BEFORE THE

Federal Communications Commission

WASHINGTON, D.C.

In re Application of	)	
	)	
SATELLITE CD RADIO, INC.	)	File Nos. 49/50-DSS-P/LA-90
	)	58/59-DSS-AMEND-90
For Authority to Construct,	)	44/45-DSS-AMEND-92
Launch and Operate a Digital	)	
Audio Radio Service Satellite	)	
System in the 2310-2360 MHz	)	
Band	)	

RESPONSE OF AMSC SUBSIDIARY CORPORATION

AMSC Subsidiary Corporation ("AMSC"), by its attorneys, hereby submits its Response concerning the above-referenced application of Satellite CD Radio, Inc. ("SCDR") to operate a Digital Audio Radio Service ("DARS") satellite system.

Background

SCDR's application seeks authority to operate a satellite system that would provide digital audio radio programming to subscribers. SCDR's programming would be transmitted to its satellites using feeder links in the 7035-7055 MHz band. It would be downlinked to subscribers using frequencies in the 2310-2360 MHz portion of a band (2310-2390 MHz) allocated domestically to aeronautical telemetry. SCDR's system would employ two widely-spaced geostationary satellites, each using 8 MHz of downlink spectrum on the same polarization, for a total of 16

MHz. SCDR states in its application that frequency reuse is possible using orthogonal polarization.

On November 13, 1992, AMSC filed Comments on the SCDR application. AMSC noted that there is a critical need for additional spectrum for the full development of MSS in the United States. AMSC demonstrated that a full 50 MHz allocation to DARS from the 2310-2390 MHz band overlooked the utility of either (i) reserving a portion of the band for reassignment of some aeronautical telemetry systems that are currently using the 1515-1525 MHz band that was allocated to MSS in Region 2 at the 1992 World Administrative Radio Conference[1/] or (ii) allocating 10 MHz of the available spectrum for a new domestic MSS downlink.

While AMSC expressed no opposition to the institution of DARS, it questioned whether 50 MHz of spectrum is necessary for the service. AMSC urged the Commission to ensure that DARS

1/ At the request of the U.S., WARC-92 adopted a footnote limiting MSS use of the 1492-1525 MHz band in the United States. See RR 722B. AMSC believes, however, that the U.S. could not have intended to impose on itself an unconditional bar on use of this band by a U.S. MSS system, and that the Commission therefore retains the flexibility to assign these frequencies to a domestic MSS system. AMSC has submitted several analyses showing that MSS systems can share this band with aeronautical telemetry users, and has proposed that the Commission assign the 1515-1525 MHz band to AMSC and condition its use on AMSC's formulating a solution for sharing with aeronautical telemetry. See Comments of AMSC, ET Docket No. 92-28 (December 4, 1992), at 17-18; see also Consolidated Opposition of AMSC to Petition to Deny, File Nos. 15/16-DSS-MP-91 (January 31, 1992), Annex to Technical Appendix; Further Reply of AMSC, RM-7400 (October 18, 1990), Technical Appendix.

systems are assigned only so much spectrum as required to provide their proposed service. This would ensure that at least a portion of the 2310-2360 MHz band would remain available to alleviate the chronic shortage of domestic MSS spectrum. AMSC pointed out that SCDR requests far more spectrum in this band than it needs. Using the polarization reuse capability that it claims, SCDR's proposed system could effectively use as little as 8 MHz total.

Numerous parties filed comments or petitions urging the denial of SCDR's application.[2/] A number of these parties questioned the technical feasibility of SCDR's proposed system.[3/] Primosphere Limited Partnership ("Primosphere") argued that SCDR's ownership structure violates the alien

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2/ See Petition to Deny of Robert D. Augsberg (November 9, 1992); Petition to Deny of Anthony V. Bono (November 12, 1992); Comments of Digital Cable Radio (November 13, 1992) ("Digital Cable Radio Comments"); Petition to Deny or Defer of the "Joint Parties" (November 13, 1992); Petition to Deny of Tim McDermott (November 12, 1992); Petition to Deny of Ralph McBride (November 12, 1992); National Association of Broadcasters' Petition to Deny (November 13, 1992) ("NAB Petition"); Petition to Deny of Primosphere Limited Partnership (November 13, 1992) ("Primosphere Petition"); Petition to Deny of Jan Stott (November 13, 1992); Comments of the Radio Operators Caucus (November 13, 1992); Comments of International Radio Satellite Corporation (November 12, 1992) ("Radiosat International Comments"); Comments of Radio Satellite Corporation (November 13, 1992) ("RSC Comments"). See also Reply Comment of Association for Maximum Service Television, Inc. (December 1, 1992).

3/ See Digital Radio Cable Comments at 8-9, 10-11; NAB Petition at 9-10; Primosphere Petition at 10; Radiosat International Comments at 5; RSC Comments at 3.

ownership restrictions of the Communications Act and the Commission's Rules. Primosphere Petition at 4-8. Digital Cable Radio also claimed that SCDR is not entitled to the Pioneer's Preference it seeks. Digital Cable Radio Comments at 14-15.

SCDR filed a pleading responding to the comments and petitions against its application. See SCDR's Opposition to Petitions to Deny and Response to Comments (December 1, 1992) ("SCDR Opposition"). SCDR dismisses AMSC's concern about the need for available frequencies in the 2310-2360 MHz band to alleviate the MSS spectrum shortage, claiming that MSS "has access to all the spectrum it needs." SCDR Opposition at 17-18. SCDR, however, does not challenge AMSC's observation that SCDR can operate its system using as little as 8 MHz of spectrum.

SCDR claims that its system "will provide the best-quality service to the American public while using the minimum practical amount of spectrum." Id. at 36. SCDR further asserts that Primosphere's impermissible alien ownership allegations are based on an outdated FCC Form 430 and that, in any event, the alien ownership restrictions of the Communications Act do not apply to SCDR's subscriber-based system. Id. at 24-26. SCDR also alleges that it is too late to challenge its request for a Pioneer's

Preference and that SCDR deserves such a preference. Id. at 27-30.[4/]

Discussion

I. SCDR's System is Spectrum Inefficient

SCDR claims that its system will provide thirty channels of DARS service. However, as shown in the attached Technical Appendix, SCDR's satellites will be able to generate at most half the power necessary for the system to produce its claimed capacity. To make matters worse, even the much lower power level that SCDR's satellites actually can produce would be achieved only by operating the satellite transmitters at saturation level, as SCDR proposes. This will produce spurious emissions that are likely to exceed permissible levels, and therefore cause interference to SCDR's own uplinks (which would operate on harmonic frequencies), other DARS systems, and existing users of SCDR's downlink band and other bands.

4/ An affiliate of AMSC, American Mobile Radio Corporation ("AMRC"), is today filing an application for authority to construct, launch and operate two high-power satellites to provide DARS to all fifty United States, Puerto Rico and the U.S. Virgin Islands. The filing of AMRC's DARS application is consistent with AMSC's position that all 50 MHz of the 2310-2360 MHz band should not be used for DARS and that DARS systems should be required to operate in a spectrum efficient manner. Indeed, AMRC's proposed system would use only 10 MHz of spectrum in the upper 25 MHz of the 2310-2360 MHz band to provide more capacity than SCDR's system and would cover more of the United States.

Moreover, SCDR's proposed system is wasteful of spectrum. SCDR proposes to employ two satellites, each using distinct 8 MHz frequency bands separated by 20 MHz, to transmit the same programming. The attached Technical Appendix shows, however, that this frequency diversity proposal does not yield enough gain to justify the use of double the spectrum for the same program.

SCDR claims that using orthogonal polarizations, its system can share the 16 MHz it intends to use with other DARS systems. As noted above, however, orthogonal polarization is not an effective means of enabling spectrum sharing between DARS systems. As discussed in the attached Technical Appendix, cross-polarization between multiple DARS systems on overlapping frequencies will result in severe interference between the systems. Nonetheless, the attached Technical Appendix shows that, as AMSC has suggested previously, SCDR can use orthogonal polarization to operate its own redundant satellites on the same frequency, thereby reducing the amount of spectrum SCDR needs to as little as 8 MHz. Indeed, when considered with the need to reduce power, and therefore capacity, to limit spurious emission levels, polarization diversity could enable SCDR to operate with less than 4 MHz of spectrum.

II. SCDR Violates the Alien Ownership Restrictions

AMSC agrees with Primosphere that SCDR's ownership structure violates the alien ownership restrictions of the Communications

Act and the Commission's Rules. Section 310(b)(4) of the Communications Act flatly prohibits a "broadcast or common carrier or aeronautical en route or aeronautical fixed radio station license" from being granted to

> any corporation directly or indirectly controlled by any other corporation of which any officer or more than one-fourth of the directors are aliens, or of which more than one-fourth of the capital stock is owned of record or voted by aliens, their representatives, or by a foreign government or representative thereof, or by any corporation organized under the laws of a foreign country, if the Commission finds that the public interest will be served by the refusal or revocation of such license.

According to an amendment to SCDR's application filed on December 14, 1992, SCDR is now a wholly owned subsidiary of CD Radio Inc. ("CDR"). The amendment indicates that nearly 40% of CDR's stock is owned by non-U.S. citizens. Moreover, two of CDR's six directors -- Mr. David Margolese and Mr. Charles Dalfen -- are citizens of Canada. As more than 25% of CDR's stock is held by an alien and more than one-fourth of CDR's directors are aliens, SCDR's ownership structure is in direct violation of Section 310(b)(4). SCDR has offered no reason why the grant of its application would nonetheless serve the public interest.

There is no merit to SCDR's argument that the alien ownership restrictions do not apply to its proposed system. SCDR's subscriber satellite broadcasting service is analogous to Direct Broadcast Satellite and other subscription video services whose licensees are subject to Section 310(b) regardless of the

service's regulatory classification. See Subscription Video Services, 4 FCC Rcd 4948 (1989); Section 100.11 of the Commission's Rules.

III. SCDR's Pioneer's Preference Request Should Be Opened to Renewed Scrutiny

AMSC disagrees with SCDR that SCDR's request for a Pioneer's Preference is no longer subject to challenge. SCDR has amended its application since the initial deadline for comments on its Pioneer's Preference request. Moreover, the Commission has for the first time established a date for filing competing DARS applications, and has only recently adopted an NPRM proposing an allocation for DARS. The public interest would be served by permitting further comment on SCDR's Pioneer's Preference request in light of these recent developments and AMSC reserves the right to file comments on SCDR's request at a later date.

IV. Spectrum in the 2310-2360 MHz Band Can and Should Be Made Available to Ameliorate the Shortage of MSS Spectrum

While AMSC supports the concept of using satellites to provide a full range of services, including broadcast services, it continues to urge the Commission, while it goes forward with the DARS proceeding, to give full consideration to making a portion of the 2310-2360 MHz band available either for relocation of aeronautical telemetry facilities presently operating in the

1492-1525 MHz band, or alternatively, as downlink spectrum for a U.S. MSS system.

SCDR is wrong that AMSC has access to "all the spectrum it needs." AMSC has shown many times that more than thirty different MSS systems worldwide plan to operate in the 28 MHz of spectrum presently assigned to AMSC. Based on AMSC's experience in the international coordination process, it is unlikely that more than a fraction of the spectrum presently assigned to AMSC can be coordinated successfully.[5/] While AMSC has sought authority to operate in the bands presently allocated domestically to the Radiodetermination Satellite Service, five other entities seek to operate non-geostationary MSS systems in these bands. Moreover, other bands allocated to MSS at WARC-92, such as 1930-2010/2120-2200 MHz and 2500-2520/2670-2690 MHz, are allocated domestically to terrestrial systems with which MSS sharing is not currently feasible, and these bands therefore are not likely to be available for MSS use for some time. Thus, access to downlink spectrum in the 1492-1525 MHz band or, alternatively, the 2310-2360 MHz band, is of great importance to the full development of the U.S. MSS system.

5/ See, e.g., Comments of AMSC, ET Docket No. 92-28 (December 4, 1992); Comments of AMSC, Gen. Docket No. 90-314, ET Docket No. 92-100 (November 9, 1992); Comments of AMSC, NTIA Docket No. 920532-2132 (November 6, 1992); Comments of AMSC, ET Docket No. 92-9 (June 8, 1992); Petition of AMSC, RM-7806 (June 3, 1991); Comments of AMSC, Gen. Docket No. 89-554 (December 3, 1990).

Conclusion

AMSC believes that even considering the DARS applications being filed, there will remain ample spectrum to help alleviate the critical need for MSS spectrum. AMRC's DARS system requires only 10 MHz of the 2310-2360 MHz band. SCDR's proposed system is technically and legally flawed, and in any event can operate with only 8 MHz or even less. Even assuming that several other DARS applications are filed, AMSC expects that a substantial amount of spectrum in the band will be available for the relocation of aeronautical telemetry facilities or as an MSS downlink. AMSC reiterates that the Commission should allocate to DARS only so much spectrum as is necessary for DARS systems to provide adequate service. The remaining spectrum should be made available to meet the pressing need for domestic MSS spectrum.

Respectfully submitted,

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TECHNICAL APPENDIX

TECHNICAL APPENDIX

Introduction

This Appendix addresses technical issues concerning the application of Satellite CD Radio, Inc. ("SCDR") for authority to construct, launch and operate a Digital Audio Radio Service ("DARS") satellite system.

Section I of this Appendix shows that the claimed 30-channel capacity of SCDR's system is overstated. Specifically, SCDR's proposed satellites have power sufficient to produce only about half that capacity. Moreover, SCDR's satellites can achieve even these much lower power levels only by operating at saturation. This will produce spurious emissions that are likely to exceed permissible levels, and therefore to cause interference to DARS systems operating on nearby frequencies, existing users of SCDR's downlink band and other bands, and even SCDR's own uplinks.

Section II demonstrates that the gain from operating two redundant satellites, transmitting the same programming on separate 8 MHz frequency bands, is too minimal to justify SCDR's proposal to take up a full 16 MHz of spectrum.

Finally, Section III shows that SCDR's proposal to accommodate independent DARS systems on the same frequencies using orthogonal polarizations is unworkable, and will result only in severe mutual interference between systems. As AMSC has suggested previously, however, SCDR can use orthogonal polarization to reduce the spectrum usage of its own system.

I. SCDR'S CLAIMED SATELLITE CAPACITY CANNOT BE ACHIEVED WHILE MEETING SPURIOUS EMISSIONS LIMITS

The satellites proposed by SCDR have power sufficient to produce only slightly more than half of SCDR's claimed thirty-channel capacity, and further capacity reduction is needed to assure that spurious emissions will be sufficiently suppressed to avoid interference to other DARS systems as well as systems in other services, including systems operating at or near the harmonics of the proposed fundamental frequencies.[1/] There is a

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1/ See SCDR Compendium of Applications and Restatement of Petition for Rulemaking (September 25, 1992) ("SCDR Compendium"), at 21, 23 and 32. SCDR contends that its emissions will comport with Section 25.202(g) of the Commission's Rules. SCDR Compendium, at 28. This Rule (continued...)

power shortage of at least 50% from the proposed transmitters despite the proposed saturated operation, even if over-optimistic assumptions are made regarding satellite transmission losses, power storage and conditioning efficiency, and power requirements of other subsystems. Moreover, simple corrections to SCDR's stated capacity level will not eliminate the onerous spurious emissions that would be generated by the saturated transmitters, the power output combining network, and other parasitic satellite elements that are exposed to the high power densities of SCDR's single time division multiplex (TDM) carrier. Reducing the attempted satellite capacity by more than 50% may be the only practical way to reduce spurious emissions and the associated interference to acceptable levels without making major modifications to the space segment.

As an initial matter, it is evident that even with operation at saturation, SCDR's system cannot achieve anywhere near its stated 2.3 GHz antenna input power of 1000 watts, and thus SCDR has overstated its satellite capacity even without considering the power reductions needed to reduce spurious emissions. The stated end of life solar array output power is 1814 watts. SCDR Compendium, at 32. Assuming over-optimistically that the power handling efficiency is 90%, 1633 watts of prime power can be delivered to spacecraft subsystems. Further assuming over-optimistically that only 100 watts is required by the attitude control subsystem, 7 GHz receiver, command receiver and processor, telemetry transmitter and processor, and all other subsystems except for the 2.3 GHz transmitters, 1533 watts of prime power would be available to the bank of 16 transmitters generating the 2.3 GHz downlink signals. On the other hand, the total RF output of the transmitter would have to be at least 1259 watts, given that the power delivered to the antenna feed is stated to be 1000 watts and assuming a net loss of only 1 dB for the waveguide, power combiner network, and other elements between the transmitter output ports and the feed. Consequently, under these idealistic circumstances, the transmitters would have to operate at 82% efficiency, which is more than twice the efficiency level obtained from operating spacecraft solid state or travelling wave tube amplifiers at saturation. Consequently, less than one-half of SCDR's stated antenna input power and capacity can be achieved.

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requires suppression of spurious emissions by 25 dB at frequencies separated from the assigned frequency by up to 100% of the authorized bandwidth, and suppression must exceed 43 dB plus 10 log (power) at frequencies separated from the assigned frequency by more than 250% of the authorized bandwidth. An even greater level of suppression is required in the event that harmful interference is caused by emissions outside the authorized bandwidth.

Although the SCDR Compendium of Applications does not provide sufficient information to estimate the absolute levels of spurious emissions that would be generated (e.g., basic parameters such as the type of transmitters used, prime power delivered to the transmitters, and method of power combining are omitted from the application), the spurious emission levels obviously will be inordinately high -- much higher than those of other satellites. Operation of a transmitter at or near saturation produces spurious emissions at levels exceeding those produced by operation in the more linear region used in other satellite systems. These powerful transmitter-produced spurious emissions may be somewhat attenuated by the power combining network, but the combining network itself will generate spurious emissions as a result of its non-linearities. The non-linearities of the waveguide, coupler, isolator, polarizer, antenna feed, and antenna surface will further add to the spurious emissions. These passively generated spurious emission levels will exceed the norm as a result of concentration of all signal power into one 3.97 Mbps carrier.[2/] The saturated transmitter operating mode, high power density, and power combining network proposed by SCDR are highly likely to result in violation of the Commission's spurious emission limits.

In addition to causing interference to other DARS systems operating on nearby frequencies, the spurious emissions from the proposed SCDR satellites could interfere with systems in the Fixed, Mobile and Radiolocation services in the 2300-2450 MHz band, as well as systems operating near second harmonics in the 4500-4800 MHz band (e.g., sensitive troposcatter systems), near third harmonics in the 5925-7075 MHz band (e.g., line-of-sight radio-relay systems), and so forth. In fact, SCDR's third harmonic emissions from its 2345 MHz downlink would severely interfere with SCDR's associated uplink at 7045 MHz.[3/]

2/ For example, the power of a third order harmonic is proportional to the cube of the power in the fundamental emission. Thus, concentrating all the power in a single carrier containing 30 TDM channels produces far greater harmonic emission power than would 30 individual carriers that each have 1/30th the total power.

3/ Even if the third harmonic emissions of SCDR's proposed 2345 MHz transmissions were well suppressed, they would be co-channel with the less powerful uplink transmissions centered at 7045 MHz. These spurious emissions would consume most of the available downlink transmission power and prevent any reception of the attempted broadcasts. The third harmonic of 2345 MHz is 7035 MHz, whereas SCDR proposes an uplink frequency of 7045 MHz. SCDR Compendium, at 23. Analog and noise-like signals of bandwidth B at the fundamental

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II. SCDR'S PROPOSED FREQUENCY DIVERSITY PROVIDES LITTLE GAIN

Significant frequency diversity gain is not achieved in addition to the gain from spatial diversity (i.e., angle or path diversity) in the redundant transmission scheme proposed by SCDR; thus, SCDR's proposed use of two 8 MHz frequency bands for redundant transmissions provides little benefit and wastes spectrum. The ineffectiveness of the proposed frequency diversity stems from the high correlation of fading of two signals having 20 MHz frequency separation. This correlation is much higher than that associated with path diversity, so the joint reduction in fading from path and frequency diversity is not much greater than the reduction in fading due solely to path diversity. For example, assuming an average delay spread of 4 nanoseconds due to multipath propagation at 2.3 GHz, which is typical of many operating environments, the coherence bandwidth is about 40 MHz (i.e., signals separated by 40 MHz undergo fading with a correlation of 0.5). Thus, signals separated by only 20 MHz are more highly correlated (i.e., they tend to fade at the same time) and the associated frequency diversity gain is low. In contrast, two angle diversity paths produce signals that are virtually uncorrelated in most environments.

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frequency are spread to a bandwidth of 3B centered at the third harmonic; however, lesser spreading can occur with digital signals. SCDR's digital uplink and downlink signal bandwidths are 20 MHz and 8 MHz, respectively. Thus, the third harmonic replica of the fundamental spacecraft emission occupies a bandwidth spanning at least 7031-7039 MHz and as much as 7023-7047 MHz, either of which overlap with the uplink bandwidth spanning 7035-7055 MHz. Thus, half of the entire third harmonic of the downlink emission is received in the uplink passband at a power level on the order of -90 dBW (i.e., assuming a waveguide filter yielding at least 60 dB suppression of the third harmonic, resulting in -50 dBW EIRP at the third harmonic toward the concentric 7 GHz antenna, assuming 20 dB edge taper from the 2.3 GHz feed emitting a 7 GHz signal, and assuming about 40 dB of other coupling and filter losses). In contrast, the desired 7 GHz uplink signal is received at a power level of -96.4 dBW, assuming operation at the saturation power flux density level.

III. ORTHOGONAL POLARIZATION IS NOT AN EFFECTIVE MEANS OF ENABLING SPECTRUM SHARING BETWEEN MULTIPLE DARS SYSTEMS

SCDR proposes a frequency plan for DARS that would assign overlapping spectrum to DARS systems using orthogonal circular polarizations. Such a scheme, however, is not workable, because it would result in unacceptable interference among the systems.[4/] Antennas suitable for mobile reception have low levels of cross-polarization discrimination ("XPD") in many directions, which severely limits the isolation between cross-polarized systems. Moreover, substantial depolarization of the signal itself occurs for significant percentages of the time and locations as a result of various propagation mechanisms; thus, even theoretically perfect receiver antennas cannot provide high isolation against orthogonally polarized transmissions. As a result, the net XPD in a DARS channel has a low average value and high variability that would cause signals on one polarization to interfere with independent, overlapping signals on the orthogonal polarization.

DARS transmissions will be circularly polarized in order to avoid the need for polarization tracking at the receiving earth station.[5/] Low gain mobile receiving antennas also will

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4/ Satellite CD Radio estimates that 20 dB of polarization isolation can be achieved between orthogonally polarized DARS systems. SCDR Compendium, at 63. This estimate is based on the polarization isolation achieved in satellite systems using earth stations with large reflector antennas that provide both high polarization purity and high discrimination against multipath signals. Neither of these attributes are achieved in DARS systems.

5/ The ionospheric effect known as Faraday rotation twists the polarization vector of signals on satellite transmission paths such that a linearly polarized signal becomes reoriented. Consequently, a linearly polarized signal reaching an earth station may be unaligned with the polarization of a linearly polarized earth station antenna, which can substantially reduce the effective antenna gain. A circularly polarized receiver antenna could be used to receive the the linearly polarized signal, but only at the expense of an effective gain reduction of about 3 dB. Alternatively, a linearly polarized antenna with polarization tracking can be used to maintain alignment with a linearly polarized signal, but this is generally practical only for large antennas. In contrast, Faraday rotation of a circularly polarized signal has no effect on the effective

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generally be "circularly" polarized, but will have voltage axial ratios averaging 2 dB or higher (i.e., elliptical polarization) over all impinging line-of-sight signal paths and exceeding 6 dB in some directions. While these axial ratios will not substantially reduce the antenna gain toward a circularly co-polarized desired signal, the gain toward an orthogonally polarized interfering signal will also be significantly high. These antenna polarization axial ratios yield average XPD levels of about 15 dB and XPD levels lower than 10 dB will occur in some directions. To make matters worse, an orthogonally polarized signal transmitted by another satellite is depolarized and sometimes even reversed by various propagation phenomena, particularly multipath, which results in woefully low net channel XPD levels.[6/] Measurements show that even at optimistically high elevation angles, the average net XPD would be only about 6 dB and even lower XPD values would occur for significant percentages of time and locations.[7/] Assuming equal power is transmitted in orthogonally polarized co-channel desired and interfering signals, the co-channel carrier-to-interference (C/I) power ratio levels will be lower than 6 dB for substantial percentages of the time and locations and even lower if fading of the desired signal is considered. Operation at these low C/I levels among overlapping co-polarized signals in separate DARS systems would result in severe mutual interference. Thus, frequency overlap must be avoided among independent systems in order to achieve filter discrimination adequate to offset the low C/I levels.

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gain of a circularly co-polarized receiving antenna provided that the signal's polarization ellipse has a low axial ratio.

6/ Polarization reversal occurs due to multipath on signal paths having elevation angles that are less than the Brewster angle, which can exceed 20° over land. This results from the concommitant 180° phase shift of only the vertical component of the multipath signal and the relatively high power levels of the multipath signals that occur at low elevation angles for substantial percentages of the time and locations. Other phenomena also can produce polarization reversal.

7/ See, e.g., J. Butterworth, Propagation Data for Land Mobile Satellite Systems (May 1985) (published in Proceedings of NAPEX VIII, June 20-21, 1985, University of British Columbia, Vancouver, Canada). The reported measurements using a crossed drooping dipole antenna show median XPD levels of 1 dB, 2 dB and 5 dB and full depolarization (0 dB XPD) for 45%, 30%, and 10% of the time and locations at elevation angles of 10°, 20° and 30°, respectively.

Nonetheless, as suggested in AMSC's previous comments on the SCDR application, SCDR could operate its own system's redundant satellite transmissions on a co-channel basis using orthogonal polarizations because receiver processing techniques are available to properly operate with both angle and polarization diversity. See Comments of AMSC (November 13, 1992), at 6-7. Specifically, SCDR could implement both angular and polarization diversity using receiver technologies developed for combating multipath degradation in the mobile-satellite service ("MSS"). Thus, while separate DARS systems cannot achieve frequency reuse through implementation of orthogonal polarizations, SCDR can employ orthogonal polarization to halve the amount of spectrum its own system uses. Moreover, when the need to reduce power, and therefore capacity, to limit spurious emission levels (as described above) is considered, polarization diversity could enable SCDR to operate with less than 4 MHz of spectrum.

DECLARATION

I, Thomas M. Sullivan, do hereby declare as follows:

1. I have a Bachelor of Science degree in Electrical Engineering and have taken numerous post-graduate courses in Physics and Electrical Engineering.

2. I am presently employed by Atlantic Research Corporation and was formerly employed by the IIT Research Institute, DoD Electromagnetic Compatibility Analysis Center.

3. I am qualified to evaluate the foregoing Response of AMSC Subsidiary Corporation. I am familiar with Part 25 and other relevant parts of the Commission's Rules and Regulations.

4. I have participated in the development of standards and criteria for space and terrestrial services in the CCIR for over fifteen (15) years.

5. I served as Technical Advisor to the U.S. Delegation to WARC-92 and participated in sessions of WARC-92 addressing frequency sharing and other technical matters.

6. I have been involved in the preparation of and have reviewed the foregoing Response of AMSC Subsidiary Corporation. The technical facts contained therein are accurate to the best of my knowledge and belief.

Under penalty of perjury, the foregoing is true and correct.

December 15, 1992
Date

Thomas M. Sullivan
Thomas M. Sullivan

CERTIFICATE OF SERVICE

I, Valerie A. Mack, a secretary in the law firm of Fisher, Wayland, Cooper and Leader, do hereby certify that true copies of the foregoing "Response of AMSC Subsidiary Corporation" were sent this 15th day of December, 1992, by first class United States mail, postage prepaid, to the following:

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