidth here is typical for an IS-95/CDMA2000 system

Minimum required separation distance = $\sqrt{\dfrac{EIRP}{PowerFlux*4*\pi}}$, where the Power Flux has a reference bandwidth of 1.25 MHz.

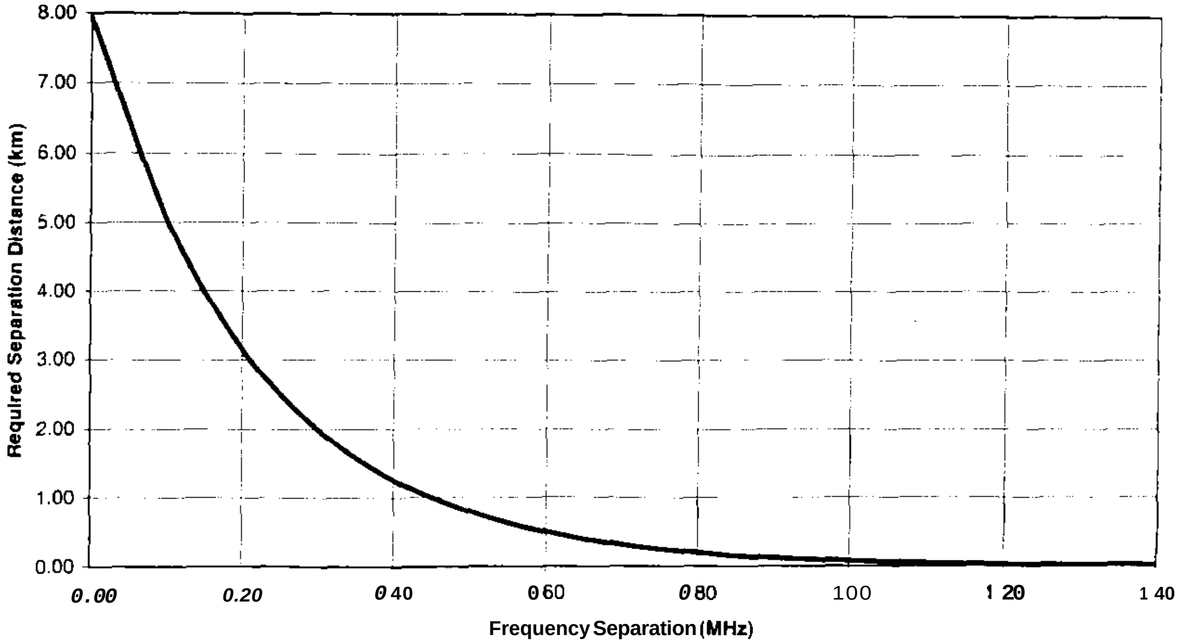
The maximum separation distance between an ATC base station and an ITFS/MMDS receiver necessary to avoid adjacent channel interference is 8 km (5 miles) assuming that the ITFS/MMDS receiver is operating directly adjacent to 2500 MHz. The ITFS/MMDS receivers can reject up to 40 dB/MHz according to measurements conducted by the FCC laboratory.[177] Table 4.2.2.A and Figure 4.2.2.A evaluate the required separation distance as a function of the proposed ATC frequency assignments.

Table 4.2.3.A ITFS/MMDS Typical Calculation of Required Separation Distance for a Specific Frequency Separation

Item	Units	Value
Frequency	(GHz)	2.5
Bandwidth	(MHz)	1.23
EIRP	(dBW)	-40.0
Frequency Offset	(MHz)	0.5
ITFS Roll-Off	(dB/MHz)	40.0
Calculated Roll-Off	(dB)	20.0
Effective EIRP (Including Roll-Off)	(dBW)	-60.0
Interference Threshold	(dBW/m^2 in 1.25 MHz)	- 129.0
Separation Distance	(km)	0.80
Separation Distance	(miles)	0.49

177 *Spectrum Study of the 2500-2690 MHz Band: The Potential for Accommodating Third Generation Mobile Systems*, Final Report, App. 5.2 (rel., March 30, 2001), *available at* <http://www.fcc.gov/3G/3gfinalreport.doc> (last visited, Feb. 4, 2003) (*Final Report on the Spectrum Study of the 2500-2690 MHz Band*).

Figure 4.23.A ITFS/MMDS Required Separation Distance versus Frequency Separation



It appears from our analysis that ATC operations on frequency assignments below **2498** MHz would not cause unacceptable interference to ITFS/MDS receivers in the adjacent frequency band. As with the TV BAS evaluation, this analysis assumes that the ITFS/MDS receiver is in direct line of sight of the Big LEO base station transmitter and there is no additional attenuation of the interfering transmission. Use of a propagation model that takes into account the effects of an urban environment in this frequency range would likely produce a smaller separation distance.

APPENDIX D: FINAL REGULATORY FLEXIBILITY CERTIFICATION

Report and Order

1. The Regulatory Flexibility Act of 1980. as amended (RFA),[1] requires that a regulatory flexibility analysis be prepared for notice-and-comment rule making proceedings, unless the agency certifies that "the rule will not, if promulgated. have a significant economic impact on a substantial number of small entities."[2] The RFA generally defines the term "small entity" as having the same meaning as the terms "small business." "small organization," and "small governmental jurisdiction."[3] In addition. the term "small business" has the same meaning as the term "small business concern" under the Small Business Act.[4] A "small business concern" is one which (1) is independently owned and operated; (2) is not dominant in its field of operation: and (3) satisfies any additional criteria established by the U.S. Small Business Administration (SBA).[5] The SBA has developed a small business size standard for Satellite Telecommunications. which consists of all such companies having $12.5 million or less in annual revenue.[6]

2. Pursuant to the RFA, the Commission incorporated an Initial Regulatory Flexibility Analysis (IRFA) into the *Flexibility Notice*.[7] We received no comments in response to the IRFA. For the reasons described below, we now certify that the policies and rules adopted in the present *Flexibility Order* will not have a significant economic impact on a substantial number of small entities.

3. The *Flexibility Order* provides additional operational flexibility for MSS providers that operate in three sets of radio frequency bands: the 2 GHz MSS band. the L-band, and the Big LEO bands. The flexibility consists of permitting the MSS providers to integrate ancillary terrestrial components (ATC) into their networks.[8] We find that providing this flexibility will have no significant economic impact on small entiries because the MSS operators will not be required to make use of the additional capability. We believe thar permitting the additional flexibility will enhance the ability of MSS operators to offer American consumers high quality. affordable mobile services on land, in the air, and over the oceans without using spectrum resources beyond the spectrum already allocated and authorized for MSS use in these bands. Operational flexibility will: (1) increase efficient spectrum use through MSS network

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[1] The RFA, *see* 5 U.S.C. §§ 601-612. has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996).

[2] 5 U.S.C. § 605(b).

[3] 5 U.S.C. § 601(6)

[4] 5 U.S.C. § 601(3) (incorporating by reference the definition of "small-business concern" in the Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies "unless an agency. afrer consultation with the Office of Advocacy of rhe Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register."

[5] 15 U.S.C. § 632

[6] 13 C.F.R. § 121.201, NAICS code 517410

[7] *Flexibility Notice*, 16 FCC Rcd at 15565-67, ¶¶ 85-93.

[8] *See generally* § II.A., *supra*.

integration and terrestrial reuse; *(2)* reduce costs. eliminate inefficiencies, and enhance operational ability in MSS systems: **(3)** encourage technological innovation and the development of new wireless applications; and **(4)** strengthen competition in the telecommunications marketplace both in the United States and in other nations. We implement the *Flexibility* ***Order*** through the addition of a footnote to the U.S. Table of Frequency Allocations, found in Section 2.106 of our Rules, 47 C.F.R. § 2.106.

4. We also find that our action – which brings additional flexibility to existing MSS licensees -- will not affect a substantial number of small entities. There are currently five 2 GHz MSS licensees, two Big LEO **MSS** licensees and three L-band MSS licensees authorized to provide service in the United Stares. Although at least one of the 2 GHz MSS system licensees and one of the Big LEO licensees are small businesses, **small** businesses often do not have the financial ability to become MSS system operators because of the high implementation costs associated with satellite systems and services. We expect that, by the time of MSS ATC system implementation. these current small businesses will no longer be considered small due to the capital requirements for launching and operating a proposed system.

APPENDIX E: INITIAL REGULATORY FLEXIBILITY ANALYSIS

1. As required by the Regulatory Flexibility Act (RFA),[1] the Commission has prepared this present Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on small entities by the policies and rules proposed in this *Norice.* Written public comments are requested on this IRFA. Comments must be identified as responses to the IRFA and must be filed by the deadlines for comments in the ***Report and Order and Norice*** of ***Proposed Rulemaking*** provided above in section **V.** The Commission will send a copy of the ***Norice.*** including this ***IRFA.*** to the Chief Counsel for Advocacy of the Small Business Administration.' In addition. the ***Norice*** and IRFA (or summaries thereof) will be published in the Federal Register.'

1. Need for and Objectives of the Proposed Rules

2. This *Notice* seeks comment on proposals for reassigning or reallocating a portion of spectrum in the Big LEO MSS frequency bands. Given the state of the Big LEO MSS industry including changing traffic patterns. consumer demand and a recent request for additional spectrum by Iridium, one of the Big LEO operators, the *Notice* seeks comment on: *(1)* the Commission's original spectrum sharing plan, *(2)* the proposal of Iridium for additional spectrum and **(3)** other possible uses of the band.

2. Legal Basis

3. This action is taken pursuant to Sections 1, and 4(i) and (j) of the Communications Act, as amended. **47** U.S.C. § § 151. 154 (i), 154(j), and Section 201(c)(11) of the Communications Satellite Act of 1962, as amended, **47** U.S.C. § 721(c)(11), and Section 553 of the Administrative Procedure Act, 5 U.S.C. § *553.*

3. Description and Estimate of the Number of Small Entities to which the Proposed Rules Would Apply

4. The **RFA** directs agencies to provide a description of, and, where feasible. an estimate of the number of small entities that may be affectrd by the proposed rules. if adopted.[4] The **RFA** defines the term "small entity" as having the same meaning as the terms "small business," "small organization." and "small governmental jurisdiction" under Section **3** of the Small Business Act.[5] A small business concern is one which: (1) is independently owned and operated: *(2)* is not dominant in its field of operation; and (3) satisfies any additional criteria established by the SBA.[6]

5. The Commission has not developed a definition of small entities applicable to geostationary or non-geostationary orbit fixed-satellite or mobile satellite service operators. Therefore, the applicable definition of small entity is the definition under the Small Business Administration (SBA) rules applicable to Communications Services. Not Elsewhere Classified.[7] This definition provides that a

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[1] ***See*** **5** U.S.C. § 603. The RFA. ***see*** 5 U.S.C. § 601 *et. seq.*, has been amended by **the** Contract **With** America Advancement Act of 1996, Pub. L. No. 104-121, 110 Stat. 817 (1996) (CWAAA). Title II of the CWAAA is the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA).

[2] ***See*** 5 U.S.C. § 603(a).

[3] *See id.*

[4] 5 U.S C. § 603(b)(3).

[5] *Id* § 601(3)

[6] *Id* § 632.

[7] 13 C.F.R § 121.201. NAICS Code 51334.

small entity is one with $11.0 million or less in annual receipts. According to Census Bureau data, there are 848 firms that fall under the category of Communications Services, Not Elsewhere Classified which could potentially fall into the L-band. Big LEO or 2 GHz MSS category. Of those, approximately 775 reported annual receipts of $11 million or less and qualify as small entities. The options proposed in this *Notice* apply only to entities providing Big LEO MSS. **Small** businesses may not have the financial ability to become MSS system operators because of the high implementation costs associated with satellite systems and services. At least one of the Big LEO licensees may be considered a small business at this time. We expect, however, that by the time of implementation they will **no** longer be considered small businesses due to the capital requirements for launching and operating their proposed systems. Therefore, because of the high implementation costs and the limited spectrum resources. we do not believe that small entities will be impacted by this rulemaking to a great extent.

4. Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements

6. The proposed action in this ***Norice*** would affect those entities applying for Big LEO MSS space station authorizations and those applying to participate in assignment of Big LEO MSS spectrum, including through potential re-allocation. In this ***Norice,*** we tentatively conclude that a re-balancing *of* the Big LEO MSS band will serve the public interest. We seek comment on the current use of the Big LEO **MSS** uplink band (1610-1626.5 MHz) by the current licensees, Iridium and Globalstar, any potential impact **on** GLONASS, the Russian Global Navigation Satellite System, and radioastronomy, and Big LEO MSS service downlink (2483.5-2500 MHz) spectrum uses. **We also** seek comment on the possibility of making Big LEO MSS spectrum available in a second Big LEO processing round, re-allocating a portion of the Big LEO spectrum for other uses, including unlicensed devices, site-based or critical infrastructure licensees, or assignment to a terrestrial commercial mobile radio service licensees. We do not propose any other reporting, recordkeeping or compliance requirements in the ***Norice.***

5. Steps Taken to Minimize Significant Economic Impact on Small Entities and Significant Alternatives Considered

7. The RFA requires an agency to describe any significant alternatives that it has considered in reaching its proposed approach, which may include the following four alternatives: (I) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; **(2)** the clarification, consolidation, or simplification of compliance or reponing requirements under the rule for small entities; **(3)** the use of performance. rather than design. standards; and (4) an exemption from coverage of the rule. or any pan thereof, for small entities.

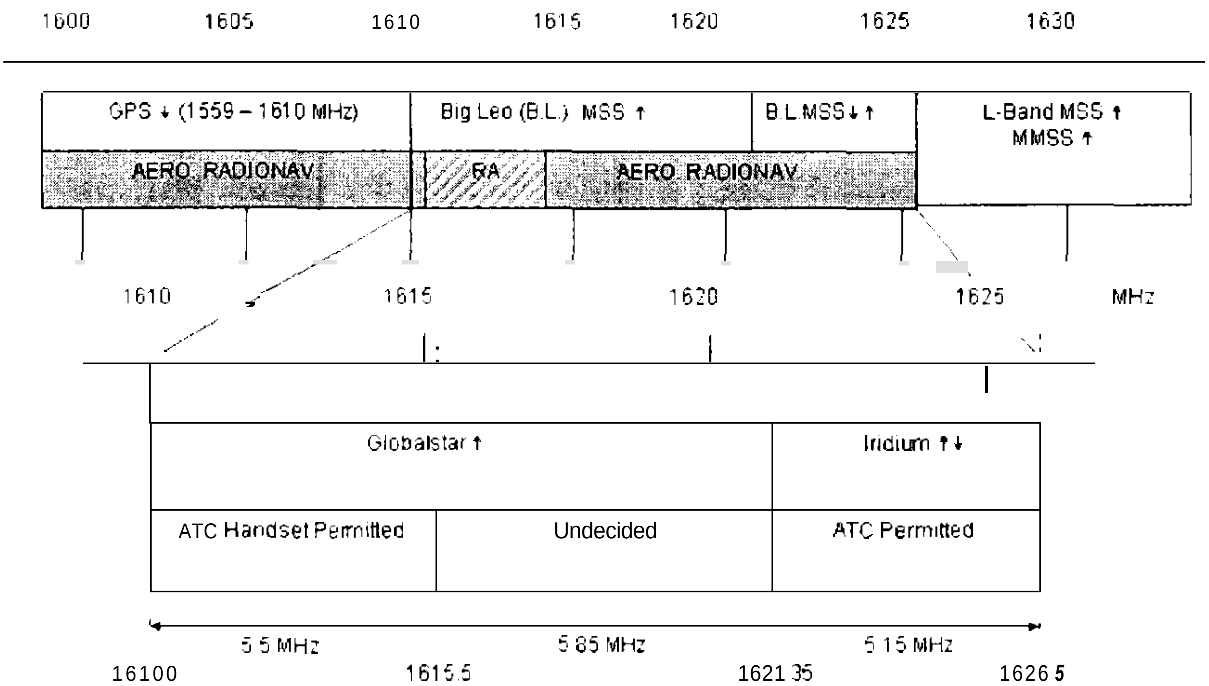
8. In developing the tentative conclusion and the proposals contained in this ***Norice,*** we have attempted to allow flexibility for efficient operations in the Big LEO **MSS** market. regardless of size. consistent with our other objectives. We have also sought comment on other uses of the spectrum that may enhance service to the public. We believe that our tentative conclusion that the Big LEO MSS band should be re-balanced. our request for comment on the current use of the band by the Big LEO licensees. and our request for comment on other uses of the band will not impose a significant economic impact on small entities because: (1) the information sought is reasonable and not overly burdensome; and *(2)* as mentioned above. we do not expect small entities to be impacted by this ***Notice*** **due** to *the* substantial implementation costs involved to use the spectrum at issue in this *Notice*. Nonetheless, we seek comment on the impact of our proposals on small entities and on any possible alternatives that could minimize any such impact.

6. Federal Rules that May Duplicate, Overlap, or Conflict with Proposed Rules

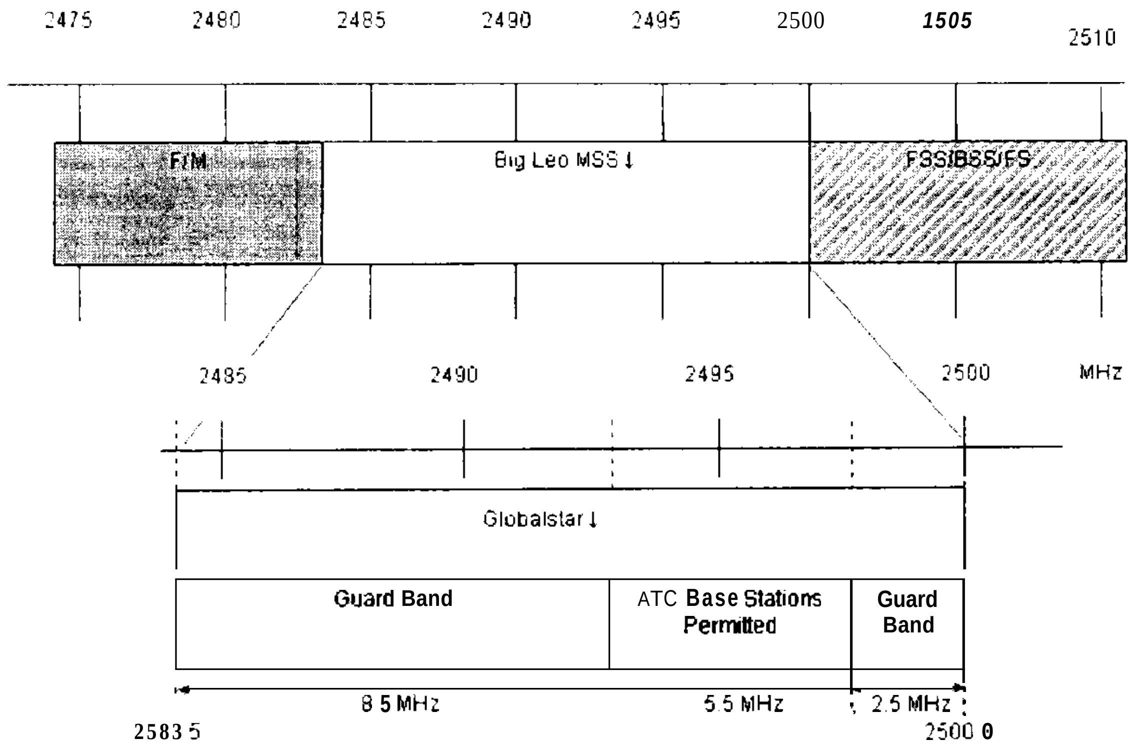
9. None.

Appendix F

Big LEO Uplink Band 1610 – 1626.5 MHz



Big LEO *Downlink Band 2483.5 –* 2500 *MHz*



SEPARATE STATEMENT OF CHAIRMAN MICHAEL K. POWELL

Re: *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands*

Re: *Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support Introduction of New Advanced Wireless Services, including Third Generation Wireless Systems.*

Today the Commission releases a family of orders that grants flexibility to licensees that provide substantial satellite service, strictly enforces our satellite milestone policies, and reallocates 30 MHz of spectrum for terrestrial use. Taken together, these orders reflect the Commission's commitment to vigorously guard the public's spectrum resource and to ensure that resource is used efficiently in the public interest. In addition, these orders will further increase the portfolio of spectrum-based services emerging as viable competitors in the voice and broadband marketplace. While I believe today's orders represent the optimal outcome under the constraints of the existing licensing regime, they also highlight areas of our current spectrum policy that warrant particular attention, from the Commission and Congress, if wc are to maximize the public interest in spectrum policy.

First, we grant existing satellite providers in three bands the option of using their spectrum assignments on the ground as well as in space. Under our traditionally bifurcated licensing regime, satellite and terrestrial spectrum rights have been assigned independent of one another. In some cases, assignment of either satellite or terrestrial rights effectively barred the assignment of the other because of interference concerns. Advances in technology have changed some of these assessments. Sharing is now often possible between satellite and terrestrial, fixed services. Indeed, in cases where the services are severable, the Commission has decided to license the rights to different parties. In other cases, the capacity of two independent services to share is far more limited.

In the bands at issue here, the satellite-based services as well as the proposed terrestrial services are mobile, making sharing less feasible. Moreover, the satellite services are already licensed and, in two of the three bands at issue, satellite licensees are already offering service. In the end, I concluded that granting additional rights to existing satellite licensees best protected those services from harmful inrerference and ensured the spectrum currently allocated to satellite services in these three bands was fully utilized. The dissent argues that the Commission should have sought additional comment on our authority to assess a fee on satellite licensees who would be granted these additional rights. As an initial matter, it should be pointed out that the Commission already sought comment in this proceeding on that very issue. Further comment seems unproductive. However, I concur in the recommendation of the Spectrum Policy Task Force that Congress consider granting the Commission fee authority. Authorizing such fees would provide the Commission with an important tool for ensuring efficient use of the public spectrum resource.

Second. today's orders emphasize the importance of milestones in our satellite licensing regime. The Commission has long acknowledged that satellite-based communications present unique challenges. Specifically there is often a tremendous lag time between the filing of an application and the actual provision of service. The ITU satellite filing and coordination regime further complicate this process. The time and regulatory resources involved strongly counsel in favor of policies that ensure satellite spectrum goes to providers committed to using the spectrum promptly. Strict enforcement of milestones ensures this result. We will continue to bc vigilant that satellite licensees fulfill their obligations to build systems – or the spectrum will be returned and re-licensed. Adherence to the obligation to construct new systems also advances our goal of multiple. facilities-based competitors in all sectors of the communications marketplace, including satellite services.

While milestone enforcement is an important policy, the Commission is also examining its satellite policies in a broader context to determine whether our processes unduly hinder market access, and thereby limits competition in voice, broadband, and other markets. The Commission is currently reassessing its satellite licensing regime to determine what improvements can be made. Our current system takes much too long and makes the challenges associated with launching and operating a satellite service all the more complex. Satellite providers should succeed or fail in the marketplace on their own merits - not to have their business plans atrophy on the shelfwhile the FCC takes years to issue a license. We can and must do better.

Finally, the Commission today reallocates 30 MHz of spectrum at 2 GHz previously allocated lor satellite use The Commission also seeks comment on reallocating additional spectrum in the Big LEO hand. These actions are not taken lightly. However, 1 believe that the highest-valued use of this spectrum is no longer for satellite service, and it is more prudent to explore other uses.

Going forward, it would be best it the Commission were not called upon to make such command-and-control determinations. If, for example, Congress were to repeal the international satellite competitive bidding prohibition in the ORBIT Act as the Task Force recommended, the Commission would be able to adopt a flexible allocation including satellite and terrestrial uses. If mutually exclusive applications were then accepted tor filing, the resulting auction would allow the marketplace – rather than the Commission – to decide the highest valued use of the spectrum in question. I believe such an outcome would maximize the public interest and. accordingly. ask Congress to consider allowing the FCC the option of distributing flexible spectrum rights via auction.

Once the Commission determined that 30 MHz of satellite spectrum at 2 GHz would be reallocated. we faced the challenging task of selecting the appropriate bands. One of the most difficult aspects of that decision was to reallocate 10 MHz of globally harmonized spectrum at 1990-2000 MHz. Globally harmonized spectrum is a vital resource and we remain committed to the ITU process and the goals of global harmonization. However, the United States had years ago determined that the 1930-1990 band would be used for PCS. That service succeeded beyond our greatest expectations. Although during this period the Commission had yet to issue 2 GHz satellite licenses because of continuing international allocation issues, it had established certain technical operating parameters. As we came closer to a decision in these proceedings, it became increasingly clear that there would be interference issues between the PCS providers at 1930-1990 and satellite operators above 1990. The resulting interference may well have jeopardized the reliability and success of each service. Thus, although I highly value internationally harmonized operations, I determined that the ability of both services to operate reliably outweighed international concerns in this circumstance. Although I am disappointed that both interests could not be accommodated, I believe in the end stronger satellite and terrestrial services will result.

The decisions we reach today are significant and complex. The Commission's talented staff deserves credit and recognition for the long hours and tireless efforts that culminated in these orders' adoption. Together their efforts will allow for more efficient utilization of the spectral resource, the development of innovative service offerings, and more diverse and competitive alternatives for consumers throughout the country.

SEPARATE STATEMENT OF

COMMISSIONER KATHLEEN Q. ABERNATHY

Re: *Flexibility for Deliver). of Communications by Mobile Satellite Service Providers in the 2GHz Band, the L-Bund. and the 1.6/2/4 GHz Bunds and Review of the Spectrum Sharing Plan Among Non-Geostationary Satellite Orbit Mobile Satellite Service Systems in the 1.6/2.4 GHz Bunds. IB Docket No. 01-185 and IB Docket No. 02-364*

By granting flexibility to mobile satellite service providers we are maximizing the value of the radiocommunications spectrum resource to deliver benefits to consumers consistent with the Commission's statutory obligations. In this proceeding the Commission was faced with balancing several public interest goals in determining how to maximize the efficiency of the spectrum resource in the 2 GHz, the Big Leo and the L bands. I believe that granting mobile satellite service providers the ability to add an ancillary terrestrial service component to their service offerings balances these goals in a manner that best serves the public interest.

Specifically, the record in this proceeding demonstrates that the shared usage of these bands by separate MSS operators and terrestrial operators would likely result in the inability for both systems to operate effectively. This is especially the case for L-band and Big Leo satellite operations. Therefore, the Commission was faced with a difficult decision: it could either isolate out the terrestrial rights from the satellite rights and auction these licenses separately despite the technical limitations, or allow integrated ancillary terrestrial use of these bands by MSS operators. In permitting an ancillary terrestrial component, the Commission will enable enhanced operations by the MSS licensees. While some had argued the terrestrial component of the spectrum should be auctioned, such an option would have devalued the amount of spectrum usable by any entity and denied services to consumers.

The record reflects many public interest benefits associated with the provision of global mobile satellite services, including the ability of these systems to provide service to rural and remote locations where traditional services may not yet operate. In addition, satellite operators have the potential to develop ubiquitous mobile telecommunications and broadband services. The Commission has adopted stringent requirements that must be met by the satellite operator to ensure that an **ATC** applicant will provide its terrestrial component consistent with the ancillary use requirement. These include requirements that the ATC applicant provide substantially a satellite service and that the provision of any terrestrial service remains an integrated service component of the overall satellite system.

Spectrum is important because it is a finite natural resource with immense potential value to the American people. Thar value is derived from commercial services, public safety and national security. Of course, fallow spectrum in general has little value. So the Commission's goal is to create regulatory policies that foster effective investment to deliver services. I believe that today's action helps to move this goal forward in the near future.

SEPARATE STATEMENT OF
COMMISSIONER MICHAEL J. COPPS
Approving in Part, Dissenting in *Part*

Re: *In the Matter of Flexibility for Delivery of Communications by Mobile Satellite Service* ***Providers*** *in the 2 GHz Bund. the L-Band, und the 1.6/2.4 GHz Bands, Review of the Spectrum Shuring Plan Among Non-Geostationary Satellite Orbit Mobile Satellite Service Systems in the 1.6/2.4 GHz Bunds: IB Docker No. 01-185, IB Docket No. 02-364.*

I agree with today's decision to grant MSS licensees the authority to provide ancillary terrestrial service for their customers. The MSS industry is in its infancy. But it has great promise -- great promise to improve rural service, to enhance national security, and to strengthen the overall satellite infrastructure. It is with hope that ATC will further efforts to turn this promise into reality that I approve of the majority of today's order.

But it is also with the intention of maintaining the promise of the **2** GHz band, L-band. and big-LEO band *that* I support the strict gating requirements we insist on before ATC authority may be exercised. Satellite licensees must protect the vitality of satellite services in order to win ATC rights. This means operating their own satellite facilities, meeting tough construction and deployment milestones, providing "substantial satellite service," providing satellite-capable phones at point of sale, and either complying with the dual-mode-phone safe harbor or successfully demonstrating that another arrangement protects satellite service.

I must dissent on one point. however. The majority rejects the proposal contained in the NPKM to charge licensees fees for the additional spectrum usage rights we grant in this order. **MSS** licensees did not pay for their spectrum licenses at auction, since this is prohibited by Congress. This means that the public has not been compensated for this private use of public spectrum. Additionally, licensees who have not internalized the cost of purchasing spectrum licenses do not have the same incentive to use spectrum resources intensively. Charging MSS licensees a usage fee could mitigate these problems.

Questions about the fee's structure and FCC authority remain, even after the record on this proposal was received in response to the NPKM. I therefore would have made a tentative conclusion lo impose such fees and would have initiated a second NRPM more specifically asking how to create a fee system, what authority the FCC has, and how fee amounts should be set. Doing so would have begun the process of insuring that the American people are adequately compensated for private use of a public resource, and that all spectrum users have the incentive to use spectrum intensively. While some in the majority believe this is "unproductive," I believe that working **to** find ways to promote the efficient use of spectrum and to compensate the public for the use of a public resource is our responsibility.

SEPAUATE STATEMENT OF
COMMISSIONER JONATHAN S. ADELSTEIN

Re: *In the Matter of Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands; Revrew of the Spectrum Sharing Plan Among Non-Geostationary Satellite Orbit Mobile Satellite Service Systems in the 1.6/2.4 GHz Bunds: IB Docket No. 01-185, IB Docket No. 02-364*

The issues addressed in today's Report and Order have been heavily debated before the Commission for almost two years, and I commend the staff for its hard work on this often contentious issue. I also commend the Chairman and my fellow Commissioners for their collective leadership on such a difficult and challenging matter. J am hopeful that today's decision facilitates the provision of mobile satellite services, particularly in those areas of the country, including rural areas, which currently are underserved by other wireless services.

I remain concerned, however. that our decision raises the possibility of unintended consequences – our decision should not allow a Mobile Satellite Services (MSS) system with an ancillary terrestrial component to evolve into a terrestrial system with an ancillary mobile satellite component. I thus write separately to underscore my commitment to ensuring that mobile satellite service licensees fully comply with the so-called "gating" restrictions prior *to receiving* ancillary terrestrial authority. I will pay particular attention to MSS licensees not presently operating systems to make certain that they satisfy the gating requirements by operating their own satellite facilities and providing substantial satellite service to the public prior to receiving authority to provide terrestrial services. I also intend to ensure that the restrictions are maintained throughout the grant of ancillary terrestrial authority by all MSS licensees.

Finally, I also share a keen interest in Congressional consideration of a grant of fee authority to the Commission.