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

In the Matter of	)	
	)	
Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band	)	WT Docket No. 07-293
	)	
Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band	)	IB Docket No. 95-91 GEN Docket No. 90-357 RM No. 8610
	)	

COMMENTS OF XM RADIO INC.

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COMMENTS OF XM RADIO INC.

XM Radio Inc. ("XM") submits its comments here in response to the Commission's *Notice of Proposed Rulemaking* in the above-referenced docket, FCC 07-215 ("*Notice*") 1/.

SUMMARY

This proceeding is critically important to XM's continued ability to provide high quality Satellite Digital Audio Radio Service ("SDARS") to our millions of subscribers. When the Commission created SDARS over ten years ago, it recognized the need for SDARS licensees to use terrestrial repeaters to ensure reliable service where satellite coverage is impossible. Since that time, even in the absence of final repeater rules, XM has invested hundreds of millions of

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1/ *Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band, WT Docket No. 07-293, Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band, IB Docket 95-91, GEN Docket No. 90-357, RM No. 8610,* Notice of Proposed Rulemaking and Second Further Notice of Proposed Rulemaking 22 FCC Rcd 22123 (2007) ("*Notice*").

dollars to develop a repeater network while working toward completion of this docket. XM built its network at such considerable expense because without repeaters, it cannot offer a commercially acceptable SDARS service in major cities and many other parts of the country.

XM urges the Commission to finish the job it began in 1997 and promptly adopt final SDARS repeater rules. The Commission can do so based on a record demonstrating the accuracy of its original conclusion that repeaters are a necessary element of the SDARS service. In these comments and the attached Technical Appendix, 2/ XM provides a detailed engineering analysis demonstrating that SDARS repeaters operating at a ground-level emission limit of Power Flux Density ("PFD") 110 dBμV/m will satisfy SDARS service needs while fully protecting adjacent WCS operations. The alternative power limits on SDARS repeaters proposed by WCS licensees are unnecessary to protect WCS operations. They only would require SDARS operators to make massive new investment in additional repeater facilities with no corresponding benefit for either service to consumers or spectrum efficiency. Furthermore, failure to grandfather current repeaters under such unnecessary limits would create substantial network disruption and service continuity risk to SDARS service, thereby reducing the quality of programming reception enjoyed by millions of customers.

At the same time, the Commission should reject the proposal by WCS licensees to relax significantly the operating limits applicable to their service. Those rules also have been in place for ten years and were tailored expressly to protect the SDARS service -- and the now millions of SDARS subscribers -- given the technical challenges of providing a nationwide, ubiquitous, real-time streaming digital audio programming service to mobile users from satellites. XM does

2/ XM and Sirius engineers worked together to prepare their respective technical exhibits. For the convenience of the Commission the exhibits are similar in form but differ in that each company has provided its own company-specific technical information.

not oppose consideration of certain changes to the WCS rules, but that review should take into account three key premises:

- First, and most importantly, any such relief must not jeopardize reliable SDARS service to the millions of customers who depend on such service on a daily basis.
- Second, modification of the WCS rules should not be allowed to delay further the adoption of final SDARS repeater rules, a long-standing task that the WCS licensees themselves argue is needed for deployment of their own service.
- Third, the Commission should recognize, as it did when it first established the WCS rules, that fixed and mobile WCS operations present very different situations; indeed, the Commission expressly warned WCS licensees that any mobile-based WCS business plans would be severely constrained by the need to protect SDARS service.

With these caveats, XM explains below how the Commission should finalize its proceeding on SDARS repeater rules, and how WCS rules might be modified for fixed and (with additional safeguards) certain mobile WCS operations. XM looks forward to working with the Commission and all parties to bring a rapid conclusion to this docket.

I. FOR TEN YEARS XM HAS DEVELOPED ITS BUSINESS RELYING ON THE COMMISSION'S 1997 SDARS AND WCS ORDERS

A. The Commission Always Has Recognized the Technical Challenges of SDARS and Imposed Limitations on WCS to Protect SDARS Service

SDARS service has been one of the Commission's significant policy successes of the past decade, bringing new competitive audio services to millions of mobile Americans. XM, for example, provides over 8.5 million subscribers with 170 channels of music, sports, news, talk, entertainment, traffic and weather, emergency, and informational data services.3/ This programming is delivered over a billion dollar infrastructure, including four operational satellites, consumer receivers, and a network of terrestrial repeaters in areas where satellite signals are interrupted by line of sight obstructions.

From the beginning of this proceeding, the Commission has recognized the significant technical challenges faced by SDARS in deploying its overall network and achieving its key service characteristics. SDARS requires (1) reception from satellites, (2) on a continuous real-time basis without interruption, (3) by low cost mobile terminals, (4) with antennas sized for vehicle installation or portable use by consumers. As a competitive necessity, XM must target (and achieve) a more than 99% service availability level across the contiguous United States to meet consumer expectations for audio programming. 4/ Each of these critical system elements creates engineering challenges for the overall SDARS network.

The Commission addressed these matters directly when it created the SDARS and WCS services in 1997. Most pertinent here, the Commission recognized the need for SDARS to use terrestrial repeaters to augment satellite signal delivery in certain areas. The Commission also limited the operations of WCS licensees expressly to prevent interference to SDARS. Both of these decisions are directly relevant to this proceeding -- SDARS licensees (and millions of

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3/ XM also plays an increasingly important role in public safety. XM broadcasts emergency alerts and safety information nationwide, on a 24 hour/7 days a week basis, through its (i) XM Emergency Alert Channel 247 (which is "free-to-air", *i.e.*, no subscription required), addressing regional and nationwide events, and (ii) 21 nationally-transmitted Instant Traffic, Weather & Alert channels, which also provide emergency information and Amber Alerts specific to select areas around the country. XM also participates in the national Emergency Alert System and airs a Red Cross Radio channel when the country experiences disasters. Moreover, XM is now a Primary Entry Point with a direct link to the Federal Emergency Management Agency.

4/ Service availability is defined as the time that programming remains uninterrupted over a given drive distance for a mobile receiver.

consumers) enjoy the service they do today because of investments made in reliance on the Commission's actions a decade ago.

1. When Establishing the SDARS Service, the Commission Correctly Found That Repeaters Are Critical to a Fully Performing System

On a geographic basis, the majority of SDARS service is received directly from the SDARS satellites. Nevertheless, repeaters are central to SDARS service given the challenges of maintaining line of sight to satellites from mobile terminals, especially in urban environments. Millions of listeners travel in and out of repeater coverage during their daily commutes, or otherwise rely on repeaters to receive quality continuous service.

The Commission recognized the core need for SDARS repeaters from the first time it authorized the service. 5/ As the Commission observed when it adopted the SDARS rules, "[i]t is important" for the SDARS "systems to maintain sufficient service link margin to reproduce the original information transmitted by the satellite." Repeaters, the Commission noted, "would re-transmit the information from the satellite to overcome the effects of signal blockage and multipath interference." 6/ In 1997, the Commission proposed rules for these terrestrial repeaters with only two technical limitations: that (1) SDARS licensees "retransmit signals received from their operating DARS satellite(s) on the exclusive frequency assignment of the licensee and for

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5/ Section 25.201 of the Commission's rules defines SDARS as a service "which may involve complementary repeating terrestrial transmitters." 47 C.F.R. § 25.201.

6/ *Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band,* Report and Order, Memorandum Opinion and Order and Further Notice of Proposed Rulemaking, 12 FCC Rcd 5754 at ¶ 138 (1997) ("*1997 SDARS Order*").

use of the same bandwidth as the satellite space station(s)" and that (2) the repeaters "not be used to extend coverage outside of the satellite systems' authorized service area." 7/

SDARS deployment over the past decade has confirmed the need for terrestrial SDARS repeaters. XM and Sirius each acquired SDARS authorizations through spectrum auctions in 1997, paying over $170 million for their licenses. 8/ The two companies then moved promptly to build their systems -- at an enormous cost and risk. XM began nationwide service on November 12, 2001 and Sirius did so in 2002. 9/ Both licensees commenced service well in advance of the milestones set by the Commission. 10/

As the Commission anticipated, SDARS repeaters have played a crucial role in the development of SDARS service, allowing licensees to offer reliable service to consumers in areas with line of sight obstruction from SDARS satellites -- both urban areas where buildings can interrupt satellite access, and exurban areas where terrain conditions interfere with reception. Repeaters provide signal continuity for a service that subscribers expect to be inherently continuous, full-time, and available without interruption. The repeaters supplement our huge investment in satellite infrastructure similarly designed to address the customers' need for continuous reception.

7/ *See id. at Appendix C.* The proposed rule also prohibited repeaters from originating programming separately from the satellites, and required compliance with environmental, international coordination, and antenna structure rules. *Id.*

8/ *FCC Announces Auction Winners for Digital Audio Radio Service,* Public Notice, 12 FCC Rcd 18727 (1997) ("*WCS Auction Press Release*"); *Satellite CD Radio Inc., Application for Authority to Construct, Launch, and Operate Two Satellites in the Satellite Digital Audio Radio Service,* Order and Authorization, 13 FCC Rcd 7971 (1997) ("*Sirius Authorization*"); *American Mobile Radio Corp., Application for Authority to Construct, Launch, and Operate Two Satellites in the Satellite Digital Audio Radio Service,* Order and Authorization, 13 FCC Rcd 8829 (1997) ("*XM Authorization*").

9/ *See Notice* at n.4.

10/ *1997 SDARS Order* at ¶ 110. The FCC required licensees to commence construction of their space stations within one year, begin operating their first satellite within four years, and begin operating their systems within six years.

Although the Commission recognized the need for SDARS repeaters, it never adopted rules governing their deployment or use. Accordingly, since 2001, the Commission has permitted SDARS repeaters to operate under Special Temporary Authority ("STA"). But STAs are not a substitute for permanent rules that can standardize necessary SDARS operations, reduce administrative burdens on SDARS licensees and the Commission staff, and facilitate network planning and deployment for the SDARS and WCS carriers. In these comments, XM proposes that the Commission adopt repeater rules, including an SDARS ground level emission standard of 110 dBμV/m, which fully protect WCS terminals incorporating normal receiver technology commonly used in other consumer services.

2. When Establishing the WCS Service, the Commission Correctly Limited That Service With Rules Intended to Prevent Harmful Interference to SDARS and Warned that Mobile Services Would Be Inhibited in the WCS Band

This rulemaking also is critical to millions of XM and Sirius customers because of the harmful interference they would encounter were the Commission to relax the WCS rules as proposed by the WCS license holders. Such changes would be inconsistent with the Commission's decisions a decade ago, based on which the SDARS licensees have built their businesses.

When the Commission established the WCS service rules in 1997, it did so with recognition of the need to ensure that WCS service would not interfere with SDARS. The WCS rules were crafted with an express appreciation of the adjacent operations of SDARS systems, the need to protect service to SDARS subscribers, and the consequent limitations on potential uses of WCS spectrum. The Commission emphasized at the very beginning of the order establishing the WCS rules: "[B]ecause the reallocated WCS spectrum is located on both sides of the spectrum allocated for [SDARS], we believe that there is a substantial risk that the out-of-band emission limits we are adopting -- which we believe are necessary to protect prospective satellite DARS licensees from interference from WCS operations -- will, at least in the foreseeable future, make mobile operations in the WCS spectrum technologically infeasible." 11/

The Commission reiterated this point several times in the *1997 WCS Order*. It stressed that the services that might be provided over the WCS spectrum "will be subject to specific technical rules we adopt *infra* to prevent interference to other services." 12/ The Commission went out of its way to make clear that this obligation to protect SDARS would both (1) limit the potential uses that might be made of WCS spectrum, particularly with respect to mobile services, and (2) require WCS to meet technical requirements that could increase equipment costs -- for both fixed and mobile applications -- compared to equipment used for similar services in other bands:

> We emphasize that with the current state of technology there is a substantial risk that these rules will severely limit if not preclude, most mobile and mobile radio location uses. Fixed uses will be less severely affected, but still will require equipment that will meet technical standards higher than those used for similar purposes on comparable bands, and therefore may be more costly. 13/

Similarly, the Commission stood firm on this principle even as it granted a request to relax the out of band emission ("OOBE") limit applicable to the lower portions of the A and B WCS

11/ *Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service*, Report and Order, 12 FCC Rcd 10785, 10787 ¶ 3 (1997) ("*1997 WCS Order*") (emphasis added); *accord*, *Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service,* Memorandum Opinion and Order, 12 FCC Rcd 3977, 3978 ¶ 3 (1997) ("*WCS MO&O*") ("The Commission adopted stringent out-of-band emission limits" to protect SDARS operations recognizing that doing so would "make mobile operations in the WCS spectrum technologically infeasible.").

12/ *Id.* at 10798 ¶ 25.

13/ *Id.*

blocks to allow low power portable (but not mobile) devices. 14/ The Commission specifically "caution[ed] prospective WCS licensees ... to carefully consider whether their anticipated uses and business plans can be successfully implemented" under the rules even as relaxed: "In particular, wide area, full mobility systems and services such as those being provided or anticipated in the cellular and PCS bands are likely to be of questionable feasibility under either the alternative restrictions or the general out-of-band emission limits." 15/

Significantly, but not surprisingly, the value of WCS spectrum in the original auction reflected these necessarily strict technical limitations in the resulting auction prices. The entire 30 MHz of WCS spectrum was auctioned for under $14 million 16/ – in contrast to the more than $170 million SDARS licensees paid for use of less aggregate spectrum in the adjacent bands. Since that time, WCS spectrum has changed hands several times, often at significantly escalated prices, no material construction has occurred, applications to extend construction deadlines have been filed 17/ and no significant commercial operations have begun. 18/ Some WCS licensees

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14/ Significantly, current WCS proposals to offer WiMax services have a far greater interference potential than these low power devices. WiMax does not adhere to these limits and based on the information XM has on WiMax protocols, such devices would have a much more harmful impact due to the variation in their transmitter duty cycle.

15/ *WCS MO&O*, 12 FCC Rcd at 3979 ¶ 5. Moreover, the FCC expressly recognized that "the 2320-2345 MHz frequency band is the only spectrum available for provision of Satellite DARS in the United States. Accordingly, if [SDARS] in this spectrum is subject to excessive interference, the service will not be successful and the American public will not benefit from the service." *Id.* at ¶ 27.

16/ *WCS Auction Press Release,* 12 FCC Rcd at 21653. Auction 14 raised a net total of $13,638,940. *See* George Gilder, *Free Markets for Telecom*, Wall St. J., Sept. 16, 1997, at A22 ("The so-called Wireless Communications Service auction in April saw licenses in St. Louis, Minneapolis, Milwaukee, Des Moines, Iowa, and Omaha, Neb., go for just $1 per person -- a fraction of 1% of the value of previous licenses."). In fact, in each of these cases, winning bidders in the WCS auction paid only $1 for the entire market.

17/ In March 2006, sixteen months before the expiration of their licenses for failure to construct, a coalition of WCS licensees requested an extension of their construction deadline. The Wireless Bureau granted a three-year reprieve, but stated that it expected the WCS licensees to act aggressively to move forward on deployment. The Bureau noted "that the WCS operating rules are established" and declined to condition the extension on completion of the SDARS repeater rulemaking. *Consolidated Request of the WCS Coalition for Limited Waiver of Construction Deadline for 132 WCS Licenses,* Order, 21 FCC Rcd 14134, at ¶ 14 (WTB 2006).

18/ Indeed, petitions have been filed asking the Commission to rescind its acceptance of build out showings for certain WCS licensees due to their failure to demonstrate "substantial service" by the end of their license terms. *See* Green Flag Wireless LLC, Petition for Reconsideration or Rescission, WCS Applications of Horizon Wi-Com, LLC, Lead File No. 0003045277 (Aug. 28, 2007); *see also* Letter from Donald J. Evans, Counsel for Green Flag Wireless, are deploying fixed WCS networks, and fixed WCS equipment has been certified under the Commission's rules and is commercially available. 19/ However, other WCS licensees are now proposing use of WCS for mobile broadband, notwithstanding the Commission's long-standing warning that the spectrum was not suitable for that purpose. 20/

WCS licensees proposing mobile WiMax operations disregard the fact that since 1997 two-way broadband wireless applications have been developing in many other bands better suited to the application. These bands include not only cellular spectrum, the ISM band, leased use of the Broadband Radio Services and Educational Broadcast Services, but also the 3.65 GHz band, AWS spectrum, and the 700 MHz band. The Commission is well-aware of these developments, and there is no need to discuss them in detail here. It is sufficient to note that opportunities abound for broadband mobile service in these and other spectrum bands, and operators are farther along than WCS licensees in providing this type of service. Maintaining reasonable limits on the WCS band therefore will not impede the development of mobile WiMax

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LLC et al, to Marlene H. Dortch, Secretary, Federal Communications Commission (Oct. 12, 2007) (NextWave renewal applications); Letter from Donald J. Evans, Counsel for Green Flag Wireless Communications, LLC, et al, to Marlene H. Dortch, Secretary, Federal Communications Commission (Oct. 5, 2007) (requesting that the Commission convene a meeting of competing mutually-exclusive applicants); Letter from Donald J. Evans, Counsel for Green Flag Wireless, LLC et al, to Marlene H. Dortch, Secretary, Federal Communications Commission (Sept. 21, 2007) (AT&T renewal applications).

19/ *See, e.g.*, Equipment Authorization FCC ID PL6-2300-BTS3-R1 (Navini Networks base station); FCC ID LKT-BMAX-SU23 (Alvarion subscriber unit).

20/ WCS licensees referenced the deployment of WiMax operations in their consolidated request for a build-out extension. Since that filing, the WCS Coalition has continually referred to mobile WiMax services as an intended use for WCS spectrum. Letter from Paul J. Sinderbrand, Counsel to the WCS Coalition to Marlene Dortch, Secretary, Federal Communications Commission, at 3 (July 9, 2007) ("*WCS Coalition July 2007 Letter*"); Reply Comments of WCS Coalition, WT Docket No. 06-102, 13 (June 23, 2006). Before the Commission commenced a proceeding to license newly designated spectrum (2155-2175 MHz Band) for advanced wireless services (AWS-3), NextWave Broadband, among others, had filed an application for licenses to provide service in the band proposing to use a Time Division Duplexing "TDD" technology based on the IEEE 802.16e WiMax standard. *See* Application for License and Authority to Provide Nationwide Broadband Service in the 2155-2175 MHz Band filed by NextWave Broadband Inc. (filed March 2, 2007). All of the AWS-3 applications were ultimately dismissed without prejudice, and the Commission commenced the AWS-3 rulemaking proceeding, in which NextWave has filed reply comments. *See Applications for License and Authority to Operate in the 2155-2175 MHz Band, WT Docket No. 07-16,* Order; *Petitions for Forbearance Under 47 U.S.C. § 160, WT Docket No. 07-30,* Order, FCC 07-161 (rel. Aug. 31, 2007). We believe NextWave's proposed mobile WiMax use of the WCS spectrum and proposed equipment is similar, if not the same, as what it proposed in the AWS-3 band.

service. Rather, such limits are consistent with the Commission's warnings that WCS rules would "severely limit if not preclude" most mobile uses. 21/

B. XM Has Designed and Constructed Its Satellite System to Meet Customer Service Requirements and In Reliance On the Commission's Rules

While the WCS spectrum has largely sat fallow, the SDARS licensees have invested billions in our businesses. It is all the more important, then, for the Commission to recognize the technical challenges that XM faced, including the extent to which XM has relied on the protection for SDARS specifically provided under the existing WCS rules in developing its system. XM must deal with the challenge of providing sufficient signal strength from space to small, inexpensive consumer receivers and their antennas. It must do so in a mobile environment across urban, suburban and rural areas, a technical task far more difficult than a fixed satellite service such as DTH. SDARS also lacks the flexibility of other digital services such as cellular that can tolerate delay and momentary packet loss; broadcast audio programming is unacceptable to consumers if the signal has intermittent dropouts, even for brief periods. Indeed, any reduction in the current service and quality availability would undermine the ability of this subscription-based service to compete with the many other options consumers enjoy for audio programming, whether free terrestrial radio, HD radio, compact discs and MP3s, internet radio, wireless telephones, or other sources. And SDARS terminals must be small and relatively inexpensive to meet consumer requirements for this service to successfully compete with other options.

XM has designed and built its network with the goal of providing greater than 99% continuous signal availability to mobile customers across the contiguous United States. XM did

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21/ *WCS MO&O,* 12 FCC Rcd at 10798 ¶ 25.

so based on its determination that any lower target would be commercially unacceptable to consumers buying a monthly subscription service -- where the primary competitor (terrestrial radio) is free to air. Given the technical challenges and vulnerabilities of SDARS reception, this service reliability target imposes huge costs on XM: not just in terrestrial repeaters, but also in additional space segment investment, in network operations, and in consumer terminals. XM designed a multiple level transmission system into the core and fabric of its network, with all system elements available and working together, in order to provide a quality audio program service to subscribers.

Importantly, a single satellite is not sufficient to provide adequate SDARS service under variable terrain conditions (buildings, hills, foliage, etc.). Rather, consumers must have service available from two spatially diverse satellites at all times to meet acceptable quality of service expectations for audio programming reception. XM engineers have therefore designed a system in which two satellites having complementary coverage patterns provide redundant signal paths on a continuous basis. 22/ XM has also established in-orbit back-up capability for these satellites to ensure that this service quality level can be maintained in the event of a single temporary outage or satellite failure.

Consistent with this design approach, XM's satellite system now consists of four space stations (two primary and two back-up) deployed at 85° W.L. and 115° W.L., at a cost of over a billion dollars. The satellites receive audio signals from XM's programming center and then retransmit the signals across the contiguous United States. The satellites provide geographic

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22/ Richard A. Michalski, Chief Engineer, Systems Engineering, XM Satellite Radio, Duy Nguyen , Senior Engineer, Systems Engineering, XM Satellite Radio, *A Method For Jointly Optimizing Two Antennas In a Diversity Satellite System,* AIA-2002-1996 (2002) available at http://www.aiaa.org/content.cfm?pageid=406&gTable=Paper&gID=144 ("*XM Satellite Radio Joint Availability Study*").

spatial diversity because they are 30° apart in longitude, enhancing the probability of a clear line-of-sight between at least one of the satellites and XM's subscriber receiver units. The footprint of each satellite was tailored to provide nearly uniform availability over the contiguous United States and to minimize transmission spillage across the United States borders. 23/ Because of longitudinal separation of the satellites, in most circumstances where reception is obscured from one satellite, an XM radio signal is still available from the other satellite.

In addition to space diversity, use of two satellites permits time diversity that further increases program service availability. Use of two satellites enables XM to design four-second satellite outage protection -- but only when both satellite signals are received simultaneously prior to the signal blockage occurring. Single satellite signal coverage would not achieve this time diversity blockage protection while maintaining the existing system bandwidth.

In short, in areas without repeaters, the XM SDARS service depends on joint availability of two satellites at different orbital positions; service from only one satellite would not be sufficient for the quality of services expected by our customers. Quite the contrary, service from a single satellite raises the jeopardy of service interruptions to an unacceptable level. For example, while XM's satellite system is designed to provide a joint availability of more than 99% to virtually the entire population in the contiguous United States from the two XM satellites, if XM operated only one satellite, then the predicted availability across the contiguous United States would drop to as low as 80% in some areas. 24/ The degradation from 99% to 80%

23/ The United States has entered into international coordination agreements with Canada and Mexico concerning SDARS service. XM operates in full compliance with those agreements and the FCC has conditioned XM's authority to operate its replacement satellites on compliance with international coordination agreements. *See XM Radio Inc., Application for Minor Modification to Relocate Satellite Digital Audio Radio Service Satellite, Application for Authority to Launch and Operate Replacement SDARS Satellites*, Order and Authorization, 20 FCC Rcd 1620, 1625-1626 ¶ 16 (IB 2005).

24/ *XM Satellite Radio, Joint Availability Study* at 6, Figure 15 (Joint Availability Curves).

means that service interruptions would increase by a factor of 20. Put another way, if service from one satellite were sufficient, XM would not have invested hundreds of millions of additional dollars in its second primary in-orbit satellite.

XM's terrestrial repeaters play an integral role in the overall SDARS system because, notwithstanding this massive space segment investment, XM customers cannot be assured that a line of sight satellite reception condition will be present in many circumstances. To be clear, investments in repeaters are themselves an enormous capital and ongoing operational expense. XM has no incentive to build repeaters unless they are needed; if service from the two satellites is acceptable, repeater deployment would be a waste of capital. In fact, while XM's initial network designs projected the need for as many as 1700 repeaters, actual network testing, redesign and refinement revealed acceptable service could be achieved with fewer repeaters, and XM reduced the number of repeaters to be deployed by more than half.

Yet the ground-level reality is that in many major markets, man-made and terrain obstructions make a commercially acceptable SDARS service impossible without repeaters to fill coverage gaps. As of today, XM's SDARS network includes 800 repeaters designed to provide service in the 63 markets comprising our national network. These repeaters play a crucial role in providing uninterrupted service to consumers. Indeed, during 2001 XM did not begin to market its service in a given area until it had constructed repeaters and optimized service availability to ensure the coverage was sufficient to meet our service quality requirements and assure acceptable audio delivery continuity to subscribers.

XM uses the satellites and repeaters in an integrated fashion to provide greater than 99% service availability in the top markets. XM transmits all program content redundantly over both satellites (with additional redundancy where repeaters are present). The duplication of the program content combines with the space and time diversity elements discussed above to improve signal robustness for brief blocking as vehicles move through varying physical environments. As a consequence, however, XM spectrum utilization in terms of transmit data bandwidth per MHz of spectrum is only one-third of the utilization of a more traditional broadcast service, substantially increasing the net investment cost per program channel. XM effectively is precluded from offering more audio channels by limiting the data delivery bandwidth in this fashion. From a system design standpoint, it is a matter of sacrificing overall system capacity in favor of service quality and continuity. 25/

Finally, XM has designed its consumer receivers to operate in this complex network environment to provide the required service availability. Each receiver system has a custom antenna, RF tuner, and baseband decoder chip that simultaneously receives the two satellite signals and any terrestrial repeater signal, and combines the signals to take advantage of this single or double redundancy. This receiver architecture adds significant cost to each receiver system used by XM subscribers.

SDARS service also is constrained by the long lives of SDARS terminals that are factory-installed in cars, trucks, and other vehicles -- which represents the fastest growing segment of XM's market. The test data in the attached Technical Appendix represents the receiver architecture that makes up the large percentage of the installed base of OEM automotive

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25/ Similarly, XM has augmented the baseline interference protection provided under the FCC's SDARS and WCS rules at the expense of additional service link capacity. For example, XM voluntarily devotes valuable spectrum to implement its own guard band between its terrestrial transmitter and the closest WCS block. This gives the WCS licensee further frequency separation from XM's repeater signal, allowing greater filter protection, increasing adjacent channel protection. XM broadcast information is split evenly into two parts: S1A, S2A, and TA carry half of the bandwidth and S1B, S2B, and TB carry the second half of the bandwidth. All of the A signals carry the same broadcast payload (audio, data) information and all of the B signals carry the second half of the payload data.

equipment. 26/ Manufacturers and SDARS operators must plan for an expected ten year life of the vehicles and the XM receivers installed in those vehicles. In addition, even after a new OEM receiver is designed, there is a significant lead time of three years or more before any such new OEM terminal design can be introduced into next generation vehicles. As a result, even assuming receiver technology changes could mitigate interference from relaxed WCS rules in this docket (a difficult technical and cost challenge depending on the nature of the new WCS rules), these new WCS rules could not be implemented for many years without harming ongoing service to existing SDARS subscribers. These long-term receiver constraints demonstrate the wisdom of the Commission's decision in 1997 to limit WCS operations that might interfere with SDARS, and its warning to WCS licensees of the associated limits on the uses of their spectrum.

These complicated system elements -- satellites, repeaters, and consumer receivers -- work together on an integrated basis to make SDARS service an attractive entertainment product for consumers. Because the XM system is digital, loss of portions of the data comprising the signal can result in loss of the *whole* signal – unlike an analog environment where signal degradation merely reduces audio clarity. As a practical matter, service quality declines as each "layer" of the system is degraded. The blockage of one satellite causes a noticeable difference to a mobile XM receiver due to the loss of time diversity to mitigate effects of short term satellite blocking (for example traveling under an overpass on an interstate highway). In an area where a customer relies on a repeater to supplement the satellite system, any degradation in the repeater signal is likely to cause signal loss, or near signal loss.

26/ XM also has been successful in introducing its service in partnership with automobile manufacturers with XM terminals provided as a factory installed device. XM's success in this area is due in large measure to the manufacturers' satisfaction with the customer experience. Any change in the interference environment reducing the level of customer satisfaction would also impact the enthusiasm that the automotive manufacturers have to continue their current level of support for SDARS going forward.

As the Commission considers further action in this proceeding, it should remain cognizant of this huge, integrated system investment made by XM -- in reliance on the existing SDARS and WCS rules -- to overcome the technological challenges of delivering audio programming to mobile consumers from a geostationary satellite system. In so doing, the Commission should ensure that no action here undermines the service quality received by millions of SDARS consumers today.

II. PERMANENT SDARS REPEATER RULES PROPOSED BY XM AND SIRIUS CAN READILY ACCOMMODATE WCS OPERATIONS CONSISTENT WITH THE CURRENT WCS RULES AND THE COMMISSION'S EXPECTATIONS WHEN IT AUCTIONED THAT SPECTRUM

XM welcomes the Commission's effort to complete its long-standing effort to adopt permanent SDARS repeater rules. In this section, we discuss rules that will meet the practical needs of SDARS operators and their customers as contemplated by the Commission in 1997.

In recent years, WCS licensees have asked the Commission to restrict SDARS repeater operations, notwithstanding the Commission's recognition of the need for such repeaters to make SDARS a viable service. XM has made many good faith efforts to discuss these concerns with WCS entities, but has found those efforts hampered by a variety of factors, including the shifting ownership of the WCS spectrum and the failure (or inability) of those parties to provide sample WCS terminal equipment for testing. It has been particularly troubling to see some WCS licensees propose mobile services of the kind that the FCC specifically had warned were "infeasible" when it created the WCS rules in the first place -- rules that XM has relied upon in deploying its own system.

Notwithstanding these challenges, XM has devoted substantial resources to evaluating the actual risk of interference by SDARS repeaters into WCS terminals. As discussed further here and in the attached Technical Appendix, SDARS repeaters will fully protect adjacent WCS systems if such repeaters operate with a PFD ground-level emission limit of 110 dBμV/m.

A. A Power Flux Density Limit on SDARS Repeaters Best Balances SDARS and WCS Interests and Is Consistent With Limits Previously Adopted By the Commission

Where licensees using adjacent spectrum operate at different power levels, the Commission has found, as discussed below, that the most effective way to ensure against interference is by adopting emission limits for the most likely situations where such services will cause interference. For most services, this occurs at ground level, because that is where the majority of receivers will be deployed. Any rule focused on transmitter power alone will be insufficient to predict the real-world impact of interference on customer receivers because a multitude of factors can influence the effect of that transmitted power on an actual receiver. In contrast, ground-based emissions limits allow operators to consider various other technical parameters, including antenna height, antenna pattern, and downtilt, all of which are highly relevant to the real-world potential for harmful interference.

As XM and Sirius have noted in previous submissions in this docket, the Commission adopted a PFD limit on ancillary terrestrial transmitters in the Mobile Satellite Service ("MSS"). 27/ In that context, the Commission found a PFD limit to be useful in minimizing interference to adjacent band satellite receivers located on aircraft that are on the ground. Similarly, early in the 700 MHz proceeding, the Commission adopted a PFD limit to protect terrestrial users from interference caused by other terrestrial systems providing different

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27/ *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; Review of the Spectrum Sharing Plan Among Non-Geostationary Satellite Orbit Mobile Satellite Service Systems in the 1.6./2.4 GHz Bands,* Report and Order and Notice of Proposed Rulemaking, 18 FCC Rcd 1962, 2040 ¶ 154 (2003) ("*MSS R&O and NPRM*").

services. 28/ The PFD limit the Commission adopted in the lower 700 MHz band allowed high power digital broadcast services to function on frequencies adjacent to low power advanced wireless services without harmful interference to ground-based devices. More recently, the Commission has extended the use of the PFD limit beyond the lower 700 MHz band, for purposes of allowing 700 MHz licensees to benefit from the power flux density regime the Commission has adopted in that band. 29/

The Commission also has relied on PFD (and equivalent PFD or "EPFD") 30/ limits to mitigate the potential for interference between satellite and terrestrial operations in adopting technical rules and procedures to govern spectrum sharing between Non-Geostationary Satellite Orbit Fixed Satellite Service ("NGSO FSS") and Multichannel Video Distribution and Data Service ("MVDDS"). 31/ The Commission found that a PFD limit provided a sensible compromise that would give each service reasonable protection. 32/ In the same proceeding, the Commission adopted an equivalent PFD or EPFD limit to measure interference from transmitters in the terrestrial fixed services into Direct Broadcast Satellite ("DBS") receivers. 33/ In doing so, the Commission found that an EPFD limit would directly measure the effect of a potentially interfering terrestrial station on a DBS receiver, and that calculating EPFD is simple, and easily

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28/ *Reallocation and Service Rules for the 698-746 MHz Spectrum Band (Tel. Channels 52-59),* Report and Order, 17 FCC Rcd 1022, 1064 ¶ 105 (2002) ("*Lower 700 MHz Order*").

29/ *Service Rules for the 698-746, 747-762 and 777-792 MHz Bands,* Report and Order and Further Notice of Proposed Rulemaking, 22 FCC Rcd 8064, 8101 ¶ 97 (2007).

30/ The EPFD method has been developed within the International Telecommunications Union to address the issue of multiple entry. International Telecommunications Union, Document 7D/47 (2001).

31/ *Amendment of Parts 2 and 25 of the Commissions Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku Band Frequency Range; Amendment of the Commission's Rules to Authorize Subsidiary Terrestrial Use of the 12.2-12.7 GHz Band by Direct Broadcast Satellite Licensees and Their Affiliates; and Application of Broadwave USA, PDC Broadband Corporation and Satellite Receivers, Ltd., to Provide A Fixed Service in the 12.2-12.7 GHz Band,* Memorandum Opinion and Order and Second Report and Order, 17 FCC Rcd 9614 (2002) ("*12 GHz Second R&O*").

32/ *Id.* at 9960 ¶ 114.

33/ *Id.* at 9642 ¶ 69.

measured and enforced. 34/ Use of a ground level received power limit is equally appropriate in this case.

The Commission observed in the *Notice* that the PFD limit originally proposed by Sirius is a measurement that does not conform to methods typically used by the FCC. 35/ XM proposes that the Commission instead adopt a PFD limit expressed in microvolts per meter (dBμV/m). As the Commission noted, this measurement eliminates the need for measurements of receiver antenna gain. 36/ It is also consistent with emission limits previously adopted to govern similar circumstances, as discussed above. In previous instances in which the Commission adopted a PFD limit, it found that such a limit is technology-neutral and allows for the use of any antenna type, tower height, or EIRP combination. 37/ Such is the case here as well.

XM continues to support the proposal by Sirius that the received power from an SDARS repeater should be modeled and, if required, measured at a height of two meters above ground level, at a distance from the base of the antenna that is equal to or greater than the effective height above ground level of the SDARS antenna. 38/ In addition, to best approximate real world conditions, XM urges the Commission to require that compliance with the PFD limit be calculated based on the TIREM or other similar propagation model. 39/ The other parameters that affect the use of the model are discussed in the attached Technical Appendix at Exhibit A, Appendix 2.

Although the proposed PFD standard will not be costly to administer and will be a very reliable predictor of harmful interference, the proposal necessarily incorporates the use of

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34/ *Id.*
35/ *Notice* at n.42.
36/ *Notice* at ¶ 18.
37/ *12 GHz Second R&O* at 9690 ¶ 113.
38/ *Notice* at ¶ 15.
39/ Technical Appendix, Exhibit A at Appendix 2.

exclusion zones. Definition of exclusion zones based on PFD limits will benefit both SDARS and WCS licensees. In this context, WCS licensees will be able to design their networks, and deploy their base stations, to address their own coverage needs. As discussed below, SDARS licensees will be able to do the same based on the exclusion zones created by the PFD limits we propose for WCS operations. Indeed, this is one of the advantages of using PFD limits to coordinate SDARS and WCS transmissions. If the Commission limited transmitter power alone, exclusion effects would still occur, but adjacent licensees would not have as reliable a means of identifying such effects and designing their networks to address them.

Because a PFD standard will involve predictive modeling, certain areas will not always conform to the model. Locations within the prediction area may exhibit "line-of-sight" propagation loss characteristics that differ from the propagation loss predicted using the proposed PFD modeling. These locations occur in a small percentage of the total area measured, due to the geometry between the antennas used during the measurement and the lack of any of the normally expected sources of additional signal attenuation, such as foliage, terrain, buildings, signage, etc. In these limited areas, SDARS or WCS licensees may need to deploy additional transmitters to compensate for increased interference.

B. A Power Flux Density Limit Of 110 dBμV/m Will Protect Properly-Designed WCS Receivers

In the attached Technical Appendix, XM demonstrates that a ground-level emission limit of 110 dBμV/m will satisfy SDARS service needs while fully protecting adjacent WCS operations. This analysis clearly shows that if WCS receivers are designed to provide protection from the SDARS repeater signals equivalent to that which the current SDARS receivers provide from WCS interference, such a ground-level emission limit is reasonable. It is notable that Sirius and XM each designed repeater networks, and worked cooperatively during network deployment to minimize interference to one another's receivers, even though the SDARS receivers, of necessity, are far more sensitive and susceptible to interference than normal terrestrial receivers.

In areas covered by repeaters, SDARS receivers must simultaneously receive relatively faint satellite signals in the presence of adjacent interfering terrestrial repeater signals (e.g., XM's radios must reject the much higher power Sirius terrestrial repeater signal only four MHz away). The challenge of radio design for a WCS system with similar arriving signal levels from an SDARS terrestrial base is far less difficult than what XM and Sirius radio designs already have met. XM and Sirius sell inexpensive radios in the retail market that coexist with each other; clearly the technology also exists for WCS operators to design inexpensive radios that will coexist with SDARS systems.

Because SDARS engineers have not had access to any 2.3 GHz WiMax equipment to test, they have relied on other low cost consumer receiver information and published WiMax link budgets to validate this analysis. This information shows that the receiver noise floor for a WiMax device will be -104 dBm instead of the -113 dBm shown in the SDARS noise floor measurement study. It follows that the operating point for a WiMax receiver is actually approximately 10 dB higher than an SDARS receiver. Given an assumption that similar out of band signal interference protection to overload would exist for both SDARS and WiMax receivers, the overload point for WiMax would be 110 dBμV/m instead of the 100 dBμV/m as measured with the SDARS receiver testing. 40/

40/ Technical Appendix, Exhibit A, at 16.

As the Commission notes, Sirius previously advocated that a -44 dBm limit (equivalent to 100 dBμV/m) apply to *both* SDARS terrestrial repeaters and WCS base stations. 41/ However, this proposed limit was based on tests conducted without the benefit of newly-available information concerning WCS receivers and had been derived primarily based on predicted interference into SDARS receivers from WCS base stations or transmitters. At the time it was proposed, the -44 dBm limit seemed to be a workable figure that could apply equally to both SDARS and WCS services. 42/ Since that time XM has identified more current information on WCS receiver design, focusing in particular on the WCS industry's intention to use its spectrum to offer WiMax and mobile WiMax products and services. This has allowed XM to identify with much more precision the potential impact of SDARS repeater operations on WCS base stations and terminals. 43/

We now have reliable data demonstrating that SDARS repeaters will not interfere with WCS receivers if SDARS repeaters comply with a PFD limit of 110 dBμV/m. Tests conducted by XM prove convincingly that WCS equipment should not be affected by SDARS terrestrial repeaters as they exist today or by SDARS terrestrial repeaters operating in compliance with the standards proposed below. XM engineers modeled the functioning of a WCS receiver based on

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41/ *Notice* at ¶ 15; *see also* Petition of Sirius Satellite Radio Inc. for Rulemaking, and Comments, IB Docket No. 95-91, GEN Docket No. 90-357, RM 8610, 4 (Oct. 17, 2006) ("*Sirius Petition for Rulemaking*").

42/ As discussed *infra* in Section III.A.2., WCS base stations should still be subject to a field strength limit of 110 dBμV/m in order to protect SDARS receivers.

43/ In addition, the -44 dBm proposal assumed that there would be a guard band interval between the SDARS band edge and the WCS transmit frequency. XM believed that this guard band would be required to allow for appropriate WCS transmit filtering to meet the current OOBE limits into the SDARS band. XM estimated this guard band to be 1.25 – 2MHz. However, a new limit for C and D blocks is required in the absence of any certainty that such a guard band exists. *See* Technical Appendix, Exhibit A, at 11-12.

inexpensive, commercially available, widely used components, and on statements made in the public record by WCS licensees as to the intended design of their receivers. 44/

XM assumed the same level of protection would be provided for the WiMax receiver as was measured in the XM receiver. XM then calculated the required protection level using information publicly available regarding receiver sensitivity levels in mobile handsets and in fixed desktop with WiMax devices. 45/ The results demonstrate that WCS receivers should be protected from an SDARS repeater signal up to a power level of 110 dBμV/m. 46/ XM also examined GSM and cellular telephone receivers and determined that WCS receivers incorporating basic mobile telephone technology would tolerate an interfering signal from an SDARS repeater at or greater than 110 dBμV/m. 47/

Accordingly, XM's findings show that properly-designed WCS receivers capable of being built at low cost for the consumer market should experience very low levels of overload interference from existing SDARS repeater sites. This is true even if the SDARS repeaters are operating at higher power levels. 48/ The data demonstrate that the use of inexpensive AGC circuitry in WCS receivers, which we understand is likely to be the case, will mitigate most

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44/ The Commission's AWS-3 proceeding has yielded much information concerning mobile system and receiver design. In that proceeding, NextWave – a member of the WCS coalition – argued for minimum equipment standards to apply to mobile devices, acknowledging that receiver design is an integral component in preventing interference among devices employing dissimilar uses of spectrum. Specifically, NextWave proposed that contention-based protocol "CBP" requirements for devices in the 3.65 GHz band also be applied to devices operating in the AWS-3 band. While the CPB generally is designed to prevent co-channel interference with other dissimilar contention devices, NextWave noted that the CPB will provide an additional layer of protection to devices operating in adjacent bands. Reply Comments of NextWave Wireless, Inc., WT Docket No. 07-195, 8-10 (filed Jan. 14, 2008) ("*NextWave AWS-3 Reply Comments*").

45/ Technical Appendix, Exhibit C, at 4-6.

46/ *Id.* at 4.

47/ *Id.* at 6.

48/ Technical Appendix, Exhibit A, at 12.

interference from SDARS repeaters. 49/ In the very limited cases where WCS user terminals are operating within a signal level from an SDARS repeater that exceeds the AGC threshold, locating a WCS base station in the vicinity of the SDARS repeater will ensure that WCS receivers will operate without harmful interference. 50/

C. The Commission Should Reject the WCS Proposal for a 2 kW EIRP Limit on SDARS Repeaters, Particularly if There is No Grandfathering of Existing Sites

The WCS licensees have argued that the Commission should adopt a 2 kW EIRP average power limit on SDARS repeaters, with no grandfathering of sites in the field. 51/ As discussed above, there is no reason for this limit because a ground level PFD limit of 110 dBμV/m with respect to SDARS repeaters fully protects WCS operations and interests.

However, to the extent that the Commission does not adopt this PFD limit, it is critical that XM's currently deployed repeaters be grandfathered from any new power limits and other requirements. The tests discussed above demonstrate that there will be no harmful interference to reasonably-designed WCS operations from existing SDARS repeaters in the field since widely-used, inexpensive AGC circuitry will prevent harmful interference into WCS receiver units. Significantly, WCS licensees have not provided any evidence showing that such interference would occur.

In contrast, adopting a 2 kW average power limit on SDARS repeaters would substantially increase the number of transmitters XM would need to deploy to offer the same level of service it currently provides in a given market. It is important to note that XM's current

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49/ *Id.*, at 8-9. Indeed, XM and Sirius have incorporated into their own receivers the same AGC circuitry advocated here for WCS receivers as a low-cost and effective measure against interference.

50/ *Id.*.

51/ The WCS Parties have proposed a brief one year grandfathering period, which is both unnecessary and impractical for the reasons discussed here.

network configuration relies on only a relatively few higher power repeaters (i.e., over 4 kW average power) and at least half of our repeater network already meets a 2 kW EIRP average power limit. 52/ However, XM would need to add 228 additional repeater sites at locations across the country to satisfy a 2 kW EIRP average power limit. 53/ To illustrate this point it is useful to consider an example based on the current XM Indianapolis market repeater deployment. This market currently utilizes a single site operating above 2 kW that is centrally located in the market at a high elevation. XM provides a coverage map showing its current service area in Indianapolis with this configuration. In order to maintain the current coverage in the market if that site were to be required to "power down" to 2 kW EIRP, XM would have to add 39 new sites around the city. 54/ The number of new repeater sites required in other markets will vary based on market circumstances, but this example illustrates the point that in certain cases a single grandfathered site both satisfies XM's system coverage goals and also minimizes the number of sites that an adjacent spectrum holder would need to account for in its network design.

Such construction would impose enormous and unnecessary costs on XM (and therefore ultimately its customers) for no purpose. Construction of each new site takes a significant amount of time and money. Based on our experience of obtaining zoning approval from local authorities and our experience with constructing repeater sites in the past, depending on the location, it can take 12 to 18 months to deploy each new repeater site, from determination of coverage need, through repeater activation. Thus, even on a network-wide deployment schedule (as opposed to a staggered schedule), it would take approximately 24 months to complete the network reconfiguration. Costs and schedule can vary dramatically from site-to-site due to the

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52/ Technical Appendix, Exhibit B at 5.

53/ *Id.*

54/ *Id.* at 3-4.

variation in leasing, zoning and permitting processes across the country. At a minimum, even without consideration of customer disruption, network continuity concerns, and repeater hardware costs, tens of millions of dollars in construction costs would be incurred. Recurring costs for the additional repeaters would be even more significant -- for site leases, utilities and network operation, and maintenance at each additional site.

In summary, WCS licensees are fully protected if SDARS repeaters observe a ground-level emission limit of 110 dBμV/m. Imposition of an EIRP limit would only add to the costs of SDARS service, and increase the number of SDARS repeaters that WCS licensees must address in their system design. At the least, however, XM should not be required to incur the unnecessary cost of replacing repeaters that are doing no harm to WCS licensees today, and that present no barrier to WCS deployment in the future.

D. SDARS Repeaters Operating at 2 W EIRP Or Below Need Not Be Subject to the Ground Level Emission Limits

Finally, XM proposes that very low power SDARS repeaters -- those operating at 2 watts EIRP average power or below -- be excused from the ground level emission limits otherwise applicable to SDARS repeaters. These devices present no threat of harmful interference to WCS operations at this power level given that the OOBE limit of 75+10log(P) will still apply. It is sufficient for such low power repeaters to be type accepted to conform to these levels.

III. THE COMMISSION SHOULD MODIFY EXISTING WCS RULES ONLY IF SUCH CHANGES DO NOT JEOPARDIZE SERVICE TO SDARS CONSUMERS

In their continuing quest to maximize the value of their licenses, the current WCS spectrum holders advocate relaxing the OOBE limits into the SDARS band that the Commission enacted ten years ago to protect the SDARS service. The WCS industry seeks a substantial increase in its flexibility to operate by asking the Commission to reduce the existing limits that control interference from WCS operations into SDARS receivers solely through relaxing the current limits on OOBE into the SDARS band. Unfortunately, the WCS proposal directly threatens SDARS reception for millions of Americans -- contrary to the letter and spirit of the WCS rules themselves.

As XM has indicated in the past, we are open to considering liberalizing the WCS rules -- *provided* any such changes will not cause harm to SDARS systems and customers. XM has participated in numerous technical discussions with WCS licensees on this subject. XM has engaged in engineering studies reflected in the attached Technical Appendix. 55/ XM has invited WCS licensees to develop mutually-acceptable joint test plans, in coordination with and under the guidance of Commission staff, as a mechanism to achieve this result. 56/ We have no interest in unnecessarily confining WCS spectrum holders if SDARS service is not affected.

In that same spirit, XM presents proposals here of how WCS rules might be relaxed, albeit only if ground level emissions into SDARS terminals are limited. Fixed WCS services present more opportunities in this area, while mobile WCS services are problematic (as the Commission has always recognized). However, through the use of appropriate EIRP and OOBE

55/ XM conducted these tests in coordination with Sirius, and under its supervision, pursuant to Special Temporary Authority granted by the Commission on January 23, 2008 (File No. 0591-EX-ST-2007, Call Sign WD9XDT).

56/ XM remains very interested in planning and participating in joint testing under the Commission's oversight to the extent that this would be helpful to bring this docket to a more rapid conclusion. The Technical Appendix presents significant data supporting both the SDARS repeater emission limit we propose, giving the Commission a full record to set final SDARS repeater rules now. The data presented here also demonstrates the limits possible with regard to relaxation of the WCS rules. However, if the Commission has any residual questions, the best way to address them is to oversee joint testing using representative SDARS and WCS terminals.

limits for the mobile and portable devices, WCS licensees can gain more flexibility without harming SDARS subscribers.

A. WCS Licensees Seek Significant Modification of Their Rules That Would Cause Serious Harmful Interference Into SDARS Receivers

First of all, the Commission should reject the proposals of the current WCS spectrum holders for a dramatic U-turn from the WCS rules that have been in place for over ten years. Those parties propose changes in power and out-of-band emissions limits that, standing alone, would seriously degrade the service received by SDARS subscribers.

1. WCS Mobile Units

As set forth in the Notice, the WCS Coalition has proposed that WCS subscriber terminals would be limited to 20 watts average power. 57/ The WCS Coalition also has requested a reduction in the Part 27 minimum suppression of OOBE from WCS subscriber units by 55 dB – from 110 + 10 log (p) to only 55 + 10 log (p) in the adjacent band. 58/ The WCS Coalition has argued that this reduction is warranted because current limits are not necessary for the protection of SDARS operations, and because WCS licensees would like more flexibility to develop wireless broadband services, and WiMax technology, in particular. 59/

However, because mobile devices both transmit and receive, the WCS Coalition's proposal to relax power and emissions limits for these terminals greatly increases the interference levels that would affect satellite radios, which are receive-only. In addition, WCS mobile operations further threaten SDARS service because it is much more likely that WCS

57/ *Notice* at ¶ 21-24.

58/ *Id.* at ¶ 24; *see also* Letter from Paul J. Sinderbrand, Counsel to the WCS Coalition, to Marlene Dortch, Secretary, Federal Communications Commission (July 9, 2007) ("*WCS Coalition July 2007 Letter*").

59/ *WCS Coalition July 2007 Letter* at 7-9.

mobile transmitters will come into close proximity to SDARS receivers than would fixed WCS equipment. Accordingly, for mobile devices, more stringent restrictions must be adopted in order to protect satellite radio customers.

In September 2007, XM and Sirius submitted a detailed technical analysis demonstrating that the WCS Coalition's proposal on OOBE, combined with its proposal for EIRP-based transmitter limits, would cause massive interference to satellite radio receivers. 60/ Our more recent findings confirm these results. XM recently conducted both laboratory and field tests designed specifically to determine the effects mobile devices deployed in the WCS frequency blocks may have on XM's receivers. The methodology and results of such tests are described more fully in the Technical Appendix. 61/ XM conducted the field tests to determine at what distance a WCS device 62/ would cause overload interference to an XM receiver. 63/ The tests provided the information required to calculate at what transmit power level a WCS device would cause interference with an XM receiver at a distance of three meters. The three meter separation parameter – which is approximately the same protection SDARS receivers get under the current rules restricting WCS OOBE 64/ – makes sense for purposes of protecting SDARS receivers, most of which are installed in automobiles. It is also a much more generous assumption than that used in other mobile-into-mobile interference contexts, which apply a one meter separation

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60/ Letter to Marlene H. Dortch, Secretary, Federal Communications Commission, from Patrick L. Donnelly, Executive Vice President, General Counsel & Secretary, Sirius Satellite Radio Inc., and James S. Blitz, Vice President, Regulatory Counsel, XM Radio Inc., IB Docket No. 95-91, GEN Docket No. 90-357, RM-8610 (filed Sept. 19, 2007) ("*Sirius/XM Sept. 2007 Ex Parte Letter*") at Annex 1: Impact of WCS Mobile Devices.

61/ Technical Appendix, Exhibit C.

62/ Although, as noted above, no WCS WiMax device was available for testing, the test was conducted using standard test equipment along with reference WiMax signals supplied by the test equipment vendor. Exhibit C at 1.

63/ The XM receiver used for testing is representative of the majority of XM receiver platforms deployed in the market. The test included both an aftermarket receiver and a factory installed receiver. The aftermarket receiver was installed as an antenna mounted on the rear roof of an automobile, with the receiver inside the vehicle. Exhibit C at 5.

64/ *Sirius/XM Sept. 2007 Ex Parte Letter*, Annex 1; *see also* 47 C.F.R. § 27.53(a)(3) (110 + 10 log (P) dB).

assumption. 65/ In the field tests, the standard used to determine whether the WCS device caused interference was based on monitoring the receiver to detect uncorrectable "Reed Solomon codewords." This is the indicator of the point at which digital audio data corruption would result in an audio mute of the XM receiver. 66/

The results of the laboratory tests showed conclusively that XM's receivers were subject to unacceptable overload interference at -44 dBm (100 dBμV/m) for the A and B block WCS signals and below -55 dBm (90 dBμV/m) in the D block. The field tests recorded the distances from which a WCS device transmitting at 112 mW would cause the receiver to degrade to the point that uncorrectable Reed-Solomon codewords were detected. This field test validated the laboratory results. Accordingly, in order to avoid muting satellite radio reception at a separation distance of 3 meters, a calculation was done to determine that a WCS mobile device would have to operate at 10 dBm EIRP in A and B blocks, and 0 dBm EIRP in the D block.

To confirm its laboratory calculations concerning measurements to determine an appropriate OOBE limit for WCS mobile devices, XM contracted with an independent test laboratory to measure the noise floor for XM's system. The independent test determined that the noise floor for the XM receivers was -113 dBm in the 4 MHz channel. 67/ Based on this calculation, and the 3 meter separation parameter, XM also calculated the allowable OOBE level that would result in a 1 dB rise in satellite noise floor. Tests conducted demonstrate that the WCS Coalition's proposed relaxation of OOBE limits, if applied to mobile devices, would mute

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65/ *See, e.g.,* Comments of Motorola, Inc., WT Docket No. 07-195 at 5 (filed Dec. 14, 2007) ("Requiring commercial wireless devices from adjacent band services to co-exist at a distance of 1 meter is a metric that has been supported by a majority of the wireless industry, including Motorola."); Comments of Verizon Wireless, WT Docket No. 07-195, at 6-7 (filed Dec. 14, 2007) ("The record in previous proceedings shows that the wireless industry generally employs a one meter separation distance as the standard for mobile operations.").

66/ Technical Appendix, Exhibit C at 7.

67/ *Id.* at Appendix 1, Noise Floor Measurement, Florida Atlantic University, EMI Research and Development Laboratory, Department of Electrical Engineering, Technical Report No. 07-119 (Nov. 26, 2007).

satellite radio receivers at great distances. In order to reduce this distance to 3 meters, OOBE for WCS mobile devices must be limited to: 102.7 + 10 log (P) where P is the average transmitter power in watts, 68/ a far more stringent measurement than that proposed by the WCS Coalition.

Test results submitted previously in response to the WCS Coalition's proposal indicated that a hypothetical WiMax mobile device operating in the 2.3 GHz WCS band would cause severe overload interference – enough to cripple satellite radio reception within 115 meters of the interfering WCS devices, causing one of the two satellite feeds to be rendered unusable to a satellite radio. 69/ This effectively would create large interference zones around each WCS mobile unit. The test data indicate that both a reduction of OOBE limits and a stricter EIRP limit must be established for WCS mobile devices to minimize the interference zone to acceptable levels. The criteria for this limit is to protect the SDARS receiver equally from interference caused either by OOBE (as determined by a 1 dB rise in the SDARS noise floor), or from overload (as determined by a 100 dBμV/m signal level at the SDARS antenna). These calculations were made to protect the SDARS receiver at a distance of 3 meters from the WCS mobile device. 70 In sum, XM's tests conclude that more restrictive power and emission limits are necessary to protect SDARS receivers from mobile WCS devices.

2. WCS Base Stations and Fixed User Terminals

As set forth in the Notice, the WCS Coalition proposed that WCS base stations be allowed to operate at 2 kW EIRP based on average, rather than peak power per 5 MHz, with a 6

68/ This level is equivalent to -124.9 dBm + 52.2 dB = -72.7 dBm, measured in a 1 MHz bandwidth. *See* Technical Appendix, Exhibit A at Section 3.3.1.5.

69/ *Id.* at Appendix 1 p. 2.

70/ An additional 3 dB of path loss over free space was included to determine the radiated limits allowed to meet this standard. Technical Appendix, Exhibit C at 9.

dB peak-to-average ratio. 71 The Coalition also proposed to relax the restrictions on OOBE in the current rules, which permit OOBE at up to 80 + 10 (log) P dB for fixed applications. 72 As XM and Sirius have discussed in previous submissions, this proposal represents an increase in the allowed base station power limits that is four times the current 2 kW peak EIRP rule for fixed WCS base station transmitters, assuming 6 dB peak to average power ratio for the transmission signal. 73/ For the reasons explained above in Section II.A., XM believes that base station power and emissions are more appropriately measured in terms of ground level PFD – as ground level is where XM receivers will be likely to experience interference. Accordingly, XM is proposing that a ground-based PFD limit be applied to WCS base stations. 74/

XM has defined fixed user terminals as "equipment which transmits only when it is connected to AC power directly or through a transformer. A fixed station does not transmit when connected only to a battery, whether internal or external." 75/ Fixed terminals represent less of an interference threat to SDARS receivers. Sirius's previously-submitted tests demonstrated that received signal levels of approximately -43 dBm from a transmitter in the WCS C block would interfere with and prevent a Sirius subscriber from receiving the signal from either of its two satellites. Tests showed similar results for XM receivers and WCS D block emissions. 76/ Based on these results, Sirius concluded that where the level of interference exceeded -44 dBm, both satellite channels likely would be blocked, preventing satellite service

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71/ *Notice* at ¶ 21.
72 / *Id.* at ¶ 24.
73/ *Sirius/XM Sept. 2007 Ex Parte Letter* at 6 n.24.
74/ *See* Technical Appendix, Exhibit A, at 12.
75/ *See id.* at Section 2.2.6.
76/ *See* White Paper: Interference to the SDARS Service from WCS Transmitters at 14 *attached to* Letter from Carl Frank, Counsel to Sirius Satellite Radio, to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No 95-91 (Mar. 30, 2006) ("*Sirius White Paper*").

from being received by SDARS subscribers. 77/ For XM, specifically, 100 dBμV/m (-44 dBM) will provide protection from overload interference from the WCS A and B blocks. The level of protection needed from WCS operations in the D Block, however -- which is directly adjacent to XM's band -- could be much greater despite XM's 2 MHz guard band intended to mitigate interference in that block. For the D block, 90 dBμV/m (-55 dBM) would be the appropriate power level. Accordingly, the Commission should adopt a PFD limit of 100 dBμV/m for interference from WCS fixed terminals in the A and B blocks, and a PFD limit of 90 dBμV/m in the D block.

B. Summary of Proposal For WCS Relief

XM's field and laboratory tests demonstrate that some relaxation of the WCS rules is possible, with the amount of relaxation depending on the band and application. Specifically, XM would not oppose the following modifications to the limits applied to WCS operations:

WCS Mobile And Portable Devices	
EIRP	
A & B Blocks	10 dBm (10 milliWatts)
C & D Blocks	0 dBm (1 milliWatt)
OOBE	
1 db Rise in noise floor	124.dBm + 52.2 dB = -72.7 dBm, measured in a 1 MHz bandwidth

77/ *Id.*

WCS Fixed User Terminals	
No Ground-Based PFD Limit if operating at less than 2 watts EIRP	
A & B Blocks	100 dBμV/m (-44 dBm isotropic equivalent power)
C & D Blocks	90 dBμV/m (-55 dBm isotropic equivalent power)
OOBE	
1 dB rise in noise floor	75+10 log (P) (-45 dBm power) measured in a 1 MHz bandwidth

WCS Base Stations	
Ground-Based PFD Limit	
A & B Blocks	100 dBμV/m (-44 dBm isotropic equivalent power)
C & D Blocks	90 dBμV/m (-55 dBm isotropic equivalent power)
OOBE	
1 dB rise in noise floor	75+10 log (P) (-45 dBm power) measured in a 1 MHz bandwidth

These standards would mark a significant relaxation of the current WCS rules and allow WCS licensees to provide services that the Commission contemplated would not be possible in 1997. Yet based on the tests as discussed in the attached Technical Appendix, these limits should not cause harmful interference to reception from the SDARS satellites by SDARS subscribers.

C. The Record in the AWS-3 Proceeding Confirms that the WCS Limits Proposed Here are Practical and Consistent with Steps that the WCS Licensees Themselves Already Need to Take to Avoid Interference

The WCS rules proposed above would materially relax limitations on fixed WCS services without unreasonable harm to SDARS service. Although mobile WCS would continue to be more constrained, especially in the C and D blocks closest to SDARS operations, WCS licensees hardly can complain about this limitation given the notice they have had regarding the limited suitability of their spectrum for mobile applications based on the need to protect SDARS. This is all the more reasonable since other spectrum is available and more compatible with mobile WiMax uses.

One example is particularly telling. Beginning in 2001, the Commission has designated 130 megahertz of spectrum for use by advanced wireless services ("AWS"). 78/ The Commission uses the term AWS for new and innovative fixed and mobile terrestrial wireless applications using bandwidth that is sufficient for the provision of a variety of applications, including those using voice and data content." 79/ Appropriately, much of the public discussion concerning WiMax operations and services has taken place in setting service and licensing rules for AWS. In its recent AWS-3 rulemaking proceeding, the Commission proposed three different technological proposals for addressing the trade-offs presented between flexible use and interference protection in the band. 80/ The AWS-3 rulemaking proceeding presents a special challenge because the designated spectrum is a single, contiguous 20 MHz segment, with base transmit bands on either side, as opposed to two separate bands. Other AWS spectrum rules employ symmetrical pairing in two separate bands. In this proceeding, the Commission

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78/ *Service Rules for Advanced Wireless Services in the 2155-2175 MHz Band,* WT Docket No. 07-195, Notice of Proposed Rulemaking ¶ 7 (2007) ("*AWS-3 NPRM*").

79/ *Id.* at n.1.

80/ *Id.* at ¶ 10.

expressed the concern that "allowing for both mobile and base transmissions in the band presents certain additional adjacent channel and co-channel interference concerns." "Thus," the Commission explained, "granting that additional flexibility may come at the cost of additional interference protections that would severely limit the utility of mobile and base transmissions." 81/

With these concerns in mind, companies seeking to develop mobile WiMax services (including NextWave, one of the largest holders of WCS spectrum and a member of the WCS Coalition) have advocated power and emission limits in the AWS-3 band that are well within the operational limits XM and Sirius advocate here, and, notably, more restrictive than the power and emission limits the WCS licensees have proposed for WCS spectrum. 82/ Part of the reason for the power and emissions proposed in that proceeding lies in the fact that mobile WiMax operations use a single channel for uplink and downlink operations. Because mobile WiMax technology calls for both base station and mobile transmitting and receiving in the same spectrum band, mobile-to-mobile and base-to-base interference can occur in the same band and in adjacent bands. 83/ When a mobile WiMax or base station transmits without adequate distance or frequency separation, it will affect mobile or base station receivers in-band as well as

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81/ *Id.* at ¶ 11.

82/ For example, NextWave proposes that the Commission apply the technical rules it adopted for the 3.65 GHz band (47 C.F.R. §§ 90.1321, 90.1323) to the AWS-3 band. Applying that framework to the AWS-3 band, base stations would be allowed to operate according to the following specifications: 25 Watt EIRP maximum power in 25 MHz bandwidth for Base Stations; 1 W/MHz EIRP maximum power spectral density for Base Stations; and attenuation of OOBE of 43 + 10 log (P). For end user devices, NextWave notes that overload and out of band emissions into mobile devices operating in the AWS-1 and AWS-2 bands is the primary concern. NextWave believes these concerns would be largely eliminated if the 3.65 GHz rules are adopted – effectively limiting EIRP to a range of 5-10 dBm. In accordance with the proposed framework, AWS-3 end user devices would meet the following specifications: 800 mW EIRP maximum power in 20 MHz bandwidth for fixed, portable, and mobile devices; 40 mW/MHz EIRP maximum power spectral density for portable and mobile devices; and attenuation of OOBE of 43 + 10 log (P). Reply Comments of NextWave Wireless, Inc., WT Docket No. 07-195, 4-8 (filed Jan. 14, 2008) ("*NextWave AWS-3 Reply Comments*").

83/ *AWS-3 NPRM* at ¶ 15.

users in the adjacent spectrum. 84/ Given the standards being proposed in the AWS rulemaking by proponents of mobile WiMax, it appears that mobile WiMax providers must be subject to more restrictive standards than the WCS Coalition has proposed in the instant proceeding in order to prevent interference *among themselves*.

In short, the WCS limits proposed by XM here are both the minimum necessary for the protection of the technically-challenging SDARS continuous service to subscribers, and are consistent with the technical requirements of the services that WCS licensees now claim they seek to offer.

IV. XM Supports Licensing Rules To Govern SDARS Repeaters That Are Consistent With Existing FCC Rules and Policies

A. Collocation Restrictions Are Not Needed

XM has concluded that intermodulation interference with respect to collocation of SDARS and WCS stations, can be worked out privately. Intermodulation studies are typically required by site providers when a new tenant is added so that all tenants at a given site may operate in a compatible, non-interfering manner. These studies predict interference levels and provide information about the isolation levels required for a compatible site environment. Most importantly, they assist in site design and planning prior to any construction.

Because customary site management practices incorporate this means for resolving collocation issues, additional measures mandated by the FCC are unwarranted. Indeed, the

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84/ Moreover, the transmitting mobile and base station will affect mobile and base station receivers in the same spectrum in adjacent geographic areas without measures in place to synchronize the networks to a common timing standard and to use the same channel symmetry. *AWS-3 NPRM* at n.27 (citing Harri Holma, Sanna Hekkkinen, Otto-Aleksanteri Lehtinen, and Antti Toskala, *Interference Considerations for the Time Division Duplex Mode of the UMTS Terrestrial Radio Access*, IEEE Journal on Selected Areas in Communications, Vol. 18, No. 8, August 2000, available at <http://lib.tkk.fi/Diss/2003/isbn9512267187/article10.pdf>. *See also* Gordon J R Povey, Elektrobit (UK) Ltd, Edinburgh Technology Transfer Centre, "Investigation of Multiple Access Interference Within UTRA-TDD," available at <http://www.eurasip.org/content/Eusipco/2000/sessions/TueAm/SS1/cr1909.pdf>).

Commission has noted previously that intermodulation interference is more appropriately addressed on site rather than in a rule. 85/ Moreover, our discussions with WCS entities have led us to believe that collocation rules that would require a showing, as Sirius has proposed, 86/ could burden WCS licensees unnecessarily where mitigating measures are already in place. XM therefore urges the Commission to refrain from adopting rules restricting collocation of SDARS and WCS stations.

B. The Commission Should Adopt Notice and Record-Keeping Requirements To Facilitate SDARS/WCS Coordination

XM supports the record-keeping and information sharing requirements for both SDARS and WCS licensees proposed by Sirius. These requirements are reasonable mechanisms to coordinate transmitter deployment and should minimize the risk of harmful interference between users of adjacent spectrum. Importantly, however, XM urges the Commission to limit the use of the coordination system proposed by Sirius to WCS and SDARS users. While appropriate, narrowly tailored rules should minimize the need for recordkeeping and coordination, XM believes that parties should maintain data about their sites and implement the database suggested by Sirius, and that the database should be maintained by a third party having frequency coordination responsibilities.

85/ *See, e.g., Service Rules for the 746-764 and 776-794 MHz Bands and Revisions to Part 27 of the Commission's Rules,* Report and Order and Further Notice of Proposed Rulemaking, FCC 07-72 ¶ 110 (Apr. 27, 2007); Third Report and Order, 17 FCC Rcd 13985, 13995-13996 (2002); *Mobile Satellite Ventures Subsidiary LLC,* Report and Order, 19 FCC Rcd 22144, 22172 (2004); *Amendment of Section 90.307(f),* Report and Order, 56 Rad. Reg. 2d (P&F) ¶ 14 (1984).

86/ *Sirius 2006 Petition For Rulemaking and Comments,* Appendix A at A-1, Annex B at B-1, B-2.

C. SDARS Repeaters Will Conform To International Agreements

XM does not object to a requirement that future SDARS repeaters comply with the agreements with Canada and Mexico, or that SDARS licensees would be required to seek prior FCC approval to operate any new SDARS repeater that exceeds the power levels and/or proximity restrictions specified in the agreements with those countries. 87/ Significantly, those agreements make use of PFD limits, underscoring the appropriateness of using a ground-based emission limit to prevent harmful interference as XM proposes here.

D. Both SDARS And WCS Transmitters Should Comply With Existing RF Safety And Antenna Structure Clearance Requirements

XM does not oppose application of the Commission's RF and antenna structure clearance rules equally on both SDARS and WCS licensees. Currently, WCS licensees must perform routine RF evaluations for stations exceeding 1640 watts EIRP. 88/ XM supports this threshold for outdoor SDARS repeaters and WCS base stations, and for any WCS user terminals that may operate in excess of 2 watts. XM does not oppose a requirement to demonstrate compliance with the environmental regulations provisions incorporated into the FCC's rules as part of any request for terrestrial repeater blanket authorization. Similarly, XM does not oppose a requirement that SDARS licensees comply with Part 17.4 antenna structure clearance rules, as already mandated by the SDARS STAs, or a requirement that SDARS licensees demonstrate compliance with Part 17 as part of any blanket authorization request. 89/ Nor does XM oppose subjecting SDARS repeaters to the FCC's equipment certification process. Compliance with these rules would be consistent with requirements the Commission imposes on licensees in other services.

87/ *Notice* at ¶¶ 37-38.

88/ 47 C.F.R. § 1.1310, *see also, Notice* at ¶ 42, and n.111.

89/ *Notice* at ¶ 44.

E. Blanket Licensing of SDARS Repeaters Is Administratively Appropriate And Consistent With the Importance Of These Repeaters To SDARS Service

The Commission proposed blanket licensing when it first proposed permanent SDARS repeater rules in 1997, 90/ and that approach remains the most efficient way to authorize these facilities. XM supports the proposal by Sirius to allow SDARS licensees to construct and operate an unlimited number of conforming terrestrial repeaters under existing SDARS space authorizations. 91/ XM also supports the proposal to allow licensees to operate these repeaters so long as the licensee maintains a valid, underlying space station license. 92/ XM believes that no purpose would be served by imposing an arbitrary limit on these crucial facilities. Indeed, the WCS Coalition has indicated support for blanket licensing of terrestrial repeaters, as the Commission notes, to the extent that compromises can be reached on some of the proposed standards to govern the repeaters. 93/ In light of the consensus between the parties on this critical issue, the Commission should adopt blanket licensing procedures as proposed by Sirius.

F. Local Origination Using Terrestrial Repeaters

Consistent with its STA authorizations, XM does not originate any local programming using its terrestrial repeaters. XM therefore does provide national broadcasts of weather, traffic and sports that, while perhaps of more interest to people in certain parts of the country than others, are carried on XM's network and available to all subscribers. 94/ The Commission

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90/ *See 1997 SDARS Order* at 5812.

91/ *Sirius 2006 Petition for Rulemaking,* Appendix A (proposed Section 25.214(d)(1)).

92/ *Id.*

93/ *WCS Coalition July 2007 Letter* at 1 n.3.

94/ *See* Reply Comments of the United States Department of Transportation, MB Docket No. 04-140 (June 21, 2004) (opposing the petition of the National Association of Broadcasters seeking to prohibit SDARS from carrying traffic and weather information based on the "strong public interest in making travel-related information readily available").

should refrain from adopting any new rules that would potentially disrupt these valuable services. 95/

V. CONCLUSION

XM respectfully urges the Commission to complete the task that it began in 1997 and finalize its rules for SDARS repeaters. These facilities have proven to be crucial to the development of SDARS, just as the Commission expected at the time. The record is complete and permanent repeater rules should be adopted now. Those rules should grandfather existing SDARS repeaters, which cause no harm to WCS operations. No practical purpose would be served by requiring SDARS operators to construct and operate hundreds of additional repeaters that would be required to maintain the required service availability to consumers.

If the Commission also is prepared to grant WCS licensees some relief from the long-standing rules governing their spectrum, the Commission should take great care not to harm audio programming service to millions of SDARS consumers. The WCS rules were expressly written to protect the challenging technical performance of SDARS service, and XM has invested over a billion dollars in reliance on those rules. XM has suggested ways in which WCS

95/ Moreover, to the extent that the Commission adopts a rule prohibiting the use of terrestrial repeaters to originate local programming, and specifically, the language previously proposed in its 2001 Public Notice restricting SDARS repeaters to simultaneous transmissions, *Request for Further Comment on Selected Issues Regarding the Authorization of Satellite Digital Audio Radio Service Terrestrial Repeater Networks,* Public Notice, Report No. SPB-176, 16 FCC Rcd 19435 (Int'l Bur. 2001), the Commission should ensure that any slight delay caused by retransmission of the satellite signal through a terrestrial receiver does not violate any such rule (restricting SDARS repeaters to simultaneous transmission). *See Notice* at ¶ 57.

rules could be relaxed, recognizing (as the Commission always has) that interference from mobile WCS service is particularly threatening to SDARS operations. XM does not oppose this limited WCS relief, but not at the expense of millions of SDARS consumers.

Respectfully submitted,

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February 14, 2008

TECHNICAL APPENDIX

CERTIFICATION: **Certification of Craig P. Wadin, Senior Vice President, RF Systems, XM Radio Inc.**

EXHIBIT A: **Transmitter Power, Ground Based Power Limits, and Out of Band Emissions Level Proposals for SDARS Repeaters, WCS Base Stations and User Terminals**

Appendix 1 – Examples of Guard Band Use in WCS Fixed Wireless Equipment

Appendix 2 – Critical Factors for RF Propagation Modeling

Appendix 3 – Ground Based Field Strength Examples

EXHIBIT B: **SDARS Repeater Grandfathering Issues**

EXHIBIT C: **Experimental Measurements of Overload Interference from WCS Transmitters to DARS Receivers and the SDARS Noise Floor**

Appendix 1 – Noise Floor Measurement, FAU EMI R&D Lab

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I, Craig P. Wadin, am the Senior Vice President, RF Systems at XM Satellite Radio Inc. I joined XM in 1999 and have been involved in digital technology for approximately 34 years. Prior to joining XM, I was employed at Motorola Inc. I hold 37 U.S. patents in the field of Digital Communication.

I hereby declare under penalty of perjury that I am the technically qualified person responsible for preparation of the engineering information contained in the foregoing Comments of XM Radio Inc. and any attachments, that I am familiar with Part 25 and Part 27 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in the Comments of XM Radio Inc. and any attachments, and that it is complete and accurate to the best of my knowledge and belief.

Craig P. Wadin
Senior Vice President, RF Systems
XM Satellite Radio Inc.

Dated: February 14, 2008

Exhibit A

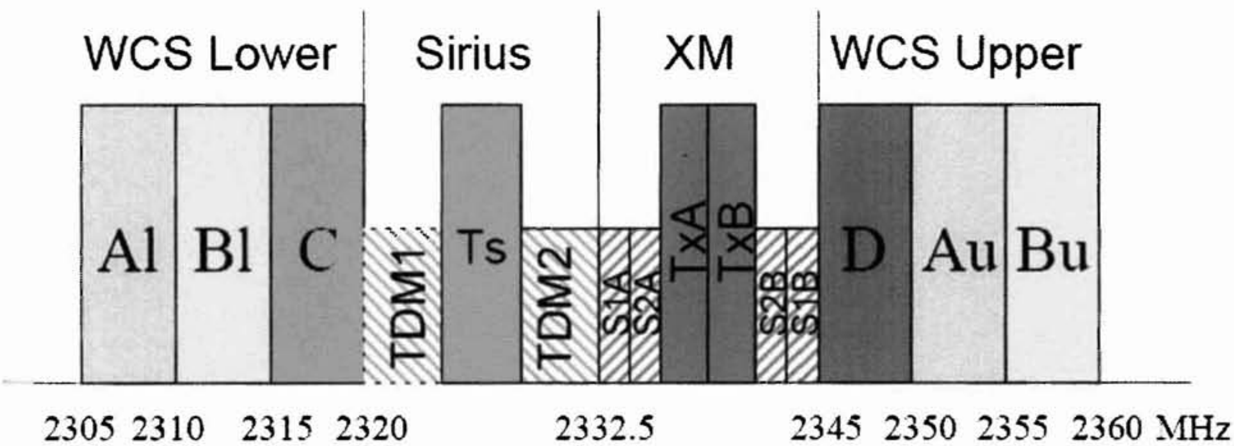
Transmitter Power, Ground Based Power Limits, and Out of Band Emissions Level Proposals for SDARS Repeaters, WCS Base Stations and User Terminals

1 Introduction

1.1 Band Plan

The WCS and SDARS services occupy 55 MHz of spectrum from 2305 MHz to 2360 MHz. The WCS service consists of six blocks of 5 MHz each, in the 2305-2320 MHz and 2345-2360 MHz bands. As shown in Figure 1 the following figure, there are paired blocks (A lower + A upper; B lower + B upper) that have been allocated on a regional basis (MEA service areas) and unpaired blocks (C and D) that have been allocated over very wide service areas (REAGs).[1] The SDARS service occupies the center 25 MHz (2320-2345 MHz) and is divided evenly between the two licensees, Sirius (2320-2332.5 MHz) and XM (2332.5-2345 MHz).

Figure1 WCS and SDARS Band Plan



TDM1 = Lower band Sirius satellite channel
TDM2 = Upper band Sirius satellite channel
Ts = Sirius COFDM terrestrial transmission channel
TxA and TxB= Two sub-bands (ensembles) of XM terrestrial transmission channels
S1A and S1B= Two ensembles of XM's first satellite
S2A and S2B= Two ensembles of XM's second satellite

Originally, all but 5 MHz of the spectrum shown in Figure 1 was proposed to be used exclusively for SDARS. In 1990, the FCC issued a *Notice of Inquiry* soliciting information to be used in identifying spectrum and developing technical rules and regulatory policies for Satellite DARS in the United States.[2] In coordination with the National Telecommunications Information Administration, the Commission supported U.S. efforts at 1992 World Administrative Radio Conference that ultimately allocated

1 *Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service,* 12 FCC Rcd 10785, 10808 ¶ 45 (1997) ("*WCS Report and Order*").
2 *Amendment of the Commission's Rules with regard to the Establishment and Regulation of New Digital Audio Radio Services*, Notice of Inquiry, 5 FCC Rcd 5237 (1990).

2310-2360 MHz for satellite DARS, and complementary terrestrial repeaters, in the United States.[3]

1.2 Differences Between Broadcast SDARS Service and Two Way WCS Service

1.2.1 Service and Network Requirements

1.2.1.1 SDARS Service and Network Requirements

The SDARS service is a mobile satellite service (MSS) serving the contiguous United States. Operating in the highly competitive marketplace for audio entertainment, this low price subscription service requires very high levels of service availability in order to ensure an almost uninterrupted listening experience, wherever the mobile or fixed customer may be.

Unlike subscribers to two-way mobile communications services, in a (one-way) broadcast service such as SDARS, the a customer has no capability to mitigate a service interruption (for example, by reinitiating a dropped call or waiting until a signal is available before placing a call). Therefore *any* small interruption to the listening experience is significant from a consumer perspective.

The SDARS service, therefore depends critically on maintaining higher levels of service availability than existing terrestrial only two way mobile wireless communications services. Both SDARS operators have used a mixture of technological innovation, as well as spatial, time, and frequency redundancy to develop and maintain greater than 99% service availability throughout the contiguous United States.[4] Recognizing that there are many locations where consumers have difficulty receiving satellite signals both SDARS operators augment the signal delivery with a limited number of ground-based repeaters in major cities. XM has deployed 800 repeaters to ensure that high availability levels are seamlessly achieved even in downtown areas with many tall buildings. The success of the SDARS hybrid satellite terrestrial architecture can be illustrated by contrasting the number of repeaters deployed to achieve >99% availability across the country with the much larger number of cellular base stations currently deployed by a typical cellular operator.[5] In augmenting the satellite delivery system, the SDARS repeaters cover less than 1% of the contiguous US land area, illustrating that the service is overwhelmingly delivered through satellite.

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3 47 C.F.R. § 2.106, international footnote S5.393 (formerly 750B).

4 Richard A. Michalski, Chief Engineer, Systems Engineering, XM Satellite Radio, Duy Nguyen , Senior Engineer, Systems Engineering, XM Satellite Radio, *A Method For Jointly Optimizing Two Antennas In a Diversity Satellite System,* AIA-2002-1996 (2002) available at http://www.aiaa.org/content.cfm?pageid=406&gTable=Paper&gID=144.

5 *See* CTIA at http://www.ctia.org/consumer_info/service/index.cfm/AID/10323 (>210,000 total base stations).

In areas where the satellite signal is impaired, such as dense urban areas, SDARS operators need to use ground-based repeaters to augment the signal delivery. XM's entire repeater network covers less than one percent of the United States land mass, but the repeaters are critical in high-traffic areas where satellite signals would be blocked and large numbers of SDARS customers routinely travel To illustrate this, Figures 1 and 2 show the results of drive tests performed by XM in May of 2004 in the Detroit metro area. Areas in blue indicate locations with an error free signal, areas in yellow indicate areas that are error free but with a low link margin, and areas in red represent locations that have errored signals. Figure 1 shows the results for the coverage provided by the combination of the satellites and repeaters; this composite coverage is 99.79% (reflected by the .21% bad coverage metric). Figure 2 shows the coverage provided by the repeaters alone, demonstrating that the area that is covered by the repeaters is 66% of the routes driven during this test.

The continuing success of the SDARS network in both ensuring seamless nationwide coverage while keeping subscription fees low, critically depends on maximizing the use of satellite infrastructure as opposed to terrestrial infrastructure with its associated higher operating costs . From a spectrum standpoint, this translates into maintaining a well understood adjacent band signal environment which minimizes degradation to the primary satellite signal reception from overload, intermodulation distortion ("IMD"), or out of band emissions.

The primary concern addressed in this document is therefore the impact of the proposed changes in Part 27 rules to allow WCS operators to transition from the successful fixed wireless access usage model upon which the original band plan was predicated to a broadband mobile wireless model that the FCC previously found unsuitable in the WCS bands.

Figure 1 XM Detroit Composite Satellite and Repeater Delivered Coverage.

Figure 2 XM Repeater Coverage for The Detroit Market

1.2.1.2 WCS Service and Network Requirements

Essentially two network types are relevant in this discussion of the WCS band, namely fixed wireless access and mobile/ portable broadband.

1.2.1.2.1 Fixed Wireless Access

The networks that were originally envisioned to operate in this band are fixed wireless, point to point or point to multipoint systems. These networks are similar in structure to the SDARS repeater network in that they consist of lower density, centralized, relatively high powered, tall transmitter sites with little or no antenna down tilt utilizing fixed user terminals with external or internal antennas. Several networks of this type are currently deployed and successfully coexisting with SDARS service. The availability target for these kind of networks is almost as high as for SDARS (99%+), but the coverage areas are typically market based as opposed to the SDARS national footprint.

1.2.1.2.2 Mobile/Portable Broadband

Mobile broadband services have significantly different network and terminal characteristics from fixed systems.[6] As contrasted with the previously described fixed network architecture, the network to support mobile service will typically consist of many more base stations (because of the weaker user terminal reverse link and the more demanding propagation environment) which may be lower in height and routinely implement antenna down tilt as a self-interference control mechanism. In addition, high densities of mobile terminals operating at significant EIRP's are used. As contrasted to fixed terminals, these mobile devices could have uncontrolled proximity to SDARS users.

Because of the architecture and use differences of these mobile broadband services it can be anticipated that the eventual coverage availability, will be in the 95% range,[7] significantly less than in the fixed wireless or SDARS case.

1.2.2 Transmitter Requirements

1.2.2.1 SDARS Transmitter Requirements

SDARS transmitters are low volume platforms with an emphasis on moderate power design and "extreme" adjacent channel and out of band emission specifications. Significant cost and effort has gone into reducing the adjacent channel and out of band emissions of these transmitters to improve the quality of the immediately adjacent satellite signals (see Figure1). The current generation of XM repeaters was designed to meet a 75+10log(P) attenuation mask (where P is the **EIRP** in watts) which includes an additional margin of 15 dB to account for antenna gain. The equivalent transmitter output referenced specification would then be **90+10log(P)** (where P is the **transmitter output** power in watts). The allowed transmitter output power for an existing SDARS repeater, outside of the SDARS band, is therefore -60 dBm in a 1 MHz bandwidth.

1.2.2.2 WCS Base Station Transmitter Requirements

A number of vendors, such as Alvarion and Navini, supply base stations for use in the 2.3 GHz band A, B, C and D blocks . This equipment either uses a proprietary airlink format or, more recently, IEEE 802.16d WiMax based equipment. From the equipment certifications it can be determined that it is technically and commercially feasible to meet the existing out of band emissions for base stations of 80+10log(P) or -50 dBm in a 1 MHz bandwidth at the transmitter output. This is 10 dB less stringent that for current SDARS repeaters The vendors use innovative techniques, such as a variable guard band, to allow the maximum possible throughput in the C and D blocks, while meeting the appropriate out of band limits, Appendix [1] illustrates the adjacent block operation of one of these devices in the C block, clearly showing the variable guard band feature.

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[6] "Comparison of IEEE802.16 WiMax Scenarios with Fixed and Mobile Subscribers in Tight Reuse," Siemens AG, C.F.Ball *et al.*, IST Mobile and Communications Summit, June 2005.

[7] LCC International, Inc., *H Block MS Overload Analysis*, (Dec. 1, 2004), *available in* Comments of Nextel Communications, Inc., WT Docket No. 04-356 (filed Dec. 8, 2004).

1.2.2.3 WCS Fixed User Terminal Transmitter Requirements

A number of vendors, such as Alvarion and Navini, supply fixed user terminals for both indoor and outdoor use in the 2.3 GHz band A, B, C and D blocks. This equipment either uses a proprietary airlink format or, more recently, IEEE 802.16d Wimax based equipment. Power control is a typical feature. From the equipment certifications it can be determined that it is technically and commercially feasible to meet the existing out of band emissions for these terminals of 80+10log(P) or -50 dBm in a 1 MHz bandwidth for all the WCS blocks, including the C and D blocks. As with the base stations, the vendors use innovative techniques, such as a variable guard band to allow the maximum possible throughput in the C and D blocks, while meeting the appropriate out of band limits.

1.2.2.4 WCS Mobile User Terminal Transmitter Requirements

XM is not aware of any mobile terminals currently available that meet the specifications for this band.

1.2.3 Receiver Requirements

1.2.3.1 SDARS Receiver Requirements

SDARS receivers are designed to allow mobile reception of relatively weak satellite signals (from 37,000 km in space) as well as to take advantage of any available repeater signals. In order to receive the satellite signals, whose levels can be as low as -102 dBm, the satellite receiver must be more sensitive than a typical terrestrial mobile receiver. The receiving noise floor for an SDARS receiver has been measured at -113 dBm (in the 4 MHz bandwidth used).[8] The receiver types fall into a variety of categories including factory and aftermarket installed in cars, and portable. While the detailed performance of these radios varies by product generation, they all are required to process a wide dynamic range of signals in order to realize the greater than 99% system availability mentioned in 1.2.1.1.

1.2.3.2 WCS User Terminal Receiver Requirements

A number of vendors, such as Alvarion and Navini, supply fixed user terminals for both indoor and outdoor use in the 2.3 GHz band A, B, C and D blocks. This equipment either uses a proprietary airlink format or, more recently, IEEE 802.16d WiMax based equipment.

One way to estimate the overload performance of WCS terminals, fixed or mobile, is to compare the protection level required in terms of the difference in signal level between the wanted signal level and the interfering signal level as a function of the frequency separation between the two signals.

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8 *See* Exhibit C, Appendix 1.

For the WCS A upper block there is a 5 MHz frequency separation between the block and the XM S1B signal. The test results for the XM receiver using a 99% duty cycle WiMax signal, which is similar to the continuous OFDM transmit signal used by the DARS repeater, show an approximate 60dB protection level (-100dBm wanted signal and -40dBm interfering signal).

The worst case frequency separation between the SDARS repeater signal and the closest WCS frequency block is ~4 MHz away so a similar level of protection capability is reasonable to assume for the WCS receiver of 60dB.

Given the lack of a WiMax hardware platform we have looked at other references to understand the WiMax receiver sensitivity. In these documents (see Figure 3 below), the consumer unit receiver sensitivity level sited is -95.2 dBm. If one assumes a receiver implementation similar to an SDARS receiver providing 60dB of protection to an interferor that is 5 MHz away, then all WCS receivers should be protected from an SDARS interferor up to a power level of approximately **-35 dBm**.

Figure 3 WiMax Link Budget

Table 2.8 Sample Link Budgets for a WiMAX System

Parameter	Mobile Handheld in Outdoor Scenario		Fixed Desktop in Indoor Scenario		Notes
	Downlink	Uplink	Downlink	Uplink	
Power amplifier output power	43.0 dB	27.0 dB	43.0 dB	27.0 dB	A1
Number of tx antennas	2.0	1.0	2.0	1.0	A2
Power amplifier backoff	0 dB	0 dB	0 dB	0 dB	A3; assumes that amplifier has sufficient linearity for QPSK operation without backoff
Transmit antenna gain	18 dBi	0 dBi	18 dBi	6 dBi	A4; assumes 6 dBi antenna for desktop SS
Transmitter losses	3.0 dB	0 dB	3.0 dB	0 dB	A5
Effective isotropic radiated power	61 dBm	27 dBm	61 dBm	33 dBm	A6 – A1 + $10\log_{10}$(A2) A3 + A4 A5
Channel bandwidth	10MHz	10MHz	10MHz	10MHz	A7
Number of subchannels	16	16	16	16	A8
Receiver noise level	104 dBm	104 dBm	104 dBm	104 dBm	A9 – 174 + $10\log_{10}$(A7*1e6)
Receiver noise figure	8 dB	4 dB	8 dB	4 dB	A10
Required SNR	0.8 dB	1.8 dB	0.8 dB	1.8 dB	A11; for QPSK, R1/2 at 10% BLER in ITU Ped. B channel
Macro diversity gain	0 dB	0 dB	0 dB	0 dB	A12; No macro diversity assumed
Subchannelization gain	0 dB	12 dB	0 dB	12 dB	A13 – $10\log_{10}$(A8)
Data rate per subchannel (kbps)	151.2	34.6	151.2	34.6	A14; using QPSK, R1/2 at 10% BLER
Receiver sensitivity (dBm)	95.2	110.2	95.2	110.2	A15 – A9 + A10 + A11 + A12 A13
Receiver antenna gain	0 dBi	18 dBi	6 dBi	18 dBi	A16
System gain	156.2 dB	155.2 dB	162.2 dB	161.2 dB	A17 – A6 A15 + A16
Shadow fade margin	10 dB	10 dB	10 dB	10 dB	A18
Building penetration loss	0 dB	0 dB	10 dB	10 dB	A19; assumes single wall
Link margin	146.2 dB	145.2 dB	142.2 dB	141.2 dB	A20 – A17 A18 A19
Coverage range	1.06 km (0.66 miles)		0.81 km (0.51 miles)		Assuming COST 231 Hata urban model
Coverage range	1.29 km (0.80 miles)		0.99 km (0.62 miles)		Assuming the suburban model

2 Establishing Appropriate Power and OOBE Levels

2.1 SDARS Repeaters, Base Stations

2.1.1 Introduction

The negative implications of the WCS Coalition's proposal to allow 2 kW blanket licensing of transmitters without additional constraints were discussed in Sirius and XM's previous ex parte filing.[9] The material presented here expands on that discussion with the objective of establishing appropriate power and out of band emission limits for WCS base stations and SDARS repeaters.

2.1.2 SDARS Repeaters and WCS Base Station Power Levels

It has been previously demonstrated that SDARS repeaters and WCS fixed wireless systems can coexist under the existing rules.[10] Such WCS fixed wireless installations generate well understood interference geometries and are similar to the SDARS repeater network in terms of the architecture.

Sirius has shown in a previous filing that ground-based limits offer the most effective solution in controlling inter-band interference between SDARS and WCS.[11] Expanded information regarding the proposed use of predictive tools in the application of ground based limits is provided in Appendix [2] of this exhibit.

In order to be effective, such limits must directly relate to the actual impact on the user terminal which, in the case of SDARS receivers, varies by WCS block (See Exhibit C, Section III). For example, the XM receiver performance is significantly degraded for an interfering signal in the "D" block). This is due to the absence of any guard band between this block and the adjacent SDARS satellite channel, S1B, significantly reducing the effectiveness of any practical receiver filtering.

XM supports Sirius's modification of its original proposal (which envisaged some form of guard band for the C and D blocks as is currently implemented in WCS fixed wireless equipment, see Appendix 1) into two distinct ground-based limits, one for the A and B blocks and one for the C and D blocks. This approach recognizes the reality that there is no defined guard band between the C and D blocks and the Sirius and XM SDARS allocation. XM has established that a common limit (for A and B and C & D blocks) can only be applied with the D block and XM. This key issue of the lack of a guard band is very similar to that identified by AT&T in the AWS proceeding.[12]

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9 *Ex Parte* Presentation of Sirius Satellite Radio Inc.and XM Radio Inc., Docket 95-91 (filed Nov. 30, 2007) ("*November 30 Sirius and XM* Ex Parte").

10 *See* Comments of XM Radio Inc., IB Docket No. 95-91, Exhibit A (filed Dec. 14, 2001).

11 *Ex Parte* Presentation of Sirius Satellite Radio Inc. and XM Radio Inc., Docket 95-91, Annex 2 (filed Dec. 05, 2007).

12 *See* Reply Comments of AT&T Inc., WT Docket 07-195, Section II(B) (filed Jan. 14, 2007) ("*AT&T AWS-3 Reply Comments*").

XM has not been able to obtain detailed WCS mobile receiver data that would help further refine its proposal for limits for SDARS repeaters. However, an estimate of the expected overload levels of mobile WCS terminals can be used in establishing the associated ground-based level proposal for SDARS repeaters. This approach is based on assuming that WCS terminals have similar performance limits to SDARS receivers.

2.1.2.1 Proposed Power Limits for SDARS Repeaters

Based on the analysis of expected WCS mobile receiver performance (see Section 1.2.3.2), XM is proposing a ground-based power limit for SDARS repeaters of 110 dBuV/m (-35 dBm equivalent isotropic received power). The appropriate bandwidth for this measurement would be 5 MHz in the case of XM. The measurement would be based on average power and consistent with the measurement procedures outlined in Section 3. These repeaters would be subject to FCC Certification.

XM proposes that SDARS repeaters at 2W EIRP or below be exempted from the ground-based limits proposed here. These repeaters would be subject to FCC Certification.

2.1.2.2 Proposed Power Limits for WCS Base Stations

Based on the measured performance of SDARS receivers (Exhibit C), XM is proposing the following ground based power limits for WCS base stations:

- A and B blocks 100 dBuV/m (-44 dBm isotropic equivalent power)
- C and D blocks 90 dBuV/m (-55dBm isotropic equivalent power)

These field strengths would be established for the nominal WCS channel signal bandwidth (i.e. 5 MHz).and measured at 2 meters AGL. These values, XM believes, represent a reasonable compromise between the scale of receiver performance degradation that XM can accept and the need for WCS operators to provide adequate coverage.

Appendix 3 provides some simplified insight into the potential application of these rules and their impact on the transmitter power/height/down tilt trade space. Tables are provided showing the predicted field strength level as a function of distance from a base station at a variety of antenna heights. Two different down tilt situations are modeled (1 degree, representing an example value for a fixed wireless base station and 10 degrees for a base station deployed to support a mobile service) using a simple free space path loss model, together with the ITU-F1336 antenna model for a 90 degree sector antenna.[13] The EIRP chosen is 2,000 watts and the distance is predicted out to 1 km. Beyond 1 km the site specific clutter is likely to reduce the applicability of the free space model. Within a 1 km radius the model serves to illustrate the relationships among the various parameters.

The general trend of areas exceeding the 100 dBuV/m limit are clear from these tables, namely, for the case of 1 degree down tilt, an antenna height of 50 meters or above essentially meets the 100 dBuV/m limit without exception at 2 kW. In practice the

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[13] ITU F1336, *recommends* 3.2, with improved side lobe performance.

propagation loss would be expected to be greater than free space as the distance from the site increased and so the 30 meter antenna height case would most likely also meet the limit as the distance from the site at which the limit is exceeded with the simple free space model is greater than 850 meters.

Another general trend that can be discerned is that, at a given down tilt and power, as the height is increased, the area where the limit is exceeded moves further out from the base station and "flattens out", i.e., the taller the site the more likely that additional excess path loss will further reduce the ground field strength level.

The dramatic effect of increased down tilt is seen in the 10 degree down tilt table. The effect here, at lower antenna heights, is to move the area where the limit is exceeded closer to the base station where the probability of excess path loss due to clutter is less. In these circumstances, power and/or down tilt would have to be adjusted for compliance, depending on how exclusion zones are allowed for.

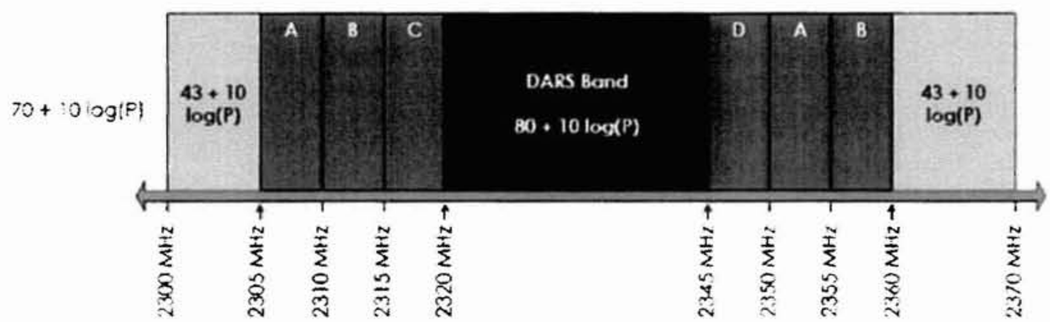
In practice, the actual predictions would use more accurate and sophisticated network planning tools as is described in more detail in Appendix 2.

2.1.3 SDARS Repeaters and WCS Base Station Out of Band Emissions Limits

2.1.3.1 Introduction

The current out of band limits for WCS base stations are illustrated in Figure 4. The out of band emissions limits for SDARS repeaters currently exceed the 80+10log(P) (-50 dBm equivalent power) by 15 dB due to the SDARS requirement for additional margin to take into account antenna gain.

Figure 4 Out of Band Emissions for WCS Fixed Service[14]



14 From Navini Networks Equipment Type Acceptance filing.

2.1.3.2 Proposed Limits for SDARS Repeater Out of Band Emissions

XM and the WCS Coalition agree on relaxing the out of band emissions limit for SDARS repeaters and WCS base stations[15], specified at the transmitter output.

XM is therefore proposing an out of band emission specification of 75 +10 Log (P) for SDARS repeaters, where P is the transmitter output power in watts. This is equivalent to a transmitter output power level of -45 dBm. The measurement bandwidth is 1 MHz and the measurement type is average power. This specification would also apply to all SDARS repeaters. The limit is measured at the transmitter output and needs to take into account the measurement requirements outlined in Section .3.

2.1.3.3 Proposed Limits for WCS Base Station Out of Band Emissions

XM is proposing an out of band emission specification of 75 +10 Log (P) where P is the transmitter output power in watts. This is equivalent to a power level of -45 dBm.. The power measurement bandwidth is 1 MHz and the measurement is average power, subject to the burst measurement requirements outlined in Section 3 of this exhibit.

2.2 WCS User terminals

2.2.4 Introduction

2.2.5 Fixed WCS User Terminals

XM has established that current fixed wireless deployments and equipment certifications of WCS fixed user terminals (utilizing innovative guard band implementations in "C" block) present little to no issue for SDARS operations in their current form. Accordingly, XM is proposing exemption from the ground-based limits required for such devices operating within EIRP limits and is supporting a relaxation of 5 dB in the out of band limits that such devices need to meet. XM believes this relief should further allow cost reductions in fixed user equipment, thereby further facilitating fixed wireless deployment in underserved rural markets.

2.2.6 Proposed Power Limits For Fixed User Terminals

XM proposes that, a fixed user terminal be defined as:

Equipment which transmits only when it is connected to AC power directly, or through a transformer. A fixed station does not transmit when connected only to a battery, whether internal or external.

15 *See Ex Parte* Presentation of WCS Coalition, Docket 95-91, Slide 6 (filed Nov. 14, 2007).

2.2.6.1 Proposed Power Limits For Fixed User Terminals Operating Above 2 Watts EIRP

XM proposes that fixed user terminals operating above 2W EIRP should be subject to the same ground based limits established for WCS based stations, namely:

For the A and B blocks 100 dBuV/m (isotropic equivalent power of -44 dBm)
For the C and D blocks 90 dBuV/m (isotropic equivalent power of -55 dBm)

Measured at 2 meters above ground in a 5 MHz bandwidth.

2.2.6.2 Proposed Power Limits For Fixed User Terminals Operating at 2 Watts EIRP or Below

Fixed user terminals operating at 2W EIRP or below are exempt from the ground-based limits proposed here. These terminals would be type accepted and utilize power control to adjust the output power to that sufficient to maintain the link.

2.2.7 Proposed Limits For Fixed User Terminal Out of Band Emissions

XM proposes that all fixed user terminals be subject to an OOBE limit of 75+10log(P) (-45 dBm power), measured in a 1 MHz bandwidth. This requirement is 5 dB less stringent than currently in force.

2.3 Mobile/Portable User Terminals

2.3.8 Introduction

The negative implications of the WCS Coalition's proposal to relax mobile out of band emissions limits without additional constraints were discussed in Sirius and XM's previous ex parte filing.[16] The material presented here sets forth additional implications and describes an appropriate framework for establishing the possible performance parameters for a mobile service, given the realities of the current WCS band plan

2.3.9 Proposed Power Limits for Mobile and Portable Devices

In the case of a mobile or portable user terminal as now being proposed by the WCS coalition, XM believes the most appropriate way to specify power and out of band limits is to directly relate them to the actual impact on the affected terminals. XM is proposing use of an interference coordination distance of 3 meters in establishing the permissible EIRP and OOB limits for WCS mobile and portable user terminals. XM believes this coordination distance represents the absolute maximum interference radius around mobile WCS user terminals that the SDARS service can tolerate without significant

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[16] *November 30 Sirius and XM* Ex Parte.

service disruption. This distance can be contrasted with the even more stringent 1 meter limits proposed in submissions in the AWS proceedings.[17]

In deriving the mobile EIRP limits, the measured results for XM reference receiver overload are used in conjunction with an estimate of path loss at a 3 meters separation to calculate the maximum EIRP that a user terminal could have without muting the reference receiver. The path loss at 3 meters is calculated by adding 3 dB to the value calculated using a free space model to account for various coupling losses[18] This approach to path loss calculation has also been confirmed in the experimental program (see Exhibit C, Section III, Figure 5). These results are calculated as a function of the serving satellite signal and the WCS signal duty cycle.

The mobile EIRP proposal is derived as follows:

For the "A" and "B" blocks XM has determined the WCS mobile / fixed receiver overload level from interpreting laboratory and field measurements of receiver performance.[19] In doing so XM has attempted to take into account the wide range of signal conditions under which interference would be experienced and to balance the needs of WCS and SDARS operators. Accordingly, a field strength of 100 dBuV/m (-44 dBm isotropically received power)) has been selected as the target level at the receiver.

At the proposed coordination distance of 3 meters, the calculated path loss is 52.2 dB using the free space + 3dB approach..

The mobile EIRP for the A and B blocks can therefore be no more than:

-44 + 52.2 dBm = **8.2 dBm** .

XM is proposing **10 dBm (10 milliWatts)** as the mobile limit for this case.

For the "C" and "D" blocks, the receiver overload level (in isotropically received power units) has been selected in the same fashion as for the A and B blocks. A field strength of . 90 dBuV/m.(-55 dBm isotropically received power) has been selected.

For a 3 meter coordination distance, the mobile EIRP can therefore be no more than:

-55 +52.2 dBm. = **-2.8 dBm**

XM is proposing **0 dBm (1 milliWatt)** as the mobile limit for this case.

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17 *See, e.g., AT&T AWS-3 Reply Comments* at Section II(A).

18 *See* Comments of Verizon Wireless, WT Docket 07-195, Attachment A (filed Dec. 14, 2007).

19 *See* Exhibit C.

2.3.10 Proposed Limits for Mobile / Portable User Terminal Out of Band Emissions

XM is proposing a new "balanced" approach to setting out of band limits for mobile devices. In this approach the overload and out of band limits are established at the same interference distance of 3 meters. The receiver impairment criteria used for the out of band limit estimation is the generally accepted 1 dB rise in satellite noise floor[20]. This level is established using the measured satellite noise floor (see Exhibit C, Appendix [1]). A bandwidth of 1 MHz is used.

The out of band emissions limit is derived as follows:

First, the noise floor is estimated:

The measured noise floor in the XM part of the SDARS band is given in Exhibit [C] ,Appendix [1] as -113 dBm in a 4 MHz bandwidth.

To normalize the value to the 1 MHz bandwidth used for OOBE limit specification a correction factor of 10*log(4/1) is applied to the value.

Corrected Noise Floor = -113 – 6.02 dBm = ~-119 dBm in a 1 MHz bandwidth..

The interference level at the receiver that would cause a 1 dB rise in this noise floor is calculated as follows:

IL_{WCSOOB} =10*log[10^($SDARS_{NF}$ /10){10^(1/10)-1}]=-124.9 dBm in a 1 MHz bandwidth.

Where

$SDARS_{NF}$ = The SDARS measured noise floor in dBm at 1MHz bandwidth.

IL_{WCSOOB}= The level of emissions from the WCS mobile, in dBm, falling into the SDARS band in a 1 MHz bandwidth .that would cause a 1 dB rise in the SDARS noise floor at the receiver.

At a coordination distance of 3 meters, the path loss is 52.2 dB using the free space + 3 dB approach.

Accordingly, the out of band emissions at the WCS mobile output can be no more than:

-124.9 dBm + 52.2 dB = -72.7 dBm, measured in a 1 MHz bandwidth.

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20 *See* "Compatibility of Services Using WiMax Technology with Satellite Services in the 2.3-2.7 GHz and 3.3-3.8 GHz Bands," WiMax Forum, Section 4 (2007).

This level is equivalent to a required attenuation level of 102.7 + 10log(P) where P is the average transmitter power in watts(measured in 5 MHz), measured in accordance with the requirements outlined in Section 3.

3 Power Measurement Issues Associated with Proposals

3.1 Introduction

In order to ensure that the proposed power limits are implemented in a consistent and fair way, it is necessary to take into account significant differences in the transmitted waveforms between SDARS repeater and WCS base station and user terminals. Specifically, WiMax power measurements depend on the extensive use of frame synchronized, time gated power measurements[21] whereas SDARS repeater measurements are based on simpler, continuous measurements.

3.2 Proposal for Power Measurements for SDARS Repeaters

SDARS transmitter output power and out of band emissions will be measured using an average power reading spectrum analyzer. The transmitter power will be measured in the XM channel bandwidth which is 5 MHz. The out of band power will be also be measured in a 1MHz bandwidth using an average reading spectrum analyzer.

In addition to the measurement of the average output power, the Complementary Cumulative Distribution Function (CCDF)[22] of the SDARS transmitted signal will be measured at the transmitter output. The SDARS output CCDF will not exceed a peak to average ratio of 8 dB when measured at the 0.1% probability level.

3.3 Proposal for Power Measurements of WCS Base Stations and User Terminals

In measuring WCS base station and user terminal transmit and out of band powers, the power measurement shall include a time gating method to establish the power (peak or average) during any burst period. XM believes that a similar approach to defining a peak power limit as that proposed for SDARS repeaters above (i.e. peak to average ratio, based on some probability of occurrence) is needed for WCS transmissions and would welcome comments from the WCS parties as to proposed values.

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[21] *See, e.g.*, "Power Measurement and Power Calculation of IEEE 802.16 Wimax™ OFDMA signals," Rohde and Schwarz, Application Note 1EF60, *available at* http://www.rhode-schwarz.com.

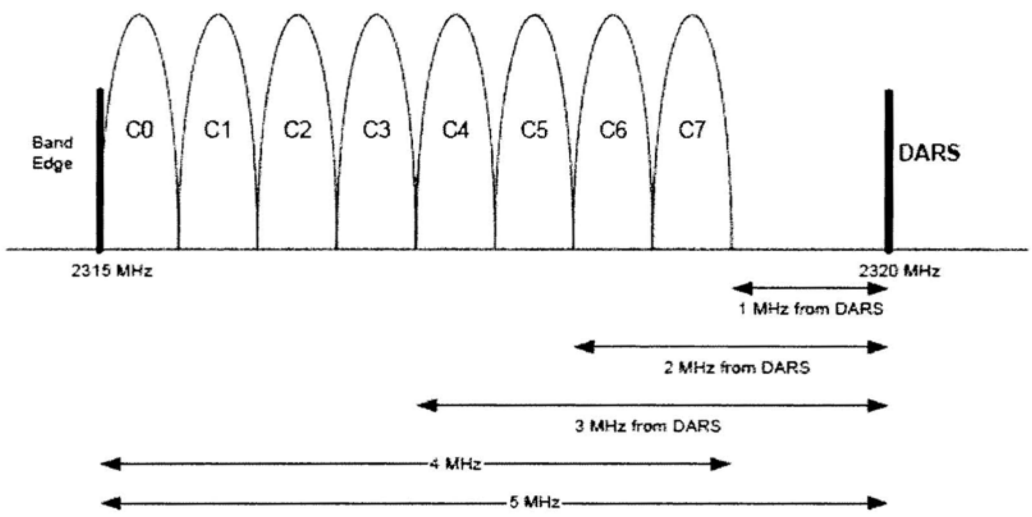
[22] *See, e.g.*, "The Crest Factor in DVB-T (OFDM) Transmitter Systems and its influence on the Dimensioning of Power Components," Rohde and Schwarz, Application Note 7TS02, *available at* http://www.rhode-schwarz.com.

Appendix 1

Examples of Guard Band Use in WCS Fixed Wireless Equipment

Navini Networks 2.3-BTS3A-R1[23]

Output Channels



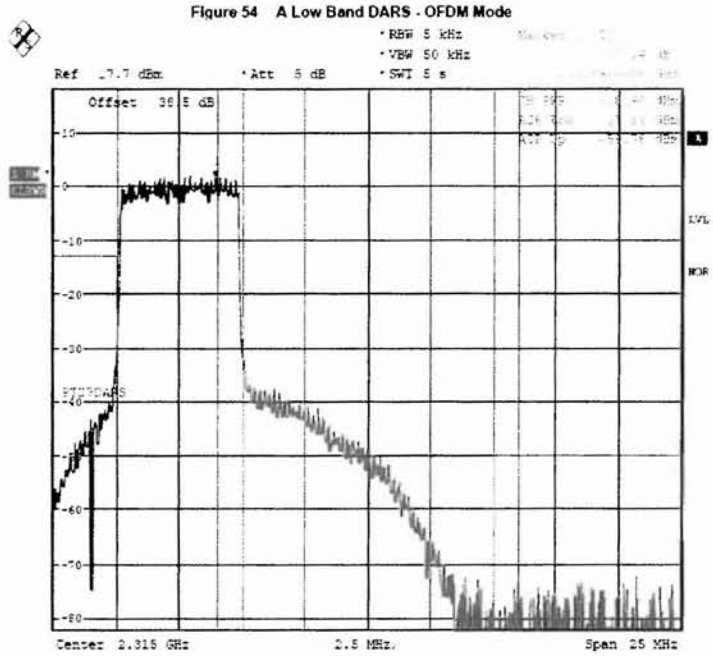
8 Carrier BTS Signal Operating in WCS C Band

23 From FCC equipment certification documents

Example Output Spectrum

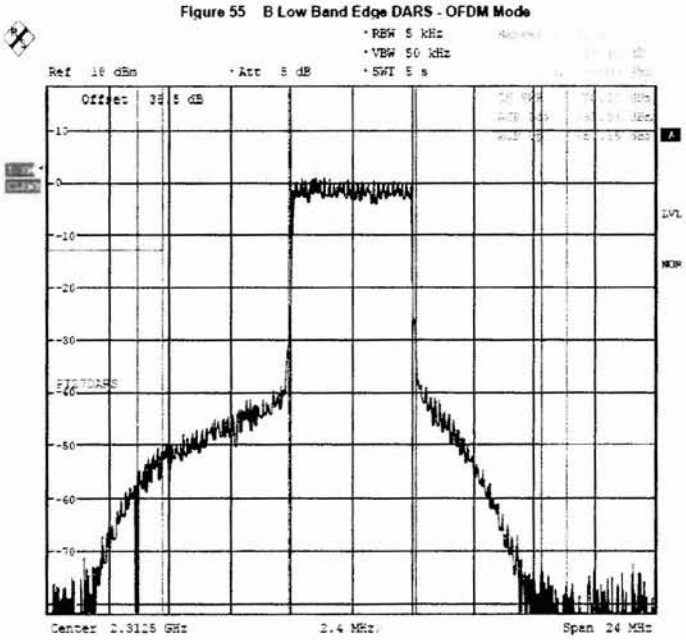
A Block (nominal bandwidth)

Figure 54 A Low Band DARS - OFDM Mode



B Block (nominal bandwidth)

Figure 55 B Low Band Edge DARS - OFDM Mode



C Block (reduced bandwidth)

Figure 57 C Band DARS – OFDM 24 Subcarrier/+28 dBm Mode

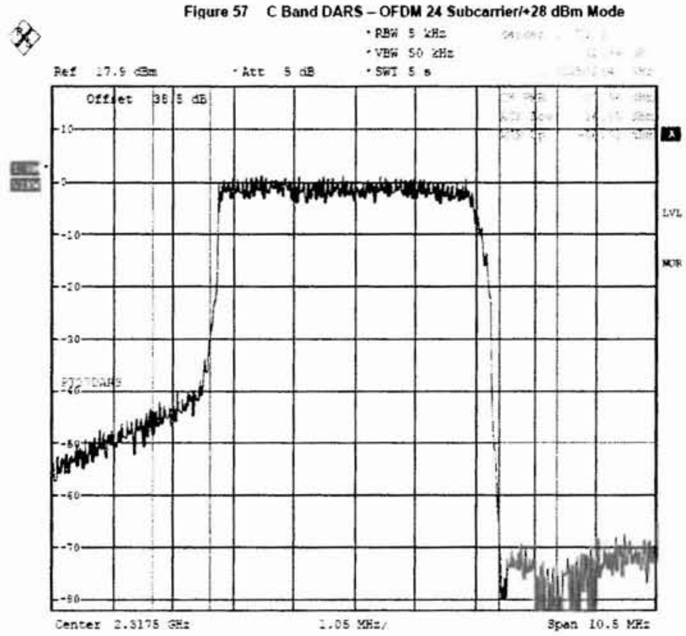
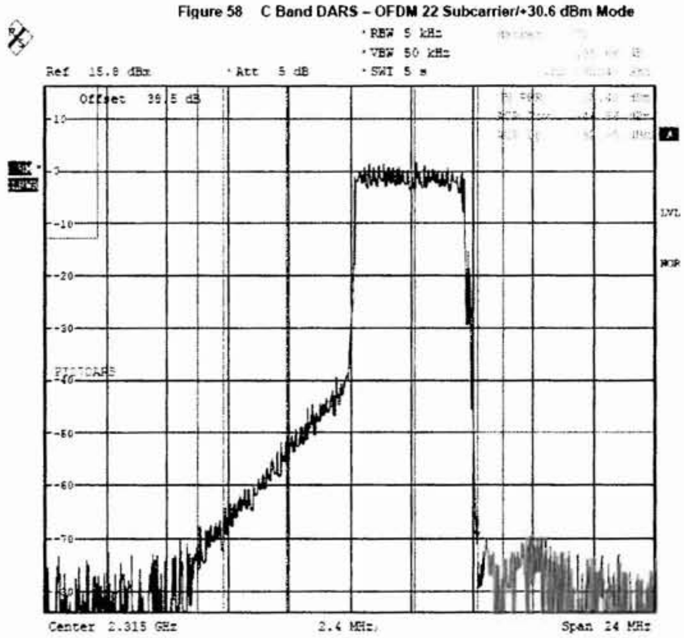


Figure 58 C Band DARS – OFDM 22 Subcarrier/+30.6 dBm Mode



Appendix 2

1 Critical Factors for RF Propagation Modeling

This document briefly describes several factors that must be considered when specifying a propagation modeling method to predict ground level power flux density. A proposal or recommendation for how to specify or model each of these factors is also provided.

The following factors must be considered when selecting and using computer-based propagation models to predict received signal strength[24]:

- Propagation model and path loss calculation technique
- Frequency range of operation
- Time and location variability
- Terrain elevation modeling
- Land use modeling (clutter)
- Prediction confidence margin
- Model calibration with measured data
- Representation of physical equipment (transmitter powers, antenna patterns & gains, line losses, etc.)

1.1 Model Selection and path loss calculation technique:

The purpose of the RF propagation model is to predict the excess path loss (XPL) that occurs along the propagation path in addition to free space path loss. The models listed in the table below are available and can be used for the SDARS / WCS frequency band.

Propagation model type	Frequency Range (MHz)
Free space + RMD	30-60,000
TIREM-EDX	30-40,000
ITUR-1546	30-3000
Longley-Rice v1.2.2	30 – 20,000
Anderson 2D v1.00	30 – 60,000

Proposal: The model proposed for WCS / SDARS received power prediction is the Free space + RMD (Reflection plus Multiple Diffraction Loss) model. This model can be configured to use terrain obstacle factors, variability factors, and urban and foliage loss factors to calculate XPL. It is an appropriate model to use for microwave path design, or area-wide system studies operating at microwave frequencies (such as MDS) where the receive sites are not random or mobile locations, but engineered receive sites with

24 The propagation modeling described here can be done using EDX Signal Pro®; however, other modeling tools and software are available that provide the same functionality.

directional antennas[25]. This model would be appropriate for use in predicting ground level power flux densities.

1.2 Time and location variability

Propagation modeling provides a statistical estimate of the received signal level at a location. Signal level statistical parameters for time and location can be varied to specify the margin of the calculation results. When specifying a time percentage, the calculated received power or voltage levels will be exceeded at least that percentage of time for similar propagation paths. Similarly, specifying a location percentage will produce results with received power or voltage levels exceeded at least the specified percentage of locations for similar propagation paths.

Proposal: The time and location percentage parameter proposed for both time and location is 50%. The statistical results for received signal strength for time and location, for all areas with similar propagation path losses, will then be unbiased about the predicted mean.

1.3 Terrain Elevation Modeling

Propagation modeling tools use digitized elevation maps to place transmitters and receivers on the ground, and with specified antenna heights AGL can determine radiation center and receive antenna heights above mean sea level (AMSL). This information is then used to calculate line-of-site propagation, diffraction effects over terrain as well as terrain blockage of the propagation path between transmitter and receiver.

Proposal: The USGS 10/30 meter terrain databases are proposed for use in conjunction with the propagation model. These databases were developed from 1:24,000-scale 7.5-minute (or better) topographic maps by the USGS[26].

1.4 Land Use Modeling (Clutter)

Propagation modeling tools use land use / land cover (LULC) data to add attenuation caused by local clutter when calculating the received signal at the receiver. Several types of clutter may contribute to the signal's attenuation, so for each clutter type a corresponding mean attenuation and height above ground level must be specified. In addition, the attenuation value for each clutter type may vary with frequency.

Proposal: The LULC data that is available from the USGS for the United States are proposed for use in conjunction with the propagation model. This data was derived from 1:250,000 and 1:100,000 scale maps and has been formatted into a grid spacing of approximately 200 by 200 meters[27]. The table below shows ten land use categories derived form the USGS LULC data, with values for average clutter height above ground level (ft) and losses from clutter at the receiver for the WCS and SDARS band.

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25 EDX Signal Pro® Reference Manual, Appendix A. Propagation Models, page A-2.
26 EDX Signal Pro® Reference Manual, Appendix B, page B-1.
27 EDX Signal Pro® Reference Manual, Appendix E, page E-2.

Land Use Category	Clutter Height (ft)	Losses from Clutter at Receiver (dB)
1 Open land	0	8
2 Agricultural	0	20
3 Range land	0	12
4 Water	0	0
5 Forest	15	25
6 Wetland	0	5
7 Residential	5	23
8 Mixed urban / dwellings	15	23
9 Commercial / industrial	20	23
10 Snow and ice	0	0

1.5 Prediction Confidence Margin

The prediction confidence margin is a parameter provided in some modeling tools that allows a prediction bias to be added to the calculated received signal level. This is useful, for example, to assure that the signal levels of the actual system will be at least as strong as the signal levels predicted by the model. If the confidence margin is set to 0 dB, the model will predict the expected received signal level without bias.

Proposal: It is proposed that the prediction confidence margin be set to 0 dB so that the prediction of received signal level is unbiased. If measured data is available that specifies the actual received signal level in the area being modeled, the prediction confidence margin can be adjusted to bring the propagation model into agreement with the actual measured data.

1.6 Model Calibration with Measured Data

Propagation modeling tools can provide the means to compare the received signal levels predicted by the model with actual real-world data. Receive signal level data are collected, with location coordinates specified for each point on the map where the received signal was measured and recorded. This recorded signal level data can then be compared with the corresponding predictions of signal levels at these locations as determined by the model. A statistical comparison of these data sets can reveal if there is a bias or other variances in the modeled data, relative to the measured data.

Proposal: It is proposed that for each RF coverage area of interest, the propagation model first be used (with zero-bias prediction confidence margin) to predict the areas with the strongest signal on the ground. Actual received signal strength data can then be collected in these areas and statistically compared with the model's predictions. The prediction confidence margin of the model must then be adjusted to bring the expected prediction levels into agreement with the measured data.

1.7 Representation of Physical Equipment

Propagation modeling tools provide the ability to input parameters specific to the particular hardware of the systems that are being modeled. In addition to antenna heights and locations, measured antenna gain patterns can be used to account for signal gains or losses that occur when the signal path passes through the antenna at various elevation and azimuth angles. Conducted transmitter power, cable losses and antenna gain patterns can then be used to determine the power radiated from the antenna at different aspect angles between the transmitter and receiver.

Proposal: It is proposed that the digitized antenna gain patterns, which are provided by each antenna's manufacturer, be used in the propagation modeling. This antenna gain pattern data, along with the conducted transmitter power and cable losses for each transmitter site can then be used to model the radiated power from each transmitter site.

Appendix 3
Ground Based Field Strength Examples

- "Fixed Wireless" (Downtilt = 1 degree)
- "Mobile Wireless" (Downtilt = 10 degree)

1 Degree Downtilt Field Strength (dBuV/m)

Antenna Height (m, AGL)

Downtilt 1 degree	5	15	30	50	70	90	110	140
Distance (m)								
5	115.5	102.5	95.3	90.3	87.2	84.9	83.1	81.0
10	114.8	102.9	95.7	90.7	87.5	85.1	83.3	81.1
15	114.1	103.0	96.1	91.0	87.7	85.3	83.4	81.2
20	113.5	102.7	96.2	91.2	87.9	85.5	83.6	81.3
25	113.7	102.6	96.2	91.3	88.1	85.6	83.8	81.5
30	113.4	102.4	96.2	91.5	88.2	85.7	83.8	81.6
35	113.3	102.2	96.2	91.6	88.3	85.9	83.9	81.7
40	113.0	101.8	96.2	91.5	88.4	86.0	84.1	81.8
45	113.1	101.7	96.1	91.6	88.4	86.1	84.1	81.9
50	113.5	101.8	95.9	91.6	88.5	86.1	84.2	81.9
55	113.4	101.5	96.0	91.5	88.5	86.2	84.2	82.0
60	113.6	101.4	95.7	91.5	88.5	86.2	84.4	82.0
65	113.9	101.4	95.6	91.5	88.5	86.3	84.4	82.1
70	114.4	101.1	95.7	91.4	88.5	86.3	84.4	82.1
75	113.8	101.2	95.5	91.4	88.5	86.3	84.4	82.2
80	117.7	101.1	95.4	91.4	88.5	86.3	84.5	82.3
85	117.2	101.0	95.3	91.3	88.5	86.4	84.5	82.2
90	119.0	100.9	95.2	91.1	88.4	86.3	84.5	82.3
95	120.5	101.0	95.2	91.3	88.5	86.3	84.5	82.3
100	121.9	101.0	95.3	91.2	88.4	86.3	84.5	82.3
125	124.8	101.0	95.0	90.7	88.2	86.1	84.6	82.4
150	124.1	100.6	94.4	90.8	88.0	86.0	84.5	82.4
175	122.8	100.7	94.3	90.4	87.8	86.0	84.4	82.3
200	121.3	100.8	94.5	90.3	87.8	85.9	84.2	82.3
225	119.7	100.4	94.0	89.9	87.7	85.6	84.1	82.2
250	117.9	101.2	94.3	90.0	87.3	85.5	83.9	82.2
275	117.1	101.3	94.2	89.9	87.5	85.5	83.9	82.0
300	115.2	101.8	94.2	89.6	87.4	85.2	83.9	82.0
325	114.5	101.1	93.9	89.8	87.4	85.0	83.6	81.7
350	112.6	104.9	93.7	89.6	87.1	84.9	83.4	81.8
375	112.0	106.6	93.6	89.6	86.8	84.9	83.3	81.6
400	111.4	108.1	93.6	89.6	86.7	84.9	83.2	81.4
425	110.9	109.3	93.6	89.7	86.6	85.0	83.2	81.7
450	108.8	110.4	93.7	89.2	86.5	84.6	83.3	81.3
475	108.4	111.2	93.9	89.4	86.5	84.8	83.4	81.3
500	107.9	111.9	94.3	89.7	86.5	84.7	83.0	81.3
525	107.5	111.5	93.8	89.3	86.6	84.3	83.2	81.4
550	107.1	111.9	94.3	89.3	86.2	84.3	82.8	81.0
575	104.9	112.1	93.9	88.9	86.4	84.4	82.8	81.2
600	104.5	111.7	94.6	89.0	86.7	84.4	82.8	81.4
625	104.2	111.7	94.2	89.2	86.3	84.1	82.8	81.0
650	103.8	111.4	95.1	89.3	86.7	84.2	82.9	81.3
675	103.5	111.1	94.7	89.0	86.4	84.4	82.5	81.0
700	103.2	110.9	94.4	89.3	86.0	84.1	82.6	80.7
725	102.9	110.6	98.6	89.0	86.5	84.4	82.8	80.8
750	102.6	110.2	98.3	89.3	86.2	84.1	82.5	80.8
775	102.3	109.9	98.0	89.0	85.9	84.5	82.7	80.5
800	102.0	109.6	97.7	89.4	86.1	84.2	82.4	80.6
825	101.8	109.3	99.7	89.2	86.3	83.9	82.7	80.8
850	101.5	108.7	101.5	89.7	86.0	84.3	82.4	80.5
875	99.2	108.5	101.3	89.4	86.2	84.1	82.2	80.7
900	99.0	108.2	102.8	89.2	86.0	83.9	82.5	80.5
925	98.7	108.0	102.6	89.8	86.3	84.4	82.3	80.7
950	98.5	107.1	103.9	89.6	86.0	84.2	82.7	80.5
975	98.3	106.9	103.7	89.3	86.4	83.9	82.5	80.2
1000	98.1	106.7	103.5	90.1	86.2	83.7	82.2	80.5

Figure 5 10 degree Downtilt Field Strength (dBuV/m)

Antenna Height (m, AGL)

Downtilt 10 degrees	5	15	30	50	70	90	110	140
Distance (m)								
5	**117.9**	**103.6**	96.1	91.1	88.0	85.7	83.8	81.7
10	**120.2**	**104.1**	96.6	91.5	88.3	85.9	84.0	81.8
15	**127.6**	**104.7**	97.1	91.9	88.5	86.1	84.2	82.0
20	**124.0**	**104.8**	97.4	92.1	88.8	86.3	84.4	82.1
25	**117.1**	**105.3**	97.6	92.4	89.0	86.5	84.6	82.3
30	**113.4**	**105.8**	97.7	92.6	89.1	86.6	84.7	82.4
35	**110.8**	**106.3**	98.0	92.8	89.4	86.8	84.8	82.5
40	**109.0**	**106.8**	98.3	92.8	89.5	87.0	85.0	82.6
45	**107.5**	**107.7**	98.5	93.1	89.6	87.1	85.1	82.8
50	**106.1**	**108.7**	98.4	93.2	89.8	87.2	85.2	82.8
55	**105.3**	**110.1**	98.9	93.1	89.8	87.4	85.2	82.9
60	**104.1**	**112.5**	98.7	93.4	89.9	87.4	85.5	83.0
65	**103.4**	**114.9**	99.1	93.4	90.0	87.5	85.6	83.1
70	**102.3**	**127.7**	99.6	93.5	90.0	87.6	85.5	83.1
75	**101.7**	**129.7**	99.7	93.7	90.1	87.7	85.6	83.2
80	**101.2**	**121.9**	99.9	93.9	90.2	87.8	85.7	83.4
85	**100.6**	**111.4**	**100.2**	93.8	90.3	87.9	85.8	83.4
90	99.7	**109.1**	**100.6**	93.8	90.3	87.8	85.8	83.5
95	99.3	**107.9**	**101.2**	94.2	90.5	88.0	85.9	83.5
100	98.8	**106.1**	**101.3**	94.2	90.4	87.9	85.9	83.5
125	96.5	**101.0**	**104.7**	94.6	90.9	88.1	86.3	83.9
150	94.9	98.1	**121.1**	95.7	91.3	88.5	86.5	84.0
175	93.3	96.2	**110.8**	97.1	91.7	88.9	86.7	84.1
200	92.1	94.5	**101.4**	98.8	92.3	89.3	86.8	84.4
225	91.1	93.0	98.5	**101.0**	93.2	89.5	87.2	84.5
250	90.2	91.7	96.2	**112.0**	94.0	90.0	87.4	84.8
275	89.3	90.9	94.2	**118.7**	95.1	90.4	87.7	85.0
300	88.6	89.7	92.7	**106.1**	96.4	91.2	88.0	85.2
325	87.9	89.0	91.4	98.8	98.7	91.8	88.5	85.1
350	86.9	88.3	90.8	96.5	**107.0**	92.6	88.8	85.7
375	86.3	87.4	89.6	94.6	**115.7**	93.9	89.3	85.7
400	85.7	86.8	89.0	93.0	**113.7**	95.3	89.9	85.9
425	85.2	86.3	88.0	91.5	**103.1**	97.4	90.9	86.7
450	84.7	85.8	87.5	90.6	97.0	**102.6**	91.8	86.6
475	84.2	85.3	86.6	89.4	94.6	**112.2**	92.4	87.2
500	83.8	84.5	86.1	88.3	92.8	**113.5**	94.1	88.0
525	83.4	84.1	85.7	87.9	91.7	**110.3**	95.6	88.3
550	83.0	83.7	84.8	86.8	90.8	**100.9**	**100.8**	88.7
575	82.6	83.3	84.5	86.5	89.4	94.8	**108.1**	89.7
600	82.2	82.9	84.1	86.1	88.6	93.5	**111.6**	90.4
625	81.9	82.5	83.7	85.2	87.8	92.3	**111.3**	91.4
650	81.5	82.2	83.0	84.8	86.7	90.5	**107.1**	92.7
675	81.2	81.9	82.6	84.5	86.4	89.5	99.1	93.4
700	80.9	81.6	82.3	83.7	86.0	88.7	94.3	98.7
725	80.6	81.3	82.0	83.4	85.1	87.8	91.8	**104.5**
750	80.3	80.6	81.7	83.1	84.8	87.1	90.7	**108.2**
775	80.0	80.3	81.4	82.8	84.5	86.3	89.6	**109.9**
800	79.7	80.1	81.2	82.0	83.6	86.1	88.7	**108.5**
825	79.5	79.8	80.5	81.8	83.3	85.4	87.8	**105.0**
850	79.2	79.5	80.2	81.5	83.1	84.3	87.0	**101.4**
875	78.9	79.3	80.0	81.3	82.2	84.1	86.7	92.4
900	78.7	79.0	79.7	81.0	82.0	83.9	86.0	91.0
925	78.5	78.8	79.5	80.3	81.8	82.9	85.2	89.7
950	78.2	78.6	79.3	80.1	81.5	82.7	84.6	89.5
975	78.0	78.3	79.1	79.9	80.8	82.5	84.3	88.4
1000	77.8	78.1	78.8	79.6	80.6	82.3	83.7	87.4

Exhibit B

SDARS Repeater Grandfathering Issues

1 Introduction

FCC grandfathering of existing SDARS repeaters would impose no burden on WCS operations, but a failure to do so would unnecessarily force SDARS operators and their customers to incur heavy costs to construct and operate many additional transmitters. With the deployment of reasonable SDARS filters on WCS base stations, and the deployment of AGC circuitry in the WCS CPE receivers, the task of providing quality service in the vicinity of SDARS high-power repeaters is straightforward.[1] By taking into account the existing SDARS repeaters, WCS operators can deploy base stations in the area near a potentially problematic repeater to insure that adequate signal power is available to the CPE receiver in regions where the AGC threshold is exceeded by the SDARS transmitter. Sirius and XM Radio have demonstrated the successful coordination of their own respective repeater networks using this system design technique; there is no reason why that success cannot be duplicated by WCS system operators. In addition, field tests have confirmed the lack of impact on fixed WCS terminals from nearby SDARS transmitters.[2]

It has also been demonstrated that converting a single high-power site into multiple lower power sites will actually generate more, not less, overall potential for interference in a given coverage area[3]

In this Exhibit, XM shows the actual operating distribution of repeater transmitter power, demonstrating that the repeater networks that would be grandfathered operate at relatively low power compared to the examples being used by the WCS Coalition.

Additionally, we provide a summary of the potential impact should XM be required to change out all of its repeater sites above 2kW.

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[1] *See* Letter from Bruce D. Jacobs, Counsel for XM Radio Inc., to Ms. Magalie Roman Salas, FCC, IB Docket No. 95-91, 3-10 (August 29, 2001) ("*XM White Paper*").
[2] *See* Comments of XM Radio Inc., IB Docket No. 95-91, Exhibit A, (filed Dec. 14 2001).
[3] *XM White Paper* at 15-20.

2 Impact of Reducing Power of Existing Sites to 2kW

2.1 The advantages of using fewer higher power repeaters instead of a greater number of low power repeaters

This analysis demonstrates the extent to which XM Radio has reduced the likelihood of interference to WCS receivers by designing networks for urban coverage that use fewer repeaters. More lower power repeaters results in a larger area where interference with WCS receivers may occur than with fewer high power repeaters.

Figure 1 illustrates the current XM repeater coverage for Indianapolis, which has a single repeater site. Figure 2 illustrates the same market area with an EIRP limit of 2000 watts and the additional 39 sites required to provide the equivalent coverage as the current single site does. The black polygon indicates the approximate boundary of the -88 dBm repeater serving level of the current single-site system for Indianapolis. The green and yellow areas indicate the high service availability and the red indicates low terrestrial signal. If one assumes that there will be some limited "exclusion zone" area around each site, it appears that it would be more difficult for the WCS operators to take into account the multiple SDARS sites than the single existing site in the market.

Figure 1. XM current Indianapolis coverage with single site

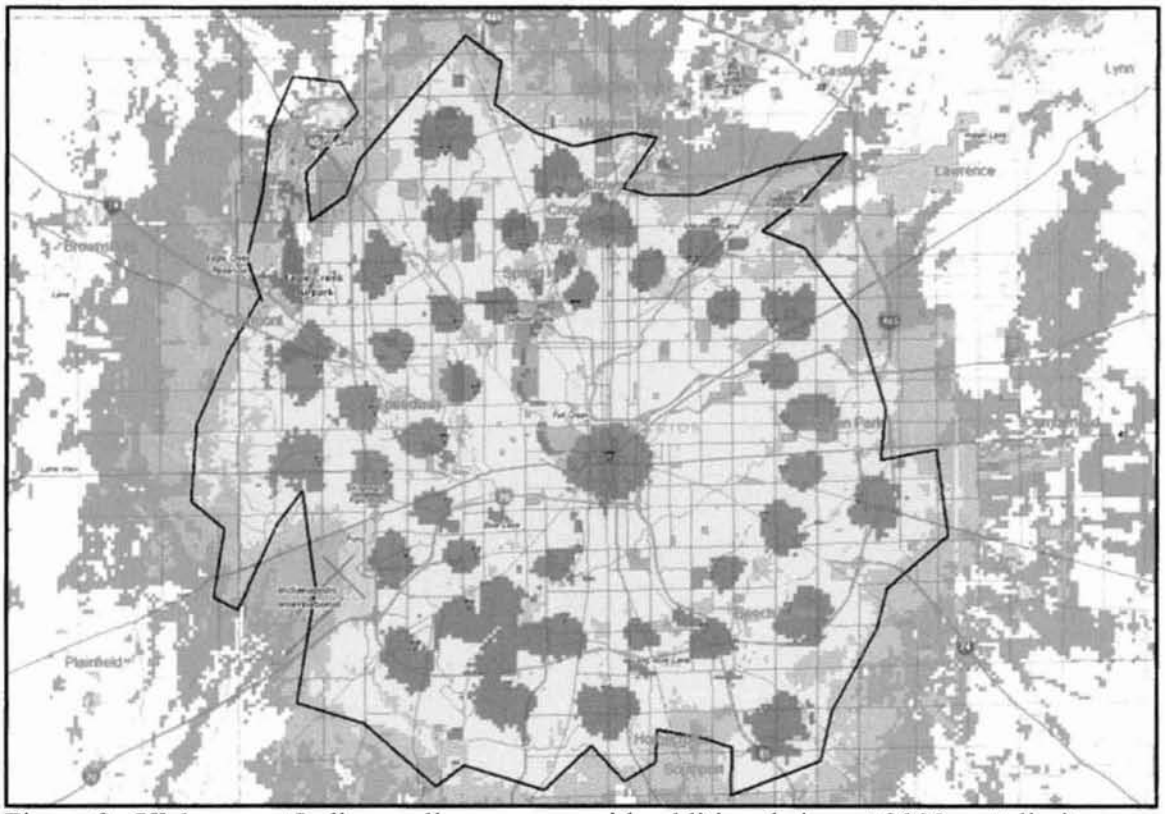
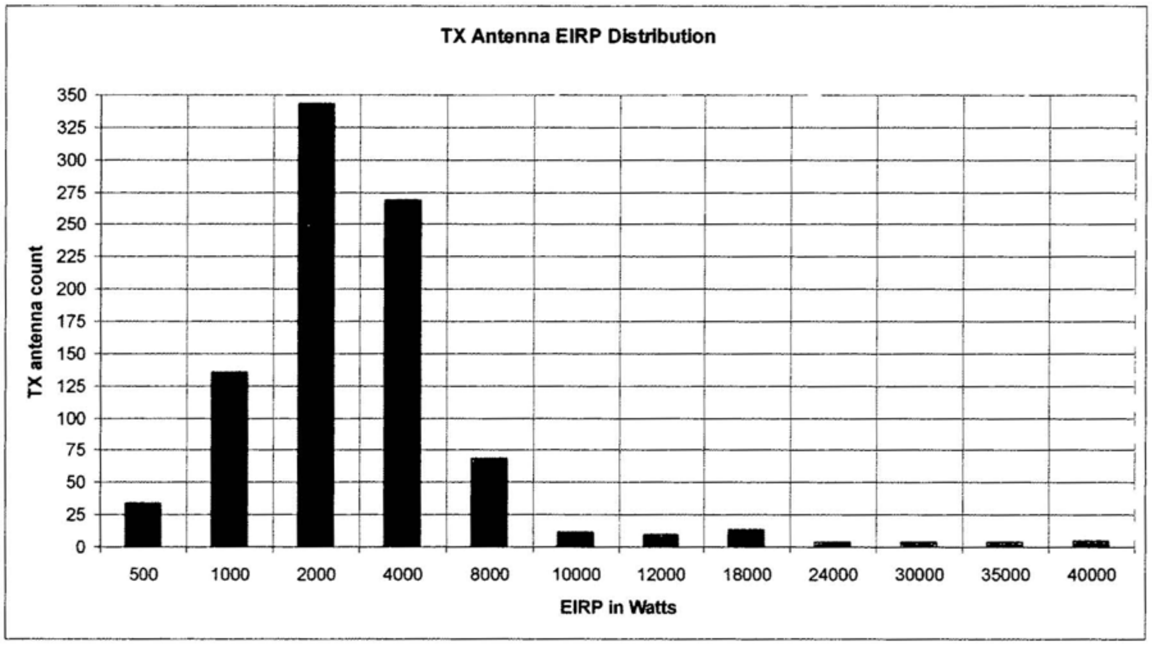


Figure 2. XM current Indianapolis coverage with additional sites at 2000 watt limit

3 Current Network Operating Levels

The following chart is a histogram showing the distribution of the current XM terrestrial network transmit antennas (903 total transmit antennas at 800 sites) designed to be used as part of XM national repeater network.



4 Economic and Schedule Impact

- Several significant problems would arise if XM is required to redesign its existing repeater network to a 2000 watt average power limit:
  - Hundreds of additional sites would be required to recover the loss in coverage due to the 2000 watt limit.
  - The estimated timeframe for the nationwide deployment of the new sites would be at least 24 months, if not longer.
  - The required effort to optimize the new network would cause severe disruption to the service in the markets where new repeaters are required.
  - The existing and new networks would have to exist simultaneously so that in the off peak hours (1-4 a.m.), the network could be reconfigured to conduct drive tests and verify performance. This would mitigate some of the disruption to the current users but lengthen the overall time to finalize the new network for commercial service.
  - The non-recurring costs for the purchase of new repeaters, antennas site acquisition, construction and commissioning activities would be in the tens of millions of dollars.
  - Recurring costs, such as the additional leases, utility cost, and operation and maintenance costs to operate the new repeaters would be in the millions of dollars annually.

Exhibit C

Experimental Measurements of Overload Interference from WCS Transmitters to DARS Receivers and the SDARS Noise Floor

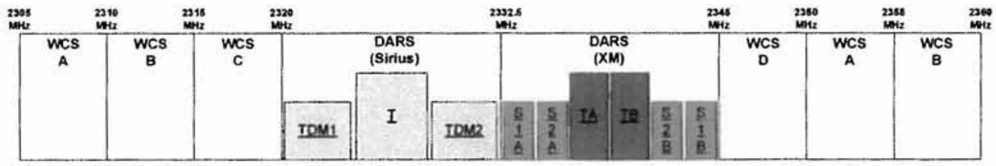
I. Introduction

XM has recently conducted a series of laboratory and field tests to establish the signal levels that would block the reception of the SDARS service satellite signals due to overload interference from devices deployed in the various WCS blocks.[1]

Also attached to this section are tests that were conducted by independent engineering authorities at the EMI Research and Development Laboratory of the Florida Atlantic University to confirm the value of the received noise floor in the presence of no interference, appropriate for out-of-band emissions calculations in the DARS service bands, as well as to measure the overall path loss between the WCS transmitter and the Sirius receiver at a three-meter interference coordination distance.

The following chart illustrates the SDARS and WCS spectrum plans for reference in the following discussion:

Figure 1 WCS/SDARS Bandplan



The following assumptions were used during these tests:

- The WCS operators' deployment will be based on the 802.16e WiMAX standard.
- The services provided by the WiMAX providers will include a range of defined WiMAX profiles.
- The tests used standard off-the-shelf test equipment along with reference IEEE 802.16e WiMAX signals supplied by the test equipment vendor.
- An XM reference receiver was used for the tests. This represents the majority of the XM receiver platforms deployed in the market (including the automotive OEM market where typical product lifecycles are 10 years).
- The upper XM satellite ensemble signals were tested using the upper WCS frequency blocks (D, A-upper, B-upper) as the interfering sources.
- The tests were conducted with representative WCS uplink and downlink transmit profiles represented by the different WiMAX TX duty cycles.

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1 XM conducted these tests in coordination with, and under the supervision of, Sirius Satellite Radio, pursuant to the Special Temporary Authority issued by the Federal Communications Commission in January 2008 (File No. 0591-EX-ST-2007, Call Sign WD9XDT).

- The tests using the WCS D block were done with the assumption of zero guard band, although a guard band will be required for the WCS D block due to required filtering to meet the WCS out-of-band emission limits into the DARS band.
- In the case of the laboratory tests, the SDARS wanted signal was set to a reasonable satellite signal level on the ground for the testing at -100dBm.
- In the case of the field tests, the radio used was put into a test mode to select the individual signals that formed the basis of the test case.

II. Test Set-Up and Description

The test effort includes a laboratory component and a field component. The laboratory tests were designed to determine the overload levels (in dBm) for various XM receivers in response to WCS interference signals. XM defined the overload point to be the received WCS interference power at which the audio stream experiences interruption (*i.e.* muting).

The laboratory tests were executed in a conducted environment, with the instrumentation and relevant equipment connected by cable. The field tests were designed to determine the distances at which a WCS emitter causes overload interference to a XM receiver, as well as the maximum WCS transmit power required to interfere with a XM receiver at a two-meter distance.

Additionally, XM engaged a third party to measure our receiver's thermal noise floor.

II.a. Laboratory Tests

II.a.I. Test Setup:

The XM signals used in the test cases were either SAT1B, SAT2B, or Terrestrial B (COFDM). XM signals were generated in the laboratory tests, while the field tests used the live, over-the-air XM downlink signals.

Overload tests were done with a single serving signal active (*e.g.*, SAT1B, SAT2B or Terrestrial B (COFDM)). The serving signals for SAT1B and SAT2B were -100 dBm, with COFDM set to -95 dBm.

XM created the WCS interference signals using an Agilent E4438C generator equipped with the capability to create and run WiMax-compatible waveforms. The waveforms are based on a mobile WiMax 5 MHz TDD profile at various duty cycles to emulate downlink or uplink traffic. The interference signals operated in the WCS A (upper), B (upper), and D blocks.

The test setup is shown below in Figure 2. The output of the WiMAX signal generator, centered at the WCS channel center frequency, passed through a band pass filter appropriate for each WCS block. After passing through an isolator and variable attenuator, the WCS signal was combined with the desired SDARS signal through a directional coupler. The composite signal was then split, with one path routed to a spectrum analyzer/power meter (Rhode and Schwartz FSQ-26) for monitoring the signal levels and the other routed to the input of a SDARS LNA. The LNA was originally embedded in an actual production XM antenna module, and removed and repackaged in a suitable enclosure for this effort. The output of the LNA was applied to the victim SDARS receiver input, and the receiver's audio output connected to a speaker to monitor and detect audio interruptions.

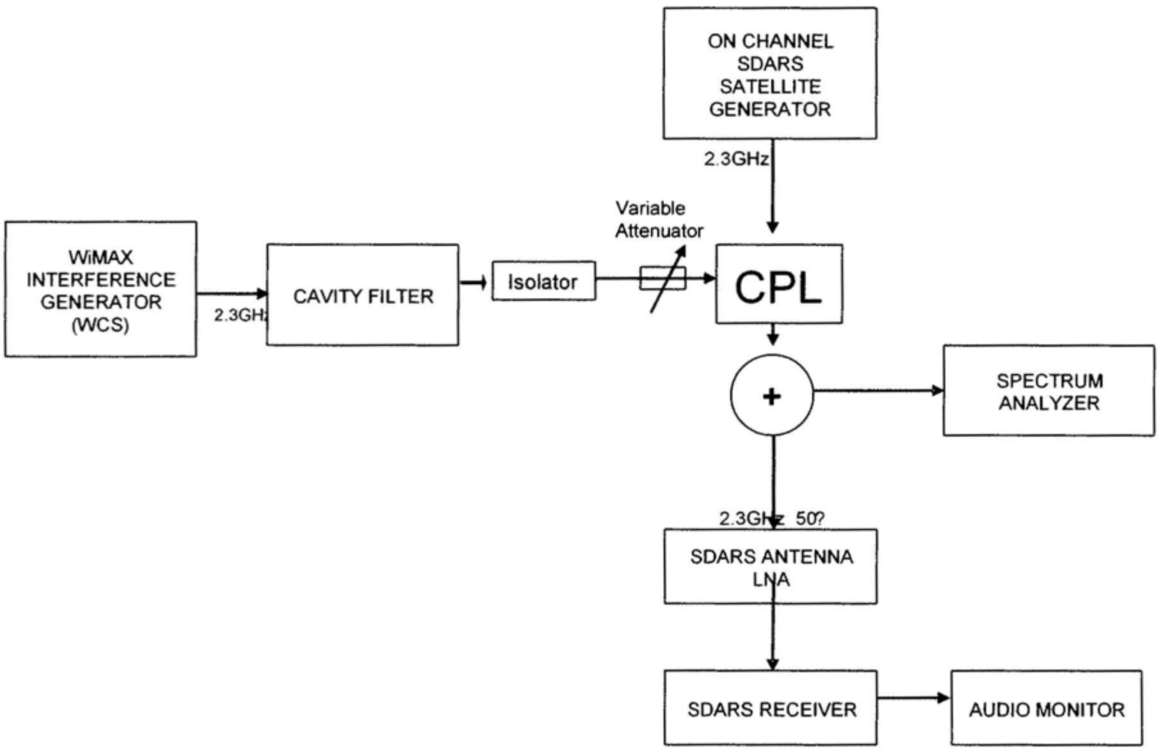

Figure 2 Laboratory Test Block Diagram

II.a.II. Laboratory Test Procedure:

For each test case, the test team used the following procedure to conduct the tests. The steps below are simplified and occur after the system has been configured and calibrated.

- Set the SDARS SAT1B/ SAT2B serving signal to a level of -100 dBm at the LNA input. For COFDM signals, the level is -95 dBm.
- For each SDARS serving signal, increase the WCS signal from a low level until audio muting occurs in the SDARS receiver.
- Reduce the WCS signal in 1 dB steps until audio is restored
- Fine tune the WCS signal level to the highest setting where the SDARS will play unimpaired audio for one minute. This setting is then recorded as the maximum tolerable WCS level before the onset of audio muting.

The preceding steps are repeated for each desired permutation of WCS Block, Duty Cycle, Receiver, and Serving Signal.

II.b. Field Tests

Field tests demonstrated the distances and signal levels at which signals from a WCS mobile device cause muting in the XM receiver. In contrast to the laboratory tests, these tests were conducted under best case conditions: in an open environment, with full satellite link margin. In addition, the test team executed a test to determine the net path loss between the WCS transmitter and SDARS receiver.

II.b.I. Field Test Setup:

Figure 3 shows the block diagram of the field test scenario. The WCS mobile transmission equipment consists of a signal generator (Agilent E4438C), amplifier (modified prototype XM μRepeater PA), filter, dipole antenna, and required cabling. The signal generator output fed a power amplifier, and the signal levels adjusted to achieve the desired transmit power (*i.e.*, 112 mW for interference distance tests). The amplifier output is then fed into a band pass filter (selected by WCS Block) which is in turn connected to the antenna. The antenna is a dipole antenna with an overall antenna gain of 0 dBi toward the horizon. The WCS transmitter equipment suite was mounted on a cart, with the antenna elevated approximately six feet above ground.

On the SDARS receiver victim side, the XM receivers were installed in the typical aftermarket fashion: antenna mounted on the middle portion of a minivan roof, with the receivers inside the vehicle. The test team inserted a directional coupler in-line with the SDARS antenna output to monitor the received desired and undesired signals on a spectrum analyzer. Figure 4 below shows photographs of the test setup in action.

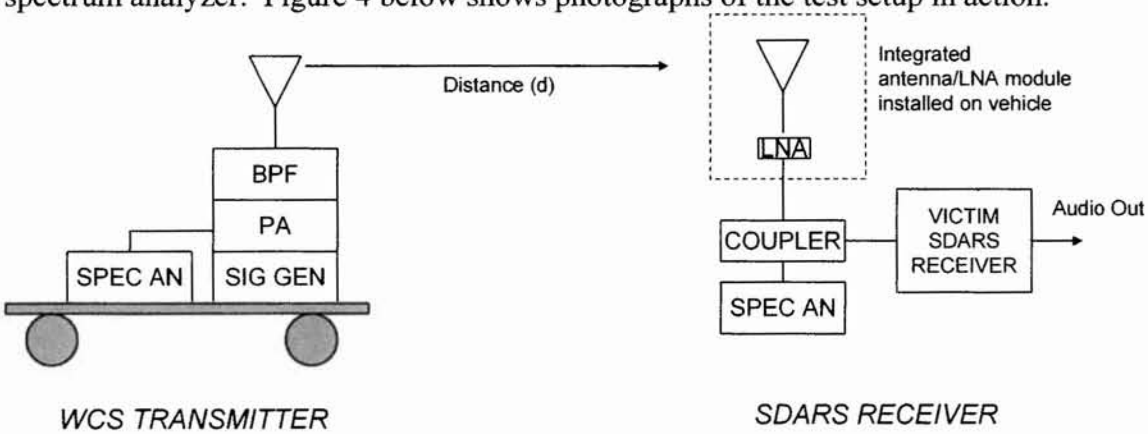

Figure 3 Static Field Tests Block Diagram

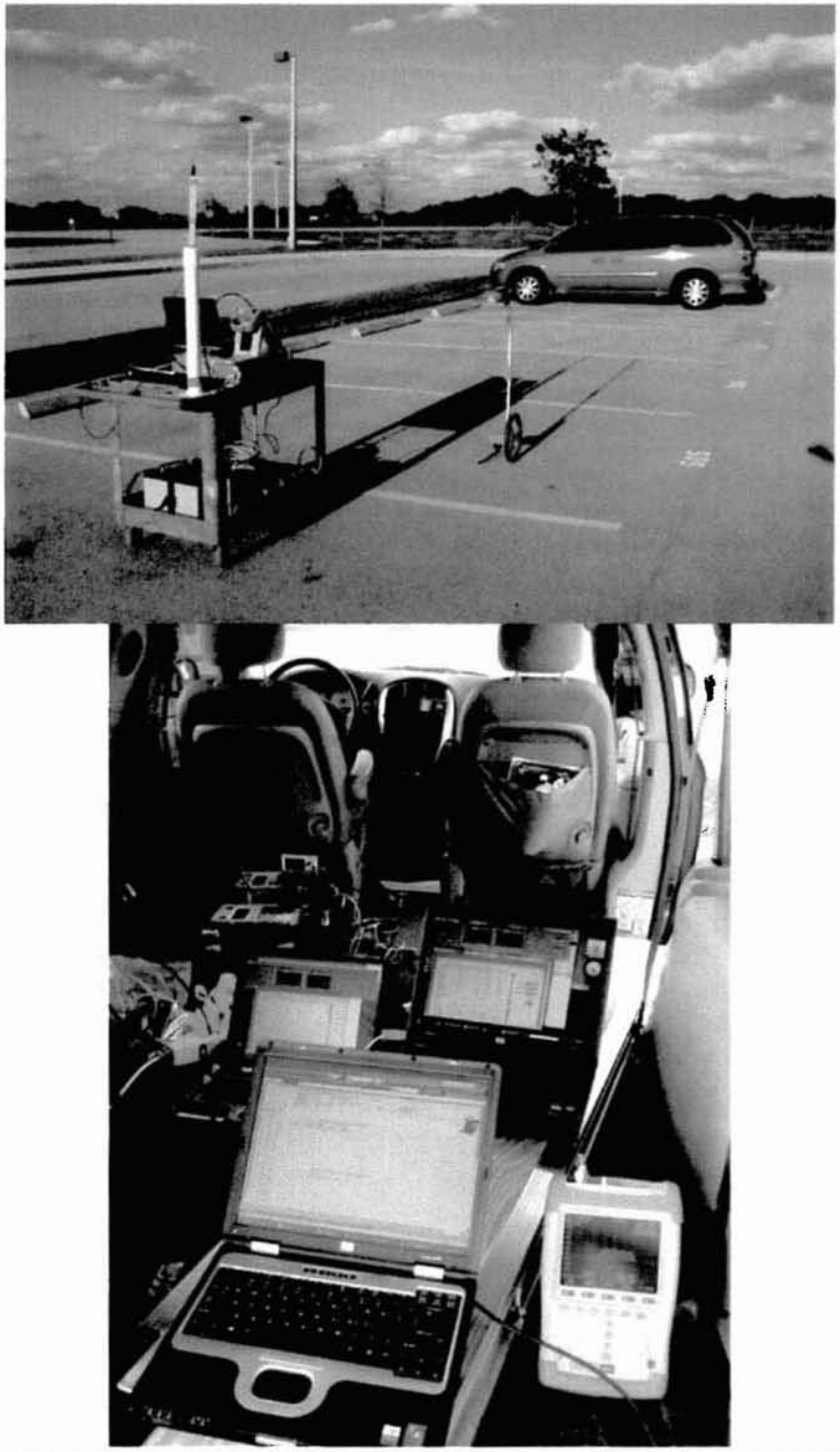

Figure 4: : WCS Transmitter Interference Distance Measurement Test where the WCS transmitter power was fixed at 112mW and the interference distance between the WCS transmitter and the XM OEM installed receiver was measured.

II.b.II. Field Test Procedure:

The test team first set the WCS transmitter to an EIRP of 112 mW (20.5 dBm). Starting from a distance close enough to cause the victim receiver to produce uncorrectable Reed-Solomon code word errors when decoding the satellite signal, the transmitter cart was moved away from the XM receiver in 1 meter increments until there were no uncorrectable Reed-Solomon code word errors. The test team then varied the position of the cart until at least 60 seconds of error free XM reception was observed. This process was repeated to confirm the measurement. The test team then logged the received power vs. distance.

A second test determined the maximum WCS transmitter power that allows error-free SDARS reception at a two-meter distance. For this test, the cart was fixed at a point two meters from the SDARS antenna. The test team increased the transmit power until the receiver produced uncorrectable Reed-Solomon code word errors when decoding the satellite signal, and then reduced the power in 1 dB increments until error-free reception was observed for 60 seconds. The corresponding transmit and received powers were then logged.

The separation distance test was performed on D-block using a Trilithic CFB-1453D filter (f_0=2348.99 MHz, 3 dB bandwidth = 5.5 MHz), with a 44% uplink WiMax signal centered on D-block (f_0=2347.5 MHz). The separation test was repeated with the WiMax 44% uplink signal centered on Au-Block (f_0=2352.5 MHz), but without using an Au-Block filter. The second test to determine the maximum interfering power at a two-meter separation distance was performed using only the D-block WiMax signal with D-block filter.

The field tests were performed under clear sky conditions with the test radios tuned to a B ensemble channel, which would experience the greatest potential interference from transmissions on WCS blocks D, A-upper and B-upper.

III. Test Results

III.a. Laboratory Results

Table 1 shows the maximum WCS interference levels, in dBuV/m, that still allow uninterrupted audio performance. Increasing the WCS interferer beyond these levels caused the onset of muting in the audio stream.

Table 1 Laboratory Test Results

		WCS - Upper Block					
		D		A-upper		B-upper	
WiMAX TX Duty Cycle	XM Wanted Signal	Interfering Signal (dBuV/m)		Interfering Signal (dBuV/m)		Interfering Signal (dBuV/m)	
		XM Ref #1	XM Ref #2	XM Ref #1	XM Ref #2	XM Ref #1	XM Ref #2
50%	**S2b**	77.6	82.6	108.6	100.6	109.6	103.6
50%	**S1b**	77.6	82.6	109.6	98.6	108.6	102.6
7%	**S2b**	79.6	85.6	105.6	103.6	110.6	107.6
7%	**S1b**	79.6	84.6	103.6	103.6	108.6	106.6

III.b. Field Test Results

Table 2 below shows the minimum distance at which an XM satellite stream will play uninterrupted audio in the presence of a 112 mW WCS transmitter under clear line of site conditions with full link margin. Moving the WCS transmitter closer to the victim receiver caused the onset of uncorrectable Reed-Solomon code word errors, resulting in audio muting.

Table 2 Stationary Field Tests,-Distance to Mute With a 112 milliwatt WCS Tramsmitter

Band-Duty Cycle	D-44%	A-44% (no filter)
inno	6.7 m	10.1 m
SkyFi2	16.2 m	13.1 m

For the results in Table 3, the distance between the WCS transmitter and the XM victim receiver was fixed at two meters, and the WCS transmit power was varied. The results shown below indicate the maximum WCS transmit power before the onset of audio muting occurs.

Table 3 Stationary Field Tests-Measured WCS Transmitter Power at Onset of Muting at a 2 meter DARS receiver separation

Band-Duty Cycle	D-44%
inno	6 dBm
SkyFi2	-3 dBm

In addition to the tests discussed above, XM also measured the received power at the receiver as the transmitter was moved away in one-meter increments. Using the known received and transmitted powers, we then calculated the overall path loss between the two antennas. The calculated overall path loss is in agreement with the loss assumption of Free-Space-Loss + 3 dB applied in the analysis throughout this document, confirming our assumptions.

III.c. Noise Floor Test Results

The results of the noise floor tests are shown in Appendix 1. This data confirms that the operating noise floor for the XM satellite service is -113 dBm in the 4 MHz channel.

IV. Discussion of Results

These test results showed the following:

- The level that DARS receivers experience overload interference can be broken down into two major categories.
    - WCS D block (Muting at < 16.2 meters separation)
    - WCS Upper A&B block (Muting at < 13.1 meters separation)
- Previous proposals have assumed that a guard band would be required for WCS D block devices to meet the WCS out of band emission limits. However, if no guard band is in place, a level of 90 dBuV/m (-55 dBm) or lower WCS Field Strength at the satellite radio receiver would be required to protect the SDARS reception.
- The noise floor appropriate for out-of-band emissions calculations is -113 dBm in the 4 MHz channel.

Appendix 1
Noise Floor Measurement

EMI Research and Development Laboratory
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Boca Raton, Florida 33431
(561) 361-4390

Technical Report No. 07-119a

Noise Floor Measurement in the Satellite Radio Band for XM Satellite Radio Systems

Performed: 26 November 2007

Customer: Think Wireless, Inc.
5497 Wiles Road, Suite 205
Coconut Creek, FL 33073

Company Official Responsible for Product(s) Tested: Argy Petros, Ph.D., President
(954) 977-4470

Test Performed and Reported by:

Thierry Jean-Charles, BSEE
FAU EMI R&D Laboratory

Approved by:

Vichate Ungvichian, Ph.D., P.E.
Director, FAU EMI R&D Laboratory

1. INTRODUCTION

This document presents the results for the noise floor measurements for XM Satellite Radio Systems. The results apply only to the specific items of equipment, configurations and procedures supplied to the Florida Atlantic University EMI R&D Laboratory as reported in this document.

2. OBJECTIVE

This evaluation was performed to determine the sensitivity of XM Satellite Radio Systems in their Digital-Audio-Radio-Services (DARS) receive frequency allocation through noise floor measurements.

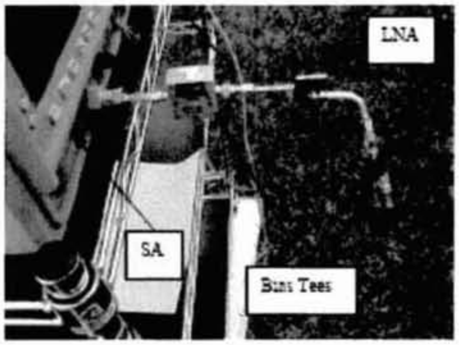
3. CONCLUSION

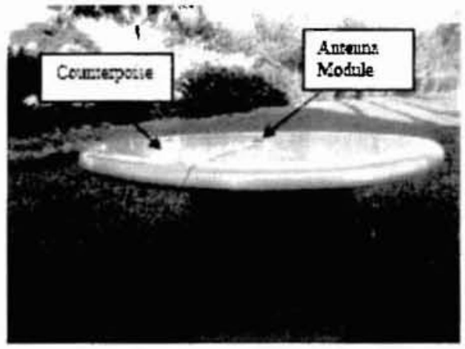
The noise floor levels for XM Satellite, in their corresponding DARS receive frequency allocation, were determined to -113.25 dBm (upper-edge of XM DARS band), as described in the following pages.

4. TEST PROCEDURES AND RESULTS

4.1 TEST PROCEDURES

The XM Satellite Radio receiver noise floor measurements were executed outdoor. The Satellite Digital-Audio-Radio Service (DARS) antenna module for the XM Satellite receivers, which consists of an antenna, a low-noise amplifier (LNA) and a 21-foot cable, was placed on a 3-foot diameter aluminum counterpoise. The antenna module was connected in series with a low-noise amplifier of 16-dB gain to the input of an Agilent E4404B spectrum analyzer (SA). Bias tees were used to activate the LNAs. Photographs 1 and 2 and Diagram 1 depict the measurement setup.





Photographs 1 & 2: Measurement Setup

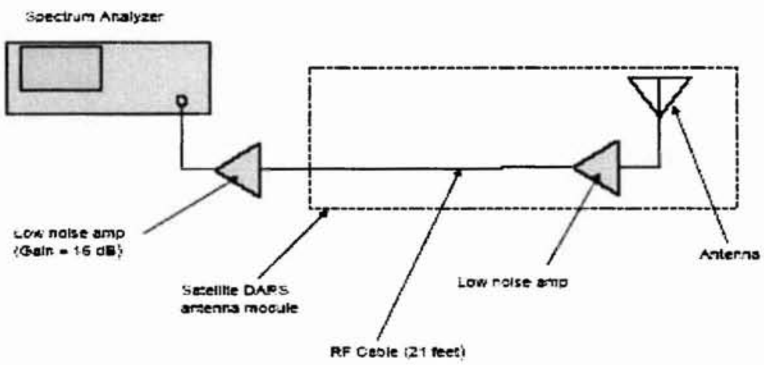


Diagram 1: Measurement Setup

4.1.1 XM NOISE FLOOR MEASUREMENTS

The DARS band corresponding to the XM Satellite Radio system was identified on SA (Diagram 2). Then the span was reduced to include only the DARS band covered by the XM SAT 1B and SAT 2B satellites, which ranges from 2341 MHz to 2345 MHz. Afterward, the location of the DARS antenna module with the counterpoise was changed so that the incident XM Satellite Radio signal is blocked by the test building. The noise floor of the system was measured using a resolution bandwidth and a video bandwidth of 3 kHz over the 4 MHz span. The data was recorded with SA on "max hold" and was averaged over 25 sweeps. Figure 1 shows the result for the noise floor measurements for the XM Satellite Radio receiver.

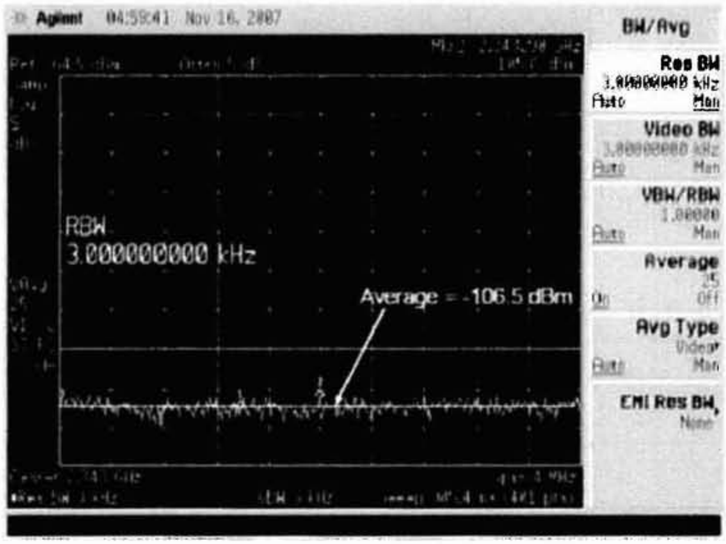


Figure 1: XM SAT 1B and SAT 2B Noise Floor Measurements

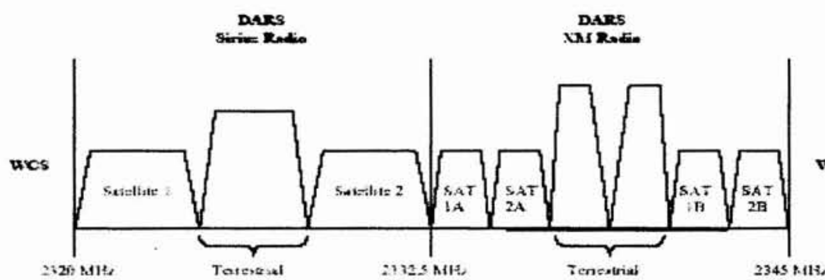


Diagram 2: DARS Receive Frequency Allocation

4.2 TEST RESULTS

Based on Figure 1 and the following parameters:

- Spectrum analyzer reading SA_NF (dBm)
- LNA in front of the Spectrum Analyzer. SA_LNA = 16 dB gain
- Spectrum Analyzer Resolution Bandwidth. RBW = 3 kHz
- Bandwidth of satellite signal. BW = 4 MHz
- Antenna module LNA gain (including the 21-foot cable loss). ALNA = 22 dB.

the calculated noise floor for the XM Satellite Radio receivers is recorded in Table 1.

Satellite Receiver	Figure No.	SA_NF (dBm)	SA_LNA (dB)	ALNA (dB)	BW (MHz)	RBW (kHz)	Calculated Noise Floor (dBm)*
XM	1	-106.5	16	22	4	3	-113.25

Table 1: Calculated Noise Floor at the Front-End of the Satellite Receiver

*Calculated Noise Floor (dBm) = SA_NF (dBm) – SA_LNA (dB) – ALNA (dB) + 10*LOG(BW/RBW)

Hence the calculated noise floor at the front-end of the satellite receiver is

- XM SAT1B & SAT2B
  - SA_NF = -106.50 dBm
  - Calculated Noise floor = -113.25 dBm

MAJOR TEST EQUIPMENT

Equipment Type	Manufacturer	Description	Model	Serial No.
Spectrum Analyzer	Agilent	9 kHz - 6.7 GHz	E4404B	MY41440110

End of Report