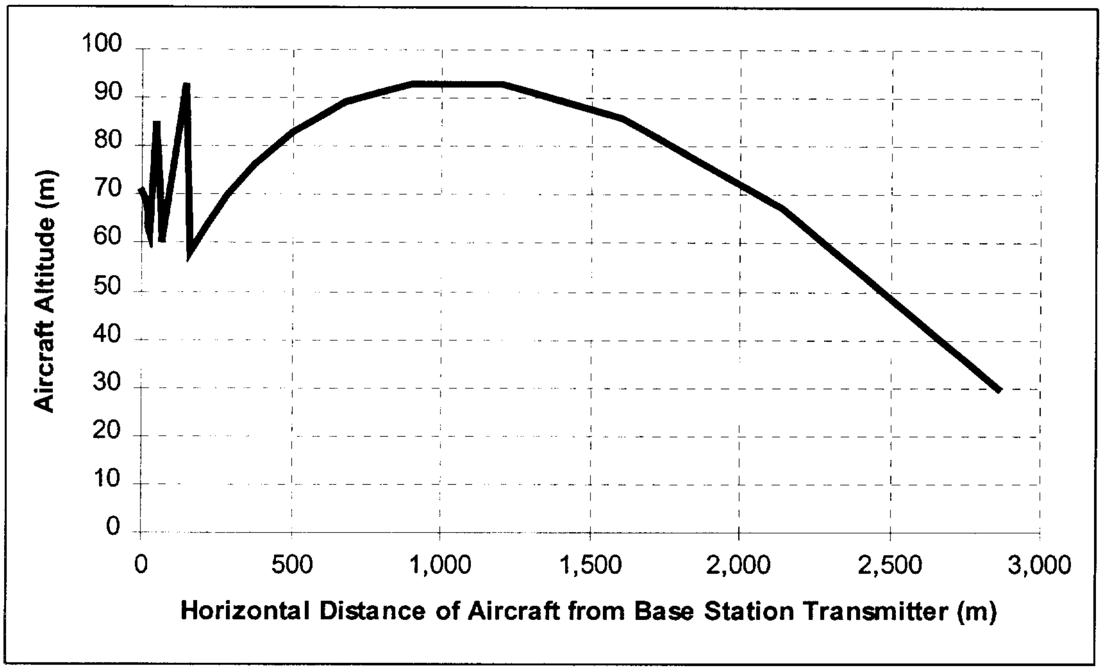
Results are also given in Figure 3.3-3 below where the only change compared to Figure 3.3-2 is the assumed overload threshold level of the Inmarsat receiver. For the sake of example, this value has been changed from –120 dBW to –88 dBW, which is the value asserted by Motient (but, as noted above, Inmarsat does not believe this value is appropriate). The results differ significantly from those given by Motient for this same threshold level: Motient suggests separation distances of less than 450 meters in the horizontal direction, but we conclude that the required separation distances are close to 3,000 meters, as shown in Figure 3.3-3.[17]

Figure 3.3-3. Downlink Interference Analysis – Overload of Inmarsat Receiver Front-End For AIRBORNE Terminals

Aircraft altitudes above which overload will not occur

Motient BTS Antenna Mask; -88 dBW Overload Threshold; Tilt Angle –5°



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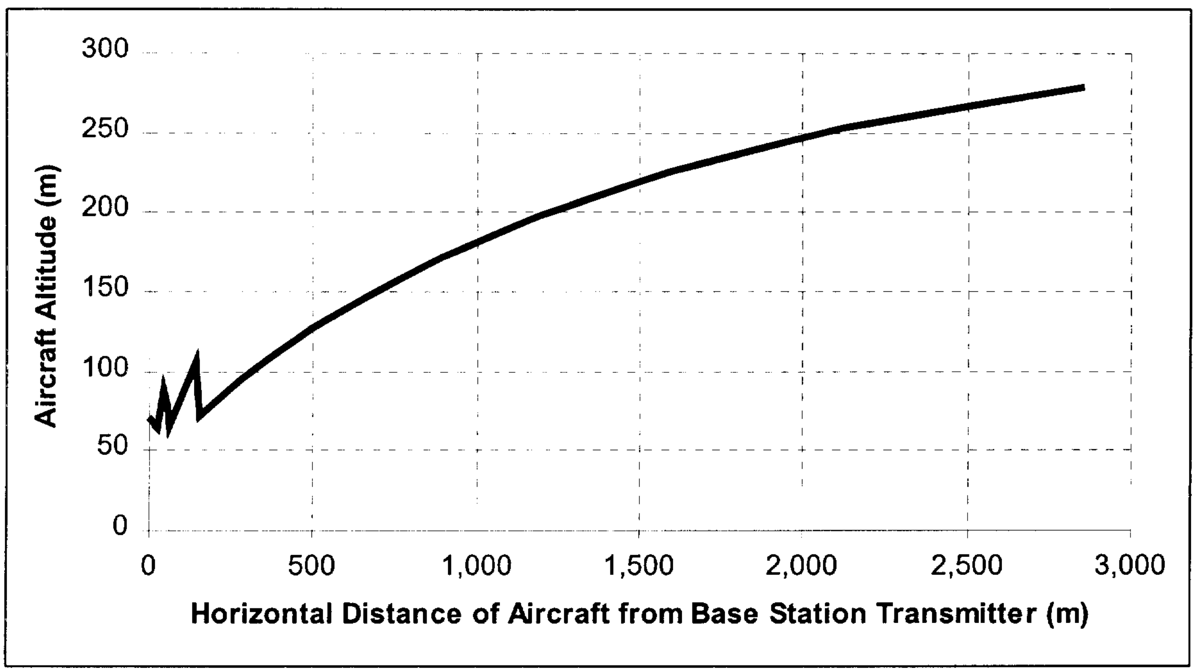
17 Motient Consolidated Opposition to Petitions to Deny and Reply to Comments, 7 May 2001, Figure 2.

All the above results assume a –5° tilt angle for the Motient base station transmit antenna, as proposed by Motient. However, this tilt angle is a highly sensitive variable in analyzing interference potential. Figure 3.3-4 below shows the same scenario as Figure 3.3-3 but with the tilt angle set to 0° instead of –5°. There is a huge effect at large distances from the base station transmitter - the "no-go" altitude has increased from a few tens of meters to hundreds of meters. This increases the "no-go" volume around the Motient base station transmitter by many orders of magnitude. It is quite easy to foresee situations where the effective tilt angle is not always set to –5° as proposed by Motient, and there would be correspondingly huge increases in interference. Such situations could be caused by undulating or hilly terrain where the aircraft flight paths are not always above the height of the Motient base station transmit antenna, or where a faulty installation has resulted in mispointing of a Motient antenna, or unintended movement of the Motient antenna has occurred due to weather or other effects.

Figure 3.3-4. Downlink Interference Analysis – Overload of Inmarsat Receiver Front-End For AIRBORNE Terminals

Aircraft altitudes above which overload will not occur

Motient BTS Antenna Mask; -88 dBW Overload Threshold; Tilt Angle 0°



We have already stated above our concern about the over-optimistic antenna gain mask of the Motient base station transmitters (see Figure 3.3-1). Figure 3.3-5 below gives the aircraft separation distances necessary if the Motient base station transmit antennas only achieved the level of performance given by ITU-R Recommendation F.1336. This result assumes the overload threshold level of –120 dBW and a –5° tilt angle for the Motient base station transmit antenna. Note that aircraft flying overhead at very high altitudes and large horizontal distances from the Motient base station would be susceptible to interference in this scenario.

Figure 3.3-5. Downlink Interference Analysis – Overload of Inmarsat Receiver Front-End For AIRBORNE Terminals

Aircraft altitudes above which overload will not occur

ITU-R F.1336 Antenna Mask; -120 dBW Overload Threshold; Tilt Angle –5°

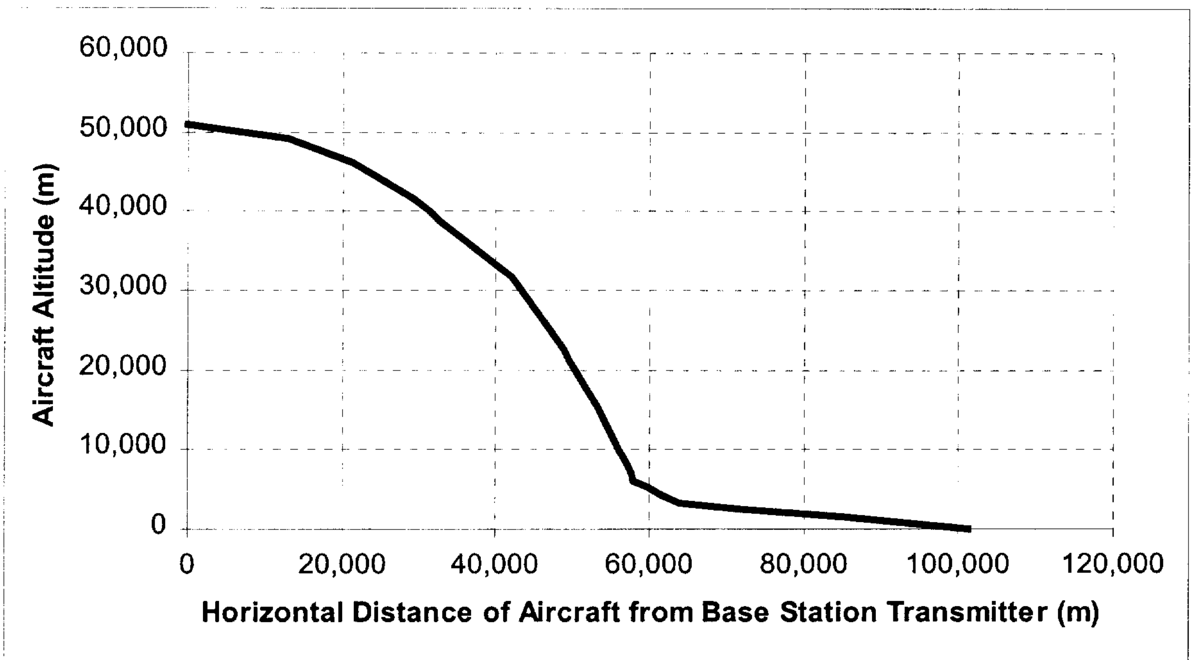


Figure 3.3-6 gives similar results assuming an overload threshold level of –88 dBW. Again this scenario gives rise to aircraft flying overhead at altitudes of less than 1,300 meters being interfered with and for considerable distances and altitudes away from the Motient base station transmitter.

Figure 3.3-6. Downlink Interference Analysis – Overload of Inmarsat Receiver Front-End For AIRBORNE Terminals

Aircraft altitudes above which overload will not occur

ITU-R F.1336 Antenna Mask; -88 dBW Overload Threshold; Tilt Angle –5°

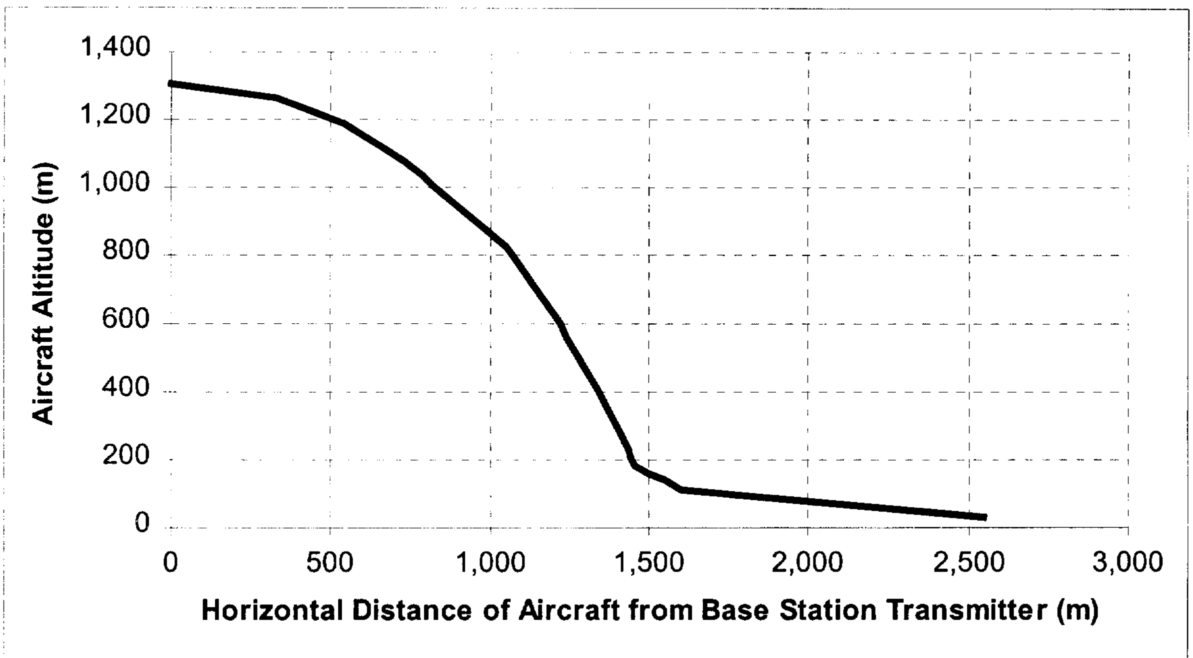


Table 3.3-3. Downlink Interference Analysis – Overload of Inmarsat Receiver Front-End For AIRBORNE Terminals

Motient BTS Antenna Mask; -120 dBW Overload Threshold (results ploted in Figure 3.3-2)

Parameter	Units	Values																		
Elevation of Aircraft from Horizontal	°	0.0	1.0	2.0	4.0	6.0	7.0	8.0	9.0	10.0	16.0	23.0	25.0	37.0	50.0	52.0	55.0	65.0	75.0	90.0
Tilt Angle of Motient Base Station Transmit Antenna	°	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0
Off-Axis Angle	°	5.0	6.0	7.0	9.0	11.0	12.0	13.0	14.0	15.0	21.0	28.0	30.0	42.0	55.0	57.0	60.0	70.0	80.0	95.0
Motient Base Station Tx Power to Antenna per 200 kHz Carrier	dBW	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Motient Base Station Antenna Gain (relative to peak)	dB	-3	-5.5	-8	-13	-18	-20.5	-23	-25.5	-28	-28	-28	-35	-35	-35	-40	-40	-40	-40	-40
Motient Base Station Antenna Gain	dBi	13.0	10.5	8.0	3.0	-2.0	-4.5	-7.0	-9.5	-12.0	-12.0	-12.0	-19.0	-19.0	-19.0	-24.0	-24.0	-24.0	-24.0	-24.0
Motient Base Station EIRP per 200 kHz Carrier	dBW	16.1	13.6	11.1	6.1	1.1	-1.4	-3.9	-6.4	-8.9	-8.9	-8.9	-15.9	-15.9	-15.9	-20.9	-20.9	-20.9	-20.9	-20.9
Total Bandwidth of Motient Base Station Transmissions	MHz	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Number of Motient Base Station Carriers per Cell (each 200 kHz)	#	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Distance of Inmarsat MES Terminal from Motient Base Station Transmitter	m	113,708	85,269	63,943	35,958	20,220	15,163	11,371	8,527	6,394	6,394	6,394	2,856	2,856	2,856	1,606	1,606	1,606	1,606	1,606
Horizontal Distance of Inmarsat MES Terminal from Motient Base Station Transmitter	m	113,708	85,256	63,904	35,870	20,110	15,050	11,260	8,422	6,297	6,147	5,886	2,589	2,281	1,836	989	921	679	416	0
Vertical Distance of Inmarsat MES Terminal from Motient Base Station Transmitter	m	30	1,518	2,262	2,538	2,144	1,878	1,613	1,364	1,140	1,792	2,528	1,237	1,749	2,218	1,296	1,346	1,486	1,581	1,636
Free Space Loss (Line-of-Sight)	dB	137.1	134.6	132.1	127.1	122.1	119.6	117.1	114.6	112.1	112.1	112.1	105.1	105.1	105.1	100.1	100.1	100.1	100.1	100.1
Shielding	dB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Control Reduction	dB	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Voice Activity Reduction	dB	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Polarization Isolation (Linear-Circular)	dB	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Gain of Inmarsat Airborne Terminal towards Motient Base Station Transmitter	dBi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Received Interfering Signal Power	dBW	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0
Threshold for Overload of Inmarsat MES Terminal	dBW	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0
Margin	dB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

3.4 Interference to Inmarsat MES Receivers Due to Out-of-Band Emissions from the Motient Base Station Transmitters

In this section we will address the downlink interference to the Inmarsat MES receivers caused by the unwanted (out-of-band) emissions from the Motient base station transmitters that actually fall within the receive channel bandwidth of the Inmarsat receivers.

We note that Motient is particularly vague about the level of protection that will be afforded other MSS systems whose MES receivers will be operating in the vicinity of the Motient base station transmitters. In the GPS/GLONASS frequency band (1559-1610 MHz) Motient proposes specific protection levels, but no such guarantees are provided for other parts of the MSS downlink frequency band below 1559 MHz.[18] In the absence of any specifically-proposed out-of-band emission constraint we can only assume that Motient intends to comply with nothing better than the general out-of-band emission limits contained in the 47 CFR § 24.238 and which is suggested in the Commission's NPRM on this matter.

For out-of-band emissions that are not in immediately adjacent channels, 47 CFR § 24.238 requires an attenuation of the signal (relative to the peak power of the transmitter) of 43+10log(P), where P is the peak power in Watts. Table 3.4-1 gives an analysis of the interference to Inmarsat MES receivers that would result if such an emission limit were imposed on Motient. The calculation shown assumes that the Inmarsat receiver is located 100 meters from the Motient base station and that a clear line-of-sight exists between them (i.e., "shielding" value of 0 dB), as was used for the downlink interference analysis provided above. Again, simply for the sake of example, and without accepting them as appropriate, we also use the values of 6 dB and 4 dB for the "power control reduction" and "voice activity reduction", respectively, as proposed by Motient, as in the analysis above. For the polarization isolation (LHCP into RHCP) we use a value of 3 dB, for the same reasons as described above. Finally, the Inmarsat receiver is assumed to have a gain of 0 dBi towards the interfering base station transmitter, which is considered conservative as discussed in Section 3.3 above.

The analysis presented in Table 3.4-1 is equally applicable to Inmarsat receivers that are on the ground or in aircraft.

18 Motient proposes to ensure that its base station transmitters comply with the requirement on out-of-band emissions that fall within the band 1559-1610 MHz to protect GPS/GLONASS, of less than –70 dBW/MHz with narrow-band transmissions less than –80 dBW/700Hz.

Table 3.4-1. Downlink Interference Analysis – Out-of-Band Emissions into the Inmarsat Receiver

Parameter	Units	Value
Motient Base Station Power to Antenna per 200 kHz Carrier	dBW	3.1
Motient Base Station Power to Antenna per 200 kHz Carrier	W	2.0
Motient Base Station Antenna Gain	dBi	16.0
Motient Base Station EIRP per 200 kHz Carrier (in Motient channel)	dBW	19.1
Out-of-Band Attenuation (43+10log(P))	dB	46.1
Motient Base Station EIRP per 200 kHz Carrier (in Inmarsat channel)	dBW	-27.0
Equivalent Motient Base Station EIRP per MHz Carrier (in Inmarsat channel)	dBW	-20.0
Distance of Inmarsat MES Terminal from Motient Base Station Transmitter	m	100
Free Space Loss (Line-of-Sight)	dB	76.0
Shielding	dB	0
Power Control Reduction	dB	6
Voice Activity Reduction	dB	4
Polarization Isolation (LHCP-to-RHCP in a multi-path environment)	dB	3.0
Gain of Inmarsat MES Terminal towards Motient Base Station Transmitter	dBi	0.0
Received Interfering Signal Power	dBW	-116.0
Received Interfering Signal Power Spectral Density	dBW/Hz	-169.0
Inmarsat MES Receive Noise Temp	K	150
Inmarsat MES Receive Noise Spectral Density	dBW/Hz	-206.8
ΔT/T increase per Motient 200 kHz Carrier	%	611842.9%

From Table 3.4-1 we can see that the 43+10log(P) results in an attenuation requirement of only 46.1 dB because of the low power and relatively high antenna gain of the Motient base station transmitter. The resulting equivalent EIRP in a 1 MHz bandwidth is –20 dBW/MHz and this can be directly compared with the GPS/GLONASS protection level of –70 dBW/MHz (i.e., 50 dB higher). Inevitably, as seen in Table 3.4-1, this results in an exceedingly large and totally unacceptable increase in the Inmarsat MES receive system noise temperature for a physical separation of 100 meters. If the out-of-band emission level were reduced to the same as the GPS/GLONASS protection level, the increase in the Inmarsat MES receive system noise temperature would be approximately 6% for this scenario, and still a source of unacceptable interference.

The Motient proposed system design could result in Inmarsat MES receivers operating in channels that are immediately adjacent to the channels being transmitted by the Motient base stations. For such a case the FCC Rules, at least in the case of space systems, provide even less attenuation of out-of-band signals than results from the application of the 43+10log(P) requirement. The FCC Rules, as contained in 47 CFR § 25.202(f) state the following:

> Emission limitations. The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:
>
> (1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the

authorized bandwidth: 25 dB;

(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;

This would result in the interference in the region (1), which is immediately adjacent to the Motient frequency band, being 21.1 dB worse than is shown in Table 3.4-1 above. In the next adjacent band, region (2), the interference would be 11.1 dB worse.

Based on the huge shortfall in interference protection that is illustrated by the above analysis, Inmarsat believes that Motient will be unable to provide the required out-of-band attenuation of the transmissions from its terrestrial base stations that fall within the frequency bands used by the Inmarsat MES receivers. To achieve the attenuation levels in the GPS/GLONASS frequency band (EIRP < -70 dBW/MHz) the Motient base station transmitters would have to be equipped with high performance fix-tuned output filters, but all base stations would require the same output filter. In the case of the attenuation required in the parts of the L-band spectrum used by Inmarsat, the Motient base station output filters would have to be able to re-tune their "stop-bands" and their "pass-bands" annually according to the changing coordination agreements between the L-band satellite operators that are agreed at the multilateral coordination meetings. This is unlikely to be feasible from a technical and economic perspective.

Significantly, Motient's own satellite system will not suffer in the same way as Inmarsat (and other MSS operators) from unacceptably high out-of-band emissions from the Motient base station transmitters. In the event that a Motient satellite downlink becomes interfered with by a Motient terrestrial base station, then Motient would be able to switch over to the terrestrial side of the Motient system as there is certain to be a terrestrial base station close enough to provide the service. For this reason, Motient will have no incentive to achieve the necessary interference protection levels to the Inmarsat receivers.

3.5 Uplink Interference to Motient's Co-Frequency Satellite Beams Serving the USA

Inmarsat believes that the introduction of the proposed Motient terrestrial system will seriously reduce the traffic capacity that Motient can achieve in its MSS satellite system, due to self-interference. This should be of major concern to the Commission, which espouses high spectral efficiency in all communications services, but particularly for satellite ones. It is also of special concern to Inmarsat because of the way in which MSS spectrum is coordinated between the different international operators of MSS systems. The problem here is simple – if Motient squanders the MSS spectrum that it has, through inefficient use caused by self-interference from the terrestrial component, then Motient will be approaching the multilateral L-band coordination meetings with a greater requirement for MSS spectrum than they would if Motient were operating a satellite-only MSS system. This would lead to less MSS spectrum being available, as a result of international coordination, to the other MSS system operators, including Inmarsat.

Table 3.5-1 provides an analysis of the uplink interference from a single Motient terrestrial mobile carrier into the Motient satellite receive beam that is operating in an adjacent geographic area. The parameter values in this analysis that relate to the Motient satellite (satellite G/T, satellite antenna gain, satellite receive system noise temperature, satellite receive antenna gain discrimination) have been taken directly from the Motient FCC Application and subsequent filings. All the other parameters are the same as those used in section 3.1 above.

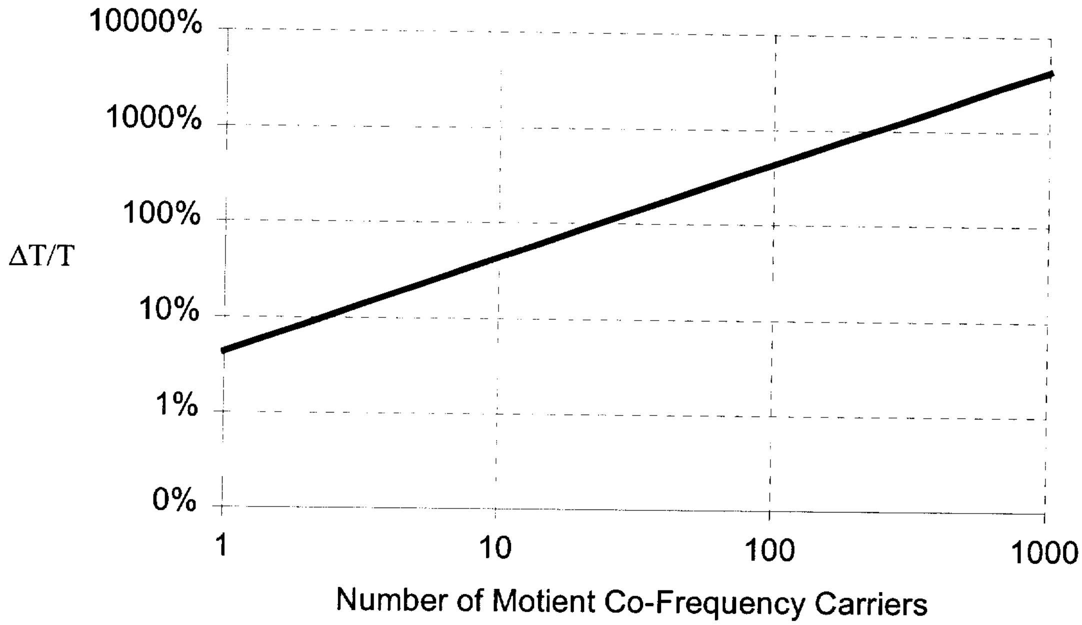
Table 3.5-1. Calculation of Uplink Interference from Motient Terrestrial Mobile Terminals to Co-Frequency Motient Satellite Beams Serving Adjacent Geographic Areas in the USA

(a single Motient terrestrial carrier is assumed)

Parameter	Units	Value
Motient Satellite G/T	dB/K	16
Motient Satellite Antenna Gain	dBi	43
Motient Satellite Receive Noise Temp	K	450
Motient Satellite Receive Noise Spectral Density	dBW/Hz	-202.1
Motient Mobile Terminal EIRP	dBW/Hz	0
Motient Mobile Terminal Bandwidth	kHz	200
Motient Mobile Terminal EIRP Spectral Density	dBW/Hz	-53
Free Space Loss	dB	188.8
Shielding (average for many terminals)	dB	3
Motient Satellite Receive Antenna Discrimination	dB	10
Power Control Reduction (average for many terminals)	dB	2
Polarization Isolation (Linear-Circular) (average for many terminals)	dB	1.4
Received Interfering Signal Spectral Density	dBW/Hz	-215.7
ΔT/T increase per Motient carrier	%	4.3%

Note that these results show that a single Motient mobile carrier will cause an increase in the Motient satellite noise temperature of more than 4.3%. Figure 3.5-1 shows the aggregate effect of multiple Motient terrestrial carriers, illustrating that the self-interference will dominate the noise with a relatively small number of co-frequency terrestrial mobile carriers in operation. For example, with only 100 terrestrial mobile carriers in operation the self-interference will be almost five times higher than the noise level. With 1000 terrestrial mobile carriers in operation the self-interference will be almost 50 times higher than the noise level.

Figure 3.5-1. Increase in Receive System Noise Temperature of the Motient Satellite as a function of the Number of Motient Terrestrial Mobile Carriers



4 Rationale for Technical Parameters Used in Interference Analysis

In this section we discuss the values we use for some of the key technical parameters used in the analyses given in Section 3 above.

4.1 Shielding Factor

In previous filings by Inmarsat and Motient there has been much debate on the appropriate value that should be assumed for shielding the interference from the Motient mobile transmitters into the Inmarsat MSS satellite receiver (or any other MSS system). In an early pleading Inmarsat assumed a shielding value of 15 dB and stipulated that "This level of shielding towards the GSO is considered a realistic average for a number of terminals operating indoors or in heavily cluttered environment." This was obviously based on an apparently incorrect assumption that all the Motient mobile transmitters would only be operating indoors, or in situations where similar signal blockage would occur. As discussed in Section 5 below, based on subsequent Motient filings, it now appears intended that the Motient mobile transmitters would be operating in quite open outside areas where signal blockage is minimal. In this case the appropriate value to assume for this shielding factor should be much less, even as low as 0 dB in certain cases.

Motient's arguments to support the use of a 15 dB shielding factor rely heavily on some propagation results reported from measurements made on NASA's ATS-6 satellite many years ago.[19] The problem with Motient's reference to these measurements is that Motient does not provide details of the "urban" and "commercial" environments, and the average figures used are not substantiated.

A useful reference for understanding the propagation environment at L-band frequencies to terminals located *inside* buildings is contained in Annex A of the ITU-R Special Publication "Terrestrial and Satellite Digital Sound Broadcasting to Vehicular, Portable and Fixed Receivers in the VHF/UHF Bands".[20] This document provides results of experiments that were undertaken to measure building penetration loss measurements at L-band. The results are quite extensive and provide the best available data to date on building loss values. Relevant results provided in this Special Publication are given in Sections 4.1.1 and 4.1.2 below.

Based on the data referred to in Section 4.1.1 and 4.1.2 below, Inmarsat believes that an average value for the shielding factor of 3 dB should be used to assess the likelihood of uplink interference when multiple interfering terminals are taken into account, although a value of 0 dB should still be used when assessing the interference from a single terminal. This assumption applies for a situation where the Motient terminals are operating both indoors and outdoors.

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19 Motient's ex-parte presentation to the FCC on July 24, 2001.

20 The details of how the experiments were carried out are not provided in this filing as they are readily available in the ITU Special Publication.

4.1.1 Shielding from operations outdoors

The ITU Special Publication reports on a study conducted in 1994 using the NASA TDRS satellite at 2.05 GHz. This data has been collected to model the situation facing the MSS and BSS(Sound) services in frequencies within approximately 600 MHz above and below 2.05 GHz, and is therefore quite well suited to the L-band MSS frequency range. Actual attenuation at the lower end of the frequency range (i.e., at L-band) would be lower than the values in the publication due to the frequency dependence of radio wave propagation. Table 4.1-1 provides a summary of the results of these experiments for a fade probability of 10%. This means that for 90% of the time the fade depths are considerably less than those given (i.e., the actual attenuation of the interfering signal is lower in 90% of the cases). This is an extremely important point to keep in mind when considering the fade as an advantageous interference blocking effect rather than a disadvantageous loss of signal.

Table 4.1-1. Summary of Fade Depths at the 10% probability level in Three Types of Outdoor Environments

Geographical Area	Attenuation (Minimum) (dB)	Attenuation (Median) (dB)	Attenuation (Maximum) (dB)
Urban Areas	- 4	-10	-17
Tree-lined Roads	-1	-8	-16
Open Areas	-0.5	-0.8	-1.0

Further insight into the shielding for different probabilities of fade depth are given in Tables 4.1-2 and 4.1-3 below, which have been extracted from the Special Report. Note that the data for 50% probability is likely to be the most relevant to the assessment of average interference shielding of the Motient mobile terrestrial terminals. Even in urban areas the 50% value was very low, except for the San Francisco measurement which exhibited a higher attenuation due to the low elevation angle to the test satellite and larger numbers of tall buildings.

Table 4.1-2. Summary of Fade Depths for Tree-Lined Roads (Data from Figure A.44, page 161 of ITU Special Publication)

City	0.1 Probability Fade Exceeds Depth (dB)	0.5 Probability Fade Exceeds Depth (dB)	0.9 Probability Fade Exceeds Depth (dB)
Vicksburg, MS	-1.5 dB	< -1 dB	0 dB
Marshall, AR	-2.2 dB	< -1 dB	0 dB
Slidell, MS	-7.3 dB	-1.7 dB	0 dB
Sequoia	Not Available	-6 dB	0 dB

Table 4.1-3. Summary of Fade Depths for Urban Areas
(Data from Figure A.45, page 161 of ITU Special Publication)

City	0.1 Probability Fade Exceeds Depth (dB)	0.5 Probability Fade Exceeds Depth (dB)	0.9 Probability Fade Exceeds Depth (dB)
Albuquerque	-4 dB	-1.2 dB	0 dB
Denver	-12.8 dB	< -1 dB	0 dB
Portland	Not Available	-3.6 dB	0 dB
San Francisco (Note 1)	Not Available	-12.6 dB	0 dB

Note 1: San Francisco suffered low elevation angle to test satellite, accounting for the higher fade depth

Given the results presented above it is clear that, for a universe of mobile terminals that are randomly distributed indoors and outdoors in the urban and suburban areas that Motient would wish to eventually deploy its terrestrial system, the average attenuation is going to be significantly less than 15 dB.

4.1.2 Shielding from operations inside buildings

The ITU Special Publication shows that there is wide variation in the level of shielding from mobile transmitters *within* buildings depending on several factors, including type of building (e.g. wood or brick), number/size of windows in a building and whether the receiver is in line-of-sight, partial line-of-sight or no-line of sight. Table 4.1-2 provides the results of experiments carried out in Canada, in 1991, for attenuation inside buildings at L-band.

Table 4.1-2. Measured Building Attenuation Factors from Canadian Experiments

Type of Building	Location	Attenuation (Minimum) (dB)	Attenuation (Average) (dB)	Attenuation (Maximum) (dB)
Concrete Building	Upper Level	8.1 (mean) 3-13 (range)	21 (mean) 11-28 (range)	31.9 (mean) 25-42* (range)
	Ground Level	8.4 (mean) 3-15 (range)	17.1 (mean) 8-28 (range)	32 (mean)
Wood Building	Ground Level	9 (mean)	16 (mean) 15-17 (range)	
* This value was measured on a floor having no windows and reserved for mechanical equipment. This floor was occupied and is not a typical receiving location.				

In addition to the Canadian measurements, the University of Liverpool in 1988 gave building penetration loss figures of between 7.5 and 15 dB for L band; the higher value is for the no line-of-sight condition whereas the lower value is for partial line-of-sight. BBC measurements made in 1993 resulted in a median value for building penetration loss of 12 dB. Clearly the above results show that there is wide variation in the amount of shielding provided from operations within a building. Taking the above results into account the Special Publication gives a mean building penetration loss, at ground floor level of 12 dB for L-band.

4.2 Inmarsat Satellite Antenna Discrimination toward the Motient Terrestrial Transmitters

The value for this parameter in the analysis is a function of the Inmarsat satellite performance and the angular separation (which relates to geographic separation) between the satellite receive antenna service area and the Motient terrestrial transmitter service area. In the case of the next-generation Inmarsat MSS satellites, which will use multiple small spot beams across the visible Earth, it is perfectly feasible for Inmarsat, subject to frequency coordination with Motient and other satellite systems operating over the US, to operate spot beams that are geographically close to the USA, yet which achieve an isolation of 20 dB (or less) from the service area in which co-frequency Motient MES terminals will operate. Therefore, a value of 20 dB will be used for this parameter.

4.3 Power Control of the Motient Mobile Transmitter

This is the average power reduction of the Motient mobile transmitter relative to its maximum EIRP capability, and is dynamically varied by closed loop power control depending on the instantaneous path attenuation between the Motient mobile transmitter and the base station. In the case of a single Motient mobile transmitter we should assume a value of 0 dB for this parameter as there will always be some time when there is no power reduction and the mobile transmits at maximum power. Only when there is a statistically large number of mobile transmitters should we assume an *average* power control reduction. The value to assume in this case will depend on the deployment scenarios of the mobile transmitters and the design of the power control system employed, neither of which is well defined by Motient. We therefore believe that it is appropriate to consider no more than a 2 dB average power reduction for this effect and only then when the number of co-frequency transmitters being averaged is statistically significant.

4.4 Polarization Isolation

Motient assumes a 3 dB polarization isolation factor in its analysis, based on a simplistic assumption that half the power is associated with each of the two polarization components when received by the interfered with system. In a multi-path environment, as exists for this interference path, a 3 dB factor is not correct. The ITU provides guidance in this respect in Section 2.2.3 of Appendix S8 of the Radio Regulations and proposes that a figure of 1.4 dB be used when a linearly polarized signal is interfering with a circularly polarized receiver, although this assumes line-of-sight signal paths to the interfered with satellite and negligible multi-path, so it may still be too high a value. Nevertheless, Inmarsat uses a value of 1.4 dB in this current analysis.

4.5 Motient terrestrial vs. MSS channel bandwidth difference

Channel bandwidth differences are correctly taken into account in the above analysis which is based on the spectral density of the interferor calculated assuming that the EIRP of the Motient mobile transmitter is spread evenly over its 200 kHz bandwidth. This is the best-case scenario from Motient's perspective.

4.6 Interference Allowance for Terrestrial Interference

In most interference analyses presented so far, an interference allowance of 6% ΔT/T has been assumed. Although Inmarsat also has used this value in previous filings, this has been done for illustration purposes only. In fact, as discussed elsewhere in this filing, there is no agreed criterion for interference from terrestrial transmitters into MSS systems at L-band, since there is no allocation to terrestrial mobile services. Inmarsat also pointed out in its original submissions to the FCC on this matter that the remaining, uncommitted, interference margin available on satellite systems is, by necessity, small.

Motient calculates in its ex-parte filing that the interference from its satellite component into an Inmarsat-4 spot beam is significantly less than the 6% ΔT/T interference threshold. From this Motient concludes that it can "fill up" the remaining allowance with interference from its terrestrial stations. However, Motient is making a fundamental mistake. The large number of beams on Inmarsat-4 means that it is possible to optimize the reuse between Inmarsat-4 and Motient's next-generation satellites to a much higher degree than is currently possible between Inmarsat-3 and Motient. This means that, if the ΔT/T for a particular Inmarsat beam is significantly less than 6%, there is another beam closer to the Motient service area where ΔT/T is closer to 6%. Inmarsat would therefore be able to reuse the spectrum in the second beam and should not be prevented from doing so by interference generated from terrestrial use of the spectrum by Motient.

5 Inadequacy of the Information Provided by Motient

The descriptions of the proposed Motient terrestrial system are vague and key parameters necessary to the interference calculation are missing. The technical inadequacies, and self-contradictions, of the Motient proposal are addressed individually below:

5.1 Where will the Motient mobile transmitters be operating?

Initially, from the Motient FCC application, one was led to believe that the Motient mobile transmitters would be operating only inside buildings or otherwise guaranteed to be in a position where the satellite signals were entirely blocked. It was on this basis that Inmarsat initially indicated in its Partial Petition to Deny that a blockage factor of 15 dB might be appropriate for all such mobile transmitters.[21,22] However, based on further submissions by Motient it has become apparent that the mobile transmitters will be operating outdoors where clear line-of-sight transmission paths exist to the Inmarsat satellite, and where the shielding factor is close to 0

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21 This blockage factor is the attenuation of the interfering signal from the Motient mobile transmitter in the direction of the Inmarsat (or other MSS system) satellite receive antenna.

22 *Partial Petition to Deny of Inmarsat Ventures*, April 18, 2001.

dB.[23] This mode of operation is further supported by the Motient statement that its base station transmitters will be located on towers and tall buildings, presumably to replicate existing terrestrial cellular networks, thereby maximizing the geographic service area of the Motient terrestrial system. Discussion of the appropriate value for this all-important shielding factor, in light of what we believe is the case with the proposed Motient terrestrial system, is given in section 3.1.1 above.

5.2 Will the Motient satellite link or terrestrial link be used where both are available?

Motient clearly states that ..."The satellite path will be the preferred communications link, but if the user's satellite path is blocked, the communications link will be sustained via the fill-in base stations". The above statement of Motient is fundamentally inconsistent with sound engineering design and basic economics, and could never be the way in which the Motient system actually will be designed or operated. The relative economics of providing a communications link to the user via satellite or via terrestrial networks is so different, maybe by a factor of 100 or more in favor of the terrestrial link, that the terrestrial link would be chosen every time there is an opportunity to do so. This would inevitably lead to a geographic expansion of the Motient terrestrial network throughout the metropolitan, urban and suburban areas until a geographic limit is reached where it becomes more economic to provide the communications link by satellite, rather than terrestrial means. It is likely that this would give rise to the Motient terrestrial networks expanding to the edges of the urban, and suburban, areas, leaving the satellite to provide service only in rural areas. Furthermore, within the service areas of these Motient base station transmitters, all communications links would be provided through the terrestrial network and not via the Motient satellite. The effect of this on the interference to Inmarsat is enormous because the number of interfering transmitting Motient terminals will be orders of magnitude larger than would be the case if the Motient satellite links truly had priority over the Motient terrestrial links.

The analyses of interference scenarios presented in this Technical Annex, and the corresponding conclusions we have reached, are valid regardless of the answer on this point. Whether the Motient satellite or the Motient terrestrial links have priority will certainly affect in practice the number of Motient mobile terminals, the number of mobile channels used by the Motient system, and therefore the full extent of the interference problem, so this is an important consideration.

5.3 How many Motient mobile transmitters could there be?

Motient has made reference to its proposed terrestrial system extending to approximately 1% of the USA.[24] While such a figure seems only a small number, and therefore suggests that the Motient terrestrial system would be quite limited in terms of sources of interference, this is absolutely not the case. The 25 most-populated cities in the USA cover only about 0.18% of the geographic area of the USA, and contain approximately 32 million people. Therefore, we can

23 *Motient Ex Parte Submissions*, July 5 and July 24, 2001.
24 *Motient's FCC Application*, Appendix A page 25.

extrapolate and conclude that 1% of the geographical area of the USA (or five times the area containing approximately 32 million people), which could be covered by the Motient terrestrial system, would contain a very large percentage of the population of the USA, and most of the larger cities in the USA. As such, the potential for vast numbers of Motient terrestrial terminals is a serious concern and, as shown in section 3.1 above, this will directly impact the full extent of the interference into the Inmarsat system.

In its 25 July 2001 ex-parte filing, Motient states "MSV's terrestrial network will not exceed a co-channel frequency re-use of 9,000". Motient goes on to say that "The above conclusion only applies to the co-channel spectrum coordinated between Inmarsat and Motient/TMI. Additional spectrum is not subject to this limitation". From this we conclude that Motient would like, if possible, to exceed the number of 9,000 for co-channel frequency re-use in the bands used by Inmarsat, and is only limiting to this value because their own optimistic calculation suggests to them that this should be allowed. In any event, as shown in Section 3.1 above, a re-use of 9,000 would cause an increase in the Inmarsat satellite noise temperature of more than 1000%, just from the Motient mobile transmitters alone. Such a situation corresponds to the interference being ten times higher than the noise level, and clearly totally unacceptable due to its adverse impact on the performance of the Inmarsat system.

The L-band frequencies used by MSS are comparable in propagation characteristics to the 2nd generation PCS systems used in many parts of the world. As such they are well suited, from a technical perspective, for cellular communications systems employing very high levels of frequency re-use by means of sectored micro-cells. Typical North American cities could employ hundreds or thousands of such cells, allowing the same frequencies to be used hundreds or thousands of times in the same city by terrestrial transmitters. Therefore, a single receive beam on an Inmarsat satellite would likely be receiving hundreds or thousands of co-frequency interfering signals from each city in which the Motient, or similar, system is operating. This could well lead to hundreds of thousands of co-frequency interfering Motient transmitters, just from North America alone. If other countries permitted similar systems to operate, which is likely if the Commission licenses Motient to operate its terrestrial system, then the total interference into the Inmarsat satellite receive beam will be further increased as it would be vulnerable to terrestrial transmissions from all the countries visible to the satellite. Indeed, based on Motient's relationship with its Canadian partners we can already safely assume that, if Motient's proposed terrestrial usage were to be licensed by the Commission for the USA then licensing by the Canadian regulatory authorities for a similar system in Canada would soon follow. Further expansion to other countries in the region, and worldwide, would likely take place in the near future. The Commission is no doubt well aware of the difficulties of regulating, even within the jurisdiction of a single national regulator, such aggregate transmissions from the Earth's surface in order to protect satellite receive beams.[25] With aggregate transmissions encompassing many countries, the situation for controlling the aggregate would be hopeless.

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[25] *See, e.g., Report of the LMDS/FSS 28 GHz Negotiated Rulemaking Committee* at ii & 90 (September 23, 1994), CC Docket 92-297 (industry unable to develop regulations that feasibly could be enforced in order to regulate aggregate interference into satellite receive beams caused by large numbers of terrestrial transmitters).

5.4 How much will the Motient terrestrial system reduce the real MSS spectrum available for Motient's satellite links?

From detailed reading of Motient's application, and subsequent FCC pleadings on this matter, we are left with no clear idea about how the spectrum will be managed between Motient's satellite system and its proposed terrestrial system, and how much of a reduction in the Motient satellite system capacity will result from the proposed terrestrial usage of the MSS frequencies. Of course we are told that Motient will only use the MSS frequencies that it has coordinated internationally for both its satellite and terrestrial systems, but this by itself is not satisfactory as it does not address the overall scarcity of L-band spectrum that exists. Inmarsat believes that, if licensed to use L-band MSS frequencies for a terrestrial service, Motient will of necessity approach the international coordination of L-band spectrum with a greater overall spectrum requirement that if it operated an MSS satellite system alone.[26]

Inmarsat has performed its own assessment of the self-interference in the Motient system and this is given in Section 3.3 of this Technical Annex.

6 Motient has provided no adequate justification for using MSS frequencies for its terrestrial system

Motient has provided no believable rationale for why it *has* to use MSS frequencies for its proposed terrestrial system.

Implicit in Motient's proposal is the idea that somehow the use of the same frequencies for both the satellite and terrestrial component of the Motient system will produce cost savings in the Motient mobile terminals. In fact the contrary is true. There is ample evidence in the mobile communications marketplace to confirm that the cost of a dual-band (or even a tri-band) mobile telephone is negligibly higher than the cost of a single-band mobile phone. However, because of the complications involved in the integration of the terrestrial and satellite spectrum into a single system, as proposed by Motient, there could be significant design and therefore cost constraints on the Motient mobile telephones, not least of which will be the severe out-of-band attenuation required to protect adjacent channel users.

26 International coordination between the operators of L-band MSS networks takes place at multilateral coordination meetings, at which each operator requests an amount of spectrum that it plans to use in the forthcoming period. This novel approach to sharing the limited spectrum between the satellite operators relies heavily on the principle that those operators will request only the spectrum that they genuinely need at that time. If Motient is approaching this coordination with a requirement for terrestrial spectrum it will inevitably request more than if it were to operate an MSS satellite system alone.

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.

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