FOR INFORMATION

UNITED STATES DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
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Mr. Edmond J. Thomas
Chief, Office of Engineering and Technology
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Dear Mr. Thomas:

The National Telecommunications and Information Administration (NTIA) appreciates the opportunity to review and provide comments on the Federal Communications Commission's (Commission) public notice requesting comments on the Mobile Satellite Ventures (MSV) license application to operate an ancillary terrestrial component (ATC) with their mobile satellite service network.[1]

In the MSV license application, there are several waiver requests of the Commission's Rules that could impact ATC base station (BS) and mobile terminal (MT) compatibility with Aeronautical Mobile Satellite Route Service (AMS(R)S) and Global Maritime Distress and Safety System (GMDSS) receivers which support critical aeronautical and maritime safety applications. To assess the potential impact that the MSV ATC waiver requests might have on these critical federal systems, NTIA conducted an assessment (enclosure) and based on the findings makes the following recommendations:

- To protect AMS(R)S receivers, the increase in the ATC BS sector equivalent isotropically radiated power (EIRP) must be limited to 12 dB instead of the 15 dB requested by MSV;

- The relaxation of the overhead antenna gain requested by MSV for ATC BSs can be permitted without impacting the operation of AMS(R)S receivers;

- To protect GMDSS receivers, ATC BSs operating at the 12 dB higher EIRP level must be located at least 2.5 km from the boundaries of all navigable waterways or they cannot exceed an aggregate power flux density level of -62.6 dBW/m^2/sector at the boundaries of all navigable waterways;

- To ensure compatibility with AMS(R)S and GMDSS receivers, the out-of-channel emission level of the ATC BSs must be limited to -53 dBW/MHz for a sector. This emission level is based on three carriers per sector. If additional carriers per sector are employed, the out-of-channel emission level for each carrier must be reduced by a factor of 10 Log (number of carriers) relative to -53 dBW/MHz;

1. Federal Communications Commission Policy Branch Information, Public Notice, Report No. SPB-200, *Mobile Satellite Ventures Subsidiary LLC Ancillary Terrestrial Component Applications Accepted for Filing* (February 9, 2004).

- ATC BSs operating at the 12 dB higher EIRP level must still comply with the EIRP limits of -100 dBW/MHz (wide band emissions) and -110 dBW (narrow band) emissions in the 1559-1610 MHz band that are specified in the MSV license application;

- The EIRP limits of -100 dBW/MHz (wide band emissions) and -110 dBW (narrow band) emissions in the 1559-1610 MHz band that are specified in the MSV license application applies to ATC BSs that employ either Time Division Multiple Access (TDMA) or Code Division Multiple Access (CDMA);

- The EIRP limits of -90 dBW/MHz (wide band emissions) and -100 dBW (narrow band emissions) in the 1559-1605 MHz band that are specified in the MSV license application applies to ATC MTs that employ either TDMA or CDMA; and

- As part of the compliance measurements of the MSV satellite/ATC MT, it is recommended that measurements of the MT be performed with and without the link margin booster to ensure that the out-of-band emission levels in the 1559-1605 MHz band do not exceed the EIRP limit of -70 dBW/MHz for the satellite MTs and -90 dBW/MHz (wideband emissions) and -100 dBW (narrowband emissions) for the ATC MTs.

NTIA does not oppose MSV's request that, with respect to frequencies that are not shared with any other visible satellite systems (e.g., non-co-channel frequencies), there can be unlimited reuse of its satellite spectrum for ATC operations. The only exception to this additional flexibility, however, is that if certain frequencies used by MSV change from being non-co-channel frequencies to being shared frequencies, as a result of changes in the international frequency coordination, MSV should be required, with respect to those shared frequencies, to comply with the applicable rules. Moreover, MSV would never be permitted to operate co-channel in the same geographic area with any AMS(R)S and GMDSS operations of another satellite system.

NTIA believes that the conditions stated above are necessary to preclude potential interference to AMS(R)S and GMDSS receivers and should not impact the implementation of ATC BSs and MTs. If you have any questions about our recommendations, please feel free to contact me at (202) 482-1850.

Sincerely,

Fredrick R. Wentland
Associate Administrator
Office of Spectrum Management

Enclosure

ENCLOSURE

ASSESSMENT OF MOBILE SATELLITE VENTURES ANCILLARY TERRESTRIAL COMPONENT LICENSE APPLICATION WAIVER REQUESTS

INTRODUCTION

In February 2003, the Federal Communications Commission (Commission) issued an order to allow mobile satellite service (MSS) providers to operate an ancillary terrestrial component (ATC) with their networks.[1] Mobile Satellite Ventures (MSV) requested authority to operate ATC base stations in conjunction with its existing L-Band MSS satellite system.[2] The MSV proposed ATC base stations (BSs) will transmit in portions of the 1525-1559 MHz frequency band and the mobile terminals (MTs) will transmit in the 1626.5-1660.5 MHz frequency band. In its ATC application, MSV requests waivers of several provisions of the Commission's Rules that could impact ATC BS and MT compatibility with the Aeronautical Mobile Satellite Route Service (AMS(R)S) and Global Maritime Distress and Safety System (GMDSS) receivers which support critical aeronautical and maritime safety applications. The purpose of this document is to assess the impact that the MSV waiver requests will have on these critical federal systems.

OVERVIEW OF L-BAND MSS ATC RULES

The service rules for L-Band ATC operation are contained in Section 25.253 of the Commission's Rules.[3] The L-Band ATC rules specify provisions for the operation of BSs and MTs in the 1525-1559 MHz and 1626.5-1660.5 MHz frequency bands. In the 1626.5-1660.5 MHz and 1525-1559 MHz bands, ATC operations are limited to the frequency assignments authorized and internationally coordinated for the MSS system of the MSS licensee that seeks ATC authority.[4]

According to the Commission's current rules, the L-Band ATC BSs must comply with the following provisions:

- Out-of-channel emission of –57.9 dBW/MHz per carrier
- Maximum of 1725 BSs operating in the United States in any 200 kHz channel
- Peak equivalent isotropically radiated power (EIRP) of 19.1 dBW/200 kHz
- Maximum of three carriers for each BS sector

1. *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band and the 1.6/2.4 GHz Bands*, Report and Order and Notice of Proposed Rulemaking, FCC 03-15, 18 FCC Rcd 1962 (2003) ("MSS ATC Order").

2. Mobile Satellite Ventures Subsidiary LLC, Federal Communications Commission Application for Space and Earth Station, SAT-MOD-20031118-00333 (November 18, 2003) ("MSV License Application").

3. *See* 47 C.F.R §25.253.

4. *See* 47 C.F.R. §25.147(a)(2)(ii).

- EIRP at the horizon of 14.1 dBW/200 kHz
- Located 470 meters from the airport runway
- Power flux density (PFD) of –73 dBW/m^2/200 kHz at the edge of airport
- Located 1.5 kilometers from the edge of waterway
- PFD of –64.6 dBW/m^2/200 kHz at the edge of waterway
- Left hand circular polarization
- Coordination is required within 27 kilometers of Search and Rescue Satellite (SARSAT) Local User Terminals
- Antenna gain as follows:

Elevation Angle (Degrees)	Antenna Gain (dBi)
0	16
5	11
10	-3
15-30	-11
30-55	-18
55-145	-24
145-180	-10
The elevation angle is measured from the boresight. The BS antenna is required to have a 5 degree down look angle below the horizon.	

According to the Commission's current rules, the L-Band ATC MTs must comply with the following provisions:

- Peak EIRP of 0 dBW
- Out-of-channel emissions of -67 dBW/4 kHz
- Variable rate vo-coder:

Nominal MT Peak EIRP	MT Transmit Duty Cycle
-7.4 dBW or less	100%
Greater than -7.4 dBW	50%
Greater than -4.4 dBW	25%
Greater than -1.4 dBW	20%
Greater than -0.4 dBW	18.2%

OVERVIEW OF MSV WAIVER REQUESTS

Table 1 summarizes the MSV license application wavier requests of the Commission's MSS ATC Rules.

Currently ATC base stations are permitted to have an EIRP of 19.1 dBW in 200 kHz, per carrier with no more than three carriers per sector. MSV proposes to increase the EIRP to 38.9 dBW that is specified as an aggregate EIRP limit per BS sector. MSV further proposes to eliminate the limit of three carriers per base station sector. MSV also proposes to operate with an aggregate EIRP per sector of up to 33.9 dBW toward the physical horizon.

Table 1.

Commission Rule Section	Waiver Request
47 C.F.R. § 25.253(a)(2)	Use of half-rate vo-coders
47 C.F.R. § 25.253(c)	Increased terrestrial reuse of co-channel frequencies and unlimited terrestrial reuse of non-co-channel frequencies
47 C.F.R. § 25.253(d)(1)	Increased ATC BS EIRP and elimination on limit on number of carriers per sector
47 C.F.R. § 25.253(d)(2)	Increased ATC BS EIRP toward the physical horizon and elimination of limit on number of carriers per sector
47 C.F.R. § 25.253(d)(3),(4)	Relaxation of restrictions on placement of ATC BSs near airports
47 C.F.R. § 25.253(d)(4)	Relaxation of PFD limit for ATC BSs near airports
47 C.F.R. § 25.253(d)(5)	Relaxation of PFD limit for ATC BSs near waterways
47 C.F.R. § 25.253(e)	Relaxation of ATC BS overhead antenna gain suppression

MSV requests that ATC base stations satisfy one of the following: 1) be located at least 470 meters from an airport runway or aircraft stand areas including takeoff and landing paths; or 2) not exceed a PFD level of -49.6 dBW/m^2/carrier at the edge of all airport runways or aircraft stand areas including takeoff and landing paths. This is an increase of 23.4 dB in the PFD limit adopted by the Commission.

MSV requests that ATC base stations satisfy one of the following: 1) be located at least 1.5 kilometers from the boundaries of all navigable waterways; or 2) not exceed a PFD level of -54.4 dBW/m^2/carrier at the water's edge. This is an increase of 10 dB in the PFD limit adopted by the Commission.

MSV requests a relaxation in the overhead gain suppression required by the Commission's Rules by 10 dB over the range of elevation angles from 55 to 145 degrees and by 8 dB over the range of elevation angles from 30 to 55 degrees.

The Commission's Rules require that L-Band ATC systems employ a Global Systems for Mobile Communications (GSM) architecture. GSM employs Time Division Multiple Access (TDMA).[5] In their license application, MSV requests that the Commission also permit the use of Code Division Multiple Access (CDMA). Specifically, MSV proposes cdma2000 which requires a 1.25 MHz channel bandwidth and W-CDMA which requires a 5 MHz channel bandwidth.

Each of the waiver requests shown in Table 1 could potentially impact the compatibility of MSS ATC BSs with AMS(R)S and GMDSS receivers and must be evaluated.

L-BAND MSS ATC ANALYSIS ASSUMPTIONS

The MSS ATC service rules adopted by the Commission were based on technical evaluations of the different L-Band ATC proposals. The evaluations of the different

5. *See* 47 C.F.R §25.253(a)(1).

technical proposals are contained in Appendix C2 of the MSS ATC Order.[6] These evaluations included assumptions regarding the operating parameters and analysis factors associated with the MSS ATC BSs. In order to maintain consistency with the evaluations previously performed by the Commission, the following analysis assumptions for the operating and analysis factors will be used in this assessment of MSV's waiver requests:

Table 2.

Operating and Analysis Factor	Value
Power Control	5.2 dB (multiple BS analysis)
Voice Activation	4 dB (multiple BS analysis) 2 dB (single BS analysis)
Polarization Isolation	1.4 dB (linear to circular) 8 dB (near off-axis for orthogonal circular) 0 dB (above the BS)

ASSESSMENT OF MSV ATC BS WAIVER REQUESTS

In assessing the potential impact to AMS(R)S and GMDSS receivers as a result of the MSV ATC BS waiver requests, several operational scenarios and interference interactions, consistent with those considered in Appendix C2 of the MSS ATC Order are considered. This assessment considers both on-channel and off-channel interference to AMS(R)S and GMDSS receivers. Single and multiple ATC BS operational scenarios are considered for assessing potential interference to AMS(R)S receivers. For assessing potential interference to GMDSS receivers, a single ATC BS operational scenario is considered.

Interference Thresholds

The interference thresholds used in this assessment consider both on-channel (saturation) and off-channel interference interactions to AMS(R)S and GMDSS receivers.

On-Channel Interference Threshold

In the MSS ATC Order, the Commission used a value of -50 dBm as the front-end radio frequency input level corresponding to the 1 dB compression point of airborne Inmarsat receivers. The Commission used this value as the basis for estimating potential interference from MSV on-channel ATC BSs. The value of -50 dBm is based on performance requirements for AMS(R)S receivers specified in ARINC Characteristic 741.[7] For land-mobile and maritime mobile earth terminal (MET) receivers not specifically covered under the ARINC requirement, the Commission reduced the ARINC requirement by 10 dB and assumed a 1 dB compression point of -60 dBm for land-based

6. MSS ATC Order Appendix C2.

7. Aeronautical Radio Inc. (ARINC), ARINC Characteristic 741P1-7, *Aviation Satellite Communication Systems Part 1 Aircraft Provisions*, (January 25, 1996) at Sections 2.2.4.2 and 2.2.4.5.

and maritime Inmarsat receivers.[8]

Measurements performed by MSV and provided as part of their license application, indicate that the 1 dB compression point for land-mobile and maritime METs occurs at a level at least 17 dB higher than the Commission's assumed threshold of -60 dBm.[9] Inmarsat also performed measurements that indicate the saturation levels of the METs are on the order of -72 dBm, which is 12 dB lower than the value used in the Commission's analysis.[10]

It is recognized that many METs could have 1 dB compression points that are above the requirements specified in the ARINC specification. However, the METs measured by MSV may not be representative of all land mobile, maritime and airborne METs. Furthermore, given the large difference between the MSV and Inmarsat measured saturation levels, it is unclear which set of measurements is representative of the co-channel interference level for METs. At a minimum, all airborne METs must conform to the ARINC level of -50 dBm. In many cases, METs used for land mobile and maritime applications will be the same as the airborne applications. An interference threshold that is consistent with the -50 dBm level will ensure that all METs are provided reasonable protection. Thus, in assessing potential on-channel interference to AMS(R)S and GMDSS receivers, an interference threshold of -50 dBm is used.

Off-Channel Interference Threshold

AMS(R)S Receiver Interference Threshold. International Telecommunication Union-Radiocommunications Sector (ITU-R) Recommendation M.1234 recognizes that interference from a MSS network contributes to the noise in the AMS(R)S channel and should be taken into account.[11] ITU-R M.1234 specifies that the maximum permissible level of interference power in a digital channel in the AMS(R)S receiver caused by transmitters of another MSS network or fixed satellite network, should not exceed 6% of the total noise power at the input to the demodulator. This single-entry interference level of 6% of the total noise corresponds to an interference-to-noise ratio (I/N) of -12.2 dB (10 Log (0.06)). This interference criteria is used to determine the interference threshold.

The receiver bandwidths of the AMS(R)S receivers vary between 600 Hz and 21 kHz depending on the receiver channel type.[12] The lowest receiver noise density is

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8. MSS ATC Order Appendix C2, at Section 1.12.

9. MSV License Application, Addendum to Appendix J, at 11.

10. Opposition of Inmarsat Ventures Ltd., File No. SAT-MOD-20031118-00333; File No. SAT-AMD-20031118-00332; File No. SES-MOD-20031118-01879 (March 25, 2004) at Appendix B.

11. Recommendation ITU-R M.1234, *Permissible Level of Interference in a Digital Channel of a Geostationary Satellite Network in the Aeronautical Mobile-Satellite (R) Service (AMS(R)S) in the Bands 1545 to 1555 MHz and 1646.5 to 1656.5 MHz and its Associated Feeder Links Caused by Other Networks of this Service and the Fixed Satellite Service* (1997).

12. Document No. RTCA DO-210C, *Minimum Operational Performance Standards for Aeronautical*

specified as -172.1 dBm/Hz.[13] The receiver power for the narrowest bandwidth would represent the lowest receiver noise power. The receiver noise power for a 600 Hz AMS(R)S receiver bandwidth is:

$$N = -172.1 \text{ dBm/Hz} + 10 \text{ Log } (600) = -144.3 \text{ dBm/600 Hz}$$

Using this receiver noise power and the I/N of -12.2 dB, the receiver interference threshold used in this analysis for AMS(R)S receivers is computed below:

$$I_T = N + I/N$$

$$I_T = -144.3 - 12.2 = -156.5 \text{ dBm/600 Hz}$$

GMDSS Receiver Interference Threshold. The GMDSS receiver system noise level is used to assess the potential of interference from ATC BSs. The GMDSS receiver system noise level used in this analysis is -202 dBW/Hz.[14]

In Appendix C2 of the MSS ATC Order, the Commission established an interference threshold 7 dB below the system noise level. This results in an increase of the system noise by 0.8 dB, which the Commission concluded should provide adequate protection for GMDSS receivers. Based on an I/N of -7 dB, the interference threshold used in this assessment for GMDSS receivers is:

$$I_T = -202 \text{ dBW/Hz} - 7 = -209 \text{ dBW/Hz}$$

Assessment of Potential Interference to AMS(R)S AND GMDSS Receivers Based on MSV ATC BS Waiver Requests

In assessing the potential interference to AMS(R)S receivers, the received interference power level is computed based on the proposed ATC BS EIRP and antenna gain waiver requests and on characteristics in accordance with the existing rules for L-Band ATC systems. This computed interference power level was compared to the interference threshold and the available margin is determined. A positive margin indicates compatibility and a negative margin indicates incompatibility. For the AMS(R)S receivers, the available margin is used to evaluate the requested BS waiver requests. For GMDSS receivers the available margin is considered in determination of the necessary separation distance for compatibility.

Table 3 provides an overview of the operational scenarios considered in evaluating potential interference to AMS(R)S and GMDSS receivers based on the MSV license waiver proposals.

Mobile Satellite Service (AMSS) at 25 (January 16, 1996).

13. *Id.* at 26.

14. MSS ATC Order Appendix C2 at Section 2.2.2.2.

Table 3.

Operational Scenario	Description
1	Higher EIRP and overhead antenna gain relaxation for single ATC BS on-channel interference to AMS(R)S receivers.
2	Higher EIRP for multiple ATC BS on-channel interference to AMS(R)S receivers.
3	Higher EIRP for single ATC BS on-channel interference to GMDSS receivers.
4	Overhead antenna gain relaxation for multiple ATC BS on-channel interference to AMS(R)S receivers.
5	Higher EIRP and overhead antenna gain relaxation for single ATC BS off-channel interference to AMS(R)S receivers.
6	Increase the number of carriers per sector for multiple ATC BS off-channel interference to AMS(R)S receivers.
7	Increase the number of carriers per sector for single ATC BS off-channel interference to GMDSS receivers.

Operational Scenario 1: Higher EIRP and Overhead Antenna Gain Relaxation for Single ATC BS On-Channel Interference to AMS(R)S Receivers

The analysis provided in Table 4 evaluates the MSV proposals for higher EIRP and relaxation of the overhead antenna gain for AMS(R)S receivers.

Table 4.

Parameter	Value	Source
ATC BS Carrier Power	19.1 dBW	47 C.F.R. § 25.253(d)(1)
Carriers Per Sector (3 Carriers)	4.8 dB	MSS ATC Order Appendix C2
Sector Per ATC BS (3 Sectors)	4.8 dB	MSS ATC Order Appendix C2
dBW to dBm Conversion	30	
Total ATC BS EIRP	58.7 dBm	
AMS(R)S Effective Antenna Gain	-10 dBi	MSS ATC Order Appendix C2
ATC BS Antenna Gain (Overhead)	-30 dBi	MSV Waiver Request
Propagation Loss	-85 dB	MSS ATC Order Appendix C2
Power Control	-5.2 dB	MSS ATC Order Appendix C2
Voice Activation	-4 dB	MSS ATC Order Appendix C2
Polarization	0 dB	MSS ATC Order Appendix C2
Total Losses	-134.2 dB	
Received Power	-75.5 dBm	
Interference Threshold	-50 dBm	
Available Margin	25.5 dB	

As shown in Table 4, the available margin is 25.5 dB; therefore, the request by MSV to increase the EIRP by 15 dB and increase the overhead antenna gain should not impact AMS(R)S receivers under the conditions of this operational scenario.

Operational Scenario 2: Higher EIRP for Multiple ATC BS On-Channel Interference to AMS(R)S Receivers

The analysis provided in Table 5 evaluates the MSV proposals for higher EIRP for AMS(R)S receivers.

Table 5.

Parameter	Value	Source
ATC BS Carrier Power	19.1 dBW	47 C.F.R. § 25.253(d)(4)
Carriers Per Sector (3 Carriers)	4.8 dB	MSS ATC Order Appendix C2
Sector Per ATC BS (1 Sector)	0 dB	MSS ATC Order Appendix C2
dBW to dBm Conversion	30	
Total ATC BS EIRP	53.9 dBm	
AMS(R)S Effective Antenna Gain	0 dBi	MSS ATC Order Appendix C2
Isolation for 1000 ATC BSs	-105 dB	MSS ATC Order Appendix C2
Power Control	-5.2 dB	MSS ATC Order Appendix C2
Voice Activation	-4 dB	MSS ATC Order Appendix C2
Polarization	-1.4 dB	MSS ATC Order Appendix C2
Total Losses	-115.6 dB	
Received Power	-61.7 dBm	
Interference Threshold	-50 dBm	
Available Margin	11.7 dB	

As shown in Table 5, the available margin is approximately 12 dB. Based on the conditions of this operational scenario, only a 12 dB increase in the EIRP can be supported instead of the 15 dB increase requested by MSV.

Operational Scenario 3: Higher EIRP for Single ATC BS On-Channel Interference to GMDSS Receivers

The analysis provided in Table 6 evaluates the MSV proposal for higher EIRP for GMDSS receivers.

Table 6.

Parameter	Value	Source
ATC BS Carrier Power	19.1 dBW	47 C.F.R. § 25.253(d)(4)
Carriers Per Sector (3 Carriers)	4.8 dB	MSS ATC Order Appendix C2
Sector Per ATC BS (1 Sector)	0 dB	MSS ATC Order Appendix C2
dBW to dBm Conversion	30	
Total ATC BS EIRP	53.9 dBm	
GMDSS Effective Antenna Gain	7.8dBi	MSS ATC Order Appendix C2
ATC BS Antenna Gain Back-Off	-3.6 dB	
Propagation Loss	-99.7 dB	47 C.F.R. § 25.253(d)(5)
Power Control	-5.2 dB	MSS ATC Order Appendix C2
Voice Activation	-2 dB	MSS ATC Order Appendix C2
Polarization	-8 dB	MSS ATC Order Appendix C2
Total Losses	-110.7 dB	
Received Power	-56.8 dBm	
Interference Threshold	-50 dBm	
Available Margin	6.8 dB	

As shown in Table 6, the available margin is approximately 7 dB. Based on the conditions of this operational scenario, only a 7 dB increase in the EIRP can be supported instead of the 15 dB increase requested by MSV. In the analysis for Operational Scenario 2, it was determined that a 12 dB increase in the EIRP for the ATC BS could be permitted. Since GMDSS receivers are only used on waterways, it is possible to establish a separation distance from the edge of waterways to ensure compatibility. The analysis in Table 6 is based on the 1.5 km required separation distance currently in the Commission's Rules. Increasing the separation distance effects both the propagation loss and the antenna gain back-off for the ATC BS. A 12 dB increase in the EIRP requires 5 dB of additional propagation loss and antenna gain back-off. For a 12 dB increase in the EIRP the ATC BS can be located no closer than 2.5 km to the edge of the waterway.

The Commission's Rules also include a PFD level at the edge of the waterway. The PFD level required to protect GMDSS receivers is computed using the following equation:

$$PFD = I_T - G_{ATC} - 10 \text{ Log } (\lambda^2/4\pi)$$

where:

G_{ATC} is the antenna gain of the ATC BS (dBi);
λ is the wavelength (m).

Using the equation above the PFD is:

$$PFD = -50 - 7.8 - (-25.2) = -32.6 \text{ dBm/m}^2\text{/sector} = -62.6 \text{ dBW/m}^2\text{/sector}$$

This would be an aggregate (for all carriers) for one sector and the limit is at the edge of the waterway.

Operational Scenario 4: Overhead Antenna Gain Relaxation for Multiple ATC BS On-Channel Interference to AMS(R)S Receivers

This analysis evaluates the MSV proposal for relaxation of the overhead antenna gain for ATC BSs and the impact on AMS(R)S receivers. To address this proposal, an analysis methodology consistent with that used by the Commission in the MSS ATC Order Appendix C2 is employed. The operational scenario used in Appendix C2 modeled the ATC BS environment as a series of concentric rings with 1000 ATC BSs uniformly distributed over a 90 km radius circular region. The aircraft with the AMS(R)S receiver is assumed to be located over the center of the ATC BS deployment. In this analysis a similar approach is used where the 90 km radius circular region is divided into concentric rings of equal area, with each ring containing 10% of the 1000 ATC BSs. The inner 10% ring is divided in half (two 5% segments) to further examine the propagation and antenna gain effects. Table 7 provides the ring radius, the percent ATC BSs, the propagation loss to the mid-point of each ring, and the elevation angle from the aircraft.

As shown in Table 7, all of the elevation angles are within 2 degrees of the horizontal. MSV proposes to increase the antenna gain at angles between 30 to 145 degrees. Therefore, the increases in the overhead antenna gain as proposed by MSV is not a significant factor over the environment considered in this operational scenario and should not result in interference to AMS(R)S receivers.

Table 7.

Ring Radius (km)	Percent ATC BSs	Propagation Loss to Mid-Point of Ring	Elevation Angle from to a ATC BS at the Mid-Point of Ring to the Aircraft (Degrees)
85.4 to 90	10	C - 38.9	0.18
80.5 to 85.4	10	C - 38.4	0.19
75.3 to 80.5	10	C - 37.8	0.2
69.7 to 75.3	10	C - 37.2	0.21
63.6 to 69.7	10	C - 36.5	0.23
56.9 to 63.6	10	C - 35.6	0.26
49.2 to 56.9	10	C - 34.5	0.29
40.24 to 49.2	10	C - 33	0.35
28.46 to 40.24	10	C - 30.7	0.45
20.12 to 28.46	5	C - 27.7	0.64
0 to 20.12	5	C - 20	1.5
C represents the 20 Log (frequency) and the constant in the free space propagation loss equation. The aircraft is at an altitude of 300 meters and the ATC BS is at 30 meters.			

A weighted (to account for the two inner circles) numeric average of the 20 Log (mid-point distance) terms can be computed from the values in Table 7:

$$(322.6 + 23.9)/10 = 34.6 \text{ dB}$$

The weighted average of the mid-point distance points is used to compute an average or ensemble value of the isolation:

$$\text{Isolation} = 10 \log (1000) - 5 - 32.45 - 63.75 - 34.6 = -105.8 \text{ dB}$$

Where 1000 is the number of ATC BSs; the 5 dB is the ATC BS antenna gain back-off at the horizon; 32.45 is the freespace propagation constant; 63.75 is the 20 Log (frequency) at 1550 MHz; and 34.6 is the weighted average of the 20 Log (distance) terms. The calculated value of -105.8 dB for the isolation is in agreement with the value of -105.1 dB used by the Commission in the analysis presented in Appendix C2 of the MSS ATC Order. Based on the results of this analysis, relaxation of the overhead ATC BS antenna gain as requested by MSV can be permitted without increasing the potential for interference to AMS(R)S receivers.

Operational Scenario 5: Higher EIRP and Overhead Antenna Gain Relaxation for Single ATC BS Off-Channel Interference to AMS(R)S Receivers

The analysis provided in Table 8 evaluates the MSV proposals for higher EIRP and overhead antenna gain relaxation for AMS(R)S receivers.

Table 8.

Parameter	Value	Source
ATC BS Out-of-Channel Emission Level	-57.9 dBW/MHz	47 C.F.R. § 25.253(b)
Carriers Per Sector (3 Carriers)	4.8 dB	MSS ATC Order Appendix C2
Sector Per ATC BS (3 Sector)	4.8 dB	MSS ATC Order Appendix C2
dBW to dBm Conversion	30	
1 MHz to 600 Hz Conversion	-32 dB	
Total ATC BS Out-of-Channel Emission Level	-50.3 dBm/600 Hz	
AMS(R)S Effective Antenna Gain	-10 dBi	MSS ATC Order Appendix C2
ATC BS Overhead Antenna Gain	-14 dBi	MSS ATC Order Appendix C2 and the MSV Waiver Request of 47 C.F.R. §25.253(e)
Propagation Loss (dB)	-85 dB	MSS ATC Order Appendix C2
Power Control	-5.2 dB	MSS ATC Order Appendix C2
Voice Activation	-4 dB	MSS ATC Order Appendix C2
Polarization	0 dB	MSS ATC Order Appendix C2
Total Losses	-118.2 dB	
Received Power	-168.5 dBm/600 Hz	
Interference Threshold	-156.5 dBm/600 Hz	
Available Margin	12 dB	

As shown in Table 8, the available margin is a 12 dB. Based on the conditions of this operational scenario, only a 12 dB increase in the EIRP can be supported instead of the 15 dB increase requested by MSV. The ATC BS antenna gain of -14 dBi is the combination of the 16 dBi mainbeam antenna gain permitted by the Commission's Rules and the 30 dB reduction in the overhead antenna gain that has been proposed by MSV. If the overhead antenna gain were reduced the ATC BS EIRP could be increased without increasing the potential for interference to AMS(R)S receivers.

Operational Scenario 6: Impact of Eliminating the Number of Carriers Per Sector for Multiple ATC BS Off-Channel Interference to AMS(R)S Receivers

The analysis provided in Table 9 evaluates the MSV proposal of eliminating the number of carriers per sector for AMS(R)S receivers.

Table 9.

Parameter	Value	Source
ATC BS Out-of-Channel Emission Level	-57.9 dBW/MHz	47 C.F.R. § 25.253(b)
Carriers Per Sector (3 Carriers)	4.8 dB	MSS ATC Order Appendix C2
Sector Per ATC BS (1 Sector)	0 dB	MSS ATC Order Appendix C2
dBW to dBm Conversion	30	
1 MHz to 600 Hz Conversion	-32 dB	
Total ATC BS Out-of-Channel Emission Level	-55.1 dBm/600 Hz	
AMS(R)S Effective Antenna Gain	0 dBi	MSS ATC Order Appendix C2
ATC BS Mainbeam Antenna Gain	16 dB	MSS ATC Order Appendix C2
Isolation for 1000 ATC BSs	-105 dB	MSS ATC Order Appendix C2
Power Control	-5.2 dB	MSS ATC Order Appendix C2
Voice Activation	-4 dB	MSS ATC Order Appendix C2
Polarization	-1.4 dB	MSS ATC Order Appendix C2
Total Losses	-99.6 dB	
Received Power	-154.7 dBm/600 Hz	
Interference Threshold	-156.5 dBm/600 Hz	
Available Margin	-1.8 dB	

As shown in Table 9, the available margin is a -1.8 dB, which indicates that additional attenuation is necessary for a compatible sharing arrangement. However, the available margin is exceeded by less than 2 dB therefore, the potential for interference to AMS(R)S receivers is believed to be minimal. Based on the conditions of this operational scenario, the out-of-channel emission level of the ATC BSs cannot be increased. Although MSV does not request an increase in the out-of-channel emission level, an important point must be made regarding the relationship between the out-of-channel emission level and the number of carriers per sector. The Commission's Rules permit a maximum of three carriers per ATC BS sector. The analysis presented in Table 9 uses the maximum number of permitted carriers per sector. As shown in Table 9, in order to maintain the current margin the combination of the out-of-channel emission level and 10 Log (3 carriers) must be -53 dBW/MHz. Thus any increase in the number of carriers per sector would require that the out-of-channel emission level for each channel be reduced by a factor of 10 Log (number of carriers) relative to -53 dBW/MHz. For example, if 10 carriers per sector are employed, the out-of-channel emission level for each of the ten carriers would have to be reduced to -63 dBW/MHz to prevent out-of-channel interference to AMS(R)S receivers.

Operational Scenario 7: Impact of Eliminating the Number of Carriers Per Sector for Single ATC BS Off-Channel Interference to GMDSS Receivers

The analysis provided in Table 10 evaluates the MSV proposal for eliminating the number of carriers per sector for GMDSS receivers.

Table 10.

Parameter	Value	Source
ATC BS Out-of-Channel Emission Level	-57.9 dBW/MHz	47 C.F.R. § 25.253(b)
Carriers Per Sector (3 Carriers)	4.8 dB	MSS ATC Order Appendix C2
Sector Per ATC BS (1 Sector)	0 dB	MSS ATC Order Appendix C2
MHz to Hz Conversion	-60 dB	
Total ATC BS Out-of-Channel Emission Level	-113.1 dBW/Hz	
GMDSS Effective Antenna Gain	7.8 dBi	MSS ATC Order Appendix C2
ATC BS Antenna Gain	16 dBi	
ATC BS Antenna Gain Back-Off	-3.6 dB	MSS ATC Order Appendix C2
Propagation Loss	-99.7 dB	Based on a 1.5 km required distance separation in 47 C.F.R. § 25.253(d)(5)
Power Control	-5.2 dB	MSS ATC Order Appendix C2
Voice Activation	-2 dB	MSS ATC Order Appendix C2
Polarization	-8 dB	MSS ATC Order Appendix C2
Total Losses	-94.7 dB	
Received Power	-207.8 dBW/Hz	
Interference Threshold	-209 dBW/Hz	
Available Margin	-1.2 dB	

As shown in Table 10, the available margin is a -1.2 dB, which indicates that additional attenuation is necessary for a compatible sharing arrangement. However, the available margin is exceeded by approximately 1 dB, therefore the potential for interference to GMDSS receivers is believed to be minimal. Based on the conditions of this operational scenario, the out-of-channel emission level of the ATC BSs cannot be increased. As discussed in Operational Scenario 6, there is a relationship between the out-of-channel emission level and the number of carriers per sector. The Commission's Rules permit a maximum of three carriers per ATC BS sector. The analysis presented in Table 10 uses the maximum number of permitted carriers per sector. As shown in Table 10, in order to maintain the current margin, the combination of the out-of-channel emission level and 10 Log (3 carriers) must be -53 dBW/MHz. Thus, any increase in the number of carriers per sector would require that the out-of-channel emission level for each channel be reduced by a factor of 10 Log (number of carriers) relative to -53 dBW/MHz. For example, if 10 carriers per sector are employed, the out-of-channel emission level for each of the ten carriers would have to be reduced to -63 dBW/MHz to prevent out-of-channel interference to GMDSS receivers.

ATC BS Emission Limits in the 1559-1610 MHz Band

The MSV license application states that in the 1559-1610 MHz radionavigation satellite service band, ATC BSs will not exceed an EIRP of -100 dBW/MHz for wideband emissions. For narrowband emissions (discrete emissions of less than 700 Hz), ATC BSs will not exceed an EIRP in the 1559-1610 MHz band of -100 dBW.[15] The

15. MSV License Application at 22.

Commission's Rules for ATC BSs require that GSM architecture which employs TDMA be used. However, as discussed earlier in this document, the MSV license application requests that they also be permitted to employ CDMA (2000cdma or W-CDMA) in addition to TDMA. The wideband and narrowband emission levels in the 1559-1610 MHz band are independent of the access scheme employed. Therefore, ATC BSs that employ CDMA would also have to comply with the EIRP limits of -100 dBW/MHz (wideband emissions) and -110 dBW (narrowband emissions) in the 1559-1610 MHz band.

ASSESSMENT OF MSV ATC MT WAIVER REQUESTS

The two MSV waiver requests for the ATC MTs that could potentially impact AMS(R)S and GMDSS operations are: 1) the use of half-rate vo-coders; and 2) the increased terrestrial reuse of co-channel frequencies and unlimited reuse of non-co-channel frequencies.

Assessment of Potential Interference to Inmarsat Satellite Receivers that Support AMS(R)S and GMDSS Operations Based on MSV ATC MT Waiver Requests

The MSV MTs will transmit in the 1626.5-1660.5 MHz to communicate with their satellite. Since METs used to support AMS(R)S and GMDSS operations will also transmit in this frequency band to communicate with Inmarsat satellite receivers, therefore the MSV waiver requests for the MTs must be evaluated.

In Appendix C2 of the MSS ATC Order, the Commission preformed an analysis that assessed the potential of interference to Inmarsat satellite receivers from ATC MTs.[16] The analysis results presented in Table 2.1.1.A (adjacent band) and Table 2.1.1.C (adjacent beam) of Appendix C2 assesses potential interference to Inmarsat 3 and 4 satellite receivers. The analysis results indicate that compared to a $\Delta T/T$ of 6%, the operation of ATC MTs resulted in insignificant values of $\Delta T/T$. For the adjacent band analysis, the $\Delta T/T$ for the Inmarsat 3 and 4 satellite receivers was 0.001%. For the adjacent beam analysis, the $\Delta T/T$ values were 0.05% (Inmarsat 3) and 0.7% (Inmarsat 4).

In the analysis, the Commission included a 3.5 dB vo-coder factor. However, in the GSM architecture a half-rate vo-coder operates at 4.75 kbps and a full rate operates at 13 kbps. Switching a MT from full rate to half rate provides 10 Log (13/4.75) = 4.4 dB of transmitter power reduction. The reduced vo-coder rate will only be used when the MT is operating at power levels near the maximum output level. Therefore, the proposed use of a half-rate vo-coder will not significantly change the vo-coder factor. However, the loss in power associated with the vo-coder factor was used inadvertently in the link budget of the MSS ATC Order. The ATC MT was determined to be operating under conditions that resulted in a 20 dB back-off in power control and as such the vo-coder rate reduction would not be invoked. The MSV license application indicates that the ATC MTs will have an average antenna gain of -4 dBi or less compared to the 0 dBi used

16. MSS ATC Order Appendix C2 at Section 2.1.1.

in the Commission's analysis.[17] MSV claims that this will increase the ATC co-channel reuse by a factor 2.5. This -4 dBi basically is nullified by the inadvertent use of the 3.5 dB for the vo-coder factor in the Commission's link budget. Thus, the computed ΔT/T values are correct and the increased co-channel reuse factor is not appropriate.

In Appendix H of the MSV license application, the -4 dBi is described as an average antenna gain in the direction of the Inmarsat satellite. The MT antenna gain in the direction of the Inmarsat satellite will be highly dependent on the orientation of the MT. It is unclear how the compliance measurements of MTs to verify this average antenna gain would be performed.

The increased terrestrial reuse of co-channel frequencies and unlimited reuse of non-co-channel frequencies does not have an impact on the analysis results assessing potential interference to Inmarsat satellite receivers.

Out-of-Band Emissions of Satellite-ATC MT Employing Link Margin Booster

In Appendix A of the MSV license application an overview of the integrated satellite-ATC terminal design is given.[18] As part of this overview, the description of a "link margin booster" is provided. The link margin booster may be placed on a window sill to enable satellite communications from inside a building. The link margin booster circuitry includes a power amplifier (PA) that is capable of providing 3 dBW to the antenna. It appears from the description that the booster could also be used for the ATC MTs which have a maximum permitted EIRP of 0 dBW. The ATC system (BS and MTs) are required to have power control so the increase in in-band power should be controlled. A possible concern is the effect that the PA will have on the out-of-band emissions. If the PA is driven into saturation or operates in a non-linear manner, this could result in a significant increase in the out-of-band emission levels (e.g., in the 1559-1605 MHz band). As part of the compliance measurements of the MSV satellite/ATC MT, it is recommended that measurements of the MT be performed with and without the link margin booster to ensure that the out-of-band emission levels in the 1559-1605 MHz band do not exceed the EIRP limit of -70 dBW/MHz for the satellite MTs and -90 dBW/MHz (wideband emissions) and -100 dBW (narrowband emissions) for the ATC MTs.

ATC MT Emission Limits in the 1559-1610 MHz Band

The MSV license application states that in the 1559-1605 MHz radionavigation satellite service band that ATC MTs will not exceed an EIRP of -90 dBW/MHz for wideband emissions. For all new ATC MTs MSV placed in service five years after MSV commences commercial operations, the wideband emission EIRP limit in the 1559-1605 MHz band will be reduced by 5 dB to -95 dBW/MHz. For narrowband emissions

17. MSV License Application at 18.

18. MSV License Application Appendix A at 1.

(discrete emissions of less than 700 Hz), ATC BSs will not exceed an EIRP in the 1559-1605 MHz band of -100 dBW.[19] The narrowband limit is reduced to -105 for all new ATC MTs placed into service five years after commercial service begins. The Commission's Rules for ATC MTs require that GSM architecture which employs TDMA be used. However, as discussed earlier in this document, the MSV license application requests that they also be permitted to employ CDMA (2000cdma or W-CDMA) in addition to TDMA. The wideband and narrowband emission levels in the 1559-1605 MHz band are independent of the access scheme employed. Therefore, ATC MTs that employ CDMA would also have to comply with the EIRP limits of -90 dBW/MHz and -95 dBW/MHz (wideband emissions) and -100 dBW and -105 dBW (narrowband emissions) in the 1559-1605 MHz band.

CONCLUSIONS

In order to protect AMS(R)S receivers, the increase in the ATC BS sector EIRP must be limited to 12 dB.

The relaxation of the overhead antenna gain requested by MSV for ATC BSs can be permitted without impacting the operation of AMS(R)S receivers.

To protect GMDSS receivers, ATC BSs operating at the 12 dB higher EIRP level must satisfy one of the following: 1) be located at least 2.5 km from the boundaries of all navigable waterways; or 2) not exceed a PFD level of –62.6 dBW/m^2/sector at the boundaries of all navigable waterways.

To ensure compatibility with AMS(R)S and GMDSS receivers, the out-of-channel emission level of the ATC BSs must be limited to –53 dBW/MHz for a sector. This emission level is based on three carriers per sector. If additional carriers per sector are employed, the out-of-channel emission level for each carrier must be reduced by a factor of 10 Log (number of carriers) relative to -53 dBW/MHz.

ATC BSs operating at the 12 dB higher EIRP level must still comply with the EIRP limits of -100 dBW/MHz (wideband emissions) and -110 dBW (narrowband emissions) in the 1559-1610 MHz band that are specified in the MSV license application.

The EIRP limits of -100 dBW/MHz (wideband emissions) and -110 dBW (narrowband emissions) in the 1559-1610 MHz band that are specified in the MSV license application would apply to ATC BSs that employ either TDMA or CDMA access schemes.

The EIRP limits of -90 dBW/MHz (wideband emissions) and -100 dBW (narrowband emissions) in the 1559-1605 MHz band that are specified in the MSV license application would apply to ATC MTs that employ either TDMA or CDMA access schemes.

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19. MSV License Application at 22.

As part of the compliance measurements of the MSV satellite/ATC MT, it is recommended that measurements of the MT be performed with and without the link margin booster to ensure that the out-of-band emission levels in the 1559-1605 MHz band do not exceed -70 dBW/MHz for satellite MTs and -90 dBW/MHz (wideband emissions) and -100 dBW (narrowband emissions) for ATC MTs.

NTIA does not oppose MSV's request that, with respect to frequencies that are not shared with any other visible satellite systems (e.g., non-co-channel frequencies), there can be unlimited reuse of its satellite spectrum for ATC operations. The only exception to this additional flexibility, however, is that if certain frequencies used by MSV change from being non-co-channel frequencies to being shared frequencies, as a result of changes in the international frequency coordination, MSV would be required, with respect to those shared frequencies, to comply with the applicable rules. Moreover, MSV would never be permitted to operate co-channel in the same geographic area with any AMS(R)S and GMDSS operations of another satellite system.