## MSV Responses to FCC's Request for Additional Information

**Background:**

On January 21, 2004 the Commission requested additional information in order to assess MSV's request for waivers of provisions in Paragraphs (a)(2), (c), (d)(1), (d)(2), (d)(3), (d)(4), (d)(5), and (e) of Section 25.253 of the Commission's rules. The Commission requested the following additional information:

Item 1: An analysis of the potential interference from MSV ATC base stations to airborne AMS(R)S terminals from both a statistical basis and a worst case basis using proposed antenna and EIRP values (see Table 2.2.3.1.A in Appendix C2 of the ATC Order), with a description of all assumptions that are used.

Item 2: An analysis of the coordination distance that should apply to SARSAT receive terminals operating in the 1525-1559 MHz band, including a description of all assumptions and propagation models that are used. Results should be presented in a manner similar to Table 3.3B in Appendix C2 of the ATC Order.

Item 3: A link budget from the ATC handset to the satellite for the -4.0 dBW EIRP terminal and average power reduction due to vocoder ½-rate operation for both the current satellite and the next generation satellite.

Item 4: An analysis of the potential for AMS(R)S airborne terminal overload similar to that contained in Table 2.2.3.2.A in Appendix C2 of the ATC Order using the proposed values of EIRP and antenna gain changes.

Item 5: In evaluating your waiver request for section 25.253(a)(2), we reviewed the relevant GSM specifications, and it appears that the specified burst duration is the same for both the full-rate and half-rate vocoders. It would appear based on this information that the additional 0.5 dB reduction in average power would not apply to this situation. Please clarify how you intend to maintain the same transmitter power and GSM burst duration. In addition, your analysis only addresses a TDMA system. Provide a similar analysis showing how the vocoder factor would be applied to a CDMA system.

## MSV Responses

### Items 1 & 4:

**Introduction:** The computer simulations and statistical analyses presented in this section take into account the proposed base station antenna with the relaxed overhead gain suppression (as specified in MSV's ATC Application Appendix L, Table 2). In addition, the **aggregate** Out-of-Band-Emissions (OOBE) EIRP density **per base station sector** has been constrained to not exceed -101.9 dBW/Hz irrespective of the EIRP per carrier and the number of carriers being radiated by a sector. This constraint (aggregate OOBE density ≤ -101.9 dBW/Hz EIRP per sector, at the base station antenna output, irrespective of the number of carriers being radiated per sector and the EIRP thereof), equates to an aggregate OOBE density ≤ -57.9 dBW/MHz per sector at the base station antenna input (the base station antenna gain is 16 dBi).

In this study, the worst-case simulations that MSV has conducted for a number of ATC base station deployment scenarios indicate that, for at least some deployment scenarios, the aggregate per sector OOBE EIRP density limit, as proposed above, is necessary to maintain consistency with the Commission's conclusions (as presented in the ATC Order) regarding the ATC's ΔT/T impact potential to airborne and non-airborne METs.

**Worst-Case and Statistical Analysis – ΔT/T Impact Potential and Overload Margin of Airborne METs:** A computer simulation has been developed to address the worst-case scenario of an airborne MET, at the minimum-allowed altitude, over a densely-populated city. The computer simulation populates the city with a specified number of ATC base stations (1000 maximum) by creating a compact contiguous lattice of base stations with a distance from base station tower to base station tower calculated, in accordance with the specified EIRP per carrier, to provide contiguous service – no gaps in service are allowed. This is in sharp contrast with the statistical analysis approach whereby the specified number of base stations (1000 maximum) is randomly and uniformly distributed over a "city" (an area visible to the airborne MET from 304 m altitude – approximately 80 km in radius). For a specified number of base stations, the statistical analysis approach addresses the average impact of the ensemble of base station deployment geometries – one of which is the compact contiguous lattice addressed by the computer simulation described herein. As such, it is expected (on intuitive grounds) that any statistical analysis approach (e.g., Monte Carlo simulation as presented by the Commission in the ATC Order, or the analytical averaging approach presented by MSV in its ATC Application; Addendum to Appendix L) will yield more optimistic (average) results than the worst-case computer simulation described herein (as is verified below).

In the computer simulation, the trajectory taken by the aircraft (airborne MET) over the city, at the lowest allowable altitude of 304 meters, is as shown in Figure 1 below. The compact contiguous lattice of base stations begins at the lower left (LL) corner (at the origin) and extends along the X and Y dimensions, forming an approximate square. As is depicted in Figure 1, the aircraft trajectory follows a diagonal path over this square (worst-case trajectory).

**Figure 1 – Airborne MET Trajectory over City**

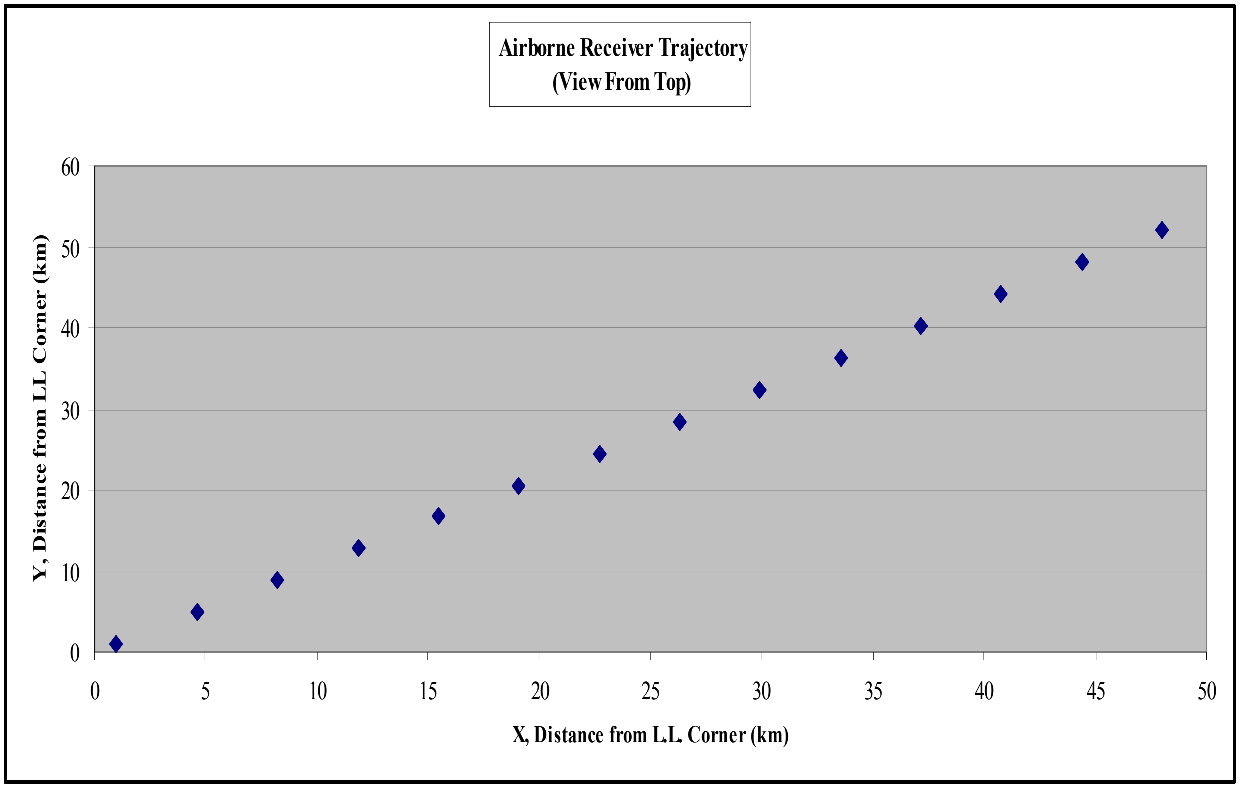



Table 1 below illustrates input parameters to the computer simulation for evaluating the ΔT/T impact potential of an airborne MET as it traverses a city as specified above.

**Table 1 – Example of Input Parameters to Computer Simulation to Evaluate the ΔT/T Impact on an Airborne MET**

| BTS Input Parameter Values | | |
|---|---|---|
| Base Station Tower Height | 30 | m |
| Frequency | 1550 | MHz |
| Number of ATC Base Stations | 1000 | |
| Base Station Service Radius | 1 | km |
| Base Station Antenna Down-Tilt | 5 | deg |

| Other Parameters | | |
|---|---|---|
| Aggregate OOBE EIRP per Sector (Maximum) | -101.9 | dBW/Hz |
| Impact of Sectors Facing Away from Airborne MET | 0 | dB |
| Number of Sectors per Base Station Facing Toward Airborne MET | 1 | -- |
| Variable Vocoder Reduction | 0 | dB |
| Voice Activity Reduction | 4 | dB |
| Closed Loop Power Control Reduction | 5.2 | dB |
| Polarization Discrimination | 0 | dB |
| Effective OOBE EIRP per Sector | -111.1 | dBW/Hz |
| MET Receiver Noise Temperature | 316.2 | K |

| Aircraft Trajectory and GNSS Antenna Values | | |
|---|---|---|
| Airborne MET Trajectory (km) | X | Y |
| Starting Point | 1 | 1 |
| Ending Point | 48 | 52 |
| Airborne MET Antenna Gain in Direction of Base Station | 0 | dBi |
| Airborne MET Antenna Gain Reduction due to Aircraft Shielding | 0 | dB |
| Aircraft Altitude | 304 | m |

Table 2 below illustrates input parameters to the computer simulation for evaluating the overload margin of an airborne MET as it traverses a city that is densely-populated (as discussed earlier) with a number of ATC base stations.

**Table 2 – Example of Input Parameters to Computer Simulation to Evaluate the Overload Margin on an Airborne MET**

| BTS Input Parameter Values | | |
|---|---|---|
| Base Station Tower Height | 30 | m |
| Frequency | 1550 | MHz |
| Number of Base Stations | 1000 | |
| Base Station Service Radius | 1 | km |
| Base Station Antenna Down-Tilt | 5 | deg |

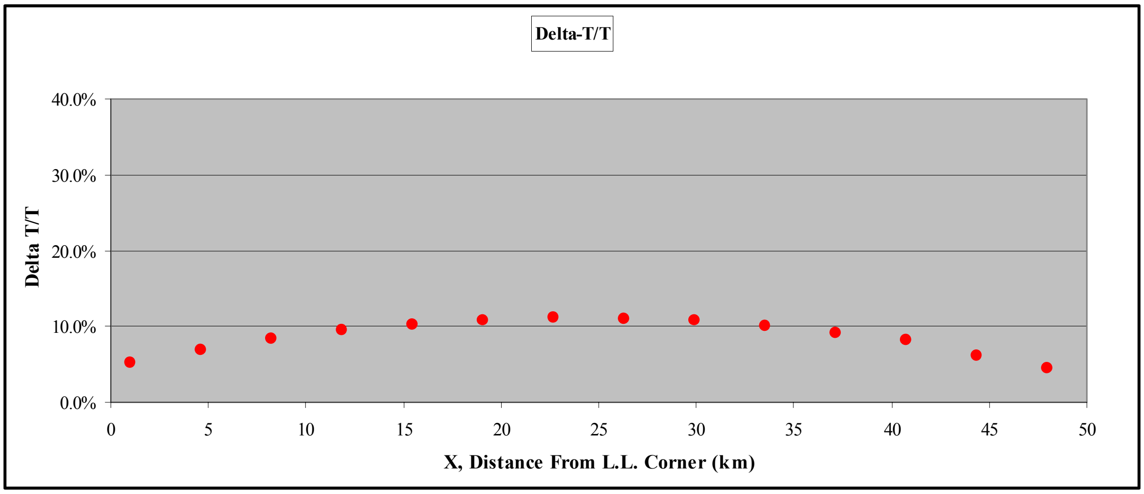
| Other Parameters | | |
|---|---|---|
| Base Station EIRP per Carrier | 19.1 | dBW |
| Contribution from Sectors Facing Away from Airborne MET | 0 | dB |
| Carriers per Base Station Sector | 3 | -- |
| Variable Vocoder Reduction | 0 | dB |
| Voice Activity Reduction | 4 | dB |
| Closed Loop Power Control Reduction | 5.2 | dB |
| Polarization Discrimination | 0 | dB |
| Aggregate Effective EIRP per Sector | 14.7 | dBW |
| Overload Threshold of Airborne MET Receiver | -50.0 | dBm |

| Aircraft Trajectory and GNSS Antenna Values | | |
|---|---|---|
| Airborne Receiver Trajectory (km) | X | Y |
| Starting Point | -10 | -10 |
| Ending Point | 48 | 52 |
| Antenna Gain of Airborne MET in Direction of Base Station | 0 | dBi |
| Shielding of MET Antenna by Aircraft | 0 | dB |
| Aircraft Altitude | 304 | m |

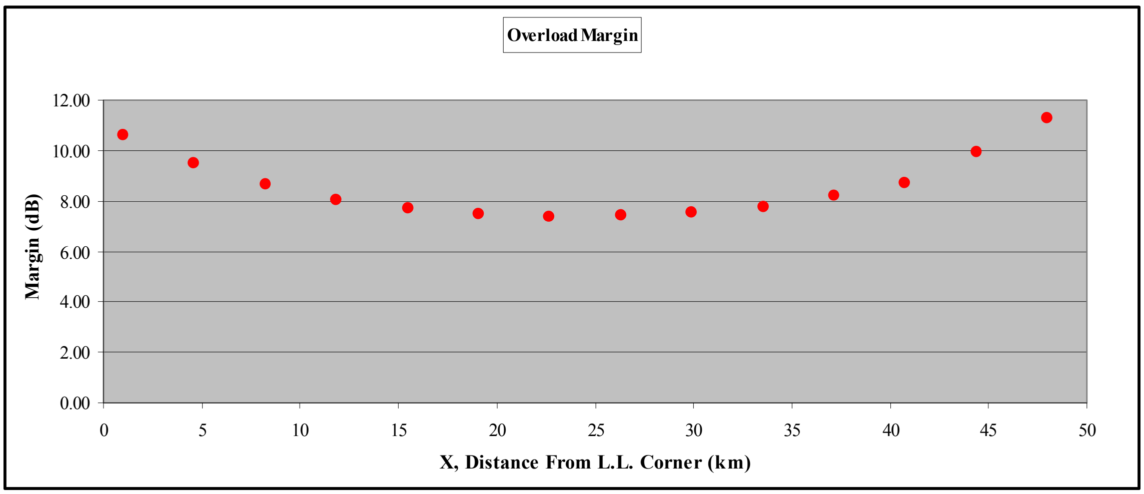
The following several Figures (Figures 2 through 8) show the ΔT/T impact potential and the overload margin potential of the airborne MET, for various different ATC base station deployment scenarios as a function of the MET's trajectory over a city. For each point on the MET trajectory, the ΔT/T impact potential and the overload margin potential is calculated taking into account the impact from each ATC base station. Free-space line-of-sight propagation is assumed (from the base stations to the airborne MET) and the proposed base station antenna pattern with the relaxed overhead gain suppression is taken into account.

**Figure 2 – The "Baseline" Case Addressed in the ATC Order: 1000 Base Stations; 3 Carriers per Sector; 19.1 dBW EIRP per Carrier; 1 km Service Radius (Aggregate Directional Inband EIRP = 19.1 + 10log(3) + 10log(1000) = 53.9)**

**(a) Worst-Case ΔT/T Impact**




**(b) Worst-Case Overload Margin**




It is interesting to observe, for the above "baseline" case, that the Commission's Monte Carlo statistical analysis predicts a ΔT/T impact of 16.5% and an overload margin of 10.4 dB (*see* ATC Order Appendix C2, Tables 2.2.3.1.A and 2.2.3.2.A). MSV's worst-case computer simulation yields more conservative (pessimistic) results. As can be seen, Figure 2(b) predicts a worst-case overload margin of 7.5 dB at the point where the airborne MET is over the city center, increasing to about 11 dB at the city edges. For the ΔT/T impact (Figure 2(a)) MSV's computer simulation predicts 12% at the center of the city. This value would have been 36% if the "spurious EIRP density" (OOBE EIRP density limit) were allowed to be -101.9 dBW/Hz per carrier (as the Commission assumes in its statistical analysis; Table 2.2.3.1.A of the ATC Order). By constraining the **aggregate per sector** "spurious EIRP density" (aggregate per sector OOBE EIRP density limit) to be no greater than -101.9 dBW/Hz (as MSV is proposing based on this study) the worst-case ΔT/T stays within the bound authorized by the Commission in the ATC Order and, furthermore, allows the number of carriers per sector to be increased[1] while all ΔT/T conclusions reached by the Commission in the ATC Order, for both airborne and non-airborne METs, continue to hold and in fact improve as is demonstrated below. The left portion of the Table below (columns A, B) is a reproduction of Table 2.2.3.1.A of the ATC Order. Columns C and D are new. Column C reflects MSV's analytical (non Monte Carlo based) statistical analysis approach (*see* MSV's ATC Application, Addendum to Appendix L) while Column D reflects the Commission's Monte Carlo statistical analysis approach. Both approaches of columns C and D have been adjusted to take into account 1) the proposed base station antenna pattern with the relaxed overhead gain suppression and 2) an aggregate spurious EIRP density per sector of -101.9 dBW/Hz (as discussed above). As such, the first numerical entry of column C and/or D "-101.9" denotes the aggregate (from all carriers that may be deployed in a sector) spurious EIRP density limit (aggregate per sector OOBE EIRP density limit).[2] The second numerical entry of column C and/or D "1" denotes the number of sectors per base station assumed to impact an airborne MET. Every other entry of column C and/or D maintains its original meaning. It is seen from column D that the Commission's statistical analysis predicts ΔT/T = 5.5% whereas the computer simulation results of Figure 2(a) are more pessimistic predicting a worst-case ΔT/T of 12% at the point where the airborne MET is over the center of the ATC base station cluster.

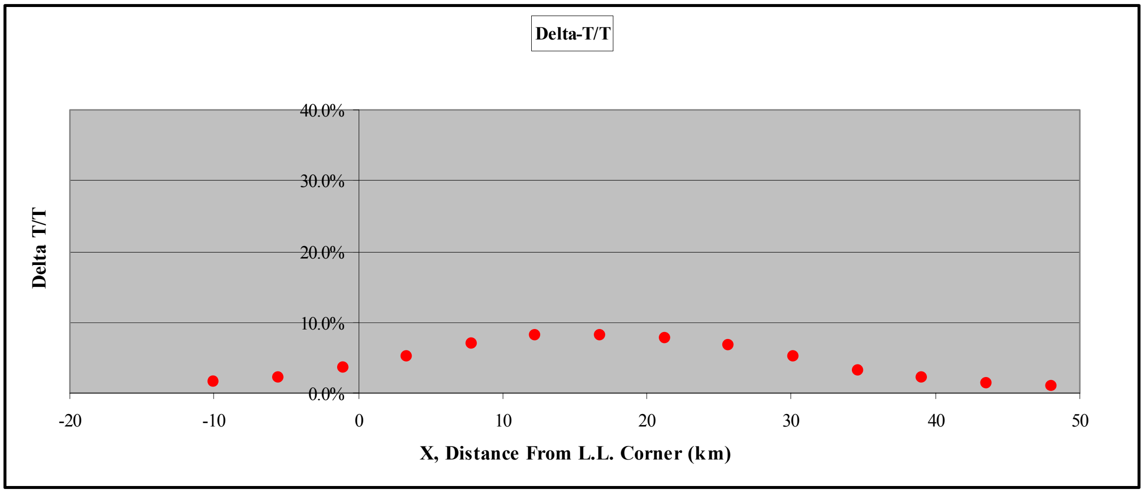
| **Modified Table 2.2.3.1.A: Potential Interference to Inmarsat Airborne Receiver from ATC Base Stations** | | A | B | C | D |
|---|---|---|---|---|---|
| | | **As shown in ATC Order** | | **Adjusted For Proposed BTS Antenna Gain and EIRP Limits** | |
| | | **1000 Base stations** | | **1000 Base stations** | |
| **Item** | **Units** | **MSV** | **FCC's Monte Carlo Approach** | **MSV (adjusted)** | **FCC (adjusted)** |
| EIRP per Carrier | (dBW) | 19.1 | | | |
| Bandwidth | (kHz/ch) | 200.0 | | | |
| EIRP Density/carrier | (dBW/Hz) | -33.9 | | | |
| Spurious EIRP density | (dBW/Hz) | -101.9 | -101.9 | -101.9 | -101.9 |
| *Assumed spurious limit (out-of-band suppression)* | (dB) | *-68.0* | *-68.0* | | |
| Carriers per sector | (#) | 3.0 | 3 | 1.0 | 1 |
| Voice activation | (dB) | 4.0 | 4 | 4.0 | 4 |
| Power control | (dB) | 6.0 | 5.2 | 6.0 | 5.2 |
| Polarization | (dB) | 8.0 | 0 | 8.0 | 0 |
| Spurious emissions average | (dBW/Hz) | -115.1 | -106.3 | -119.9 | -111.1 |
| | | | | | |
| Gain discrim. Inmarsat MES to Base Station | (dB) | 0.0 | 0.0 | 0.0 | 0.0 |
| Calculated Isolation | (dB) | -101.6 | -105.1 | **-105.4** | **-105.1** |
| Received interference power | (dBW/Hz) | -216.7 | -211.4 | -225.3 | -216.2 |
| | | | | | |
| Receiver Noise Temperature | (dBK) | 25.0 | 25.0 | 25.0 | 25.0 |
| Receiver Noise Temperature | (K) | 316.2 | 316.2 | 316.2 | 316.2 |
| Receiver Noise Density | (dBW/Hz) | -203.6 | -203.6 | -203.6 | -203.6 |
| Interference Temperature | (T) | 15.4 | 52.1 | 2.1 | 17.4 |
| **Delta-T/T** | **(%)** | **4.9%** | **16.5%** | **0.7%** | **5.5%** |
| Interference to Noise Ratio (Io/No) | (dBW/Hz) | -13.1 | -7.8 | -21.7 | -12.6 |

[1] As MSV is requesting subject to the upper bound of 38.9 dBW aggregate EIRP per sector (*see* MSV's ATC Application Appendix J).

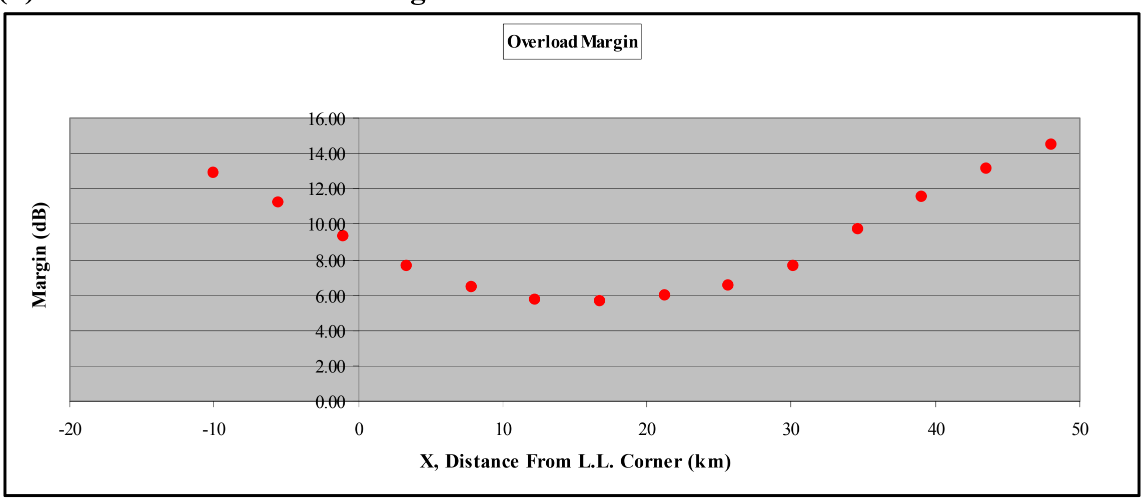
[2] This means that as a function of the number of carriers deployed by a sector <u>and</u> as a function of the in-band EIRP per carrier, the filtering requirements of the sector may vary. Alternatively, a single filter design may be developed based on a "maximal" deployment scenario (e. g., 6 carriers per sector, 29.1 dBW EIRP per carrier) and such filter (with 13 dB more out-of-band rejection relative to a filter designed for the baseline case; 3 carriers per sector, 19.1 dBW EIRP per carrier) could be used everywhere.

**Figure 3 - 500 Base Stations; 6 Carriers per Sector; 19.1 dBW EIRP per Carrier; 1 km Service Radius per Base Station**
**(Aggregate Directional Inband EIRP = 19.1 + 10log(6) + 10log(500) = 53.9)**

**(a) Worst-Case ΔT/T Impact**




**(b) Worst-Case Overload Margin**




The computer simulation results for overload margin (Figure 3(b) above) can now be compared with the overload value that the Commission's Monte Carlo statistical analysis predicts for this case. The Table below is a reproduction of Table 2.2.3.2.A of the ATC Order (first two columns). The right-most column in new and addresses the Commission's statistical analysis approach adjusted to take into account the base station antenna pattern with the relaxed overhead gain suppression and the new base station deployment scenario of Figure 3 (500 base stations, 19.1 dBW EIRP per carrier, 6 carriers per sector).

| Modified Table 2.2.3.2.A: Evaluation of Potential for AMS(R)S Airborne Terminal Overload | | A | B | C |
|---|---|---|---|---|
| | | As shown in ATC Order | | Adjusted For Proposed BTS Antenna Gain and EIRP Limits |
| | | 1000 Base stations | | 500 Base stations |
| Parameter | Units | MSV Value | FCC Analysis | FCC (adjusted) |
| BS EIRP per carrier | (dBW) | 19.1 | 19.1 | **19.1** |
| Carriers per sector | (#) | 3.0 | 3.0 | 6.0 |
| Voice activation | (dB) | 4.0 | 4.0 | 4.0 |
| BS power control | (dB) | 6.0 | 5.2 | 5.2 |
| EIRP per sector | (dBW) | 13.9 | 14.7 | 17.7 |
| Polarization isolation | (dB) | 8.0 | 0.0 | 0.0 |
| Gain discrimination MES to base station | (dB) | 0.0 | 0.0 | 0.0 |
| Calculated base station isolation | (dB) | -101.6 | -105.1 | **-108.1** |
| Effective power per sector at A/C | (dBW) | -95.7 | -90.4 | -90.4 |
| Power at A/C receiver | (dBm) | -65.7 | -60.4 | -60.4 |
| Overload level | (dBm) | -50.0 | -50.0 | -50.0 |
| Margin | (dB) | **15.7** | **10.4** | **10.4** |

It is seen from the above Table (right-most column) that the Commission's Monte Carlo statistical analysis, when adjusted to reflect the deployment scenario of Figure 3 (500 base stations, 19.1 dBW EIRP per carrier, 6 carriers per sector) and the proposed base station antenna with the relaxed overhead gain suppression, predicts the same (as for the baseline case) overload margin of 10.4 dB.[3] In contrast, MSV's "worst-case" computer simulation (Figure 3(b) above) predicts an overload margin of 6 dB when the airborne MET is over the center of the city (over the center of the base station cluster), increasing to 14 dB at the edges of the city. It is evident that the statistical analysis approach predicts an "ensemble average" overload margin and is not able to predict variations about this average as a function of specific base station deployment scenarios. Clearly the base station deployment scenarios of Figures 2 and 3 differ. Figure 2 reflects the baseline case of 1000 base stations, 19.1 dBW EIRP per carrier, and 3 carriers per sector. Figure 3 is based on 500 base stations, 19.1 dBW EIRP per carrier, and 6 carriers per sector. Intuitively, the deployment scenario of Figure 3 may be expected to yield lower worst-case overload margin given the higher aggregate EIRP per base station sector. The computer simulation results of Figure 3(b) bear this out. While the statistical analysis predicts the same overload margin for both deployment scenarios, the computer simulation results of Figures 2(b) and 3(b) differ and reflect the impact of reducing the number of base stations (to half the original number) while at the same time the aggregate EIRP per sector is doubled. As seen from Figures 2(b) and 3(b) the overall effect is to reduce the worst-case overload margin from 7.5 dB to 6 dB (a value that is still consistent with RTCA and ITU recommendations; *see* RTCA Document DO-235; ITU-R M.1477).

The next Table shows that according to the Commission's statistical analysis relating to $\Delta T/T$ for this case, a $\Delta T/T$ of 2.8% is predicted. The worst-case computer simulation result of Figure 3(a) predicts a $\Delta T/T$ of 8%.

[3] The effect of the proposed base station antenna with the relaxed overhead gain suppression (*see* MSV's ATC Application, Appendix L, Table 2) is completely negligible. As has been shown previously, and also verified by the present study, the effect of the proposed antenna is to increase the "calculated base station isolation" by less than 0.03 dB (*see* MSV's ATC Application, Addendum to Appendix L).

| Modified Table 2.2.3.1.A: Potential Interference to Inmarsat Airborne Receiver from ATC Base Stations | | A | B | C | D | |
|---|---|---|---|---|---|---|
| | | **As shown in ATC Order** | | **Adjusted For Proposed BTS Antenna Gain and EIRP Limits** | | |
| | | **1000 Base stations** | | **500 Base stations** | | |
| **Item** | **Units** | **MSV** | **FCC's Monte Carlo Approach** | **MSV (adjusted)** | **FCC (adjusted)** | |
| EIRP per Carrier | (dBW) | 19.1 | | | | |
| Bandwidth | (kHz/ch) | 200.0 | | | | |
| EIRP Density/carrier | (dBW/Hz) | -33.9 | | | | |
| Spurious EIRP density | (dBW/Hz) | -101.9 | -101.9 | -101.9 | -101.9 | Per Sector Aggregate Limit |
| *Assumed spurious limit (out-of-band suppression)* | (dB) | *-68.0* | *-68.0* | | | (for Columns C and D) |
| Carriers per sector | (#) | 3.0 | 3 | 1.0 | 1 | Sectors/BTS Seen by MET |
| Voice activation | (dB) | 4.0 | 4 | 4.0 | 4 | |
| Power control | (dB) | 6.0 | 5.2 | 6.0 | 5.2 | |
| Polarization | (dB) | 8.0 | 0 | 8.0 | 0 | |
| Spurious emissions average | (dBW/Hz) | -115.1 | -106.3 | -119.9 | -111.1 | |
| | | | | | | |
| Gain discrim. Inmarsat MES to Base Station | (dB) | 0.0 | 0.0 | 0.0 | 0.0 | |
| Calculated Isolation | (dB) | -101.6 | -105.1 | **-108.4** | **-108.1** | |
| Received interference power | (dBW/Hz) | -216.7 | -211.4 | -228.3 | -219.2 | |
| | | | | | | |
| Receiver Noise Temperature | (dBK) | 25.0 | 25.0 | 25.0 | 25.0 | |
| Receiver Noise Temperature | (K) | 316.2 | 316.2 | 316.2 | 316.2 | |
| Receiver Noise Density | (dBW/Hz) | -203.6 | -203.6 | -203.6 | -203.6 | |
| Interference Temperature | (T) | 15.4 | 52.1 | 1.1 | 8.7 | |
| **Delta-T/T** | **(%)** | **4.9%** | **16.5%** | **0.3%** | **2.8%** | |
| Interference to Noise Ratio (Io/No) | (dBW/Hz) | -13.1 | -7.8 | -24.7 | -15.6 | |

We conclude that, in general, a computer simulation that takes into account the specific deployment geometry of a given base station cluster (compactness, lattice regularity, and service radius per base station) yields more pessimistic results in both overload margin potential and ΔT/T potential than a statistical analysis (Monte Carlo based or not) which can only address the impact of the ensemble average of all deployment geometries of a given number of base stations. The computer simulations presented herein (Figures 2 through 8) evaluate the worst-case values for overload margin potential and ΔT/T potential, for various different ATC base station deployment scenarios, as the airborne MET traverses a city at the minimum allowed altitude (304 m).[4]

The specific deployment scenarios identified in Figures 2 through 8 are illustrative. However, at least some of these scenarios (or variations thereof) may be deployed in MSV's nation-wide ATC depending on the specific requirements of particular markets (cities) such as geographic area to be covered, existing cellular/PCS infrastructure (base station towers) to be reused by the ATC, and traffic densities. In certain cases, other scenarios (not addressed herein) may prove necessary. For each specific deployment scenario that becomes necessary for a specific geographic area, MSV will evaluate the worst-case overload margin and ΔT/T impact potential to airborne METs in accordance with the worst-case simulation tool presented herein. As such, the Commission need not a priori authorize specific deployment architectures of ATC base stations; the Commission need only remove the present restrictions on carrier EIRP and number of carriers per sector. As the present worst-case analysis clearly demonstrates, such restrictions are unnecessary for the protection of airborne METs.

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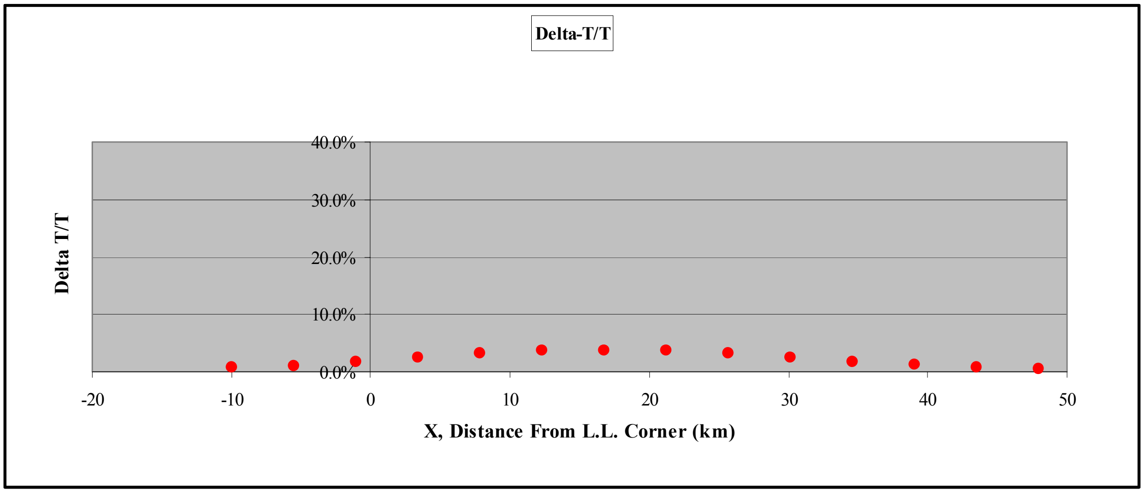
[4] Furthermore, as the Commission has recognized, zero polarization discrimination benefit in conjunction with 0 dBi MET antenna gain in the direction of a base station tower represent conservative parameter choices (*See* ATC Order, Appendix C2, §§ 2.2.3.2). This further underscores the conservative and worst-case nature of the results presented in Figures 3 through 8.

**Figure 4 - 250 Base Stations; 3 Carriers per Sector; 25.1 dBW EIRP per Carrier; 1.5 km Service Radius per Base Station**
**(Aggregate Directional Inband EIRP = 25.1 + 10log(3) + 10log(250) = 53.9)**

## (a) Worst-Case ΔT/T Impact




## (b) Worst-Case Overload Margin

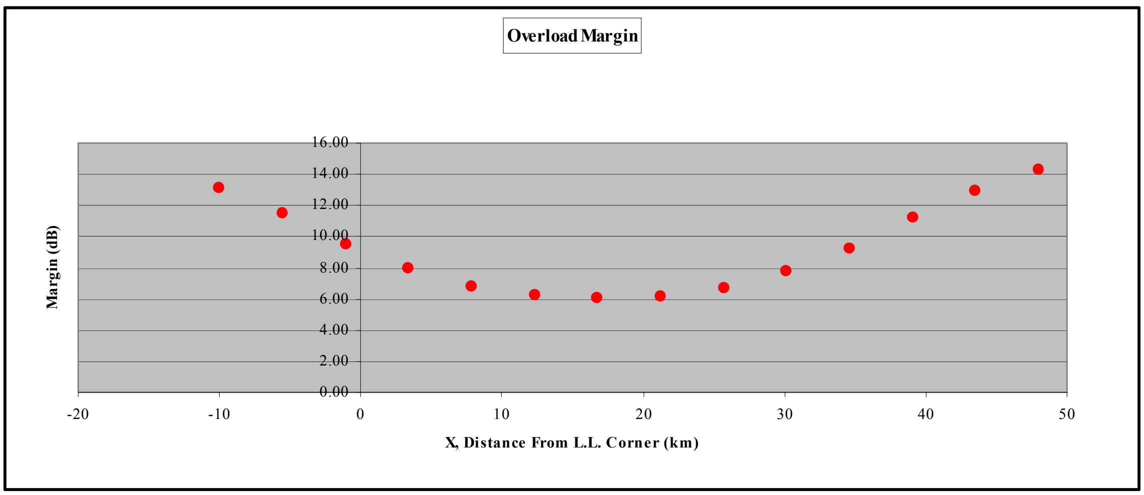
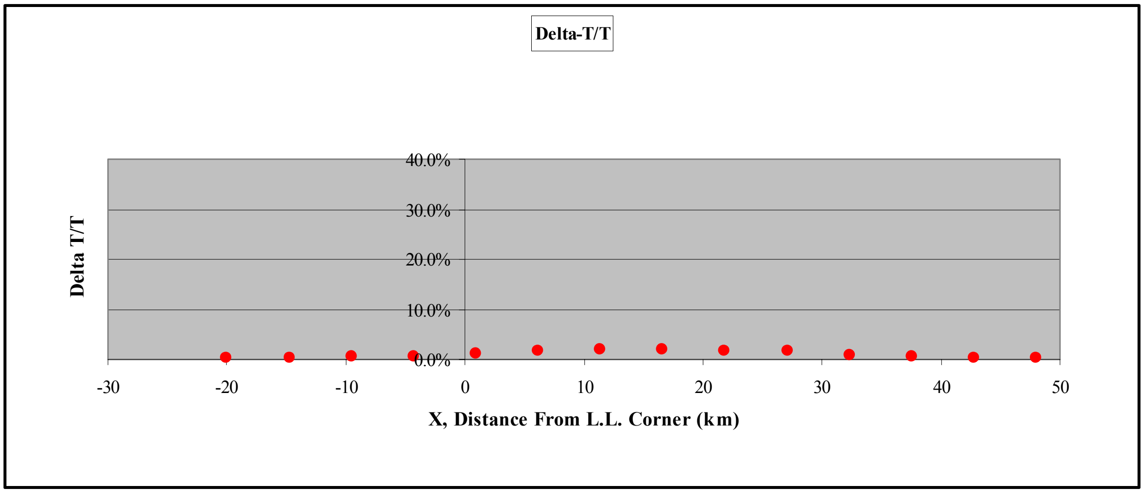


**Figure 5 - 125 Base Stations; 6 Carriers per Sector; 25.1 dBW EIRP per Carrier; 2 km Service Radius per Base Station (Aggregate Directional Inband EIRP = 25.1 + 10log(6) + 10log(125) = 53.9)**

**(a) Worst-Case ΔT/T Impact**




**(b) Worst-Case Overload Margin**

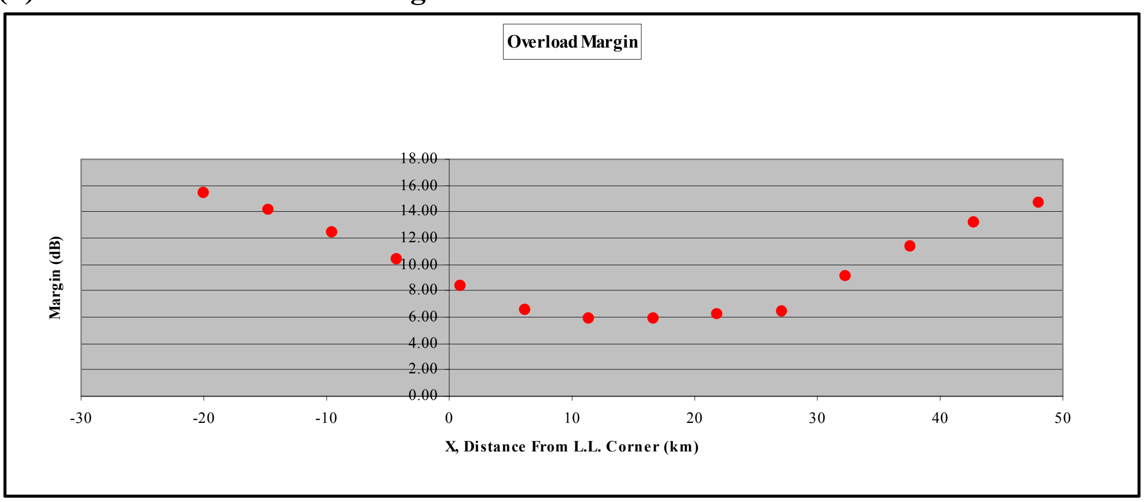
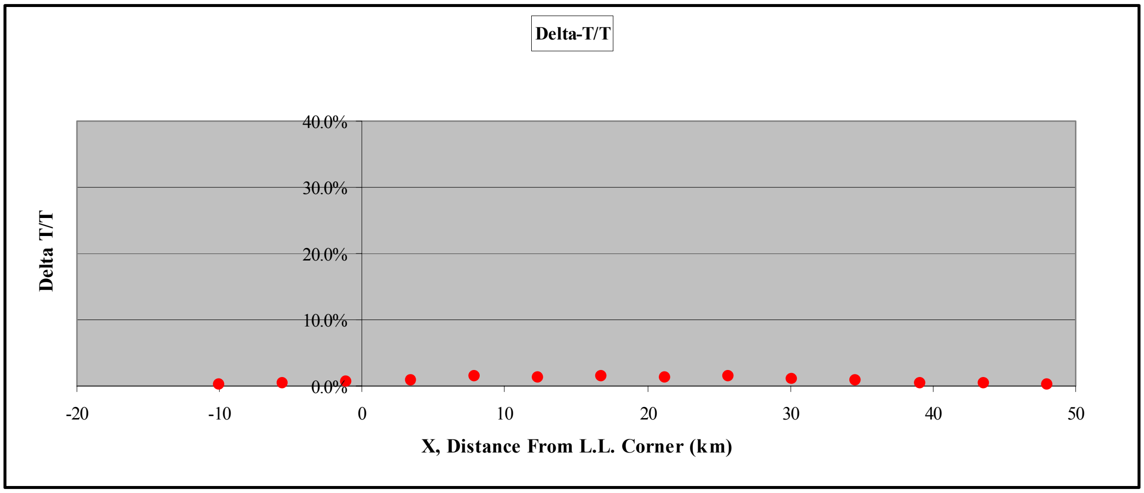


**Figure 6 - 100 Base Stations; 3 Carriers per Sector; 29.1 dBW EIRP per Carrier; 2.5 km Service Radius per Base Station (Aggregate Directional Inband EIRP = 29.1 + 10log(3) + 10log(100) = 53.9)**

## (a) Worst-Case ΔT/T Impact




## (b) Worst-Case Overload Margin

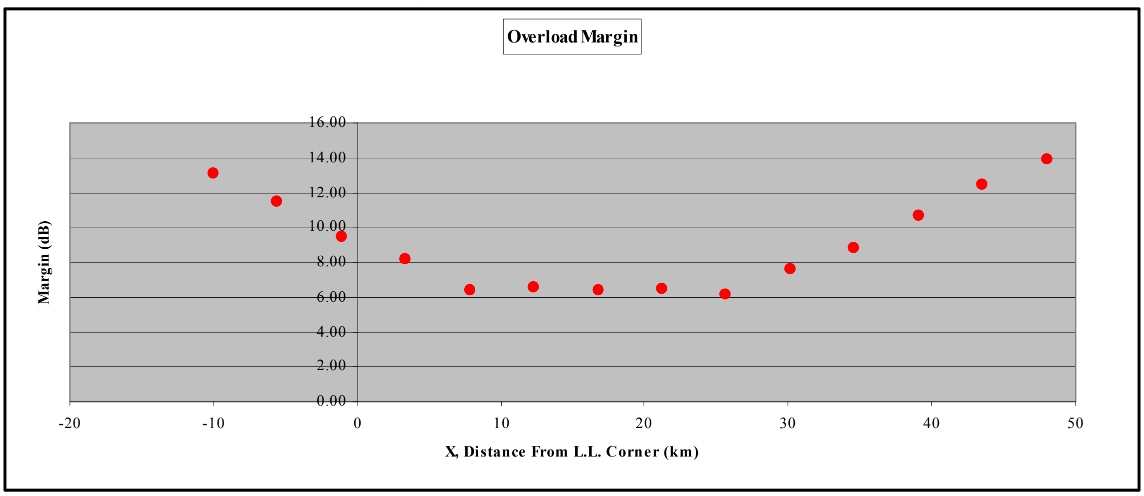
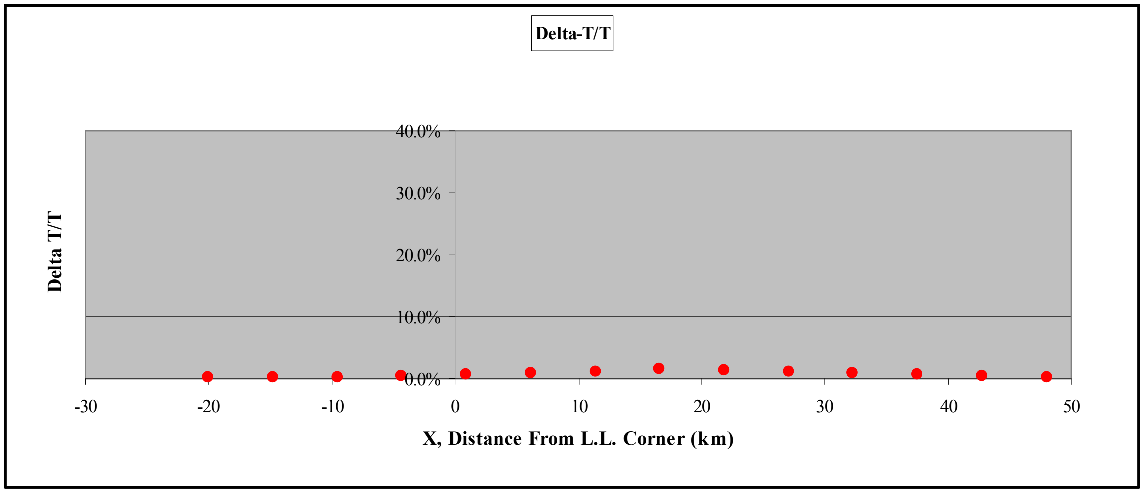


**Figure 7 - 100 Base Stations; 6 Carriers per Sector; 26.1 dBW EIRP per Carrier; 2.7 km Service Radius per Base Station (Aggregate Directional Inband EIRP = 26.1 + 10log(6) + 10log(100) = 53.9)**

## (a) Worst-Case ΔT/T Impact




## (b) Worst-Case Overload Margin

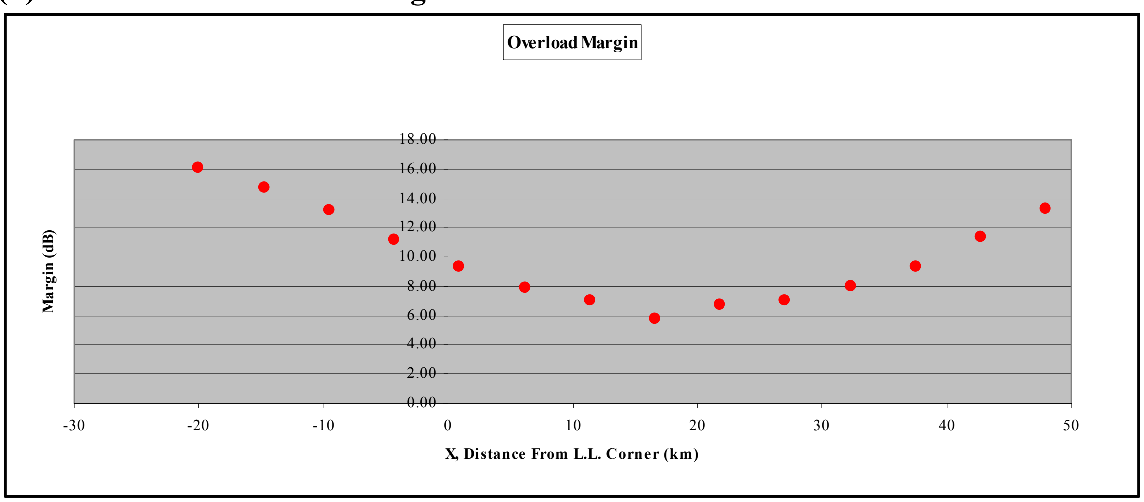
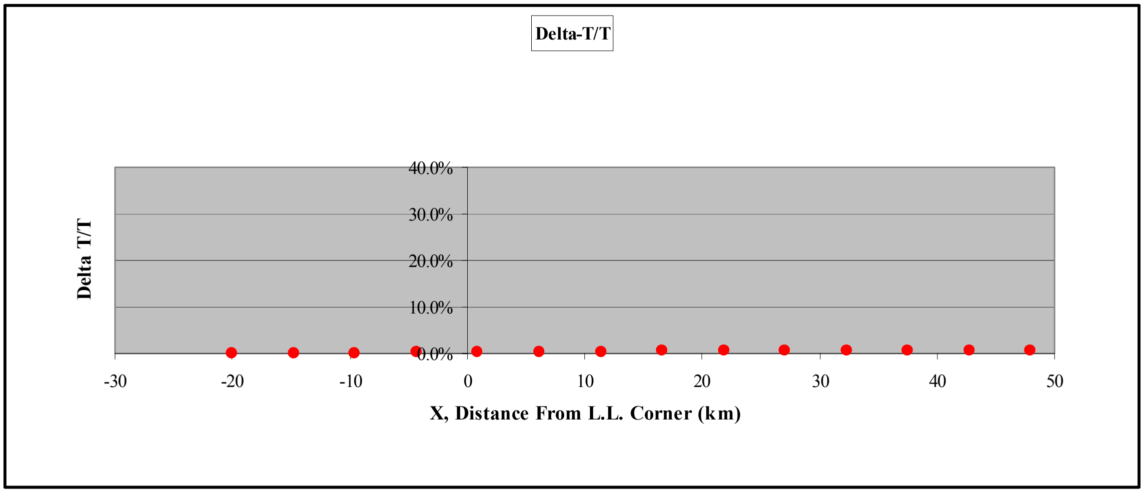
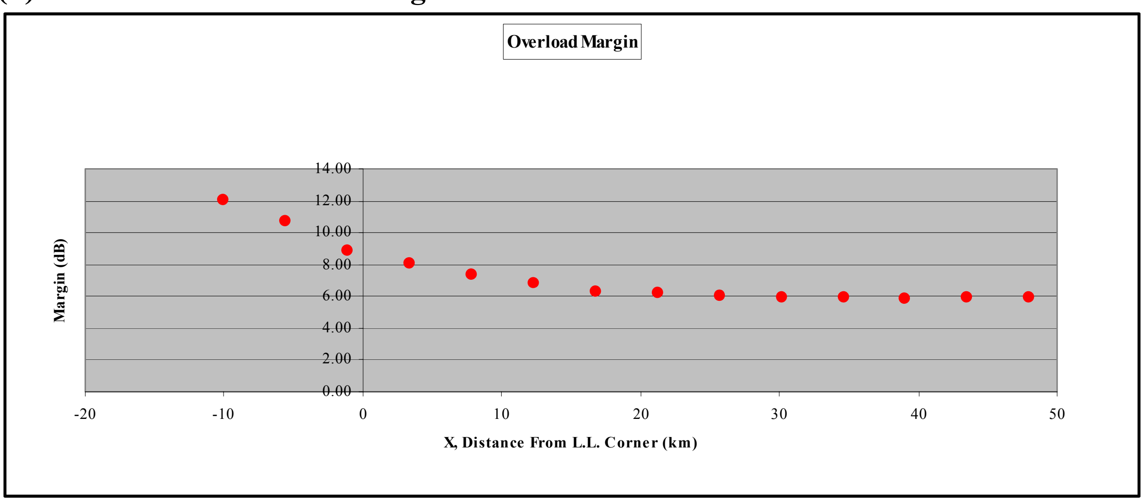


**Figure 8 - 87 Base Stations; 1 Carrier per Sector; 38.9 dBW EIRP per Carrier; 5.7 km Service Radius per Base Station (Aggregate Directional Inband EIRP = 38.9 + 10log(1) + 10log(87) = 58.3)**

**(a) Worst-Case ΔT/T Impact**




**(b) Worst-Case Overload Margin**



**Item 2:**
The Commission requested an analysis of how Table 3.3.B of Appendix C2 to the ATC Order would change using MSV's proposed values. The table is reproduced below with changes highlighted in **bold**. Since MSV is not authorized to provide MSS in the 1544-1545 MHz band, the potential for interference is strictly an out-of-band case. While MSV has asked the Commission for an increase in carrier/sector in-band EIRP, it has not asked for any change in out-of-band emissions density (-57.9 dBW/MHz) into the base station antenna. On the contrary, MSV is proposing to make the aggregate Out-of-Band-Emissions (OOBE) density per sector into the base station antenna port no greater than -57.9 dBW/MHz, irrespective of the number of carriers per sector and in-band EIRP thereof.

**Modified Table 3.3.B: Analysis of SARSAT Avoidance Distance**

| Item | Units | Value | Comment |
|---|---|---|---|
| Nominal Center Frequency | (MHz) | 1554.5 | |
| Polarization | | | Note 1 |
| Elevation Angle | (Degrees) | 0 | Note 2 |
| Antenna Diameter | (m) | 1.8 | |
| | | | |
| SARSAT Gain (typical) | (dBi) | 26.7 | |
| SARSAT (G/T) | (dB/K) | 4.0 | |
| SARSAT Noise Temperature | (dBºK) | 22.7 | |
| | | | |
| Receiver Noise Power | (dBW/Hz) | -205.9 | |
| Allowable I/N | (dB) | -11.32 | |
| Maximum Allowable Io | (dBW/Hz) | -217.2 | |
| | | | |
| Receive Gain | (dBi) | 26.7 | |
| Isotropic Area | (dBm^2) | -25.3 | |
| Receive Antenna Effective Area | (dBm^2) | 1.5 | |
| Allowable Power Flux at Antenna | (dBW/m^2 Hz) | -218.6 | |
| | | | |
| **Aggregate per Sector OOB Emission** | (dBW/MHz) | -57.9 | |
| MSV BS peak Antenna gain | dBi | 16.0 | |
| BS Gain Reduction Toward Horizon | dB | 5.0 | |
| **Sectors with LOS to SARSAT (1)** | dB | **0** | |
| Power Control | dB | -2.3 | |
| Voice Activation | dB | -1.8 | |
| Polarization Discrimination | dB | 0 | |
| Peak Out-of-band Emission | dBW/MHz | **-53.9** | |
| MSV OOB Emission Density | (dBW/Hz) | **-113.9** | |
| Required Loss | (dBm^2) | **130.0** | |
| | | | |
| Maximum Interference Distance | (km) | **48.8** | |
| Maximum Interference Distance | (mi) | **29.3** | |

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

Even though the maximum interference distance is reduced (from its original value of 85.6 km; *see* ATC Order Appendix C2, Table 3.3.B) to 48.8 km, the Commission's coordination threshold of 27 km still seems appropriate.  MSV proposes to coordinate all ATC base stations that it locates within 27 km of a SARSAT receiver where a line-of-sight path exists between the ATC base station transmitting antenna and the SARSAT receiver.

**Item 3:**

Tables 1 and 2 below present the return- and forward-link satellite link budgets for MSV's next generation satellite based on the -4 dBW EIRP satellite terminal. (These link budgets appear in MSV's satellite application amendment filed on November 18, 2003 (File No. SAT-AMD-20031118-00335)).

**Table 1: GMR-2 Return Link Budget**

| | Voice Traffic Channels | | |
|---|---|---|---|
| **Channel Type →** | **"1/2-Rate" Robust Mode** | **"1/4-Rate" Basic Mode** | **Units** |
| **CARRIER PARAMETERS:** | | | |
| Carrier Noise Bandwidth: | 50.0 | 50.0 | kHz |
| Number of voice channels per return-link carrier: | 4 | 8 | |
| **DOWNLINK: (satellite to Gateway)** | | | |
| Satellite gateway G/T: | 36.5 | 36.5 | dB/ºK |
| Satellite EIRP Per Carrier: | 20.5 | 20.5 | dBW |
| Rain Loss (w/ site diversity): | -6.0 | -6.0 | dB |
| Path loss: | -205.2 | -205.2 | dB |
| 2-satellite diversity combining: | 3.0 | 3.0 | dB |
| Boltzmann's constant: | -228.6 | -228.6 | dBW/Hz·ºK |
| **Downlink C/No** | **77.4** | **77.4** | **dB·Hz** |
| **UPLINK:** | | | |
| User Terminal PA Output Power: | 0.0 | 0.0 | dBW |
| User Terminal Antenna Gain: | -4.0 | -4.0 | dBi |
| User Terminal EIRP: | -4.0 | -4.0 | dBW |
| **Allocated fading & blockage:** | **-14.3** | **-10.5** | **dB** |
| U/L Path Loss: | -188.8 | -188.8 | dB |
| Polarization Loss (linear to CP) | -3.0 | -3.0 | dB |
| Dual polarization recombination gain (at satellite gateway) | 4.0 | 4.0 | dB |
| Satellite G/T: | 21.0 | 21.0 | dB/ºK |
| 2-satellite diversity combining: | 4.0 | 4.0 | dB |
| ΔT/T interference allowance due to ATC: | -0.2 | -0.2 | dB |
| Boltzmann's constant: | -228.6 | -228.6 | dBW/Hz·ºK |
| **Uplink C/No** | **47.3** | **51.1** | **dB·Hz** |
| **INTRA-SYSTEM INTERFERENCE:** | | | |
| Effective frequency reuse: | 28 | 28 | |
| Voice activity improvement factor: | 2.0 | 2.0 | dB |
| Avg. adj. beam discrimination: | 25.0 | 25.0 | dB |
| C/I: | 12.7 | 12.7 | dB |
| C/Io: | 59.7 | 59.7 | dB·Hz |
| **C/Io:** | **59.7** | **59.7** | **dB·Hz** |
| **TOTAL: C/(No+Io):** | **47.1** | **50.5** | **dB·Hz** |
| **Per User C/(No+Io):** | **41.0** | **41.5** | **dB·Hz** |
| **Required Per User C/(No+Io):** | **40.0** | **40.5** | **dB·Hz** |
| **Link Margin:** | **1.0** | **1.0** | **dB** |

## Table 2: GMR-2 Forward Link Budget

| Link Type → | Voice Traffic Channels: "1/2-Rate" Robust Mode | "1/4-Rate" Basic Mode | Units |
|---|---|---|---|
| **CARRIER PARAMETERS:** | | | |
| Carrier Noise Bandwidth: | 200.0 | 200.0 | kHz |
| Carrier channel bit rate: | 270833.3 | 270833.3 | bps |
| Number of voice channels per forward link carrier: | 16 | 32 | |
| **DOWNLINK:** | | | |
| Satellite EIRP Per Carrier: | 61.4 | 61.6 | dBW |
| Path loss: | -188.3 | -188.3 | dB |
| Polarization Loss (CP to linear) | -3.0 | -3.0 | dB |
| **Allocated fading & blockage** | **-14.3** | **-10.5** | **dB** |
| User Terminal G/T: | -31.0 | -31.0 | dB/ºK |
| Boltzmann's constant: | -228.6 | -228.6 | dBW/Hz·ºK |
| **Downlink C/No:** | **53.4** | **57.4** | dB·Hz |
| **UPLINK:** | | | |
| Gateway Uplink EIRP per Carrier: | 61.0 | 61.0 | dBW |
| U/L Rain Loss (assume site diversity): | -6.0 | -6.0 | dB |
| U/L Path Loss: | -206.7 | -206.7 | dB |
| Satellite Ku-band feeder link G/T: | -3.0 | -3.0 | dB/ºK |
| Boltzmann's constant: | -228.6 | -228.6 | dBW/Hz·ºK |
| **Uplink Peak C/No:** | **73.9** | **73.9** | dB·Hz |
| **INTRA-SYSTEM INTERFERENCE:** | | | |
| Effective frequency reuse: | 28.0 | 28.0 | |
| Voice activity improvement factor: | 4.0 | 4.0 | dB |
| Avg. adj. beam discrimination: | 25.0 | 25.0 | dB |
| C/I: | 14.7 | 14.7 | dB |
| C/Io: | 67.7 | 67.7 | dB·Hz |
| Intermodulation C/Imo: | 67.0 | 67.0 | dB·Hz |
| **C/Io:** | **64** | **64** | **dB·Hz** |
| **TOTAL:** | | | |
| **C/(No+Io):** | **53.0** | **56.5** | dB·Hz |
| **Per User C/(No+Io):** | **41.0** | **41.5** | dB·Hz |
| **Required per User C/(No+Io):** | **40.0** | **40.5** | dB·Hz |
| **Link Margin:** | **1.0** | **1.0** | **dB** |

It is seen from both the return- and forward-link budgets above that more than 10 dB of link margin is available in the "basic" mode (32 users per 200 kHz carrier) with more than 14 dB of link margin available in "robust" mode (16 users per 200 kHz carrier).[5] (The robust mode trades capacity for link margin by allocating two time slots per frame to the user as well as more channel coding; *see* GMR-2 specification.) The satellite link vocoder assumed in the above link budgets is the DVSI 3.6 kbps vocoder (as used in the ACeS system). Tables 3 and 4 below present the return- and forward-link budgets for MSV's present satellite system. The 2.4 kbps DVSI vocoder is assumed, and the EIRP of the "link margin booster" to the integrated ATC terminal (*see* MSV's ATC Application Appendix A) is 6 dBW. The available link margin in robust mode is 6 dB.

[5] *See* the "Allocated fading & blockage" entries of the Tables.

## Table 3: MSAT GMR-2 Return Link Budget

**MSAT GMR-2 Return Link Budget**

| | Voice Traffic Channels: | | |
|---|---|---|---|
| Component | GMR-2 1/2-Rate Robust | GMR-2 1/4-Rate Basic | Units |
| **CARRIER PARAMETERS:** | | | |
| Channel Noise Bandwidth: | 50.0 | 50.0 | kHz |
| Num. voice channels per return carrier: | 4 | 8 | |
| **DOWNLINK:** | | | |
| Reston Hub E/S G/T: | 36.5 | 36.5 | dB/K |
| Total S/C downlink EIRP: | 60.0 | 60.0 | dBW |
| Total return downlink BW: | 500.0 | 500.0 | MHz |
| Satellite EIRP Per Carrier: | 20.0 | 20.0 | dBW |
| Rain Loss (w/ site diversity): | -6.0 | -6.0 | dB |
| Path loss: | -205.2 | -205.2 | dB |
| 2-satellite diversity combining: | 3.0 | 3.0 | dB |
| Boltzmann's constant: | -228.6 | -228.6 | dB |
| **Downlink Peak C/No** | **76.9** | **76.9** | **dBHz** |
| **UPLINK:** | | | |
| User Terminal PA Output Power: | 3.0 | 3.0 | dBW |
| Min. User Terminal Tx Antenna Gain: | 3.0 | 3.0 | dBi |
| User Terminal Uplink EIRP: | 6.0 | 6.0 | dBW |
| **Allocated fading & blockage** | **-6.0** | **-2.4** | dB |
| U/L Path Loss: | -188.8 | -188.8 | dB |
| Polarization Loss from Circular | 0.0 | 0.0 | dB |
| Dual polarization recombination gain | 0.0 | 0.0 | dB |
| S/C G/T: | 1.6 | 1.6 | dB/K |
| 2-satellite diversity combining: | 4.0 | 4.0 | dB |
| ATC ΔT/T interference allowance: | 0.0 | 0.0 | dB |
| Boltzmann's constant: | -228.6 | -228.6 | dB |
| **Uplink Peak C/No** | **45.4** | **49.0** | **dBHz** |
| **INTRA-SYSTEM INTERFERENCE:** | | | |
| System max freq. reuse factor: | 2.0 | 2.0 | |
| System loading: | 100.0% | 100.0% | % |
| Voice activity improvement factor: | 2.0 | 2.0 | dB |
| Avg. adj. beam discrimination: | 20.0 | 20.0 | dB |
| C/I (freq. reuse): | 22.0 | 22.0 | dBHz |
| C/I0 (freq. reuse): | 69.0 | 69.0 | dBHz |
| **Peak C/I0 (total):** | **69.0** | **69.0** | **dBHz** |
| **TOTAL:** | | | |
| **Total Peak C/(N0+I0):** | **45.4** | **48.9** | **dBHz** |
| **Total Average C/(N0+I0):** | **39.4** | **39.9** | **dBHz** |
| **Required Average C/(N0+I0):** | **38.2** | **38.7** | **dBHz** |
| **Link Margin:** | **1.1** | **1.2** | **dB** |

## Table 4: MSAT GMR-2 Forward Link Budget

**MSAT GMR-2 Forward Link Budget**

| Component | Voice Traffic Channels: S-TCH/HRS 1/2-Rate Robust | S-TCH/QBS 1/4-Rate Basic | Units |
|---|---|---|---|
| **CARRIER PARAMETERS:** | | | |
| Channel Noise Bandwidth: | 200.0 | 200.0 | kHz |
| Carrier raw bit rate: | 270833.3 | 270833.3 | bps |
| Num. voice channels per return carrier: | 16 | 32 | |
| **DOWNLINK:** | | | |
| Satellite EIRP Per Carrier: | 43.0 | 43.0 | dBW |
| Path loss: | -188.3 | -188.3 | dB |
| Polarization Loss from Circular | 0.0 | 0.0 | dB |
| **Allocated fading & blockage** | **-6.0** | **-2.4** | dB |
| **User Terminal G/T:** | **-24.0** | **-24.0** | **dB/K** |
| Boltzmann's constant: | -228.6 | -228.6 | dB |
| **Downlink Peak C/N0:** | **53.3** | **56.9** | dBHz |
| **UPLINK:** | | | |
| E/S Uplink EIRP per Carrier: | 61.0 | 61.0 | dBW |
| U/L Rain Loss (assume site diversity): | -6.0 | -6.0 | dB |
| U/L Path Loss: | -206.7 | -206.7 | dB |
| S/C G/T: | -3.0 | -3.0 | dB/K |
| Boltzmann's constant: | -228.6 | -228.6 | dB |
| **Uplink Peak C/N0:** | **73.9** | **73.9** | dBHz |
| **INTRA-SYSTEM INTERFERENCE:** | | | |
| System max freq. reuse factor: | 2.0 | 2.0 | |
| System loading: | 100.0% | 100.0% | % |
| Voice activity improvement factor: | 4.0 | 4.0 | dB |
| Avg. adj. beam discrimination: | 20.0 | 20.0 | dB |
| C/I (freq. reuse): | 24.0 | 24.0 | dB |
| C/I0 (freq. reuse): | 77.0 | 77.0 | dBHz |
| Intermodulation C/Im0: | 67.0 | 67.0 | dBHz |
| **Peak C/I0 (total):** | **66.6** | **66.6** | **dBHz** |
| **TOTAL:** | | | |
| **Total Peak C/(N0+I0):** | **53.1** | **56.4** | dBHz |
| **Total Average C/(N0+I0):** | **41.0** | **41.3** | dBHz |
| **Required Average C/(N0+I0):** | **40.0** | **40.5** | dBHz |
| **Link Margin:** | **1.0** | **0.8** | **dB** |

**Item 5:**

The Commission is correct. The burst duration is the same for both the full-rate and half-rate GSM vocoders. When an ATC terminal switches from using the full-rate vocoder to the half-rate vocoder it switches from transmitting 13 kbps to 4.75 kbps. Just prior to switching to half-rate mode the terminal radiates one burst per frame. After switching to half-rate mode the terminal radiates only one burst per two frames. This (once per two frames bursting) suffices to transmit the information delivered by the half-rate vocoder since the half-rate vocoder outputs less than half of the information rate of the full-rate vocoder. It is the "less than half" information rate of the half-rate vocoder that yields at least an additional 0.5 dB of terminal power reduction during the burst.[6] Thus, in forcing an ATC terminal to switch from the full-rate to the half-rate vocoder two things occur simultaneously: **1**) the terminal transmits one burst per two frames (this is a 3 dB reduction in average transmitted power), and **2**) the power during the burst is reduced by at least 0.5 dB since the information rate of the "half-rate" vocoder is 4.75 kbps instead of 6.5 kbps.

In general, as a communications link switches from transmitting 13 kbps (full-rate vocoder) to 4.75 kbps (half-rate vocoder) the average transmitted power required by the link, assuming the same Bit Error Rate (BER) at the receiver, reduces by 10log(13/4.75) ≈ 4.4 dB. This is a fundamental result and is independent of the multiple access technology (TDMA or CDMA). We can, therefore, state that as an ATC terminal (CDMA or TDMA) reaches or exceeds an output power level of ($P_{Max}$ - 3.5 dB) the vocoder of that terminal will be commanded to switch to half-rate mode. The terminal's vocoder (having been switched from full-rate to half-rate) may be switched back to full-rate as the terminal's output power level becomes lower than or equal to ($P_{Max}$ - 7 dB).

[6] We observe that 10log(6.5/4.75) ≈ 1.4 dB; MSV conservatively uses 0.5 dB. Thus, the once per two frames bursting of the half-rate vocoder mode yields 3 dB of average power reduction while the less than half information rate of the half-rate vocoder conservatively yields an additional 0.5 dB of power reduction for an overall effective average power reduction of 3.5 dB.