APPENDIX B

1. Introduction

This Appendix reviews the technical calculations provided by Inmarsat and shows that the overly pessimistic assumptions used in the preparation of their supporting material is overly conservative and thus leads to a gross over-estimation of the interference possibility from the ancillary terrestrial component (ATC) of MSS systems.

The technical analysis presented in this Appendix is not as rigorous as those analyses presented by Inmarsat in response to this consultation, on the basis that ICO is not intimately familiar with the MOU issues and the coordination agreements between TMI, Inmarsat and the other L-band MSS operators. However, this analysis does highlight the impact of using more realistic parameters for interference mitigation factors, such as EIRP, shielding, antenna discrimination, and in estimating the number of potential interference sources.

2. Interference Paths

This Appendix is organized in a fashion similar to the Inmarsat technical comments and considers the interference potential along two potential interference paths, while considering five potential interference scenarios. Assuming an ATC operated by TMI according to Appendix 1 to the consultation, the following cases are to be considered:

1. The interference from MSV ATC mobile earth terminal (MET) transmitters to the MSS satellite receivers. There are three aspects to be considered:
   a. Co-channel, non-co-coverage interference to other MSS satellites that are serving areas well outside North America (see section 3.1);
   b. Non-co-channel, co-coverage interference to other MSS satellites that are serving the same area as the ATC deployment (see section 3.2);
   c. Co-channel, non-co-coverage interference to the MSV satellite into their beams that are close to the ATC service area (see section 3.5).

2. The interference from MSV ATC base station (BS) transmitters to the MSS receive earth terminal (MET) of other systems operating in the vicinity of the ATC BS. The following three cases are considered:
   a. Interference caused by the ATC BS transmitters resulting from insufficient signal rejection by the other MSS MET receiver and potentially resulting in overload of the receiver's front end (see section 3.3);
   b. Out-of-Band (OOB) interference from the ATC BS transmitter falling into the MSS MET receiver pass-band (see section 3.4).

3. Interference Analysis

This section compares the results obtained by Inmarsat in their technical annex to their comments on the consultation with revised calculations taking into account more reasonable assumptions.

3.1 Co-channel, non-co-coverage interference from ATC MET to other MSS satellites that are serving areas well outside North America

As indicated by Inmarsat, this interference path is analogous to the already existing interference path from the MSS MET to the Inmarsat satellite serving areas well outside North America. It is understood that the interference from ATC MET to the Inmarsat satellites is an aggregate interference issue, since the interference from a single terminal will be shown to be negligible. As a result, many of the interference calculation parameters must necessarily take an average form. Inmarsat did consider this, but in many cases used overly protective values. In the case of interference from MSS SC MET to Inmarsat satellites on the uplink, the interference comes from only one or a small number of terminals such that the averaging factor is not always relevant. These two situations are compared in this section.

Table 3.1-1 shows the results of calculations for interference from ATC MET transmitters to Inmarsat-4 satellites as calculated in Inmarsat's technical appendix and revised calculations using more realistic parameters. For completeness, calculations are also provided for Inmarsat-3 satellites.

Table 3.1-1 Uplink Interference from ATC MET into Inmarsat Satellites (54°W) with Beams serving Areas Well Outside North America (Single ATC MET assumed)

parameter	**units**	**MSV ATC MET into INM-4 (per Inmarsat)**	**MSV ATC MET into INM-4 (revised)**	**MSV ATC MET into INM-3**
Inmarsat Sat. G/T	dB/K	13.0	13.0	-1.5
Inmarsat Sat. Gain	dBi	41.0	41.0	**27.0**
Noise Temp.	K	650.0	650.0	708.0
Noise Density	dBW/Hz	-200.5	-200.5	-200.1
MSV MET EIRP **(Peak)**	dBW	0.0	0.0	0.0
MSV MET BW	kHz	200.0	200.0	200.0
MSV MET EIRP dens.	dBW/Hz	-53.0	-53.0	-53.0
Free-Space Loss	dB	188.8	188.8	188.8
Shielding (AVG)	dB	3	**10**	**10**
INM Sat. Ant. Disc. (AVG)	dB	20	**25**	**20**
Voice Activation (AVG)	dB	2	2	2
Power Control Red. (AVG)	dB	0	**6**	**6**
Pol. Isolation (AVG)	dB	1.4	**3**	**3**
Rx. Interf. Power Density	dBW/Hz	-227.2	-246.8	-260.8
Δ T/T per MSV Carrier	%	0.213%	0.002%	0.0003%

From the above results, it can be seen that using more realistic assumptions, the interference from ATC MET transmitters to Inmarsat-4 satellites would be at least *100 times lower* than the levels predicted by Inmarsat. This is due to four parameters that were under-estimated in their original analysis: shielding, satellite antenna discrimination, power control reduction and polarization advantage. Each are discussed below.

In their calculations, Inmarsat assumed only 3-dB average shielding from ATC MET to the Inmarsat satellite. This might be an acceptable average for a single terminal roaming in a portion of Canada where the elevation angle is high so that the results provided by the references given by Inmarsat would be valid. But in this case, it can clearly be seen that interference from a single ATC MET transmitter is negligible. The only interference potential would come from very large numbers of terminals. However, the intent of the aggregate interference calculations is to obtain the realistic interference from all co-channel ATC MET transmitters operating over the entire Canadian territory and not just a single terminal. Considering that the Inmarsat AOR West satellite (54°W) is visible with elevation angles from less than 5° (Vancouver/Victoria) to no more than 38° (in Halifax), the applicability of some of the measurement results cited by Inmarsat to this situation is certainly doubtful.[1] Also, when Inmarsat considered the Hess model, they recognized that 50% of the time, the fade level exceeded 7 dB. In all these cases, the measurements were conducted outside buildings while driving into the streets. Thus these measurements did not take into account any additional blockage due to structures containing the ATC transmitter such as a building, vehicle, etc. The very reason for deploying an ATC component to MSS systems is to increase building penetration and accessing the urban canyons. In fact, in those areas where ATC will be deployed, the user will most likely be using his/her terminal indoors or in a vehicle for the majority of time. Therefore, ICO believes that the average attenuation would be at the very least 10dB for a large population of ATC transmitters.

In their calculations, Inmarsat assumed only 20dB satellite antenna discrimination for their satellite antenna sidelobes for beams operating well outside North America. As for the shielding effects, such a number might be reasonable when considering a single MET transmitter located in the worst sidelobe of the Inmarsat-4 satellite receive beam. However, when considering very large numbers of MET transmitters scattered across the country, such an assumption is not reasonable. The beam contours were generated using commercially available software to represent an Inmarsat-4 receive beam centered over Western Europe and having a peak gain of 41 dBi. Figure 3.1-1 shows the contours for this beam, corresponding to an Inmarsat-4 satellite located at 54°W. This figure shows that while the -20 dB contour reaches North America, the gain of the antenna pattern quickly drops below 25 dB over a very large portion of Canada. It should also be noted that the most pessimistic ITU-R satellite antenna pattern (Recommendation ITU-R S.672-3, Ln=-20dB) was used for this graph. While some very small portions of eastern Canada will “hit” the satellite at the –20dB level, the average gain is better than 25 dB below peak gain.

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[1] The measurements performed in Tokyo by Karasawa et al. were done for a satellite that was at 32° elevation angle as described in the Inmarsat technical appendix.

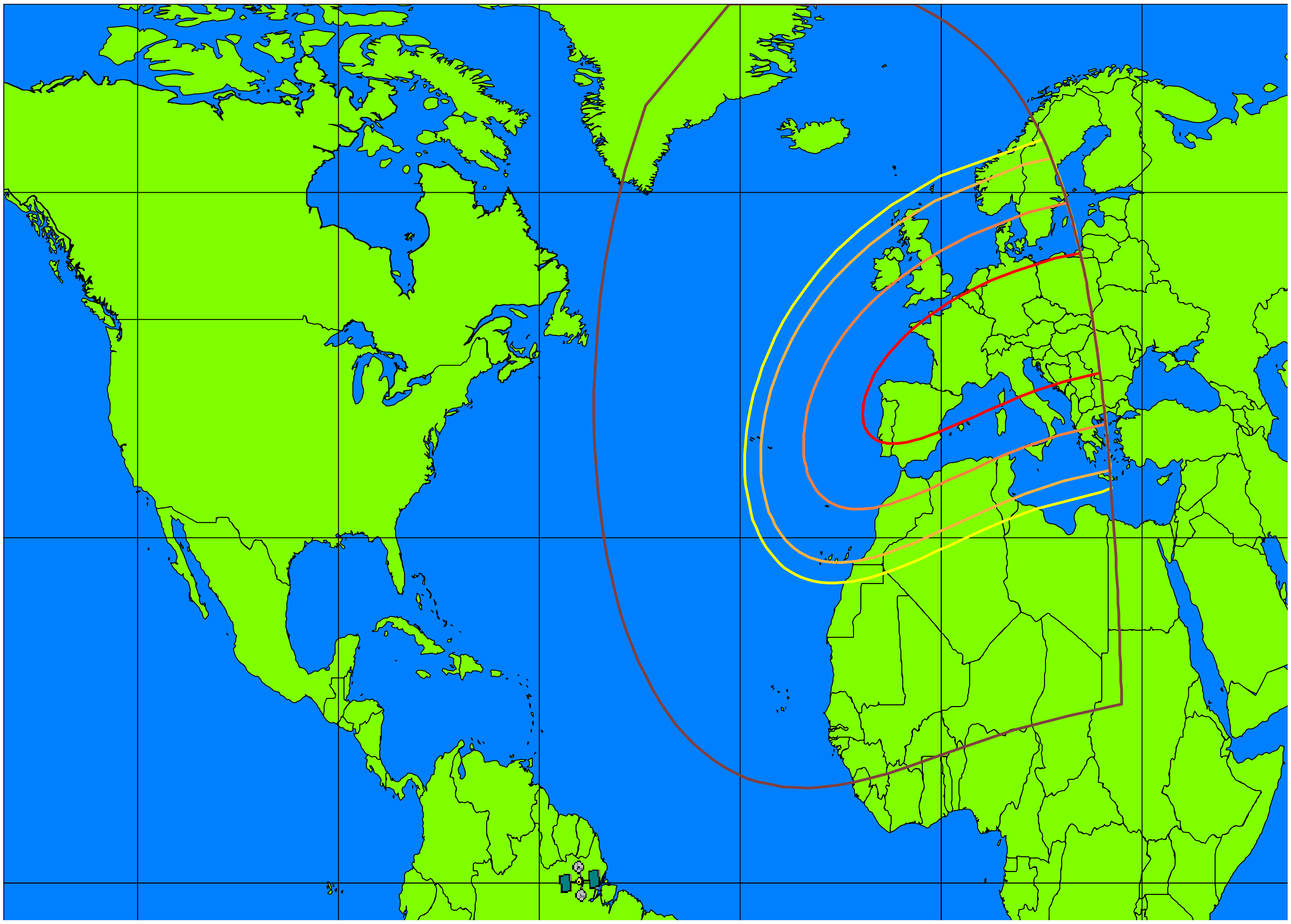
Figure 3.1-1 – Inmarsat-4 Beams with 41 dBi Gain
(Assuming ITU-R S.672-3, Ln=-20dB pattern;
contours are -3, -10, -20, -25 and –30 dB)

If we were to consider a better antenna pattern for the Inmarsat-4 satellite, such as Recommendation ITU-R S.672-3, Ln=-30dB, as shown in Figure 3.1-2 below, the average gain to Canadian cities would be 30dB below the peak gain. This would improve the interference calculation results by another 5 dB (or a reduction of 3 in ΔT/T).

In their calculations, Inmarsat assumed that the ATC MET operated at peak EIRP with a power control reduction of only 2 dB. There was no description on the reason for using such a low value and whether this was due to voice activation, power control or a combination of both. However, in later sections of their Appendix, they used 4 dB for voice activation and 6 dB power control in the case of base station transmitters. It is unclear why these values were not also assumed for the ATC MET transmitters. ICO believes that 2 dB (60%) voice activation is reasonable and concurs that the value of 6 dB for ATC MET power control is also relevant to this analysis. In fact, ICO ATC proposals are based on similar values. Therefore, ICO's calculations reflect these values.

Lastly, Inmarsat believes that only 1.4 dB is applicable for polarization advantage in the case of interference from linearly polarized signals to circularly polarized signals. In a recently adopted ITU-R Recommendation (Rec. ITU-R S4/BL/20), it was demonstrated that 3 dB is the applicable value for these cases.

Figure 3.1-2 – Inmarsat-4 Beams with 41 dBi Gain (Assuming ITU-R S.672-3, Ln=-30dB pattern; contours are -3, -10, -20, -25 and –30 dB)



It was shown in this analysis that the interference from each ATC MET into Inmarsat-4 satellite beams operating well outside North America would be less than 0.002% which is entirely negligible. For the case of Inmarsat-3 satellites and using their highest gain beam[2], the interference from a single ATC MET is even lower with an increase of noise temperature of about 0.0003%. In this case, the antenna sidelobes were assumed to be -20dB from peak gain because the beams are much larger in coverage than the Inmarsat-4 spot beams.

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[2] Based on Inmarsat-3 AOR West-2 ITU Filing, the highest gain beam is 27 dBi with noise temperature of 708K (Beam LUR).

It is interesting to compare the interference level from a single ATC MET to that caused by a single MSV MSS MET. This is done in Table 3.1-2. The three columns represent the ATC MET, MSV proposed MSS MET and the current MSAT MSS MET calculations.

Table 3.1-2 Uplink Interference from ATC/MSS MET into Inmarsat-4 Satellite (54°W) with Beams serving Areas Well Outside North America (Single MET assumed)

parameter	**units**	**MSV ATC MET into INM-4**	**MSV MSS MET into INM-4**	**MSAT MSS MET into INM-4**
Inmarsat Sat. G/T	dB/K	13.0	13.0	13.0
Inmarsat Sat. Gain	dBi	41.0	41.0	41.0
Noise Temp.	K	650.0	650.0	650.0
Noise Density	dBW/Hz	-200.5	-200.5	-200.5
MSV MET EIRP	dBW	0.0	5.0	5.5
MSV MET BW	kHz	200.0	50.0	5.0
MSV MET EIRP dens.	dBW/Hz	-53.0	-42.0	-31.5
Free-Space Loss	dB	188.8	188.8	188.8
Shielding (AVG for ATC)	dB	10	3	3
INM Sat. Ant. Disc. (AVG for ATC)	dB	25	20	20
Voice Activation (AVG)	dB	2	2	2
Power Control Red. (AVG for ATC)	dB	6	0	0
Pol. Isolation (AVG)	dB	3	0	0
Rx. Interf. Power Density	dBW/Hz	-246.8	-214.8	-204.3
Δ T/T per MSV Carrier	%	0.002%	3.726%	41.801%
Ratio of Interference from MSS MET to ATC MET			1592	17867

As can be seen from the above table, each MSS MET causes about 1600 times more interference than the ATC MET, while the MSAT terminals can cause levels that are close to 18000 times higher than the ATC terminal. These calculations assume that the MSS transmitters do not operate with power control and that they are located in eastern Canada where the Inmarsat-4 satellite has less discrimination. In this case, this is a reasonable assumption since there would be very few co-channel interference sources from the MSS MET because of lower frequency reuse. In addition, the MSS component is assumed to operate on circular polarization thus resulting in no polarization discrimination.

In order to determine the number of co-channel interference sources a simple comparison is made to existing Canadian PCS operators. Because MSV plans to operate GSM carriers, the comparison is made to the current deployment status of Microcell's Fido® network. According to the most recent subscriber figures[3], Microcell had just over 1

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[3] http://www.cwta.ca/industry_guide/SubscribersStats_Q3_01.PDF

million subscribers in Canada at the end of the 3Q 2001. An estimate of co-channel users is provided in Table 3.1-3.

This is also based on the average user activity of 185 minutes per month as provided by the CWTA. Assuming a 12-hour active day, the average user utilizes his/her PCS phone for 0.86% of the time. To be conservative and to account for peak usage, we assume that each user is active 2% of the time (almost a three times increase).

Table 3.1-3 Estimate of Co-Channel PCS Users in Canada

Parameter	**Value**	**Units**
total subscribers	1110000	
total licensed bandwidth	15	MHz
bandwidth per carrier	200	kHz
number of channels	75	
user activity factor	2%	
total active users	22200	
users/channel across Canada	296	
TDMA slots	6	
users/channel at any instant in time	49.33	

Based on the above results, each channel has on average 50 users active at any given time. Results for other PCS operators[4] would result in similar order of magnitude.

Therefore, if successful PCS operators which have been in business in Canada for more than 6 years (more than 15 years in the case of the incumbent cellular providers) achieve an average of 50 active users per channel at any given time, it is totally unrealistic to claim that the ATC component will comprise thousands of active co-channel users, as claimed by Inmarsat[5].

Even if comparable levels are obtained through the use of ATC to PCS, the total noise increase into Inmarsat-4 satellites would be about 0.1%, much less than the 6% threshold level for inter-system coordination and 4*00 times* less than the levels that would be experienced from the currently operating MSAT MES terminal.

3.2 Non-co-channel, co-coverage interference from ATC MET to other MSS satellites that are serving Canada

This relates to the possible out-of-band interference from ATC MET into adjacent bands used by other MSS satellites, such as Inmarsat. The calculations provided by Inmarsat are compared to revised calculations using somewhat more conservative, but realistic, assumptions as previously described. In this case, the shielding assumed is the very

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[4] Rogers AT&T has about 2.8 million subscribers but as an original cellular provider, has access to more than three times the bandwidth resulting in similar per channel users.

[5] *See* Inmarsat comments' technical appendix at 7.

conservative 3 dB figure used by Inmarsat, but as explained before, the conditions are different for ATC from those used in the various measurement programs. Most notably is the fact that the majority of ATC users will be inside buildings and not necessarily roaming on the streets as was done for the measurement campaigns. The only change to the Inmarsat calculations was to assume transmit power control of 6 dB for the ATC MET.

Table 3.2-1 Uplink Adjacent Channel Interference from ATC MET into Inmarsat-4 Satellite (54°W) with Beam serving Canada (Single MET assumed)

parameter	**units**	**MSV ATC MET**	**MSV ATC MET**
Inmarsat Sat. G/T	dB/K	13.0	13.0
Inmarsat Sat. Gain	dBi	41.0	41.0
Noise Temp.	deg K	631.0	631.0
Noise Density	dBW/Hz	-200.6	-200.6
MSV MET EIRP	dBW	-43.0	-43.0
MSV MET BW	kHz	200.0	200.0
MSV MET EIRP dens.	dBW/Hz	-96.0	-96.0
Free-Space Loss	dB	188.9	188.9
MET gain disc. to satellite	dB	0.0	0.0
Shielding (AVG)	dB	3	3
INM Sat. Ant. Disc. (AVG)	dB	0	0
Voice Activation (AVG)	dB	2	2
Power Control Red. (AVG)	dB	0	**6**
Pol. Isolation (AVG)	dB	1.4	1.4
Rx. Interf. Power Density	dBW/Hz	-250.3	-256.3
Δ T/T per MSV Carrier	%	0.00107%	0.00027%

Inmarsat claims that these interference levels are totally unacceptable when considering the aggregate interference from the "tens of thousands of MSV [ATC] terrestrial channels simultaneously in use in such an area[6]". However, based on the estimates provided in the previous section for the PCS operators' average users per channel, Inmarsat's claims of tens of thousands of co-channel users cannot be substantiated. It was estimated that 50 PCS users operate co-frequency across Canada at any given time. The area described by Inmarsat represents roughly one-third of Canada's population, so if ATC is as successful as PCS and operates in a 5 MHz band (25 active 200-kHz channels), it is conceivable that 416 users would operate co-frequency at any time over the Canadian ATC network. The interference from these users to Inmarsat-4 satellites would correspond to less than 0.11% increase in noise levels which is negligible. It would require over 3500 active co-channel ATC transmitters in every single ATC channel to raise the noise floor by 1%!

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[6] This "area" is defined in the Inmarsat technical appendix on page 8 as encompassing a large part of the populated areas of Montreal, Ottawa, and Toronto.

3.3 Interference from ATC BS to MSS Mobile Terminals (MET) due to overload from the adjacent channel transmissions

In their study, Inmarsat claims that their Mini-M receivers are sensitive to out-of-band emissions due to overloading of the receiver front end (LNA). They state that an aggregate incident PFD of –105 dBW/m^2 in the direction of main gain is enough to saturate the receiver front end. No technical analysis is provided to support such claims. Based on this specification, Inmarsat states that the receive noise level that would cause receiver degradation is –120 dBW. ICO is very incredulous of this specification.

Firstly, it is questionable whether such a sensitive terminal could survive in the presence of MSS satellite transmissions alone. Assuming a fully loaded L-band (assumed as 30 MHz of spectrum in this analysis), it is possible to compute the PFD into the Inmarsat terminal from aggregate satellite transmission. This is done in Table 3.3-1. The EIRP per carrier of each MSS system was derived from data supplied in the ITU weekly circulars[7] and the PFD for each carrier was calculated. It was then assumed that each MSS system used 5 MHz from the L-band spectrum (10 MHz for Inmarsat) and the aggregate PFD within a 30 MHz band was computed. The calculated aggregate PFD from these MSS systems is –96 dBW/m^2 well over the value claimed by Inmarsat as detrimental.

Table 3.3-1 Downlink aggregate PFD levels from multiple MSS into Inmarsat MET – Overload of receiver front-end

System	Beam	BW	Power	Gain	EIRP	EIRP/4KHz	PFD/4kHz	PFD/5 MHz
Inmarsat-3 AOR West-2	LDR	12.5	-0.4	27.0	26.6	21.7	-140.8	-109.9
Inmarsat-3 AOR West-2	LGD	12.5	4.3	19.5	23.8	18.9	-143.6	-112.7
MSAT/MSV	LC x	7.5	-4.0	29.2	25.2	22.5	-140.0	-109.1
MSAT/MSV	LE x	5.0	1.3	34.0	35.3	34.3	-128.2	-97.2
Volna-13	G18	8.0	9.0	18.0	27	24.0	-138.5	-107.5
Solidaridad-1M		5.0	-15.8	30.0	14.2	13.2	-149.3	-118.3
total PFD (in 30 MHz)								-96.2

Secondly, it is normal to design satellite earth station receivers without any filtering in front of the LNA in order not to degrade the G/T performance, so the aggregate interference that can cause receiver overload would be all the signals that fall within the passband of the LNA. While there are not many terrestrial operations in the core L-band MSS bands[8], there is a primary allocation immediately below the MSS bands, in use in Canada for Subscriber Radio Systems under SRSP-301.4. Since LNA's are wideband devices, the Inmarsat terminals would also be subject to interference from these carriers.

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[7] This data can be obtained from the Space Network System On-line featured at the ITU web site (http://www.itu.int/sns/)

[8] There are primary allocations to the fixed service in certain, mostly European and African, countries under footnote S5.355 and S5.359.

These terminals also have to contend with signals originating from GPS satellite transmitters in the band immediately above the L-band MSS allocations.

Table 3.3-2 compares the levels of interference from MSV ATC, as computed by Inmarsat, to those levels from SRS transmitters.

Table 3.3-2 Downlink Adjacent Channel Interference from ATC BS into Inmarsat MET – Overload of receiver front-end

parameter	**units**	**MSV ATC BS**	**FS - SRS**
MSV BS/SRS EIRP per carrier	dBW	19.1	45.0
carrier BW	MHz	0.2	10.0
Total Bandwidth	MHz	5.0	10.0
Number of carriers		25.0	1.0
MSV BS/SRS EIRP	dBW	33.1	45.0
distance from SRS/BS to Inmarsat MET	m	100.0	100.0
Free Space Loss	dB	76.2	76.2
Shielding	dB	0.0	0.0
Power Control Reduction	dB	6.0	0.0
Voice Activation		4.0	0.0
Polarization Isolation (linear into circ.)	dB	3.0	3.0
Gain of Inmarsat MET towards SRS/BS	dBi	0.0	0.0
Received Interfering Signal Power	dBW	-56.1	-34.2

These results show that the Inmarsat MET would be far more sensitive to overload from existing SRS transmitters than the corresponding MSV ATC BS. Furthermore, the interference from SRS is coming from a single carrier whereas the interference from ATC BS would require simultaneous and continuous transmissions from 25 carriers at the base station. Even then, the interference from SRS has the potential of being 22 dB worse under similar propagation conditions.

While it was not possible to independently verify the actual level that can cause receiver saturation, it is certain that it will not be as sensitive as Inmarsat portrays it to be. Based on the calculations contained in Table 3.3-1, ICO believes that the sensitivity of the Inmarsat terminals is much less severe than the levels claimed by Inmarsat and is confident in the analysis presented by Motient[9].

Another area of disagreement between Inmarsat and Motient is in the representation of the MSV BS antenna pattern. Inmarsat claims that ITU-R antenna patterns for point-to-multipoint base station antennas, as given in Recommendation ITU-R F.1336 are applicable. Based on a careful reading of the stated recommendation, one notices that the antenna pattern described in *recommends* 2.1.1 is generally applicable to antennas with gains between 8 dBi and 13 dBi (see Note 3 of the recommendation). It is not clear whether such an antenna pattern is applicable to antenna gains of 16 dBi, such as the one

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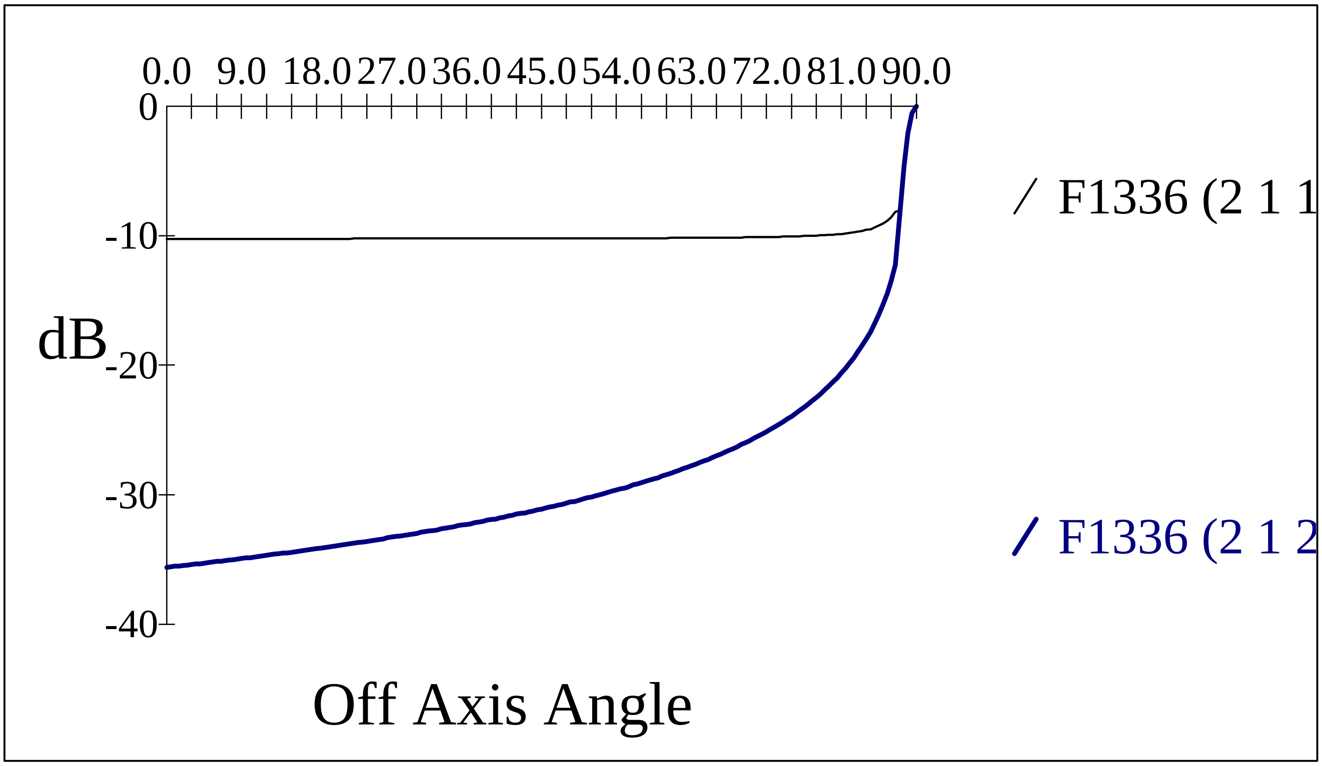
[9] As quoted in Inmarsat's technical annex (FN14, p.12)

proposed by MSV. Furthermore, Recommendation ITU-R F.1336 also contains patterns for antennas with improved sidelobes[10], which is exactly what MSV proposes to use.

Figure 3.3.1 provides the antenna pattern, in terms or relative gains, for the two models described in the recommendation. In the figure below, the 90 degrees mark represents the direction of maximum gain (in the case of the -5° tilt angle this would be shown as 90° on the abscissa), while 0° represents Zenith.

Figure 3.3-1 Antenna Patterns for Base Stations with 16 dBi Gain Based on Two Models of Recommendation ITU-R F.1336



This figure clearly shows that ITU-R recommended antenna patterns with improved sidelobes provide much better isolation than the model assumed by Inmarsat. There is another compelling reason not to use the model provided in *recommends* 2.1.1. Since the maximum gain of the antenna is 16 dBi, the first model would result in gains over all directions greater than 6 dBi, since the maximum discrimination is only 10 dB. It is not physically possible to construct an antenna that has positive gain in all directions. Using this model for the antenna described by MSV will necessarily result in unrealistically high levels of interference.

Based on these observations, it is our opinion that the base station antenna can meet the specifications supplied by MSV which are similar to the model proposed in Recommendation ITU-R F.1336 (*recommends* 2.1.2).

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[10] See *recommends* 2.1.2 of Recommendation ITU-R F.1336.

Ignoring the results obtained by Inmarsat using the unrealistically poor performance antenna, the results of interference from ATC BS into aeronautical MET do not appear so severe. For example, based on the –88 dBW overload threshold, the horizontal distance required between MSV ATC BS and aircraft receivers is only 3 km[11]. This can be easily met by maintaining at least this distance between the ATC BS and any major airport. The minimum separation distance for aircraft flying over an ATC BS is less than 100m and no more than 300m for antennas with 0° tilt angle. No Inmarsat-equipped aircraft would fly this low. Even using the unrealistically poor threshold conditions provided by Inmarsat, the maximum safe altitude is 2500 m[12]. No commercial aircraft uses such altitudes except on final approach to airports. Since the threshold supplied is not realistic, ICO does not believe that a separation distance of 120 km is required. The results provided using the –120dBW threshold combined with the ITU-R F.1336 antenna pattern are totally unrealistic and should not even be considered[13].

3.4 Interference from ATC BS to MSS Mobile Terminals (MET) due to Out-of-band emissions

For this interference mode, the critical issue is the out-of-band (OOB) rejection capability of the ATC BS signals. The OOB specification used by Inmarsat in its studies is the minimum mandated by the FCC. It is a well-known fact that systems can be designed to significantly improve on this specification. Inmarsat results show an interfering signal which is 38 dB above the Inmarsat MET receiver noise. If these assumed parameters were to be used, the ATC BS transmissions would also interfere into adjacent carriers of the MSV satellite network. In order to control self-interference, the ATC BS transmissions will need to improve on the FCC specification. In fact, ICO believes that it would be possible to provide much more isolation for OOB attenuation into other MSS operators' usable band[14]. Figure 3.4-1 shows the concept of using additional guard bands to protect adjacent licensees operations. As can be seen from this figure, it is possible to allocate more sensitive MSS downlink carriers (those that are operated closest to the base station) further away from the ATC band. Additional guard bands can be provided to protect adjacent MSS systems.

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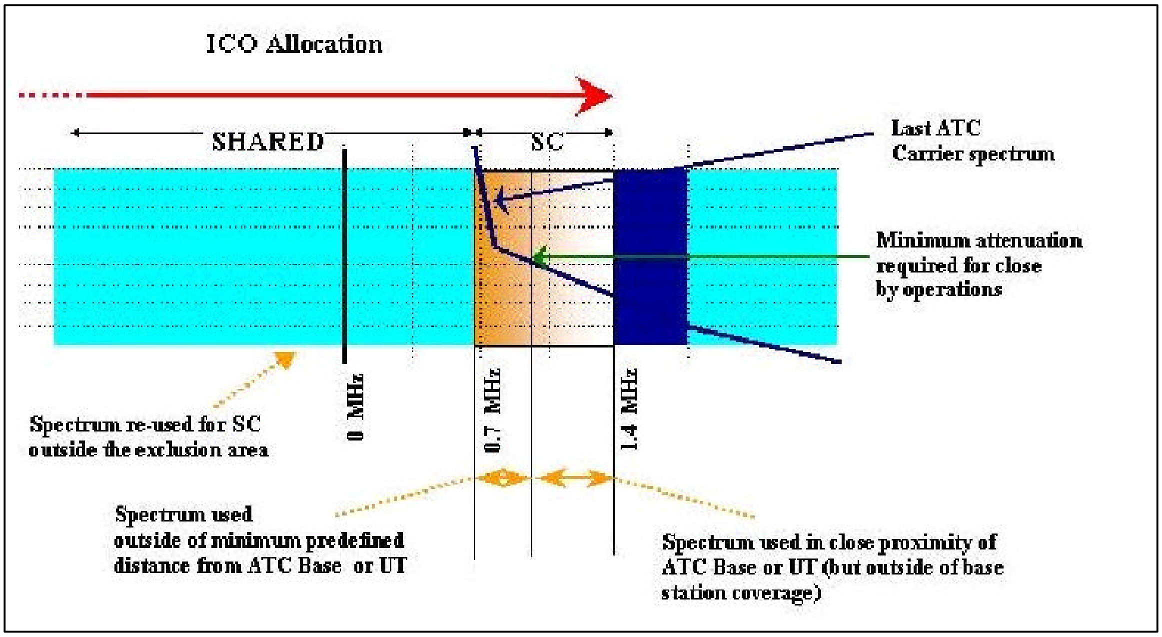
[11] *See* Figure 3.3-3 from Inmarsat's technical appendix on page 15.

[12] Id. in Figure 3.3-2 (page 14).

[13] Id. in Figure 3.3-5 (page 17)

[14] Additional attenuation is contributed by factors such as improved ATC hardware and the use of appropriate guard bands.

Figure 3.4-1 Possible Spectrum Reuse Approach
Showing Additional Discrimination to Other MSS Systems



3.5 Co-channel, non-co-coverage interference from ATC MET to MSV MSS satellites that are serving adjacent areas

The interference path is generally similar to that described in section 3.1 except that the victim is MSV's own satellite. It is understood that the interference from ATC MET to the MSV satellites is an aggregate interference issue, since the interference from a single terminal will be shown to be relatively benign. As a result, many of the interference calculation parameters must necessarily take an average form. Inmarsat claims to have considered this, but in many cases used overly protective values.

Table 3.5-1 shows the results of calculations for interference from ATC MET transmitters to MSV satellites as calculated in Inmarsat's technical appendix and revised calculations using more realistic parameters.

Table 3.5-1 Uplink Interference from ATC MET into MSV Satellite with Beams serving Areas Outside the ATC Operation (Single ATC MET assumed)

parameter	**units**	**MSV ATC MET**	**MSV ATC MET**
MSV Sat. G/T	dB/K	16.0	16.0
MSV Sat. Gain	dBi	43.0	43.0
Noise Temp.	K	450.0	450.0
Noise Density	dBW/Hz	-202.1	-202.1
MSV MET EIRP peak	dBW	0.0	0.0
MSV MET BW	kHz	200.0	200.0
MSV MET EIRP dens.	dBW/Hz	-53.0	-53.0
Free-Space Loss	dB	188.8	188.8
Shielding (AVG)	dB	3	**5**
INM Sat. Ant. Disc. (AVG)	dB	10	10
Voice Activation (AVG)	dB	2	2
Power Control Red. (AVG)	dB	0	**6**
Pol. Isolation (AVG)	dB	1.4	**3**
Rx. Interf. Power Density	dBW/Hz	-215.2	-224.8
Δ T/T per MSV Carrier	%	4.9%	0.5%

As was discussed in section 3.1, several of the assumed parameters were set at overly conservative values. For instance, the shielding from ATC MET to the satellites was set at 3 dB. This might be relevant to determine the worst-case interference from a single MET but does not represent the average attenuation that would be experienced for interference from large number of terminals. Considering that the majority of ATC users will be indoors or inside vehicles, where attenuation can easily exceed 20 dB, it is not realistic to calculate aggregate interference on the basis of only 3 dB shielding. In this case, a very conservative value of 5 dB was used to take into account that the MSV satellite is higher elevation than the Inmarsat satellite modeled in section 3.1, where a 10 dB average attenuation was assumed. Similarly, for some unexplained reason, Inmarsat did not consider any power control advantage for the MET transmitter, but used 6 dB combined with 4 dB voice activation for the ATC BS transmitters. ICO believes that 6 dB for power control and 2 dB voice activation are reasonable as explained earlier. Lastly, Inmarsat used 1.4 dB instead of the normal 3 dB to account for linear interference into circular signals. Taking all of these factors into account results in increase in noise temperature of 0.5% for the average MET instead of the 4.3% calculated by Inmarsat. As calculated in section 3.1, there would typically be about 50 co-frequency users on a given ATC channel at any given time (see Table 3.1-3). With 50 users, the total increase in noise floor to the MSV satellite would be less than 25%. This can be managed quite well in the MSV satellite carrier link budget.

Furthermore, many of these users, the majority in fact, will not be located on the MSV satellite spot beam's –10dB contour. Therefore, the additional satellite discrimination will reduce this interference level substantially.

Inmarsat claims that it would not be possible to operate ATC while re-using satellite frequencies within the MSS spot beams because the beam structure and the minimum required 10 dB discrimination cannot be maintained. While it is true that there are no areas in Canada where all of the available MSS spectrum will be usable for ATC, at any given point there would be some spectrum available for ATC. Consider the simplified beam structure in Figure 3.5-1. In this figure it is assumed that the satellite uses a 7-cell re-use pattern. Each beam has a frequency group labeled F1 – F7. The center cell obviously cannot re-use frequencies from the group F1 for the ATC component without removing the corresponding frequencies for satellite access. However, consider point P1. Here, it is possible to use any frequencies from groups F4 to F7 without taking any spectrum away from the other beams and thus without any penalty in the satellite capacity. So in any part of the satellite coverage area, at least 50% of the satellite capacity can be reused for ATC without any reduction in satellite capacity.

Figure 3.5-1 Possible Spectrum Reuse Approach
Showing Additional Discrimination to Other MSS Systems