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Federal Communications Commission
Office of Secretary

Before the
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554

In re:	)	File Nos. SAT-MOD-20031118-00333
Applications of	)	SAT-AMD-20031118-00332
Mobile Satellite Ventures Subsidiary LLC	)	SES-MOD-20031118-01879

REPLY

Inmarsat has asked the Commission to review the Bureau's grant of an ATC license to MSV which, if not reversed: (i) will cause harmful interference into Inmarsat spacecraft by authorizing a *40%* increase in the number of ATC mobile terminals, (ii) will "endanger" Inmarsat safety services, and "seriously degrade and obstruct" other Inmarsat services,[1] by allowing a *6x* increase in ATC base station power and thereby disrupting MSS service around tens of thousands of ATC base stations, and (iii) shifts the burden to MSS, the primary service, to resolve interference from ATC, the secondary service.

In its Opposition, MSV confirms that its licensed ATC system *will interfere* with nearby Inmarsat terminals,[2] and admits its intention to deploy an ATC system capable of serving *tens of millions of terrestrial users* (MSV Opp. at 5, 15-16). MSV admitted in a meeting yesterday with DOD and the FCC that it plans to deploy ATC transmitters on existing cellular and PCS tower sites. MSV's confirmation about the expected scale of its terrestrial network makes even more critical the Bureau's failure to enforce the requirement that ATC terminals constrain interference into MSS spacecraft by substantially reducing power when operating outdoors.

MSV grossly mischaracterizes the Inmarsat-4 program and Inmarsat's BGAN service, by falsely equating the *transitional RBGAN service* with the *forthcoming BGAN service*.[3] Regional

[1] *See* 47 CFR §2.1 (definition of "harmful interference").

[2] Inmarsat's Technical Annex, attached as Appendix A hereto, responds to the Technical Appendix in MSV's December 23, 2004 Opposition.

[3] A point-by-point rebuttal of a number of MSV's distortions is attached as Exhibit 1.

BGAN (or RBGAN) service is a developmental offering over a Thuraya satellite that does not even see North America. ***BGAN is an entirely new and completely different broadband MSS service.*** BGAN (i) uses new spacecraft, (ii) employs completely different user terminal technology, (iii) provides three times the transmission speeds, (iv) offers significantly enhanced user functionalities, and (v) has new RF characteristics, pricing and service offerings.

Ubiquity is a hallmark of MSS service. The new I-4 network and BGAN service are designed to meet the expectations of MSS users of service capability "anywhere and any time," as reflected in the record,[4] and to provide the recognized public policy benefits of MSS to U.S. businesses and consumers nationwide.[5] Inmarsat has met the needs of MSS users for over 23 years, constantly improving its service, and developing a successful commercial business, and is now able to launch a new MSS system optimized for high-speed *data services* to small mobile terminals (rates of up to 432 kbps). This new system will, for the first time, enable critical *broadband* connections for mobile users, governmental, military, public safety, humanitarian, and commercial alike, "anywhere and any time." MSV, in sharp contrast, has apparently not found a successful commercial formula for MSS, and therefore seeks to compete directly with terrestrial cellular and PCS voice services.

Maximizing spectrum efficiency was a key design element of the I-4 MSS network. The spacecraft design reflects this, with 228 spot beams, and 13x the current level of frequency reuse.[6] BGAN terminals similarly have been optimized for high-throughput data services, using

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[4] *See, e.g.,* Comments of Stratos and MarineSat (Dec. 23, 2004); Letter from IMSO (Dec. 17, 2004); Letter from Ofcom (Dec. 20, 2004); Letter from Telenor (Dec. 20, 2004); Letter from Nera (Dec. 23, 2004); Letter from Satcom Direct (Dec. 8, 2004); Letter from GMPCS Personal Communications (Dec. 20, 2004); Letter from Global Communications Solutions (Dec. 16, 2004); Letter from AOS (Dec. 20, 2004); Letter from Glocom (Dec. 15, 2004).

[5] *See In re Establishment of Policies and Services Rules for MSS in the 2 GHz Band,* FCC 00-302 at ¶1 (rel. Aug. 25, 2000) (recognizing that MSS enhances competition with terrestrial communications services and provides important benefits to all U.S. consumers nationwide).

[6] I-4 spacecraft can share even more spectrum with MSV than before. The Commission should not countenance MSV's warehousing of L-Band spectrum or allow MSV's use of a two-decade-old

a state-of-the art modulation scheme (16QAM with Turbo Coding) that maximizes performance over the limited spectrum resource. This advanced system design supports a substantially larger Inmarsat MSS customer base, including in the United States.[7]

Now six years in the making, and developed in reliance on longstanding allocations governing the L-Band and the February 2003 ATC rulemaking decision, the I-4 system is a reality. The first spacecraft is being shipped in less than a month for a launch from Florida on March 10, 2005. The second spacecraft---planned to serve North America---is undergoing testing, and is scheduled for launch in July of this year. The third spacecraft, to be maintained as a ground spare until the successful launch of the other two, is about to commence tests, and is scheduled to be available for launch by January 2006, when it could be placed into a number of locations to serve the U.S.[8]

To facilitate the deployment of broadband MSS data services, Inmarsat has developed new, lightweight, and low-cost BGAN antennas, some as small as 5.5" x 8", and some with "tracking" antennas never possible before in such a small and inexpensive MSS terminal.[9] Those smaller, more affordable, and more functional MSS terminals are particularly suited for cars, trucks and aircraft that *will* operate in the vast parts of the US---including urban and suburban areas---where there are *simply no constraints* on the location of ATC base stations.

MSV argues that "market forces" somehow will obviate the potential for ATC interference into MSS, because MSV asserts there will be no overlap between MSS and ATC

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satellite design to serve as a barrier to more efficient MSS use of the L-Band. MSV's latest replacement satellite design is at least 4-5 years away from ever being realized.

[7] MSV's estimate of the number of supportable I-4 users has no basis and does not reflect reality.

[8] The need to take into account the locations of the I-4 spacecraft is supported by the recognition that the Commission's ATC interference analysis must consider all L–Band networks in the ITU queue. *In re MSV,* DA 04-3553 (rel. Nov. 8, 2004) at ¶63.

[9] MSV's arguments that BGAN terminals will be the equivalent of FSS and thus not entitled to interference protection therefore are misguided. MSV Opp. at n.27. Anticipating these new MSS antenna technologies was the reason the Commission *did not* exempt all BGAN terminals from E911 requirements. *See MSS 911 Report and Order,* 18 FCC Rcd 25340 (2003), at ¶28.

service areas. This is flatly contradicted by the record.[10] Moreover, even MSV does not dispute that satellite service in urban areas is technically feasible, or that the Bureau was wrong when it assumed that an MSS satellite signal will not be "usable" in the vicinity of an ATC base station.

MSV's assertion that the urban usage of MSS will be lower than the urban usage of DBS or FSS because there is less MSS bandwidth available is nonsense and it misses the point. The FSS and DBS experience demonstrates that satellite service is used in urban areas, particularly where it offers important advantages. This is true for Inmarsat's I-4 network, which offers the significant advantage of ubiquitous coverage---service any time, anywhere---and reliable, high-speed connectivity that is independent of the vulnerable local phone and power networks. Indeed, MSV provides a litany of examples where first responders rely on MSS terminals in urban environments for these very reasons. MSV Opp. at 13-14. Moreover, the pricing of the *transitional RBGAN* service compares favorably to the roaming charges for GPRS, a terrestrial data service;[11] BGAN service will be priced even lower.

Thus, it is *regulatory actions in the U.S.*---relaxations of ATC rules that will cause harmful interference into MSS, and continued ORBIT Act limitations on "advanced services"---that threaten to constrain the growth of new Inmarsat land mobile services in the U.S.

Admitting that its ATC network poses an interference threat to MSS, MSV turns to new policy issues, urging the Commission to require that Inmarsat terminals be made like PCS or cellular handsets, to overcome ATC interference. This radical suggestion ignores the realities that (i) MSS satellite terminals are carefully designed to operate with low noise so they can be sensitive enough to communicate with their "base station" located 22,300 miles away, (ii) MSS satellite terminals are fundamentally different than PCS terminals, (iii) over 350,000 Inmarsat terminals already have been commissioned at an estimated investment of over $3 Billion and

[10] *See* comments and letters cited in note 2.

[11] *See* Exhibit 2.

cannot be retrofitted, and (iv) it is disingenuous for MSV to assert that Inmarsat and its manufacturers in the 11^{th} hour of a 6-year, $1.5 Billion program can change system designs and hardware on which they have proceeded in reliance on longstanding regulatory structures, and the February 2003 ATC rulemaking order, in favor of an ATC system still on drawing board and that may never be realized. While MSV must overcome significant financial, technical and other implementation hurdles before its ATC network becomes operational, the first I-4 spacecraft will be launched in the *next two months.* If there are changes to be made in the way ATC is accommodated in the L-Band, MSV has the flexibility to make those changes, not Inmarsat.[12]

MSV cannot have its wish that the L-Band be treated like other MSS bands: (i) there is a shortage of L-Band MSS spectrum, (ii) the L-Band is shared on a co-channel basis (not segmented), and (iii) billions have been invested in reliance on longstanding allocations governing the L-Band. Once MSV acquires the TMI 2 GHz MSS license, MSV can deploy an ATC system in the "greenfield" at 2 GHz, without any of the constraints MSV complains of in the L-Band. 2 GHz is where MSV's experiment with a vastly different concept of ATC---with tens of millions of users---should be conducted, not in the heavily utilized L-Band.

For these reasons, the Commission must protect Inmarsat's I-4 system from ATC interference, and must reject MSV's proposal that Inmarsat, its distributors, manufacturers, and users bear the burden of resolving ATC interference. As demonstrated in the record of this proceeding, the critical and sensitive nature of many uses of the Inmarsat system, and the settled expectations that ubiquitous MSS service will continue to be available to serve those needs, must be protected. Therefore, the Commission must follow its February 2003 ATC rulemaking order, and ensure that ATC does not cause harmful interference to the Inmarsat MSS system.

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[12] Inmarsat has met with MSV to discuss the interference problems posed by MSV's ATC system. But MSV has not made any concrete proposals, MSV's technical analyses were not conclusive, and MSV insisted on Inmarsat making system changes to accommodate MSV's ATC system.

Respectfully submitted,

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January 5, 2005

<u>**Exhibit 1**</u>

<u>**MSV Misstatements:**</u> "BGAN service costs over one hundred times more than a faster terrestrial wireless service, at a whopping $11/megabyte (compared with $0.08/megabyte for existing terrestrial service)." "There is simply no demand for expensive and unwieldy land-transportable MSS terminals when wireline providers, terrestrial wireless providers and even Fixed Satellite Service ("FSS") operators offer the same service at significantly lower prices." MSV at iv, 11, 12.

<u>**Facts**</u>: BGAN service is not yet offered, and when it is offered, this 432 kbps broadband service will be competitive with third generation terrestrial wireless networks (3G) in terms of both price and service quality. This cited rate is the average current retail price for the transitional Regional BGAN service, which compares favorably with 3G (or 2.5G/GPRS) roaming charges for terrestrial wireless through providers such as Vodafone. See Exhibit 2. Wholesale Regional BGAN airtime is being reduced in some geographic areas by over 40% as part of a program where Inmarsat is seeking to replace a single global rate with pricing reflective of the local competitive environment. BGAN service will be even less expensive.

<u>**MSV Misstatements:**</u> "BGAN equipment is priced at about $1600, is big and bulky, and requires precise pointing and line of sight to a satellite." MSV at iii-iv, 11.

<u>**Facts:**</u> BGAN terminals have not yet even been introduced. Regional BGAN terminals are available for less than $500 as part of a 12 month service commitment. Inmarsat's BGAN terminals will be as small and easy to carry, and will have ISDN, Bluetooth, USB, Ethernet and Wi-Fi connectivity. One of the smallest BGAN terminals will be about 5.5" by 8", and will appear as follows.

Reviews of Regional BGAN terminals comment favorably on ease of use and set up, and forthcoming BGAN terminals will be even easier to use:

- "It takes seconds [to set up] and seems foolproof. Once this is done, and the BGAN has logged into the satellite network, you have a TCP/IP network connection – it's that simple." Jon Honeyball, *Inmarsat Regional BGAN Satellite IP Modem*, PC PRO, February 2003, at 195.

- "It doesn't require a PhD to plug it in, it's just like a voice modem, only it's a small box instead of a wire." Lindsay Nicolle, *Dish of the Day*, INTERNET WORLD February 2003 at 22.

MSV Misstatements: "Even Inmarsat's CEO has predicted that Inmarsat will experience no more than single-digit growth in the minimal expected BGAN penetration in the United States." (MSV at 11, citing Communications Daily (August 25, 2004))

Facts: This is a misrepresentation of this article, which describes the situation today, with ORBIT restrictions in place: "Sukawaty said only 0.5% of the company's revenue (associated with U.S. terminals for land-based services) would be impacted if the company were found not compliant with the [Orbit] Act: 'The *immediate impact* is fairly minimal, but we want to be licensed for land-based services in the U.S.'" (emphasis supplied). There is no reason to believe the U.S. portion of Inmarsat's land mobile business will not increase significantly once BGAN is introduced and related ORBIT Act restrictions are lifted. For the nine-month period ended September 30, 2004, land mobile services accounted for 29.3% of Inmarsat's global revenues.

Exhibit 2

Attached is a summary of *terrestrial* roaming charges for mobile internet access, as of August 2004, almost all ranging from 8 to 17 Euros/mb ($10.80 to $22.95/mb).

August 2004

INTUG International mobile roaming in Greece

Prices for GPRS

 there are also prices for SMS and voice

Country	*Operator*	*1MB (Euros)*	*Exchange rate*	*home currency*	*URL (only host shown)*
Spain	vodafone	5.00			http://www.vodafone.es/
Denmark	sonofon	7.56	7.44	56.25	http://www.sonofon.dk/
Ireland	vodafone	8.00			https://www.vodafone.ie/
UK	vodafone	8.84	0.66	5.88	http://www.vodafone.co.uk/
Hungary	pannon	9.60	254.25	2441.40	http://www.pgsm.hu/
Netherlands	t-mobile	9.80			http://www.t-mobile.nl/
Croatia	ht mobile	9.91	7.39	73.20	http://www.htmobile.hr/
Belgium	proximus	10.00			http://customer.proximus.be/
UK	O_2	10.60	0.66	7.05	http://www.o2.co.uk/
Singapore	singtel	10.80			http://www.ideas.singtel.com/
Norway	telenor-mobile	10.87	8.28	90.00	http://telenormobil.no/
Spain	telefonica	11.00			http://www.movistar.com/
Sweden	telia mobile	11.00			http://www.teliamobile.se/
UK	t-mobile	11.28	0.66	7.50	http://www.t-mobile.co.uk/
Romania	connex	11.42	1.23	14.01	http://www.connex.ro/
USA	att-ws	11.65	1.72	20.00	http://www.attwireless.com/
Austria	a1	11.80			http://www.a1.net/
Portugal	optimus	12.00			http://www.optimus.pt/
USA	t-mobile	12.22	1.23	15.00	http://www.t-mobile.com/
Switzerland	sunrise	13.10	1.54	20.12	http://mobile.sunrise.ch/

Belgium	mobistar	13.31			http://www.mobistar.be/
Austria	one	13.50			http://www.one.at/
Germany	t-mobile	13.80			http://www.t-mobile.de/
Italy	wind	15.00			http://www.wind.it/
Austria	t-mobile	15.00			http://www.t-mobile.at/
NewZealand	vodafone	15.98	1.88	30.00	http://www.vodafone.co.nz/
Italy	tim	16.00			http://www.privati.tim.it/
Hong Kong, SAR	smartone	16.59	9.65	160.00	http://www.smartone.com.hk/
Australia	vodafone	17.47	1.72	30.00	http://www.vodafone.com.au/
Australia	telstra	17.47	1.72	30.00	http://www.telstra.com.au/
France	bouygues	20.00			http://www.servicevoyage.bouyguestelecom.fr/
France	sfr	24.00			http://www.sfr.fr/
France	orange	25.00			http://www.orange.fr/

Notes:
All data are from public web sites. They confirmed the week ending 21 August 2004. The prices are for Internet access and not special access or to the "walled gardens" of the mobile network operators. Tariffs used are for monthly subscription (business or the equivalent). The data presented here are intended only for policy purposes and for not the selection of operators. Connex in Romania quotes its prices in US$.

 http://www.intug.net/surveys/gsm/olympics/gprs.html

This page is maintained by the webmaster.

Last updated 24 August 2004.

Appendix A

Technical Annex – January 5, 2005

In this technical annex we respond to the technical points raised in MSV's December 23 pleading, which are mainly contained in the Technical Appendix to that pleading.[1] For clarity, the numbering scheme in this technical annex corresponds to that in the MSV Technical Appendix.

I. Impact of Increased ATC Base Station EIRP and Relaxed ATC Base Station Overhead Antenna Gain Suppression on the Downlink Interference into Inmarsat METs

MSV has once again failed to adequately address Inmarsat's concerns about the downlink interference to Inmarsat's METs, which will degrade and obstruct Inmarsat service by creating tens of thousands of "no-go" areas around ATC base stations where Inmarsat terminals will no longer work, but where Inmarsat users expect to be able to receive interference-free service.

A. Appropriate Propagation Model for Interference from ATC Base Stations to Inmarsat METs

MSV asserts that a Walfisch-Ikegami model is the appropriate propagation model to use in all cases when assessing the interference from ATC base stations to Inmarsat receivers. Inmarsat disagrees, as explained in its December 8 Application for Review, and believes that there are many scenarios of ATC base station deployment where a free-space line-of-sight propagation model is appropriate, and should be used to assess the required separation distances.[2] This is particularly true as MSV extends its base stations outside of the "high-rise" urban centers into "low- rise" urban and suburban areas – a scenario that is inevitable given MSV's stated desire to deploy ATC through the very same tower sites used to provide cellular and PCS service.

MSV also implies that Inmarsat is inconsistent insofar as its following two claims are concerned:

(a) the relaxation in ATC base station EIRP limit will result in harmful interference into Inmarsat METs at relatively large distances from ATC base stations where there is line-of-sight between the base station and the Inmarsat MET.

(b) high levels of blockage between ATC terminals and the ATC base station could force many MSV ATC terminals to transmit at high EIRP levels and thereby

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1 Opposition of MSV to the Application for Review of Inmarsat, December 23, 2004. .

2 Inmarsat's rationale for this is fully explained in Section 1.2 of the Technical Annex to Inmarsat's Application for Review, December 8, 2004.

cause higher levels of interference to Inmarsat satellites than the Commission has calculated.

These two claims are not inconsistent at all. In reality both situations will occur. The point is that situation (a) leads to worse downlink interference to Inmarsat and of course occurs closer to the center of an ATC cell (i.e., nearer to the base station). Situation (b) leads to worse uplink interference to Inmarsat and is likely to occur more when MSV's ATC MTs are located towards the edge of an ATC cell, well away from the base station. Neither is an acceptable situation and each will lead to harmful interference into the Inmarsat system.

Regardless of what propagation model is valid, it remains a fact that an 8 dB increase in ATC base station EIRP will significantly increase the size of the harmful interference zones around ATC base stations.[3]

B. The Combined Effect of Relaxed ATC Base Station Overhead Antenna Gain Suppression and Increased ATC Base Station EIRP Limits on Interference to Inmarsat's Aeronautical METs

In the record of this proceeding Inmarsat has repeatedly voiced its serious concerns over the harmful interference that would occur to Inmarsat receivers operating on aircraft, particularly as those aircraft are at the critical stage of flight on take-off and landing flight paths. In its latest pleading MSV states that Inmarsat's analysis of this interference mechanism for a single ATC base station interferer is incorrect and that MSV's own analysis shows that an aircraft flying at 65 meters altitude maintains more than 6 dB margin against harmful interference as it passes over an ATC base station. Further, MSV asserts that, as the horizontal distance between the aircraft and the ATC base station increases, the interference margin increases rapidly. As demonstrated below, MSV's calculations are incorrect, and its presentation of the data is misleading.

As an initial matter, and as Inmarsat has repeatedly expressed in the past, –50 dBm is *the wrong* interference threshold to use for assessing ATC interference into aeronautical receivers. The –50 dBm value was derived from the non-mandatory ARINC Characteristic 741 for the LNA compression point. However, saturation of the LNA is not the limiting factor. Other stages or components of the receiver chain down-stream from the LNA are likely to be susceptible to saturation and intermodulation product generation at a significantly lower level. It should be stressed that the ARINC Characteristics are not mandatory requirements. They are voluntary avionics implementation guidelines developed by the Airlines Electronic Engineering Committee (AEEC) primarily to foster equipment interchangeability among different suppliers. The relevant interference threshold is derived from the mandatory interference susceptibility requirement as presented in RTCA DO-210D, section 2.2.4.1.3, as Honeywell has explained and as Inmarsat has expressed in previous pleadings.[4] Moreover, the FAA's Technical Standard Order (TSO) C-132 (attached as Annex A) presents the minimum requirements for certification

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3 Using the W-I LOS propagation model the required separation distance will double, and the area affected increase by four times, as a result of the 8 dB increase in ATC base station EIRP. Using a free-space line-of-sight model the distance will increase by 2.5 times and the area affected will increase by 6.25 times.

4 Opposition of Inmarsat, March 25, 2004 at 48 & Appendix C

of Inmarsat aeronautical terminals and that TSO is entirely reliant on the RTCA requirements. Using the correct specification, the relevant interference threshold level is -72 dBm, which will result in a substantial increase in the calculated aircraft altitude and horizontal distances where service to Inmarsat aeronautical terminals will be disrupted by ATC interference. The terms of MSV's ATC license, and the protection criteria in the ATC rules, must be modified to take into account the correct interference criteria.

Turning to MSV's new analysis, MSV's results are summarized in its table which is reproduced below:

MSV's Analysis of AMS(R)S Receiver Trajectory over one ATC Base Station Emitting 32 dBW EIRP per Sector and using the Relaxed Overhead Gain Suppression Pattern (AMS(R)S Receiver at 65 Meters Altitude; Base Station Located at X, Y = 0, 0 km)

X	-4	-3.4	-2.8	-2.2	-1.5	-0.9	-0.3	0.3	0.9	1.5	2.2	2.8	3.4	4
Y	-4	-3.4	-2.8	-2.2	-1.5	-0.9	-0.3	0.3	0.9	1.5	2.2	2.8	3.4	4
Over. Level (dBm)	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
Agg. Rec. Sig. (dBm)	-68.5	-67.2	-65.7	-63.9	-61.6	-58.7	-56.9	-56.9	-58.7	-61.6	-63.9	-65.7	-67.2	-68.5
Margin (dB)	18.51	17.22	15.71	13.89	11.63	8.73	6.87	6.87	8.73	11.63	13.89	15.71	17.22	18.51

From this table MSV concludes that when the aircraft is horizontally close to the ATC base station (i.e., within 300 meters) the margin is 6.87 dB, and that the margin increases to 18.51 dB for horizontal distances of 4 km. Unfortunately, although MSV lists its assumptions used in this analysis, it does not provide the calculations that support these results. Inmarsat has been unable to replicate these results, as explained further below.

MSV's assumptions used in its analysis are as follows:

(a) ATC base station antenna height is 30 meters above the ground;

(b) 4 dB interference reduction due to voice activity;

(c) 5.2 dB interference reduction due to power control;

(d) AMS(R)S antenna gain is 0 dBi;

(e) ATC base station down-tilt angle is 5°;

(f) No shielding due to aircraft body;

(g) 0 dB polarization discrimination.

Using these assumptions, Inmarsat's interference calculations, for the simple case of the aircraft immediately overhead the ATC base station, are as follows:[5]

ATC base station peak EIRP per sector

[5] Inmarsat has also analyzed the interference for all aircraft horizontal positions relative to the ATC base stations, but is demonstrating this one calculation for clarity.

= +32 dBW (i.e., 8 dB increase over the value in the ATC rules)

Gain suppression towards aircraft (at zenith)
= 30 dB (i.e., using the relaxed overhead gain suppression mask)

ATC base station EIRP per sector towards aircraft
= +2 dBW

Distance between ATC base station antenna and aircraft at zenith
= 35 meters (i.e., 65 meters altitude less ATC antenna height of 30 m)

Spreading loss from ATC base station antenna to aircraft
$= 10 \log (4 \pi 35^2) = 41.87$ dB

Effective aperture of 0 dBi receive antenna at 1.5 GHz
$= G \lambda^2 / 4 \pi = 0.003183 \text{ m}^2$
$= -25.0 \text{ dB-m}^2$

Interfering signal power at Inmarsat receiver (per sector)
= +2 – 41.87 – 25.0 – 4 – 5.2 = –74.07 dBW = –44.07 dBm

This shows there is a problem. The resulting interfering signal power is approximately 6 dB higher than the assumed overload threshold, and therefore the margin is negative 6 dB and not positive 6.87 dB. This represents a significant difference from MSV's results. In fact the altitude would need to be increased to 100 meters, using this same analysis with identical assumptions as MSV, to get zero interference margin, and 182 meters altitude to get the positive 6.87 dB margin that MSV indicates.[6]

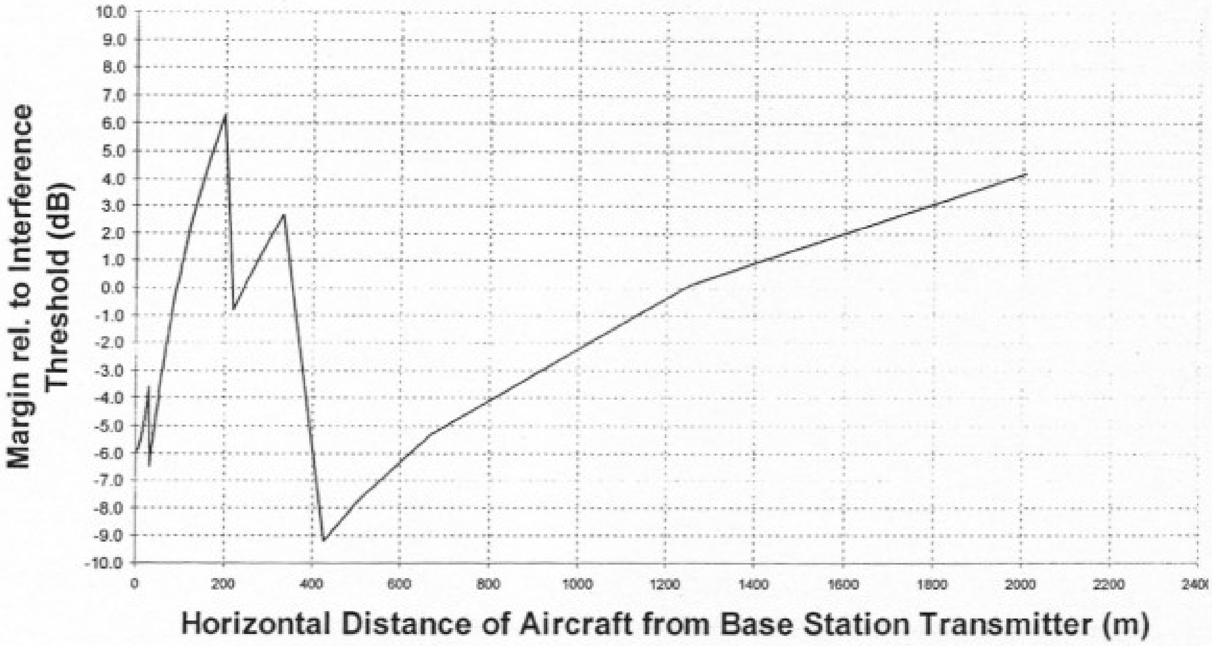
Inmarsat is also unable to confirm MSV's assertion that "*... as the horizontal distance between the aircraft and the ATC base station increases, the interference margin increases rapidly ...*". Because of the nature of the proposed ATC base station antenna overhead gain suppression mask, the zenith situation is not the worst case in terms of interference margin, as Inmarsat has shown repeatedly in the past. The figure below shows the margin, relative to the assumed interference threshold of -50 dBm, for a range of horizontal distances, and using the same calculation methodology and assumptions as described above.[7] Note that the margin is -6 dB at zero horizontal distance (as shown above), but the margin then becomes positive before then going negative again, reaching a worst-case of -9.2 dB at around 425 meters from the base station. Clearly this shows a result that is completely different from what MSV asserts. The significance of this is that the worst-case interference is not when the aircraft is immediately over

6 Inmarsat has used the assumptions proposed by MSV for this analysis, which are not the same as Inmarsat's own assumptions used in the past.

7 These results have been obtained by systematically varying the horizontal distance from zero to 2400 meters, and calculating the corresponding range distance and hence spreading loss for each case. In addition, for each case the appropriate ATC base station antenna gain is calculated based on the angular offset relative to peak gain.

the ATC base station, but when it is some distance (425 meters for the particular assumptions used here) horizontally away from the base station.

Thus, MSV's analysis is not only incorrect in the calculated values, but also appears misleading in the way the results were presented in tabular form, where the true shape of the margin curve has effectively been concealed by appropriate choice of horizontal spacing values in the MSV table.



MSV's analysis, as well as the analysis presented above, only takes account of the interference from one sector of the ATC base station antenna. Although this may be appropriate for situations where the aircraft is a large distance horizontally from the base station, it certainly is not the case when the aircraft is close to being overhead relative to the ATC base station. In these situations the interfering power of all sectors should be added together to assess the interfering power to the Inmarsat receiver. In the case of an ATC base station with three sectors, this would be a 4.77 dB increase in interference, or reduction in interference margin, resulting in a 73% increase in the required separation distances relative to those calculated in this Technical Annex.

Furthermore, it is highly questionable whether the voice activity interference power reduction (4 dB) and the power control reduction (5.2 dB) are appropriate for the case of a single ATC base station. The Commission included these factors when assessing the impact of a large number (1000) of ATC base stations, based on the statistical effect of these mechanisms over a large number of channels, and MSV has assumed that they apply equally well to the case of a single ATC base station. The voice activity power reduction would be approximately zero for data communications, which is a growing type of traffic on mobile communications systems. Similarly, when a base station is communicating with a disadvantaged ATC user, there will be no power control reduction. These two factors amount to 9.2 dB, which is a 2.9 times increase in the required separation distances to avoid harmful interference. This needs to be taken into account when assessing the size of the zones around ATC base stations where ATC interference will preclude or disrupt Inmarsat MSS service.

C. MSV's Proposition that Inmarsat Overcome Downlink Interference by Changes to the Inmarsat Receivers, and by the Use of Power Control

Admitting that its ATC network poses an interference threat to Inmarsat, MSV urges the Commission to require that Inmarsat terminals be made like PCS or cellular handsets, so they can overcome the effects of ATC interference. MSV proposes that simple dual conversion heterodyne receivers are the solution to the problem. This suggestion ignores the following realities:

(i) Satellite receivers are designed with great emphasis on minimizing front-end noise so that they can be highly sensitive to receive very weak signals from their "base station" located 22,300 miles away;

(ii) This low-noise requirement is fundamentally different from PCS terminals which do not require such high sensitivity because they are able to use base station power control to combat interference;

(iii) Inmarsat's terminal manufacturers would be required to carry out lengthy research on new and innovative technologies for effectively dealing with the interference that Inmarsat terminals will be subject to when in the proximity of the high-powered ATC base stations, that do not comply with the February 2003 ATC rules;

(iv) The over 350,000 Inmarsat terminals that already have been commissioned at an estimated total investment of more than $3 billion cannot be retrofitted;

(v) It is far too late to suggest that Inmarsat change a system design on which it has proceeded in reliance on the February 2003 issuance of ATC rules by the Commission, in a proceeding that started almost four years ago in 2001.

(vi) In proposing that Inmarsat use power control to combat downlink interference into Inmarsat terminals, MSV, despite being an MSS operator, fails to acknowledge that the primary driver for the introduction of a power control mechanism in MSS systems, and the way in which the downlink power control system operates. Downlink power control is used to minimize satellite power to the level actually required depending on the link characteristics. It cannot be used to overcome the high levels of ATC interference, including receiver saturation, that would occur in the vicinity of ATC base stations.

In view of the above, and considering that ATC has not yet been implemented, it begs the question of why MSV is not willing to explore what it can do to modify its ATC implementation to limit interference, for example, by the use of a MSS operation detection mechanism in the neighborhood of ATC base stations, which can be used to limit, on a dynamic basis, the base station transmitted power of the relevant sector in which the MSS terminal may be operating.

II. Uplink Interference to Inmarsat Satellites

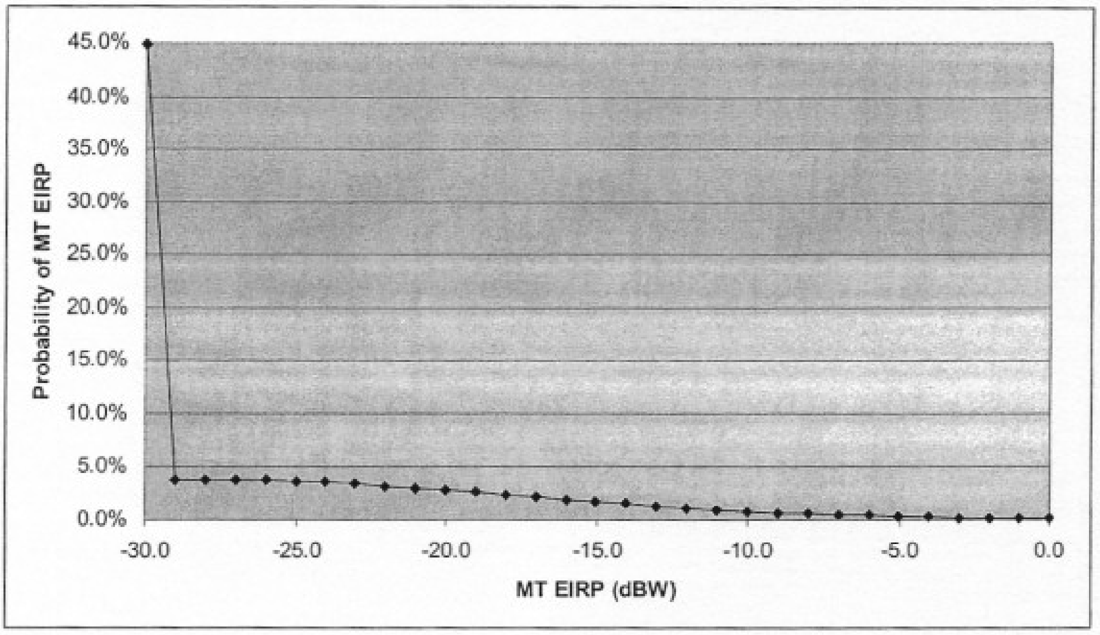
The Commission's February 2003 ATC order assumed that the average equivalent outdoor EIRP of all ATC terminals will be at least 20 dB below maximum EIRP.[8] There is simply is no evidence that the MSV ATC system is consistent with this assumption. As a result, there is no assurance that Inmarsat spacecraft will be protected from uplink interference from ATC, as assumed in the February 2003 ATC Order. This is demonstrated below.

MSV quotes its August 31, 2004 ex parte as evidence that it will achieve an interference reduction factor of 20 dB due to power control. The key parameters of MSV's GSM link budget are shown below.

Required isotropic power at base station antenna	dBW	-160
Maximum MT EIRP	dBW	0
Structural attenuation margin	dB	18
Lognormal margin	dB	7
Path loss to cell edge (75% Ps)	dB	135
Cell radius with Cost 231/Hata model	km	1.01

The EIRP at the cell edge (for 75% coverage) can be calculated to be –25 dBW from these parameters. Also, based on the characteristics of the cell it can be estimated that the average range taper is 3.6 dB. Hence, the MT EIRP required for 75% coverage within the cell is –28.6 dBW. Finally, based on the lognormal margin assumed, the standard deviation of the distribution can be calculated as 10.4 dB. With this information we can produce the distribution of EIRP levels in the cell. In doing this we take into account that the EIRP range is –30 dBW to 0 dBW. The EIRP distribution is shown in the following figure.

[8] *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*, 18 FCC Rcd 1962 (2003), *Errata*, IB Docket Nos. 01-185 and 02-364 (rel. March 7, 2003), *on reconsideration*, FCC 03-162 (rel. July 3, 2003) (the "*ATC Order*"). at 2152 (Appendix C2 § 1.3.5).



The average EIRP from this distribution is –17.5 dBW, i.e. 2.5 dB above –20 dBW.

It should be noted that in this example we have used the maximum EIRP of 0 dBW as specified by MSV in its link budget. If the maximum EIRP instead were –4 dBW (due to an average antenna gain of –4 dBi) there would be no significant difference. The minimum EIRP would become –34 dBW, the distribution above would be shifted by 4 dB and, to comply with the 20 dB power control margin, the required average EIRP would be –24 dBW. The main difference in this case is that MSV would be required to reduce the size of the cell to maintain the same link margin.

In MSV's example link budget the average path loss at 1 km distance is given as 135 dB compared to the free-space loss of 97 dB. Hence, the MSV link budget includes a 38 dB margin with respect to free-space conditions, but does not satisfy the assumption that the average equivalent outdoor EIRP of all ATC terminals will be at least 20 dB below maximum EIRP. The margins and average EIRP would vary depending on the specific characteristics of the cell and depending on the design techniques that are employed by MSV, but it is clear from MSV's example that significant care has to be taken to ensure that the average EIRP is kept at least 20 dB below maximum. Certainly, the need to control ATC emissions toward MSS spacecraft is much greater than the need to simply "bar licensees from extending a base station's coverage area to such an extent that a mobile terminal at the edge of the area would have to transmit at EIRP higher than –18 dBW merely to overcome free-space loss", which is the only significance the Bureau places on the 18 dB structural attenuation margin requirement. (MSV Order at 33)

Based on the Bureau's interpretation of the 18dB structural attenuation requirement, MSV could deploy cells that require an MT to transmit at 18 dB below maximum EIRP only when the MT is at the edge of a cell and has line-of-sight to the base station. Under this approach, all MTs that do not have line-of-sight to the base station would be allowed to increase the EIRP above this level. Such a result is antithetical to the interference calculations underlying the February 2003 decision to authorize ATC on a secondary, non-harmful interference, basis. As demonstrated in Inmarsat's Application for Review – this interpretation would result in an average MT EIRP far above what was assumed in the Commission's original ATC interference analysis, and it therefore cannot be reconciled with the February 2003 ATC decision.

Although it is evident from the above discussion that a cell in an urban area that is designed to require an MT EIRP 18 dB below maximum for line-of-sight conditions at the edge of the cell would leave significant holes in the coverage, there may still be cases where MSV would decide that it is in its best interest to do this. For example, this would be a method to extend the size of cells at the edge of ATC coverage areas. Most importantly, there are many intermediate cases between the "minimalist" design required based on the Bureau's interpretation of the structural attenuation rule and the near-ideal coverage case shown in MSV's link budget. MSV may well choose to deploy such intermediate cell designs, and if it does they would cause much more interference to Inmarsat than the FCC intended. As even the near-ideal case fails to meet the intent of the rule to limit the average MT EIRP, there is little hope that MSV will voluntarily go to the trouble needed to protect Inmarsat's satellites. For these reasons, Inmarsat continues to urge the Commission to ensure that the average MT EIRP of the MSV ATC system is at least 20 dB below maximum EIRP.

Annex A

Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, DC

TSO-C132

Effective
Date: 3/25/04

Technical Standard Order

Subject: TSO-C132, Geosynchronous Orbit Aeronautical Mobile Satellite Services Aircraft Earth Station Equipment

1. **PURPOSE.** This Technical Standard Order (TSO) is for manufacturers of geosynchronous orbit Aeronautical Mobile Satellite Services (AMSS) Aircraft Earth Station (AES) equipment applying for a TSO authorization. In it, the Federal Aviation Administration (FAA) tells you what minimum performance standards (MPS) your AMSS AES equipment must meet for approval and identification with the applicable TSO marking.

2. **APPLICABILITY.** This TSO affects new applications submitted after this TSO's effective date.

3. **REQUIREMENTS.** New models of AMSS AES equipment identified and manufactured on or after the effective date of this TSO must meet the MPS in RTCA Document No. RTCA/DO-210D, "Minimum Operational Performance Standards (MOPS) for Geosynchronous Orbit Aeronautical Mobile Satellite Services (AMSS) Avionics," Section 2.0, dated April 19, 2000 to include Change 1, dated December 14, 2000, and Change 2, dated November 28, 2001.

a. **Functionality.** This TSO's standards apply to AMSS AES equipment that provides direct worldwide communications between aircraft subnetworks and ground subnetworks using aeronautical mobile satellites and their ground earth stations. AMSS will support both data and voice communications between aircraft users and ground-based users, such as Air Route Traffic Control Centers (ARTCCs) and aircraft operators. Communication services with AMSS functions include four categories: Air Traffic Services (ATS), Aircraft Operational Control (AOC), Aeronautical Administrative Communications (AAC), and Aeronautical Passenger Communications (APC).

> **NOTE:** We may have more airworthiness requirements for installing AMSS AES equipment intended for ATS communications. Contact your local geographic Aircraft Certification Office (ACO) for more information.

b. **Failure Condition Classification.** Failure of the function defined in paragraphs **3** and **3a** of this TSO is a minor failure condition. You must develop the system to at least the design assurance level equal to this failure condition classification.

c. **Environmental Qualification.** Test the equipment according to RTCA Document No. DO-160D, "Environmental Conditions and Test Procedures for Airborne Equipment," dated July 29, 1997 to include Change 1, dated December 14, 2000, Change 2, dated June 12, 2001, and Change 3, dated December 5, 2002.

d. **Software Qualification.** If the article includes a digital computer, develop the software according to RTCA Document No. RTCA/DO-178B, "Software Considerations in Airborne Systems and Equipment Certification," dated December 1, 1992.

e. Deviations. We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, you must show that your equipment maintains an equivalent level of safety. Apply for a deviation under 14 CFR § 21.609.

4. MARKING.

a. Mark at least one major component permanently and legibly with all the information in 14 CFR § 21.607(d), except for:

(1) Section 21.607(d)(2). Use the name, type, and part number instead of the optional model number, and

(2) Section 21.607(d)(3). Use the date of manufacture instead of the optional serial number.

b. In addition, mark the following permanently and legibly with at least the name of the manufacturer, manufacturer's subassembly part number, and the TSO number:

(1) Each component that is easily removable (without hand tools),

(2) Each interchangeable element, and

(3) Each separate sub-assembly of the article that you determined may be interchangeable.

c. If the component includes a digital computer, then the part number must include hardware and software identification. Or, you can use a separate part number for hardware and software. Either way, you must include a means for showing the modification status.

> **NOTE:** Similar software versions, approved to different software levels, must be differentiated by part number.

d. When applicable, identify the equipment as an incomplete system or that the appliance performs functions beyond those described in paragraphs **3** and **3a** of this TSO.

5. APPLICATION DATA REQUIREMENTS. Under 14 CFR § 21.605(a)(2), you, as a manufacturer-applicant, must give the FAA's ACO manager responsible for your facilities, one copy each of the following technical data to support our design and production approval:

a. Operating instructions and equipment limitations, sufficient to describe the equipment's operational capability.

b. Installation procedures and limitations, sufficient to ensure that the AMSS AES equipment, when installed according to the installation procedures, still meets this TSO's requirements. The limitations must identify any unique aspects of the installation. Finally, the limitations must include a note with the following statement:

> The conditions and tests for TSO approval of this article are minimum performance standards. Those installing this article, on or within a specific type or class of aircraft, must determine that the aircraft installation conditions are within the TSO standards. TSO articles must have separate approval for installation in an aircraft. The article may be installed only according to 14 CFR part 43 or the applicable airworthiness requirements.

c. When applicable, identify the appliance as an incomplete system or a multi-use system. Describe the functions that the appliance is intended to provide.

d. Schematic drawings of the installation procedures.

e. Wiring diagrams of the installation procedures.

f. List of the components, by part number, that make up the AMSS AES system complying with the standards in this TSO. You should include vendor part number cross-references, when applicable.

g. Instructions, covering periodic maintenance, calibration, and repair, for the continued airworthiness of installed AMSS AES equipment. Instructions should include recommended inspection intervals and service life.

h. Material and process specifications list.

i. The quality control system description required by 14 CFR §§ 21.605(a)(3) and 21.143(a), including functional test specifications. These test each production article to ensure compliance with this TSO.

j. Manufacturer's TSO qualification test report.

k. Nameplate drawing with the information required by paragraph 4 of this TSO.

l. A list of all drawings and processes, including revision level, to define the article's design. For a minor change, you only need to make revisions to the drawing list available on request.

m. An environmental qualifications form as described in RTCA/DO-160D for each component of the system.

n. If the article includes a digital computer: a Plan for Software Aspects of Certification (PSAC); Software Configuration Index; and Software Accomplishment Summary. We recommend that you submit the PSAC early in the software development process. Early submittal allows us quickly to resolve issues, such as partitioning and determining software levels.

6. MANUFACTURER DATA REQUIREMENTS. Besides the data to be furnished directly to the FAA, a manufacturer must have available for review (by the responsible ACO) the following technical data:

a. The functional qualification specifications for qualifying each production article to ensure compliance with this TSO.

b. Equipment calibration procedures.

c. Corrective maintenance procedures within 12 months after TSO authorization.

d. Schematic drawings.

e. Wiring diagrams.

f. Material and process specifications.

g. The results of the environmental qualification tests conducted per RTCA/DO-160D.

7. FURNISHED DATA REQUIREMENTS. With each article manufactured under this TSO, provide the following:

(1) One copy of the technical data and information specified in paragraphs **5a(1)** through **(8)** of this TSO. Add any other data or information necessary for the proper installation, certification, and use, or for continued airworthiness, or for both, of the AMSS AES equipment.

(2) One copy of the data and information in paragraphs **5a(11)** through **(13)**, if the appliance performs functions beyond those described in paragraphs **3** and **3a** of this TSO. You must send these data to each person receiving one or more of the equipment for use.

8. HOW TO GET REFERENCED DOCUMENTS.

a. You can buy copies of RTCA Document Nos. DO-210D, DO-160D, and DO-178B, from RTCA, Inc., 1828 L Street, NW, Suite 805, Washington, DC 20036. Telephone (202) 833-9339, fax (202) 833-9434. You can also get copies through the RTCA website @ www.rtca.org.

b. You can buy copies of 14 CFR part 21, Subpart O, from the Superintendent of Documents, Government Printing Office, Washington, DC 20402-9325. Telephone (202) 512-1800, fax (202) 512-2250. You can also get copies from the Government Printing Office (GPO), electronic CFR Internet website @ www.access.gpo.gov/ecfr/.

c. You can get FAA Advisory Circular (AC) 20-110 or the most current revision, "Index of Aviation Technical Standard Orders," and AC 20-115 or the most current revision, "Index of Articles Certified under the Technical Standard Order System," from the U.S. Department of Transportation, Utilization and Storage Section, M-443.2, Washington, DC 20590. Telephone (301) 322-4477, fax (301) 386-5394. You can also get copies from the FAA's Regulatory and Guidance Library (RGL) @ www.airweb.faa.gov/rgl. On the RGL webpage, select "Advisory Circulars."

Susan J. M. Cabler

Susan J. M. Cabler
Acting Manager, Aircraft Engineering Division
Aircraft Certification Service

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in the foregoing submission, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this pleading, and that it is complete and accurate to the best of my knowledge and belief.

Richard Barnett

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Dated: January 5, 2005

CERTIFICATE OF SERVICE

I, Thomas A. Allen, hereby certify that on this 5th day of January, 2005, the foregoing "Reply" was served by hand(*) or via first class mail, postage pre-paid, upon the following:

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