Table 5.1-3. Out-of-Band Interference from Point-to-Point or Point-to-Multipoint WCS Systems in Scenario 2

	P-P (1)	P-P (2)	P-MP (1)	P-MP (2)	P-MP (3)	Mobile (1)	Mobile (2)
Transmit Power (dBW)	-43.0	-43.0	-43.0	-43.0	-43.0	-43.0	-43.0
Transmit Antenna Gain (dBi)	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Transmit EIRP (dBW)	-18.0	-18.0	-18.0	-18.0	-18.0	-18.0	-18.0
Path Distance (km)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Path Loss (dB)	79.7	79.7	79.7	79.7	79.7	79.7	79.7
Receive Antenna Gain (dBi)	33.0	20.0	25.0	20.0	10.0	10.0	0.0
Interfering Signal Power (dBW)	-64.7	-77.7	-72.7	-77.7	-87.7	-87.7	-97.7
$C_{received}$ (dBW)	-59.8	-72.8	-61.7	-66.7	-76.7	-76.7	-86.7
C/I (dB)	**5.0**	**5.0**	**11.0**	**11.0**	**11.0**	**11.0**	**11.0**

From the analysis performed in this section, the required C/I for WCS systems can be determined. These results have shown that, in order for the WCS systems to operate in the expected environment (i.e., with other adjacent channel WCS systems operating in the same geographic area), the expected C/I values could be as low as 0 dB. These results will be used to assess the potential for out-of-band interference from Sirius Satellite Radio terrestrial repeaters into WCS systems.

5.2 Out-of-Band Interference from Sirius Satellite Radio Terrestrial Repeaters Into WCS Systems

The analysis of out-of-band interference from Sirius Satellite Radio terrestrial repeaters into WCS systems will be performed by calculating the C/I levels at the victim WCS receivers. These results will then be compared to the expected required C/I values determined in Section 5.1.

The potential for interference from the out-of-band transmissions of Sirius Satellite Radio terrestrial repeaters into WCS systems is evaluated for the same two scenarios that were considered in section 5.1 and illustrated in Figure 5.1-1. In this case, however, the transmitter on the tower is assumed to be the Sirius Satellite Radio terrestrial repeater instead of the WCS transmitter. For this analysis, the WCS receiver is assumed to be operating at a frequency of 2320 MHz, where the highest level of interference would occur. At frequencies further removed from the center frequency of the *Sirius Satellite Radio* terrestrial transmitter, the out-of-band power spectral density of the Sirius Satellite Radio emissions will be lower than that used in this analysis.

For both of the scenarios, the interfering signal power received from the transmissions of a Sirius Satellite Radio transmitter are calculated using Equation (3):

$$I_{received} = PSD_t + G_t - \text{Transmitter Losses} - \text{Path Loss} + G_r + BW_{factor} \quad \text{(dBW)} \quad (3)$$

where,

PSD_t is the transmitter spectral power density of the Sirius Satellite Radio transmitter at the band edge of the WCS allocation (i.e., 2320 MHz) (in dBW/MHz)

G_t is the Sirius Satellite Radio transmitter antenna gain in the direction of the WCS receiver (in dBi)

Transmitter Losses are the coupling and transmission line losses of the Sirius Satellite Radio transmitter (in dB)

Path Loss[5] is calculated as (32.44 + 20*log10(frequency(in MHz)*distance from Sirius Satellite Radio transmitter to WCS receiver(in km))

G_r is the WCS receiver antenna gain in the direction of the Sirius Satellite Radio transmitter (in dBi)

BW_{factor} is the difference between the WCS receiver bandwidth and one MHz and is calculated as 10*log10(BW_{WCS} / 1 MHz) (in dB). It is assumed that the WCS systems employ occupied bandwidths of 1 MHz or greater, as was assumed in section 5.1.

6. Results of Analysis for Out-of-Band Interference from Sirius Satellite Radio Terrestrial Repeaters to WCS Systems

6.1 Scenario 1

The resultant C/I levels from out-of-band interference from Sirius Satellite Radio terrestrial repeaters into the WCS systems for scenario 1, in which the WCS receiver is located at the base of the tower that houses the Sirius Satellite Radio transmitter, are given in Table 6.1-1. For this scenario, the WCS receiver is assumed to point near the horizon and the gain of the WCS

[5] This analysis assumes free space loss. The Hata-suburban model gives a propagation loss that is 30 dB higher for distances on the order of 20 km.

receiver for the point-to-point and the first two point-to-multipoint systems is calculated using Recommendation ITU-R F.699. For the third point-to-multipoint system and the two mobile systems, the antenna is assumed to be omnidirectional and the maximum antenna gain is used. The Sirius Satellite Radio transmitter is assumed to be operating with a tilt angle of -10° and the gain of the Sirius Satellite Radio antenna in the direction of the WCS receiver is calculated using Recommendation ITU-R F.1336 ("Reference Radiation Patterns of Omnidirectional and Other Antennas in Point-to-Multipoint Systems for Use in Sharing Studies" - also applicable to sectoral antennas). With the WCS receiver at the base of the Sirius Satellite Radio transmitter tower, the Sirius Satellite Radio transmit antenna gain in the direction of the WCS receiver is 7.9 dBi. For this analysis, the height of the Sirius Satellite Radio transmitter is assumed to be 10 meters.

Table 6.1-1. Out-of-Band Interference from Sirius Satellite Radio Terrestrial Repeaters to WCS Systems in Scenario 1

	P-P (1)	P-P (2)	P-MP (1)	P-MP (2)	P-MP (3)	Mobile (1)	Mobile (2)
Transmit Power (dBW)	-91.0	-91.0	-91.0	-91.0	-91.0	-91.0	-91.0
Transmission Loses (dB)	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Transmit Antenna Gain (dBi)	7.9	7.9	7.9	7.9	7.9	7.9	7.9
Transmit EIRP (dBW)	-85.1	-85.1	-85.1	-85.1	-85.1	-85.1	-85.1
Path Distance (km)	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Path Loss (dB)	59.7	59.7	59.7	59.7	59.7	59.7	59.7
Receive Antenna Gain (dBi)	-2.7	3.9	1.4	3.9	10.0	10.0	0.0
Interfering Signal Power (dBW)	-147.5	-141.0	-143.5	-141.0	-134.8	-134.8	-144.8
$C_{received}$ (dBW)	-59.8	-72.8	-61.7	-66.7	-76.7	-76.7	-86.7
C/I (dB)	**87.7**	**68.2**	**81.8**	**74.3**	**58.1**	**58.1**	**58.1**

Comparing these C/I levels to those in Table 5.1-2 shows that the C/I from the Sirius Satellite Radio terrestrial repeaters is 43.5 dB greater than those in the same scenario using the assumed point-to-point or point-to-multipoint WCS systems as the interfering systems.

As noted in Section 5.2, at frequencies less than 2320 MHz (i.e., further removed from the center frequency of the Sirius Satellite Radio terrestrial transmitter, the out-of-band power spectral density of the Sirius Satellite Radio emissions will be lower than that used in the above analysis. As shown in Figure 2-1, the modulated spectrum of the Sirius Satellite Radio emissions will roll-off past this frequency at about 2 dBW/MHz. If a frequency were chosen in the center of the WCS frequency band, 2312.5 MHz, there would be an additional 15 dB of spectrum roll-off. Taking this into account in the above analysis, the resultant C/I levels would be 58.5 dB greater than those in the same scenario using the assumed point-to-point or point-to-multipoint WCS systems as the interfering systems. For the upper WCS band (2345 - 2360 MHz), there would be an additional 20 dB of spectrum roll-off from the calculations in the above table. Taking this into account, the resultant C/I levels would be 63.5 dB greater than those in the same scenario using the assumed WCS systems as self-interferers.

6.2 Scenario 2

The resultant C/I levels into WCS Systems from the out-of-band emissions of Sirius Satellite Radio terrestrial repeaters in scenario 2, in which the WCS receiver is located directly in the mainbeam of the Sirius Satellite Radio transmitter antenna and the WCS antenna is directed at an azimuth and elevation such that the mainbeam of the receiver is pointing directly at the Sirius Satellite Radio transmitter, are given in Table 6.2-1. The distance between the Sirius Satellite Radio transmitter and the WCS receiver is assumed to be 100 meters.

Table 6.2-1. Out-of-Band Interference from Sirius Satellite Radio Terrestrial Repeaters to WCS Systems in Scenario 2

	P-P (1)	P-P (2)	P-MP (1)	P-MP (2)	P-MP (3)	Mobile (1)	Mobile (2)
Transmit Power (dBW)	-91.0	-91.0	-91.0	-91.0	-91.0	-91.0	-91.0
Transmission Loses (dB)	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Transmit Antenna Gain (dBi)	18.0	18.0	18.0	18.0	18.0	18.0	18.0
Transmit EIRP (dBW)	-75.0	-75.0	-75.0	-75.0	-75.0	-75.0	-75.0
Path Distance (km)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Path Loss (dB)	79.7	79.7	79.7	79.7	79.7	79.7	79.7
Receive Antenna Gain (dBi)	33.0	20.0	25.0	20.0	10.0	10.0	0.0
Interfering Signal Power (dBW)	-121.7	-134.7	-129.7	-134.7	-144.7	-144.7	-154.7
$C_{received}$ (dBW)	-59.8	-72.8	-61.7	-66.7	-76.7	-76.7	-86.7
C/I (dB)	**62.0**	**62.0**	**68.0**	**68.0**	**68.0**	**68.0**	**68.0**

Comparing these C/I levels to those in Table 5.1-3 shows that the C/I from the Sirius Satellite Radio terrestrial repeaters is 57.0 dB greater than those in the same scenario using the assumed point-to-point or point-to-multipoint WCS systems as the interfering systems.

As noted in Section 5.2, at frequencies less than 2320 MHz (i.e., further removed from the center frequency of the Sirius Satellite Radio terrestrial transmitter, the out-of-band power spectral density of the Sirius Satellite Radio emissions will be lower than that used in the above analysis. As shown in Figure 2-1, the modulated spectrum of the Sirius Satellite Radio emissions will roll-off past this frequency at about 2 dBW/MHz. If a frequency were chosen in the center of the WCS frequency band, 2312.5 MHz, there would be an additional 15 dB of spectrum roll-off. Taking this into account in the above analysis, the resultant C/I levels would be 72.0 dB greater than those in the same scenario using the assumed point-to-point or point-to-multipoint WCS systems as the interfering systems. For the upper WCS band (2345 - 2360 MHz), there would be an additional 20 dB of spectrum roll-off from the calculations in the above table. Taking this into account, the resultant C/I levels would be 77.0 dB greater than those in the same scenario using the assumed WCS systems as the interfering systems.

7. Summary and Conclusions

The results of the analyses performed for this report indicate that the maximum out-of-band emissions from Sirius Satellite Radio terrestrial repeaters into WCS systems are far less than WCS adjacent band interference requirements and, therefore, should not cause any harmful interference. The analysis has modeled the WCS systems as accurately as possible given the limited information available (The operating parameters for the WCS systems are to be developed by the WCS licensees and, as such, specific operating parameters for these systems are unknown.) The analyses have calculated the C/I levels expected for the WCS systems due to the out-of-band emissions from WCS systems operating in adjacent bands. The analyses have also calculated the C/I levels expected for the WCS systems due to the out-of-band emissions from Sirius Satellite Radio terrestrial repeaters.

The analyses were performed for two different scenarios. In the first, the victim WCS receiver is located at the base of the tower that houses either the interfering WCS transmitter or the Sirius Satellite Radio transmitter. In the second scenario, the victim WCS receiver is located in the mainbeam of the interfering WCS transmitter or Sirius Satellite Radio transmitter. In this second scenario, the WCS receiver antenna is directed at an azimuth and elevation so that it points directly at the interfering WCS transmitter or Sirius

Satellite Radio transmitter. The results of the analysis for scenario 1 show that the resultant C/I levels due to the out-of-band emissions of Sirius Satellite Radio terrestrial repeaters are 43.5 dB higher than those due to the out-of-band emissions of an interfering WCS system. For scenario 2, the results show that the resultant C/I levels due to the out-of-band emissions of Sirius Satellite Radio terrestrial repeaters are 57.0 dB higher than those due to the out-of-band emissions of an interfering WCS system.

Since the WCS systems will need to be designed to operate in an environment with the out-of-band emissions from other WCS systems and the impact of the out-of-band emissions from Sirius Satellite Radio terrestrial repeaters into the WCS systems is much less than that of the out-of-band emissions of other WCS systems, it can be concluded that there will be no harmful interference into the WCS systems from the out-of-band emissions of Sirius Satellite Radio terrestrial repeaters.

Further, it should be noted that the analysis was performed assuming that the WCS receivers were at a center frequency of 2320 MHz. The out-of-band signal power density will roll-off as it is further removed from the Sirius Satellite Radio carrier center frequency and, therefore, will be lower at frequencies less than 2320 MHz. If a frequency at the center of the lower WCS band (2312.5 MHz) were used and the additional spectrum roll-off of the Sirius Satellite Radio emitted spectrum were taken into account, the resultant C/I levels would be 58.5 dB higher for scenario 1 and 72 dB higher for scenario 2 compared to those in the same scenarios using the assumed point-to-point or point-to-multipoint WCS systems as the interfering systems. In the higher WCS band (2345 - 2360 MHz), the closest band edge to the Sirius Satellite Radio carrier center frequency will be further removed than in this analysis and the interfering transmitted power spectral density will be lower. If the spectrum roll-off is taken into account, the resultant C/I levels would be 72.0 dB higher for scenario 1 and 77.0 dB higher for scenario 2 compared to those in the same scenarios using the assumed point-to-point or point-to-multipoint WCS systems as the interfering systems.

EXHIBIT 2
Assessment of Interference Potential from Sirius Terrestrial Transmitters into MDS, MMDS, and ITFS Systems in Frequency Bands Near 2 GHz

Assessment of Interference Potential from Sirius Satellite Radio Terrestrial Transmitters into MMDS, MDS and ITFS Systems in Frequency Bands near 2 GHz

1. Introduction

The Multichannel Multipoint Distribution Service (MMDS), Multipoint Distribution Service (MDS) and Instructional Television Fixed Service (ITFS) operate in the 2150 - 2162 MHz and 2500 - 2686 MHz frequency bands in the United States. This report will address the potential for interference from the out-of-band transmissions of Sirius Satellite Radio terrestrial transmitters into MMDS, MDS and ITFS stations (hereafter referred to as MDS stations for convenience) operating in these nearby bands in two interference scenarios, both of which produce higher levels of interference than would be experienced in normal practice. The report will model these systems as accurately as possible given the information available and assess the impact of interference into the receivers that may be used for MDS. Additionally, this report will address potential in-band interference to the broadband receivers that are used by some MDS stations that encompass the entire 2.15 - 2.69 GHz range and not just the two allocated frequency bands.

2. Parameters for MMDS, MDS and ITFS Systems

The parameters used in this analysis are based on equipment parameters of MDS products offered by California Amplifier.[1] These parameters are assumed to be typical of MDS systems that operate in these frequency bands. Table 2-1 gives the relevant parameters for MDS systems for this analysis.

[1] Equipment specifications found at California Amplifier web site (http://calamp.com).

Table 2-1. Parameters of MMDS, MDS and ITFS Systems

	Digital	Analog
MDS Transmit EIRP (dBW)	23.0	29.0
MDS Transmitter Distance from Receiver (miles)	40.0	40.0
MDS Receive Antenna Gain (dBi)	24.0	24.0
Antenna Front to Back (Gain) Ratio (dB)	21.0	21.0
Bandwidth (MHz)	5.0	4.2
Industry Recommended C/I (dB)	27.0	45.0

Additional parameters for the MDS stations used in this analysis are taken from the Petition for Expedited Reconsideration of Report and Order (FCC 97-50) filed by the Wireless Cable Association International, Inc. (WCA). WCA is the principal trade association of the wireless cable industry. Its membership includes virtually every wireless cable operator in the United States, the licensees of many of the MDS stations and ITFS stations that lease transmission capacity to wireless cable operators, producers of video programming and manufacturers of wireless cable transmission and reception equipment. The WCA petition addresses the interference potential from Wireless Communications Systems (WCS) to the operations of MDS and ITFS systems throughout the United States. The parameters used in the analyses presented in that petition regarding the overload of the MDS block converters are also used in this analysis.

Due to the nature of the MMDS, MDS and ITFS, which encompass frequencies from 2.15 GHz to 2.69 GHz, the receiving devices, antennas, and block converters deployed to date tend to be broadband in nature. As such, the frequency selectivity of some of this current equipment is somewhat limited, and the WCA petition proceeds to calculate the possible interference from the WCS signals (within the WCS allocated bandwidth) that might cause overload of the wideband front ends of the MDS receivers. The petition from the WCA states that "it was generally agreed within the subcommittee, which included three of the major manufacturers of block downconverters, that the signal power level at which overload of the block downconverter occurs, the 1 dB compression point of the input stage, is -6 dBm". The WCA analysis also assumed that the MDS station would be employing a 24 dBi antenna to receive an acceptable MDS signal (same as the antenna gain given in Table 2-1).

It is useful to compare the MDS receiver front-end compression point as provided by WCA (-6 dBm) to the assumed operating signal level as derived from Table 2-1 above. For the digital MDS system in Table 2-1 the path loss corresponding to the 40 mile range is about 137 dB.[2] This gives a received signal power of –90 dBW (or –60 dBm). For the analog MDS system in Table 2-1, the corresponding received signal power is –84 dBW (or –54 dBm). The difference between the 1 dB compression point and the assumed operating signal level is therefore 54 dB for the digital case and 48 dB for the analog case, which is a rather high dynamic range. This would reinforce the assumption that the assumed operating signal levels in Table 2-1 are likely to be minimum operating power levels in the MDS system, and therefore the analysis presented here corresponds to the highest level of interference that is generally expected in the MDS receivers.

3. Characteristics of Sirius Satellite Radio Terrestrial Repeaters

The characteristics for the Sirius Satellite Radio terrestrial repeaters in the highest power configuration are given in Table 3-1.

Table 3-1. Characteristics of Sirius Satellite Radio Terrestrial Repeaters (Highest Power Configuration)

Maximum Transmitter Output Power (Watts)	1000.0 (See Note 1)
Maximum Transmitter Output Power (dBW)	30.0
Coupling Losses (dB)	0.5
Transmission Line Losses (dB)	1.5
Antenna Boresight Gain (dBi)	18.0
Maximum E.I.R.P. (dBW)	46.0
Antenna Type	Sectoral - 120° half-power beamwidth
Height above ground	variable
Azimuth	variable
Tilt Angle	variable
Center Frequency (MHz)	2326.25
Bandwidth (MHz)	4.012

Note 1: Output power of 1000 Watts, as shown in this table, represents the highest power configuration of the Sirius Satellite Radio terrestrial repeaters.

The out-of-band emissions for the Sirius Satellite Radio terrestrial repeaters are specified to be (75 + 10 log(p)) dB (where p is the EIRP in Watts) less than the transmitter EIRP and are specified in a 1 MHz measurement bandwidth. These out-of-band emissions limits were adopted by the SDARS providers and are significantly more stringent than the emission limits required by the FCC's normal rules. The maximum EIRP spectral density transmitted out-of-band by the Sirius Satellite Radio terrestrial repeaters is, therefore, 46.0 - (75 + 46.0) = -75 dBW. Using the characteristics in Table

[2] Assuming free space path loss. Actual pathloss may be more than freespace.

3-1, the resultant transmitter power spectral density to achieve a maximum EIRP spectral density of -75 dBW in 1 MHz at the band edges (i.e., 2320 MHz and 2332.5 MHz) is equal to -91.0 dBW/1 MHz (-91.0 dBW/MHz - 0.5 dB - 1.5 dB + 18.0 dB = -75 dBW/MHz). In reality, the out-of-band signal power density will roll-off as it is further removed from the Sirius Satellite Radio carrier center frequency and therefore will be lower at frequencies less than 2320 MHz and at frequencies greater than 2332.5 MHz. The modulated spectrum of Sirius Satellite Radio emissions will roll-off out-of-band as indicated by the typical data provided in Figure 3-1.

For the higher MDS band (2500 - 2686 MHz), the closest frequency to the Sirius Satellite Radio band edge is 167.5 MHz away. For the lower MDS band (2150 - 2162 MHz), the closest frequency to the Sirius band edge is 158 MHz away. At the Sirius Satellite Radio band edges (i.e., 2320 MHz and 2332.5 MHz), the modulated spectrum of Sirius emissions is about 60 dB below the peak signal. Using the roll-off characteristics from Figure 3-1, the resultant Sirius out-of-band emissions at the closest MDS band edge will be an additional 20 dB lower than the peak signal. The measured spectrum plot in Figure 3-1 does not extend to the MDS frequency bands, so it is assumed that the roll-off levels out at frequencies beyond those shown in the plot. For the purposes of this analysis, a Sirius Satellite Radio transmitter power spectral density of -111 dBW/MHz will be used.[3]

[3] This corresponds to an EIRP spectral density of –95 dBW / MHz worse case.

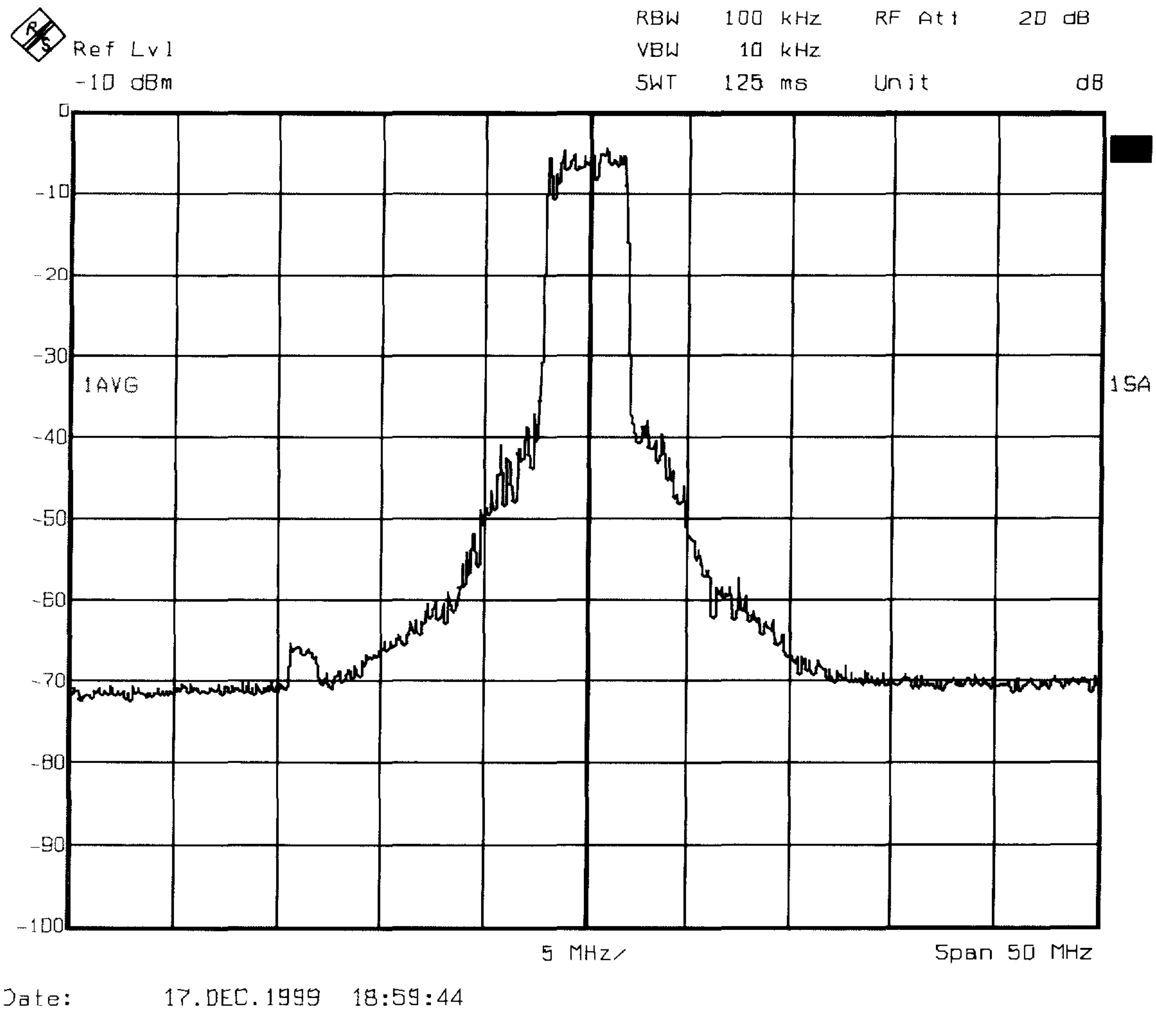

Figure 3-1. Example of the Spectrum Roll-Off of the Out-of-Band Emissions of the Sirius Satellite Radio Terrestrial Repeaters

4. Description of Analyses

The carrier to interference power (C/I) ratios at the MDS receivers will be analyzed in two different interference scenarios, both of which produce higher levels of interference than would be experienced in normal practice. In the first scenario, the MDS receiver is located at the base of the tower that houses the Sirius Satellite Radio terrestrial repeater. In the second scenario, the MDS receiver will be located such that it is in the mainbeam of the Sirius Satellite Radio transmitter antenna and the MDS receiver antenna is directed such that it receives the interfering signal through its mainbeam. In both of these scenarios, the C/I ratios will be calculated for several distances between the Sirius Satellite Radio transmitter and MDS receiver. Additionally, the distance necessary to meet the required C/I levels given in Table 2-1 will be calculated. The analysis will be performed using the lower MDS band edge (2162 MHz) since it is closer to the center frequency of the Sirius Satellite Radio transmitted signal than the higher MDS band edge (2500 MHz). The carrier power is determined from equation (1) and the interfering signal power is determined from equation (2).

$$C = EIRP_{MDS} - \text{Path Loss} + G_{r,MDS} \quad (dBW) \qquad (1)$$

where,

$EIRP_{MDS}$ is the transmitted EIRP of the MDS system (in dBW)
Path Loss[4] is calculated as (32.44 + 20*log10(frequency(in MHz)*distance from MDS transmitter to MDS receiver(in km)))
$G_{r,MDS}$ is the MDS receiver antenna gain (in dBi)

$$I = EIRP_{CD} - \text{Path Loss} + G_{r,MDS} + BW_{factor} \quad (dBW) \qquad (2)$$

where,

$EIRP_{CD}$ is the transmitted EIRP power density of the Sirius Satellite Radio terrestrial repeater (in dBW/MHz)
Path Loss[4] is calculated as (32.44 + 20*log10(frequency(in MHz)*distance from Sirius Satellite Radio terrestrial repeater to MDS receiver(in km)))
$G_{r,MDS}$ is the MDS receiver antenna gain in the direction of the Sirius Satellite Radio terrestrial repeater (in dBi)
BW_{factor} is the difference between the MDS receiver bandwidth and the one MHz reference bandwidth of the Sirius Satellite Radio out-of-band emission and is calculated as 10*log10(BW_{MDS}/1 MHz) (in dB)

5. Results of Analyses

5.1 Calculation of C/I Ratios

[4] This analysis assumes free space loss.

Table 5.1-1 gives the results of the analysis for the first scenario in which the MDS receiver is located at the base of the tower that houses the Sirius Satellite Radio terrestrial repeater. In this scenario, the MDS receive antenna is assumed to be directed near the horizon and the receive antenna gain in the direction of the Sirius Satellite Radio transmitter is 3 dB (From Table 2-1, maximum antenna gain (24 dBi) - front to back ratio (21 dB)). The Sirius Satellite Radio transmitter is assumed to be operating with a tilt angle of -10° and the gain in the direction of the WCS receiver is calculated using Recommendation ITU-R F.1336 ("Reference Radiation Patterns of Omnidirectional and Other Antennas in Point-to-Multipoint Systems for Use in Sharing Studies" - also applicable to sectoral antennas) as 7.9 dB. The example calculation is for a Sirius Satellite Radio transmitter height of 10 meters.

Table 5.1-1. C/I Ratios for Scenario 1

	Digital MDS System	Analog MDS System
MDS EIRP (dBW)	23.0	29.0
Distance from MDS Xmtr to MDS Rcvr (km)	67.0	67.0
Frequency (MHz)	2162	2162
Path Loss (dB)	135.6	135.6
MDS Receive Antenna Gain (dBi)	24.0	24.0
C (dBW)	-88.6	-82.6
Sirius Satellite Radio Transmit Power Density (dBW/MHz)	-111.0	-111.0
Sirius Satellite Radio Transmitter Losses (dB)	2.0	2.0
Sirius Satellite Radio Transmit Antenna Gain (dBi)	7.9	7.9
Sirius Satellite Radio Transmit EIRP Density (dBW/MHz)	-105.1	-105.1
Bandwidth of MDS Receiver (MHz)	5.0	4.2
Distance from Sirius Satellite Radio Transmitter to MDS Receiver (meters)	10	10
Path Loss (dB)	59.1	59.1
MDS Receive Antenna Gain (dBi)	3.0	3.0
I (dBW)	-154.2	-155.0
C/I (dB)	**65.6**	**72.4**

From Table 2-1, the required C/I ratio for digital MDS systems is 27 dB and the required C/I ratio for analog MDS systems is 45 dB. For a Sirius Satellite Radio terrestrial transmitter at a height of 10 meters, both of these requirements are easily met (by 38.6 dB and 27.4 dB for digital and analog, respectively). Very few, if any, Sirius Satellite Radio transmitters are expected to be operated from towers at this low height. The necessary distances between the Sirius Satellite Radio transmitter and MDS receiver in this scenario to meet the C/I requirements for digital and analog MDS receivers are 0.1 and 0.4 meters, respectively. These results indicate that there is no harmful out-of-band interference in this scenario.

Table 5.1-2 gives the C/I values for the second scenario in which the MDS receiver is located in the mainbeam of the Sirius Satellite Radio transmit antenna and the MDS antenna receives the out-of-band interfering signal from the Sirius Satellite Radio transmitter through its mainbeam.

Table 5.1-2. C/I Ratios for Scenario 2

	Digital MDS System	Analog MDS System
MDS EIRP (dBW)	23.0	29.0
Distance from MDS Xmtr to MDS Rcvr (km)	67.0	67.0
Frequency (MHz)	2162	2162
Path Loss (dB)	135.6	135.6
MDS Receive Antenna Gain (dBi)	24.0	24.0
C (dBW)	-88.6	-82.6
Sirius Satellite Radio Transmit Power Density (dBW/MHz)	-111.0	-111.0
Sirius Satellite Radio Transmitter Losses (dB)	2.0	2.0
Sirius Satellite Radio Transmit Antenna Gain (dBi)	18.0	18.0
Sirius Satellite Radio Transmit EIRP Density (dBW/MHz)	-95.0	-95.0
Bandwidth of MDS Receiver (MHz)	5.0	4.2
Distance from Sirius Satellite Radio Transmitter to MDS Receiver (meters)	100	100
Path Loss (dB)	79.1	79.1
MDS Receive Antenna Gain (dBi)	24.0	24.0
I (dBW)	-143.1	-143.9
C/I (dB)	**54.5**	**61.3**

These results show that, at a distance of 100 meters, the C/I ratio for digital and analog receivers is easily met (by 27.5 dB and 16.3 dB, respectively). The necessary distances between the Sirius Satellite Radio transmitter and MDS receiver in this scenario to meet the C/I requirements for digital and analog MDS receivers are 4.2 and 15.3 meters, respectively. Given these short distances and the low probability that the Sirius Satellite Radio transmitter antenna and MDS receiver antenna would be in this mainbeam-to-mainbeam alignment, these results indicate that there is no harmful out-of-band interference in this scenario.

5.2 Protection of MDS Stations from In-Band Emissions from Sirius Satellite Radio Terrestrial Repeaters

If the MDS receiver were to receive signals from across the entire band (i.e., 2150 -2700 MHz), the potential for receiving interfering signals in the Sirius Satellite Radio terrestrial repeater transmission band exists. In this case, the Sirius Satellite Radio signal level, within the Sirius Satellite Radio allocated bandwidth, would be likely to cause overload of the MDS downconverters. The easiest way to overcome this problem in these wideband receivers is to use some sort of filtering across the Sirius Satellite Radio transmit band. It should be noted that at least one company (California Amplifier) has offered products that filter out signals from the WCS and PCS bands since 1997.

Table 5.2-1 shows the received signal power at the MDS receiver assuming that it is receiving signals in the Sirius Satellite Radio terrestrial repeater band. The calculations are done using Scenario 2 for four separation distances between the Sirius Satellite Radio terrestrial repeater and the MDS receiver. The resultant received signal powers are compared to an overload level of -36 dBW (-6 dBm).

Table 5.2-1. Comparison of Received Signal Powers in the Sirius Satellite Radio Terrestrial Repeater Band to MDS Overload Levels

Sirius Satellite Radio Xmit EIRP Density (dBW/MHz)	30.0	30.0	30.0	30.0
Bandwidth of Sirius Satellite Radio (MHz)	4.0	4.0	4.0	4.0
Transmitter Losses (dB)	2.0	2.0	2.0	2.0
Max Antenna Gain (dBi)	18.0	18.0	18.0	18.0
EIRP (dBW)	46.0	46.0	46.0	46.0
Distance (meters)	10.00	100.0	1000.0	2048.0
Frequency (MHz)	2326.25	2326.25	2326.25	2326.25
Path Loss (dB)	59.8	79.8	99.8	106.0
MMDS Rcvr Antenna Gain (dBi)	24.0	24.0	24.0	24.0
P at Input Stage (dBW)	10.2	-9.8	-29.8	-36.0
Overload Level (dBW)	-36.0	-36.0	-36.0	-36.0
Difference (dB)	46.2	26.2	6.2	0.0

These results indicate that if the MDS receiver is very broadband and receives signals in the Sirius Satellite Radio terrestrial repeater band, the overload level of the MDS receiver will be exceeded at distances less than

2048 meters when the MDS receiver is located in the mainbeam of the Sirius Satellite Radio terrestrial transmitter and with the MDS antenna pointed directly at the Sirius Satellite Radio terrestrial transmitter. In situations where this unlikely antenna alignment does not exist the required separation distance will be much less than 2048 meters. This overload possibility in such MDS receivers can be completely eliminated by a simple filter similar to the PCS image blocking filter that is already used in MMDS systems.

6. Further Considerations

6.1 Consideration of Two-Way MDS Systems

The analyses presented above only considered interference into one-way MDS systems. In two-way MDS systems, there would be transmissions between two MDS stations and not just from one to another. The analysis presented here addresses the potential interference from the out-of-band transmissions of Sirius Satellite Radio terrestrial transmitters into MDS stations in two interference scenarios, both of which produce higher levels of interference than would be experienced in normal practice. The results of these analyses can easily be applied to the two-way MDS situation.

For scenario 1, in which the MDS receiver is located at the base of the tower that houses the Sirius Satellite Radio terrestrial repeater, the situation would be the exact same for two-way MDS systems as for one-way MDS systems since the location of the MDS receiver is the primary factor in the level of out-of-band interference that is received. The analysis calculates a necessary separation distance between the Sirius Satellite Radio terrestrial transmitter and the MDS receiver.

For scenario 2, the MDS receiver is located such that it is in the mainbeam of the Sirius Satellite Radio transmitter antenna and the MDS receiver antenna is directed such that it receives the interference signal through its mainbeam. In the two-way MDS case, this MDS receiver would then be transmitting to another MDS receiver that is located closer to the Sirius Satellite Radio terrestrial transmitter, but has its antenna directed away from the transmitter. Thus, the interference would be coming into the backlobes of the MDS receiver antenna and the interference levels would be significantly less than those calculated for this scenario would. In fact, this second MDS receiver interference scenario would more closely resemble Scenario 1.

6.2 Impact of PCS on MDS

PCS base stations, which are much more widely deployed than Sirius Satellite Radio's planned terrestrial infrastructure, can cause significant interference to MDS services. The problem becomes more acute as service providers add more radio carriers (and therefore transmitter power) to meet the exploding demand for wireless service.

The MDS frequency band is 2150 to 2162 MHz and the MMDS band is 2500 to 2686 MHz. PCS base stations transmit between 1930 and 1990 MHz at EIRP levels up to 1640 watts. The basic interference mechanism is due to the PCS band potentially falling in the image frequency band of MMDS/MDS receivers. As an example, for a typical MMDS receiver (low side LO) IF output frequency of 222 to 408 MHz, the image frequency can be 1870 to 2056 MHz, encompassing the PCS band. The absence of significant filtering at the image frequency before the mixer can therefore lead to a susceptibility to PCS signals.

7. Summary and Conclusions

The results of the analyses performed for this report lead us to conclude that there is no harmful out-of-band interference problem caused by the emissions of the Sirius Satellite Radio terrestrial repeaters into MDS, MDS and ITFS stations. To meet the required C/I levels of the MDS receivers, the necessary separation distances are small. In the case where the MDS receiver is located at the base of the tower that houses the Sirius Satellite Radio terrestrial repeater, the necessary separation distance is less than 1 meter. For the case of the MDS receiver located in the mainbeam of the Sirius Satellite Radio terrestrial repeater antenna and the MDS antenna receiving the out-of-band interfering signal through its mainbeam, the necessary distance to meet the required C/I for digital MDS receivers is 4.2 meters. To meet the required C/I for analog receivers, the necessary distance is 15.3 meters. In addition to these small distances, the probability of the Sirius Satellite Radio transmit antenna and the MDS receive antenna being in this mainbeam-to-mainbeam alignment is very low. The calculations were performed assuming an out-of-band EIRP density of -75 dBW/MHz at the Sirius Satellite Radio band edge with an additional 20 dB due to spectrum roll-off at the MDS frequencies. It should be noted, however, that the filtering of the signal beyond the Sirius Satellite Radio band edge was not included in the analysis and this could result in even less out-of-band interference to the MDS systems.

With respect to in-band interference produced by Sirius Satellite Radio terrestrial repeaters, the interference received by the MDS receivers which receive across the entire range of frequencies from 2150 MHz to 2700 MHz may cause overload of the block downconverter unless the Sirius Satellite Radio terrestrial repeaters are located more than approximately 2000 meters away from the MDS receivers. This separation distance is required only when the MDS receiver is located in the mainbeam of the Sirius Satellite Radio terrestrial transmitter and with the MDS antenna pointed directly at the Sirius Satellite Radio terrestrial transmitter. In situations where this unlikely antenna alignment does not exist the required separation distance will be much less than 2000 meters. It should also be noted that this worst case interference condition would only occur within ±2.006 MHz of the frequency 2326.25 MHz. Filtering of the MDS receivers in this band would totally remove this interference possibility. It should be noted that at least one company has offered products that filter out signals from the WCS and PCS frequency bands since 1997.

These analyses have been performed assuming one-way MDS systems, but the results would be equally applicable to two-way MDS systems due to the nature of the analyses in which two interference scenarios that produce higher levels of interference than would be experienced in practice are performed.

EXHIBIT 3
Sirius's Suggested Revisions to 47 C.F.R. § 25.144(e), as Proposed in Appendix C of the *Further NPRM*

1. A new Section is proposed to be added to 25.144 to read as follows:

§ 25.144 Licensing provisions for the 2.3 GHz satellite digital audio radio service.

* * * * *

(e) Licensing of satellite DARS complementary terrestrial repeaters. Satellite DARS licensees may construct and operate terrestrial transmitters to retransmit **the same programming** ~~{signals received}~~ **transmitted** from their operating DARS satellite(s) on the exclusive frequency assignment of the licensee ~~{and for use of the same bandwidth as the satellite space station(s)}~~. Terrestrial gap-fillers shall not be used to originate programming ~~or transmit signals~~ other than that ~~{those received}~~ **transmitted** from the authorized DARS satellite. Nor shall terrestrial gap fillers be used to extend satellite DARS coverage outside of the satellite systems' authorized service area. Terrestrial gap-fillers may be implemented by a satellite DARS licensee ~~{only after}~~ **without** obtaining prior Commission authorization ~~{and the licensee demonstrates the following:}~~**, unless one of the following circumstances applies:**

(1) International coordination. Satellite DARS licensees ~~{must demonstrate that its repeating transmitter is located at a distance sufficiently away from the Canadian and Mexican borders or otherwise obtain prior coordination with adjacent country}~~ **shall obtain prior approval for repeating transmitter(s) that exceed the power levels and/or proximity restrictions specified in coordination agreements reached with Canada and Mexico for** co-frequency systems;

(2) Antenna structure clearance required. Satellite DARS licensees shall ~~{demonstrate that its}~~ **obtain prior approval for** repeating transmitter construction or alteration **that** will ~~{comply with}~~ **deviate from** the requirements of Section 17.4 of the Commission's Rules;

(3) Environmental. Satellite DARS licensees shall ~~{demonstrate that its}~~ **obtain prior approval for** repeating transmitter(s) ~~{comply with the Commission's Rules for}~~ **that will have significant** environmental effects as defined by Sections 1.1301 through 1.1319 of the Commission's Rules.

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EXHIBIT 4

Report on Measurements of SDARS Terrestrial Repeater Transmitters

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I. Introduction and Background

Sirius Satellite Radio Inc. (SSR) is building a system to provide Satellite Digital Audio Radio Service (SDARS) across the continental United States utilizing geosynchronous satellites. One hundred audio channels originate in a broadcast studio in New York City, and then are uplinked to three overhead satellites (only two at any given time). These satellites retransmit back to the earth at S-Band. The high elevation angles produced by the proposed orbit geometry, and the use of spatial, frequency and time diversity will provide high quality digital radio service nationwide.

Notwithstanding the overall high quality coverage, it remains true that, in some areas, such as dense urban cities, the satellite signals will need to be supplemented by terrestrial repeaters to provide ubiquitous coverage. These terrestrial repeaters will rebroadcast satellite-transmitted programming in areas where the satellite signals are blocked.

SSR anticipates a need for about 105 sites in approximately 46 cities initially. Additionally, several hundred low power radiators referred to as "Coverage Extenders" will be needed to overcome local blockage conditions (*e.g.*, tunnels, long underpasses, ravines, etc.). The terrestrial repeaters will operate with various antenna heights and power levels depending on the coverage requirements for each area. In major metropolitan areas, larger repeater configurations, including multiple repeaters, will be required to ensure uninterrupted coverage.

In order to demonstrate the feasibility of a terrestrial repeater network for SDARS, SSR selected two disparate locations to test operations of such a network. The two locations, San Francisco and Houston, permitted demonstrations in a variety of climatic and terrain ranges over which any terrestrial repeater network would need to operate in order to ensure seamless coverage. Additionally, these locations contain a number of incumbent, adjacent channel operations. As discussed in more detail below, SSR's experimental operations were able to establish the lack of significant adjacent channel interference when operating at typical proposed power levels.

This engineering report derives adjacent channel protection ratios and demonstrates that use of terrestrial repeaters to supplement SDARS will not cause out-of-band emission interference problems. In fact, the industry determined emission mask requirements are more stringent than current FCC guidelines and should readily protect adjacent band operations. An analysis of potential interference into adjacent band operations (e.g. WCS, MMDS/MDS, ITFS) is provided in two separate white papers.[1]

II. Technical Characteristics and Need for Terrestrial Repeaters

A. Satellite Coverage to Mobiles

In its modification application, SSR has requested authority to utilize geosynchronous satellites rather than the originally approved geostationary satellites.[2] Contrary to geostationary satellites, use of geosynchronous orbits will enable SSR to achieve high elevation angles in the northern half of the United States. This is extremely advantageous when compared to geostationary coverage due to the foliage and building density characteristics of the US Northeast and Northwest. The high elevation angles and diversity of two satellites minimize the

[1] *See* Exhibits 1 & 2 on interference analysis for WCS and MMDS/MDS from SDARS

[2] *See* Application of Satellite SSR, Inc. to Modify Authorization, filed December 11, 1998.

requirements for terrestrial repeaters. In general, the link quality will improve with elevation angle because of a general reduction in the number of objects intercepting the path, reduction of foliage attenuation and a reduction in multipath effects. The principal weaknesses of satellite footprint are likely to occur in major metropolitan areas where building heights and spacing shadow vehicles from satellite coverage.

1. Typical Station Operation

Typical operation will involve transmissions from multiple SSR spacecraft. Two such signals will be transmitting at any time, in 4 MHz blocks at either end of licensed 12.5 MHz bandwidth. In most areas, a customer will be in line of sight to one such satellite, and will receive the satellite DARS transmission directly from space.

In cases where both satellites are blocked, the user receiver will utilize the middle 4 MHz of the licensed bandwidth. There, terrestrial signals, containing 100 audio channels, will be retransmitted locally on the terrestrial repeater. The retransmission will employ Coded Orthogonal Frequency Division Modulation (COFDM) at each terrestrial site. COFDM is characterized by transmitting the signal on a large number of carriers (frequency division multiplexing) and thereby allowing each carrier to transport only a moderate bit rate.

2. Effects of Urban Environments

Given the satellite elevation angles to be utilized by SSR, it becomes important to determine any areas where the obstruction (terrain or structure) is greater than the minimum satellite elevation from the location of the receiver. It is rare for natural terrain to cause an obstruction of the line of sight to both satellites. In order to determine the level of obstruction or blockage of the satellite signal, the location of the receiver (*i.e.*, distance from the structure) and