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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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In the Matter of	)	IB Docket No. 95-91
	)	GEN Docket No. 90-357
Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band	)	RM No. 8610

SUPPLEMENTAL COMMENTS OF XM RADIO INC.

XM Radio Inc. ("XM Radio") hereby submits supplemental comments regarding the Commission's proposed rules for satellite Digital Audio Radio Service ("DARS") terrestrial repeater facilities to be operated in the 2320-2345 MHz band (the "S-band") in conjunction with licensed DARS systems. XM Radio is near completion of the design phase of its DARS terrestrial repeaters; these comments describe the likely technical characteristics of these facilities, the signals of which will cover only approximately one percent of the CONUS coverage area of XM Radio's two DARS satellites.

XM Radio requests that the Commission expeditiously finalize its regulatory framework for terrestrial repeaters. As the Commission proposed in this rulemaking, it should adopt a simple blanket licensing framework for DARS terrestrial repeater facilities, allowing DARS licensees to deploy and operate repeaters at any location that is consistent with the Commission's general rules regarding RF operations. Such flexible licensing and operational rules are critical to XM Radio's efforts to improve its DARS coverage in areas where it is difficult to receive satellite-based signals and thereby provide a seamless, high-quality, multichannel national radio service to the U.S. public.

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I. XM Radio and Its Authorized DARS System

XM Radio was authorized in October 1997 to launch and operate a satellite DARS system.[1/] Under XM Radio's system plan, the key technical components of this satellite DARS network will be the following: (i) XM Radio's authorized space segment, which will consist of two high-power satellites, operating at approximately 85° W.L. and 115° W.L.; (ii) a Satellite Control Center; (iii) uplink facilities that will transmit audio programming to the satellites; (iv) terrestrial repeaters to boost otherwise blocked satellite signals; and (iv) the customers' radios. Fundamentally, XM Radio's DARS network will be a satellite system, with all programming uplinked to XM Radio's satellites and transmitted by these satellites throughout the United States. XM Radio expects to spend more than $500 million on the construction and launch of its satellites, almost twice the projected total cost of its terrestrial repeater facilities.

Since receiving its license, XM Radio has made significant progress in the development of its DARS system. XM Radio has begun construction of its satellites, contracted for the launch of the satellites and the construction of a satellite control center, and entered into agreements for the manufacture of consumer radios for the automotive and home markets. In addition, XM Radio has reached programming agreements with such diverse media companies as AsiaOne, BBC World Service, Black Entertainment Television Inc., Bloomberg News Radio, C-SPAN Radio, CNN News Group, CNN/Sports Illustrated, Heftel Broadcasting Corp., One-on-One Sports, PBS, Radio One, Inc., Salem Communications Corp., Syndicated Communications, Inc., USA Today, and The Weather Channel. Finally, XM Radio has received an investment of $250 million in convertible debt from a consortium of investors that includes Clear Channel

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[1/] The Commission granted XM Radio's application to provide satellite DARS on October 16, 1997. American Mobile Radio Corporation, 13 FCC Rcd 8829 (Int'l Bur., 1997).

Communications, Inc., DirecTV, Inc., and General Motors Corporation, and in October 1999 XM Radio successfully completed an initial public offering of over ten million shares, raising another $114.2 million for the company.

II. Technical Design of XM Radio's Planned Terrestrial Repeaters

The deployment of XM Radio's complementary, gap-filling terrestrial repeaters will facilitate the provision of a high-quality, multichannel radio service, providing a receivable XM Radio signal in those limited areas where it may be difficult to receive satellite-based signals due to line-of-sight blockage from buildings, and where the satellite signal receives interference from various terrestrial sources, such as microwave ovens. In particular, the use of repeaters will be vital to service in urban mobile environments where, without such facilities, users would be subjected to an annoying loss of service while they are listening, as the signal level changes. In a digital environment, the loss of an adequate signal can be particularly bothersome, since it can produce a total loss of audio. Through the use of terrestrial repeaters, XM Radio will be able to compensate for blockage of or interference to the satellite signal and provide greater effective coverage.

As described further in the attached Technical Statement at Appendix A ("Technical Appendix"), XM Radio initially intends to deploy and operate approximately 1500 terrestrial repeaters, within a 20 to 30 mile radius of the urban centers of the largest seventy metropolitan areas in the country. XM Radio will determine the exact number of repeaters it needs to deploy in each metropolitan area, as well as the precise location of these repeaters, through frequency-specific propagation studies, including analysis of the significance of blocking and of interference generated by such terrestrial sources as microwave ovens. XM Radio is currently

conducting tests pursuant to its national experimental license for terrestrial repeaters,[2] and will conduct additional tests following the launch of its first authorized DARS satellite.

III. Rules for DARS Terrestrial Repeaters

The Commission proposed licensing and operational rules for satellite DARS terrestrial repeaters in March 1997.[3] XM Radio continues to support these proposed rules,[4] and it urges the Commission to finalize its regulatory framework for terrestrial repeaters as soon as possible. Such action is necessary to allow XM Radio to move quickly to implement its DARS system and make its innovative services available to the U.S. public.

As the Commission has proposed, it should issue a simple blanket license for repeaters. A national blanket license will provide the flexibility to deploy and operate repeaters at any location that is consistent with the Commission's general rules regarding radiofrequency ("RF") operations. In addition, as the Commission itself noted in the *FNPRM*, a framework requiring the separate licensing of each DARS terrestrial repeater would impose too great an administrative burden on both the Commission and the DARS licensees. *FNPRM* at para. 142. There is no need for power limits for repeaters other than reasonable limits for out-of-band emissions. XM Radio has exclusive use of its licensed S-band frequencies and it will be able to avoid unreasonable interference to service providers operating in adjacent frequency bands.

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[2] *See* FCC File No. 0199-EX-PL-1999 (Call Sign WB2XCA).

[3] Report and Order Memorandum Opinion and Order and Further Notice of Proposed Rulemaking, Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band, 12 FCC Rcd 5754, paras. 138-142 (1997) ("*FNPRM*").

[4] Comments of American Mobile Radio Corporation, at 3-4 (June 13, 1997).

Pursuant to an agreement with Sirius Satellite Radio, Inc. ("Sirius Radio"), XM Radio's out-of-band emissions will be attenuated below the transmitted EIRP ("p") (measured in watts) by not less than 75 + 10 log (p) dB. (This agreed limit is described further in the Technical Appendix.) In adhering to this standard, XM Radio will be able to avoid harmful interference to radio operators in adjacent frequency bands. This limit provides 32 dB more protection than licensees in the Wireless Communications Services ("WCS") are required to provide to each other under the Commission's rules. *See* 47 C.F.R. 27.53(a)(3). As a further safeguard, as it deploys its repeaters XM Radio will discuss issues relating to the location of its terrestrial repeaters with the other satellite DARS licensee, Sirius Radio.

In the *FNPRM*, the Commission proposed that before being licensed for its terrestrial repeaters, a DARS licensee will have to coordinate its border repeaters with any affected Canadian and Mexican operator or otherwise demonstrate that such operators would not be harmed. With respect to this proposal, XM Radio is currently supporting the Commission's effort to coordinate the operation of the U.S. DARS systems. The U.S. and Canada have concluded an agreement about the operation of the satellite system. That agreement may need to be modified to reflect the proposed operation of terrestrial repeaters in the vicinity of the Canadian border. Any operation by XM Radio of repeaters near either the Canadian or Mexican borders will be consistent with the appropriate coordination agreement.

XM Radio supports the requirements and restrictions contained in the *FNPRM* pertaining to antenna structure clearance, environmental effects, RF emissions, signal coverage, and local programming origination, and XM Radio will comply with all of these provisions. In addition, XM Radio's frequency plan for its planned terrestrial repeaters, described in detail in the Technical Appendix, is consistent with the Commission's existing and proposed rules for DARS

and the Commission's satellite DARS spectrum allocation.

Conclusion

In light of the foregoing, XM Radio Inc. requests the Commission to expeditiously finalize its rules for DARS terrestrial repeater facilities and permit XM Radio to move forward with the rapid implementation of its satellite DARS network.

Respectfully submitted,

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TABLE OF CONTENTS

APPENDIX A

TECHNICAL DESCRIPTION OF PLANNED TERRESTRIAL REPEATER FACILITIES

I. Terrestrial Repeater Design Overview

II. Technical Information

- A. Terrestrial Repeater Characteristics
  - 1. Carrier Frequencies
  - 2. Modulation
- B. Antenna Height and Power Levels
- C. Location

III. Interference to Systems in Adjacent Bands

APPENDIX A
TECHNICAL DESCRIPTION OF PLANNED TERRESTRIAL REPEATER FACILITIES

I. System Overview

XM Radio Inc. ("XM Radio") has been authorized to launch and operate two high-powered geostationary satellites to provide Digital Audio Radio Service to CONUS with high availability. High availability will be achieved by providing high link margin and angular diversity on the satellite links and by deploying terrestrial repeaters in urban areas, where line-of-sight between the satellite and the receiver is blocked by buildings and other obstructions. XM Radio plans to locate its terrestrial repeaters primarily on rooftops and tower structures.

XM Radio's planned terrestrial repeaters will transmit the signals that are transmitted from both satellites. The planned terrestrial repeaters receive the signals from either satellite with an S-band receive-only VSAT. The receiver downconverts them into an IF frequency. The signals are then provided to a signal-processing unit that performs the demodulation of the QPSK carriers. The satellite bit stream is then reformatted for the terrestrial broadcast and modulated into a Multicarrier Modulation ("MCM") waveform. The MCM format spreads information over multiple, low-data-rate carriers that are DQPSK modulated for transmission. The MCM symbols used for the terrestrial signal generation constitute a juxtaposition of equally spaced orthogonal carriers. The signals are then upconverted to the assigned S-band terrestrial carrier frequencies and amplified for transmission through a directional or omni-directional antenna.

II. Technical Information

A. Terrestrial Repeater Characteristics

1. Carrier Frequencies

The XM Radio frequency band consists of 12.5 MHz located between 2332.5 MHz and 2345 MHz. XM Radio plans to assign six carriers assigned to the band. The baseline frequency plan is shown below. Each of satellite channels (S_A and S_B) is a 3.28 Mbps carrier consisting of 256 channels digitized at 8 kbps. The planned terrestrial carrier is a 3.067 Mbps carrier consisting of 258 channels digitized at 8 kbps.

The planned frequency plan of satellite downlinks and terrestrial repeaters is illustrated on the following page in Figure 1.

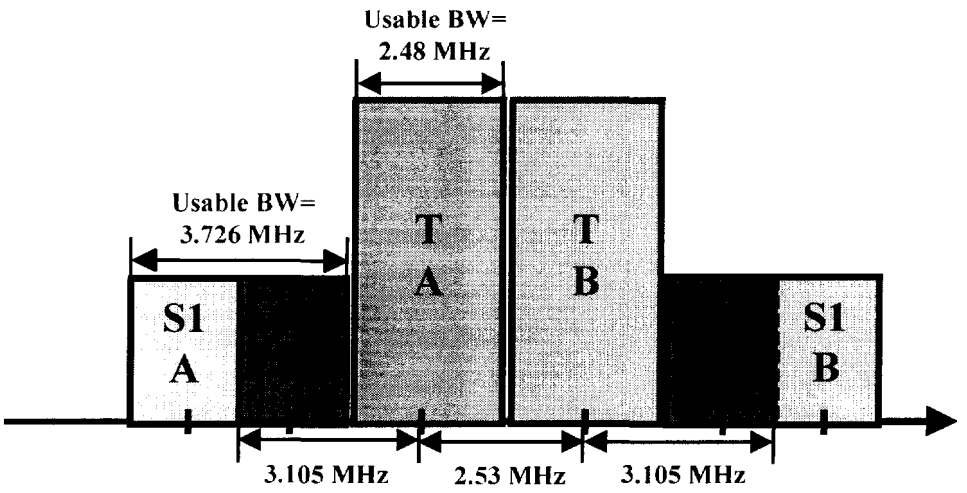


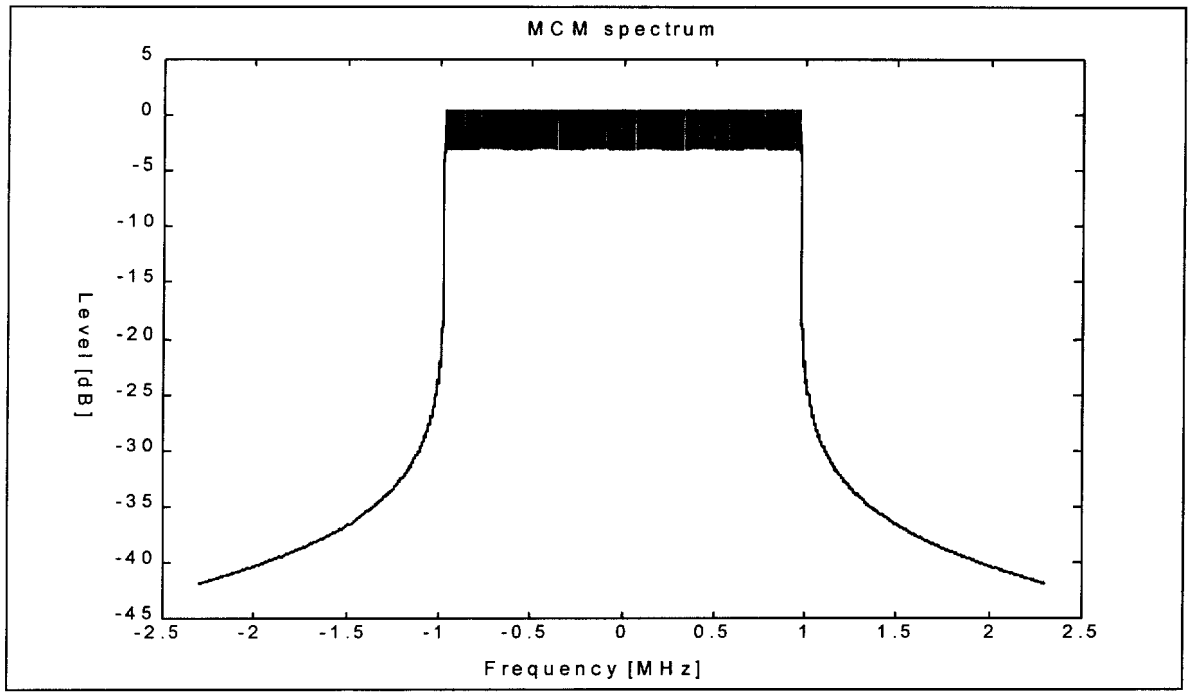
Figure 1

Satellite/ Terrestrial	Carrier	Center Frequency	Usable Signal Bandwidth
Satellite S1	A	2333.465 MHz	1.886 MHz
Satellite S2	A	2335.305 MHz	1.886 MHz
Terrestrial T	A	2337.490 MHz	2.48 MHz
Terrestrial T	B	2340.020 MHz	2.48 MHz
Satellite S1	B	2342.205 MHz	1.886 MHz
Satellite S2	B	2344.045 MHz	1.886 MHz

The spacing of center frequencies between the S1 satellite and the S2 satellite is 1.84 MHz. The center frequency spacing between terrestrial carrier A and terrestrial carrier B is 2.53 MHz.

2. Modulation

The MCM spectrum is as shown in the Figure 2 below.



Spectrum Characteristics

Figure 2

B. Antenna Height and Power Levels

XM Radio will deploy four types of terrestrial repeater: (1) standard, (2) intermediate, (3) high-power, and (4) microrepeater. All of XM Radio's repeaters will transmit two separate carriers, with each carrier containing half of XM Radio's audio programming channels.

XM Radio currently plans to deploy a total of approximately 1500 standard, intermediate, and high-power repeaters. A standard repeater will typically provide 200 watts of RF power into an omni-directional antenna, resulting in an EIRP of approximately 1 kW per carrier. In certain areas XM Radio will also employ the use of directional antennas with up to 14 dBi gain. The EIRP for a standard repeater with a directional antenna will be approximately 2.5 kW per carrier.

An intermediate repeater will typically provide 500 watts of RF power into an omni-directional antenna. The resulting EIRP will be approximately 2.5 kW per carrier.

XM Radio currently plans to deploy approximately 150 high-power terrestrial repeaters, most of which will typically provide two 1000-watt channels of RF power into an

omnidirectional antenna. High-power repeaters utilizing directional antennas will typically provide two 1000 watt channels of RF power into antennas with up to 14 dBi gain. Under its current system design, most of XM Radio's high-power repeaters will have an EIRP ranging between 3 and 10 kW per carrier. Approximately twenty-five of XM Radio's planned high-power repeaters will have an EIRP of 10 to 20 kW per carrier.

The transmit antennas for XM Radio's planned terrestrial repeaters will be no larger than 1.22 meters (4 feet). The standard and the high-powered repeater will use a common antenna designed to be mounted on the tops of buildings and towers. These locations are generally inaccessible to the general public. XM Radio intends to deploy its planned 10-20 kW repeaters only in remote and isolated locations containing minimal population.

XM Radio plans to deploy omnidirectional "microrepeaters" in urban and suburban areas around the country. A microrepeater is designed to provide 1 to 10 watts of power into an omni-directional antenna. The EIRP for any given location will be designed to match the coverage area required. Microrepeater antennas will generally be mounted on lampposts, in tunnels, and on the sides of buildings to provide coverage in areas that are not adequately covered by signals broadcast by the satellite or the other types of repeaters. These antennas are designed to provide a small profile.

C. Location

Terrestrial repeaters will be located initially in the 70 largest U.S. metropolitan areas to fill in the gaps in coverage that are caused by buildings and other obstructions. The typical design approach is to provide terrestrial repeater coverage within a 20-30 mile radius of each urban center.

III. Interference to Systems in Adjacent Bands

The power of any emission outside the frequency band of operation, 2332.5-2345 MHz, will be attenuated below the transmitter EIRP (p) measured in watts, by the following amount: not less than 75 + 10 log (p) dB.

Compliance with these provisions will be based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or less, but at least one percent of the emission bandwidth of the fundamental emission of the transmitter, provided the measured energy is integrated over a 1 MHz band-width.

Shown on the following page in Figure 3 is a typical example of a standard repeater out of band emission mask.

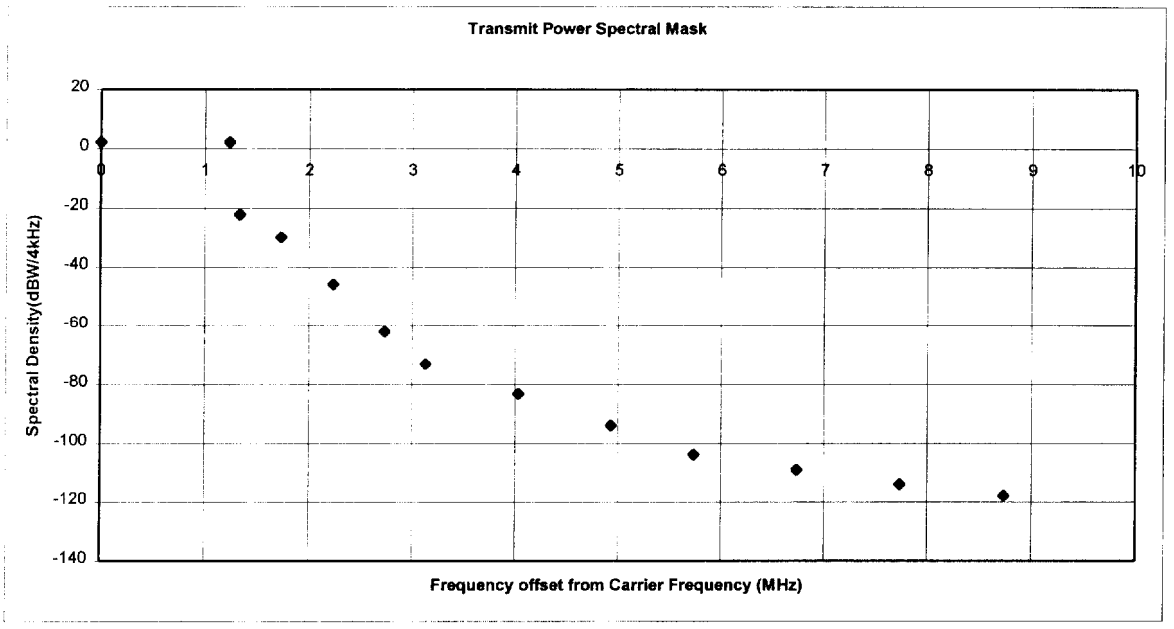

Transmit Power Spectral Mask
20
0
-20
-40
-60
-80
-100
-120
-140
0
1
2
3
4
5
6
7
8
9
10
Spectral Density(dBW/4kHz)
Frequency offset from Carrier Frequency (MHz)

Figure 3

Technical Certification

I, John (Jack) Wormington, Senior Vice President, Engineering and Operations of XM Satellite Radio Inc. ("XM Radio"), hereby certify the following under penalty of perjury:

I have reviewed the foregoing "Supplemental Comments of XM Radio Inc.," and the technical information contained in this application is true and correct to the best of my belief.

John (Jack) Wormington

Dated: December 17, 1999

CERTIFICATE OF SERVICE

I, Marilyn Murphy, a secretary to the law firm of Fisher Wayland Cooper Leader & Zaragoza L.L.P., hereby certify that on this 17th day of December, 1999, I served a true copy of the foregoing **"SUPPLEMENTAL COMMENTS OF XM RADIO INC."** by first class United States Mail, postage prepaid, upon the following:

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