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LAWLER, METZGER & MILKMAN, LLC

1909 K STREET, NW
SUITE 820
WASHINGTON, D.C. 20006
PHONE (202) 777-7700
FACSIMILE (202) 777-7763

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November 15, 1999

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

BY HAND

Magalie Roman Salas, Secretary
Federal Communications Commission
445 Twelfth Street, S.W. - Suite TW-A325
Washington, D.C. 20554

Re: WT Docket No. 96-86
WTB-2, National Coordination Committee
Written Ex Parte Communication

Dear Ms. Salas:

Transmitted herewith for inclusion in the public record of the above-referenced "permit but disclose" proceeding are two copies of a written *ex parte* presenation by FreeSpace Communications that was delivered this day Kathleen M. H. Wallman, Chair of the National Coordination Committee.

Please direct any questions concerning this filing to the undersigned.

Sincerely,

Ruth M. Milkman

cc: Kathleen Wallman
Michael J. Wilhelm (By Hand)

Enclosure

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LAWLER, METZGER & MILKMAN, LLC

1909 K STREET, NW
SUITE 820
WASHINGTON, D.C. 20006
PHONE (202) 777-7700
FACSIMILE (202) 777-7763

November 15, 1999

BY HAND

Kathleen M. H. Wallman, Chair
National Coordination Committee
c/o Wallman Strategic Consulting
555 12th Street, NW
Suite 321
Washington, DC 20004

Re: Notice of Proposed Rulemaking; Service Rules
For 746-764 and 776-794 MHz Bands, and Revisions
To Part 27 of the Commission's Rules
WT Docket No. 99-168

Dear Ms. Wallman:

As you know, FreeSpace Communications has proposed in the above-referenced proceeding that the Federal Communications Commission establish guard bands in the 746-764 and 776-794 MHz bands to protect adjacent-channel public safety communications from interference. Under the FreeSpace proposal, these guard bands would be subject to strict power spectral density limits and other safeguards to protect the adjacent public safety operations.

On November 11, 1999, Motorola, Inc. filed an *ex parte* presentation in this proceeding raising questions regarding whether FreeSpace's proposal would protect public safety operations in adjacent bands from interference. The attached memo responds to Motorola's letter and confirms that FreeSpace's proposal will provide strong protection for public safety operations.

Please do not hesitate to contact me if you have any questions or need further information.

Sincerely,

Ruth M. Milkman
Counsel to FreeSpace Communications

cc: Michael J. Wilhelm
Designated Federal Office
National Coordination Committee

Enclosure

ORIGINAL

THE FREESPACE PROPOSAL WILL PROTECT PUBLIC SAFETY OPERATIONS IN THE 700 MHz BAND FROM INTERFERENCE

FreeSpace Communications (FreeSpace) submits this memo to respond to an *ex parte* letter filed by Motorola, Inc. on November 11, 1999 in the FCC's pending proceeding in WT Docket No. 99-168.[1] In this letter Motorola questions whether the proposal FreeSpace has submitted in this proceeding will protect public safety operations in adjacent spectrum bands.

Although Motorola professes that it "is not [its] intention in this proceeding or in any other proceeding to denigrate the technology of another manufacturer," much of its letter mischaracterizes the record or engages in unfounded speculation in an effort to conjure up a parade of horribles and create the false impression that the FreeSpace proposal will not protect public safety operations from interference. The Commission should reject this effort. As set forth in FreeSpace's previous filings and below, the FreeSpace system will provide strong interference protection for public safety communications operating in the 700 MHz band. Indeed, its proposal will provide protection that is equal to or better than the protection afforded by Motorola's frequency coordination approach.

FreeSpace is not asking the Commission to endorse a particular technology or type of equipment that will be used in guard bands adjacent to public safety spectrum, nor is it asking the FCC to set aside this spectrum to benefit a particular segment of private industry. To the contrary, FreeSpace has strongly urged the FCC to set technical rules that will provide strong interference protection for pubic safety, but otherwise to let *any* party willing to comply with these technical rules to bid for the spectrum in these bands to provide whatever services will most benefit consumers.

Motorola's proposed frequency coordination approach may be one way to protect public safety operations. But it is not the *only* way to do so. FreeSpace has proposed another approach that employs very low spectral density power limits as well as other safeguards that will also provide strong protection against interference to public safety systems. The Commission can employ both approaches in establishing technical rules to prevent such interference and, by doing so, avoid picking "winners and losers" in assigning this spectrum through the competitive bidding process as required by the Communications Act. This will both protect public safety communications and benefit consumers.

Strict Power Spectral Density Limits and Other Safeguards Will Protect Public Safety from Interference

Motorola's November 11 letter incorrectly suggests that the FreeSpace proposal relies solely on power spectral density limits to protect public safety operations. In fact, as FreeSpace's November 8, 1999 *ex parte* submission makes clear, FreeSpace's proposal

[1] Letter of Leigh M. Chinitz, Motorola, Inc. to Magalie Roman Salas, FCC Secretary, WT Docket No. 99-168 (filed Nov. 11, 1999).

includes a number of safeguards to prevent interference to public safety.[2] The central component of these safeguards is indeed a requirement that would impose stringent power spectral density limits on services operating in the guard bands. These limits would provide clear and effective protection against interference caused by both blocking and out-of-band spurious emissions.[3] But FreeSpace has proposed further safeguards as well, including:

- FreeSpace has supported the adoption of out-of-band spurious emissions limits, such as those proposed by the International Association of Fire Chiefs (IAFC) and the International Municipal Signal Association (IMSA).[4] FreeSpace has further stated that it would support more stringent limits that those proposed by the IAFC/IMSA filing.

- FreeSpace has also proposed a system that incorporates active power control mechanisms that cause each unit in its system to operate at the minimum transmit power at any given time.

- FreeSpace has stated that it would support an FCC rule requiring the use of TDMA or other technologies in these guard bands to ensure that the aggregate power of the units operating in these guards bands will never exceed the power limits that apply to a single transmitting device.

- FreeSpace has stated that it would support a requirement that users of the low power guard bands immediately adjacent to public safety bands locate their base stations designated distances from public safety sites in order to achieve additional protection against interference.

- FreeSpace has noted that internetworked systems, such as the FreeSpace system, could be designed to automatically avoid situations that may lead to interference. For example, by making a database of public safety locations available over the network,

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[2] Letter of Ruth Milkman, Lawler, Metzger & Milkman, to Thomas J. Sugrue, Chief, Wireless Telecommunications Bureau, WT Docket No. 99-168 (filed Nov. 8, 1999) (FreeSpace Nov. 8 *Ex Parte* Submission) (copy attached).

[3] FreeSpace has previously proposed that the Commission impose a power spectral density limit of 4mW/kHz in the 1MHz bands directly adjacent to the public safety bands, and a power spectral density limit of 20mW/kHz in the 1MHz bands that are "second adjacent" to the public safety bands (*i.e.*, the 1MHz bands that are adjacent to the 1MHz bands subject to the 4mW/kHz limit). As an alternative to these two separate 1MHz guard bands, FreeSpace would also support establishing a single guard band of 1.5MHz next to the pubic safety bands that would be subject to a power spectral density limit of 4mW/kHz.

[4] Comments of International Association of Fire Chiefs, Inc. and International Municipal Signal Association at 2, WT Docket No. 99-168 (filed July 19, 1999).

those units that find themselves positioned too close to a public safety site could automatically switch channels or shut down to avoid interference.[5]

Motorola's November 11 letter glosses over or ignores each of these safeguards, even though they were clearly set forth in FreeSpace's November 8 *ex parte* submission. Moreover, Motorola's November 11 letter strains to leave the impression that its proposed private radio/frequency coordination approach is the one and only way to protect public safety operations. This is simply not true. To the contrary, in some cases the FreeSpace proposal would provide greater interference protection than Motorola's approach. For example, it is unclear how Motorola's frequency coordination process will accommodate *future* as well as current public safety systems. The FreeSpace proposal, in contrast, embodies clear and effective operating limits that should protect current as well as future public safety operations.

The fundamental point is that the Commission can establish a set of technical rules that use power spectral density limits and other safeguards that will ensure that the licensee of the guard bands -- whether it is FreeSpace or some other entity -- will protect adjacent-band public safety communications. FreeSpace believes its proposal provides an effective framework for crafting such rules, and is of course willing to work further with the Commission staff and the public safety community in designing rules that will provide strong interference protection.

Incorrect Claims About the FreeSpace Proposal

Motorola's attempt to throw into question the ability of the FreeSpace proposal to protect adjacent public safety operations is fraught with inconsistencies, baseless speculation, and significant technical errors. In the following paragraphs, FreeSpace refutes Motorola's arguments and sets the record straight.

Claim #1: "...there will be four times more interference to Public Safety caused by FreeSpace than by CMRS using the PMRS plan."

Fact: The FreeSpace proposal will provide similar or better interference protection compared to the protection from CMRS systems provided under the PMRS plan.

In a section entitled "Site Isolation," Motorola's letter argues that CMRS and FreeSpace sites would have similar radii of interference, and that FreeSpace sites would therefore present an increased interference hazard if one postulates a greater number of FreeSpace sites. In particular, they claim that a 100 watt CDMA CMRS site would produce an interference radius of about 500ft, and that according to the most recent *ex parte*

[5] This would require a unit to know its own position, which could easily be accomplished through the use of an embedded Global Positioning System receiver, or by having a technician log the location of the unit in a network database upon installation.

submission by FreeSpace, a FreeSpace site would produce a similar interference radius of about 550ft. This argument, however, mischaracterizes the record because these two numbers for interference radii are based on *completely different sets of assumptions*. In particular, Motorola bases its calculation of interference radius for CMRS on an out-of-band emissions level of "no more than –57dBm in the first 6.25 kHz channel of the Public Safety equipment," with a further assumption of 75dB of site isolation, which leads to a received interference power of –132dBm (–57dBm – 75dB = –132dBm). FreeSpace November 8 *ex parte* submission makes clear that it based its out-of-band emissions on the proposed rule of $43+10\log_{10}(P)$, resulting in a level of –73dBm/Hz, which equals –35dBm in a 6.25kHz bandwidth. It then calculated the distance corresponding to 91dB of site isolation leading to a received interference power of –126dBm (–35dBm – 91dB = –126dBm). Thus, the assumed equipment requirements and site isolations for the FreeSpace system and Motorola's hypothetical 100 watt CDMA CMRS site are *completely different*. Motorola's November 11 letter ignores this fact, making its comparison of the two systems inaccurate and unfair.

A fair comparison proceeds as follows. Let us assume, as proposed by Motorola, that units operating in the guard bands adjacent to public safety bands must comply with Motorola's proposed out-of-band emissions limit of –57dBm in a 6.25kHz bandwidth. This requirement is predicated on the assumption of 75dB of site isolation. The relevant question is simply, *at what distance do the guard band units achieve a site isolation of 75dB*? Applying the formula in the FreeSpace November 8 *ex parte* submission results in a distance of only 76m (240 ft), which is less than half of the CMRS interference radius provided by Motorola. It follows that, while there may be more FreeSpace sites, the interference area per site is less than one fourth that of the 100 watt CDMA CMRS system Motorola uses for its example. In this fair comparison, the FreeSpace system clearly provides better protection.

FreeSpace's proposed transmit power restrictions consequently make it possible for the systems immediately adjacent to public safety to achieve a level of interference protection that equals or exceeds the protection provided by commercial systems operating 1.5MHz away under Motorola's proposal, as the previous example clearly illustrates. It should also be noted that Motorola's November 11 letter makes no comparison between commercial systems operating under rules proposed by FreeSpace and private systems operating under rules proposed by Motorola. In the section entitled "Emissions Masks and PMRS Interference" below, we make such a comparison to show that the FreeSpace proposal will in fact provide protection that equals or exceeds the interference protection provided under Motorola's proposed plan.

Claim #2: "...if the FreeSpace equipment uses spread spectrum technology, for example, there is no opportunity to employ frequency coordination."

Fact: The opportunity to employ frequency coordination depends upon how many frequency channels are established in the band, not upon what type of modulation is used. Furthermore, as previously stated, FreeSpace equipment does not use spread

spectrum technology and will comply with appropriate interference safeguards the FCC decides to impose.

Motorola's claim, set forth in a section of its letter entitled "Modulation," is incorrect. To use frequency coordination, one must be able to judiciously choose among several frequency channels. Thus, the only technical requirement is that the systems operating in the guard bands use more than one channel. The use of spread spectrum technology – or any other specific modulation technique – is irrelevant with respect to the question of frequency coordination. Furthermore, Motorola assumes the worst-case scenario when it considers what would happen if "the entire 2MHz (in the FreeSpace plan) were used by a single spread channel." There is no basis in the record to support this speculation. In fact, the FreeSpace system will not use only a single frequency channel. Moreover, Motorola's letter ignores FreeSpace's November 8 *ex parte* submission which explicitly states that "an additional benefit of the FreeSpace system arises through the use of TDMA technology." FreeSpace's submission goes on to express support for a requirement that TDMA or similar technologies be used by systems operating in the guard bands adjacent to public safety bands.

In any event, the important point is that FreeSpace's previous submissions show that it will comply with appropriate safeguards the Commission adopts to prevent interference, including harmful out-of-band emissions. As described on pages 1-2 above, FreeSpace's November 8 *ex parte* submission describes not only power spectral density limits but also other safeguards that would ensure that a user of the guard bands does not interfere with public safety communications in adjacent bands.

Claim #3: "...FreeSpace equipment would need to [reduce emissions] by 71dB in the first adjacent channel, an extremely aggressive level."

Fact: In keeping with standard practice, one would only require such attenuation in, at worst, the second adjacent channel.

In making this claim in the section of its letter entitled "Out of band emissions," Motorola attempts to cast doubt on the ability of manufacturers to meet an emissions limit of –57dBm in the first 6.25kHz public safety channel. In its argument, Motorola arbitrarily assumes that radio channels within the guard band would be positioned directly at the edge of the public safety band, so that the first adjacent channel would lie within the public safety band. In such a situation, it would indeed be difficult to achieve the required 71dB of attenuation.

However, in practice, the band would be appropriately channelized and a transition band would be built in to allow out-of-band emissions requirements to be met. It is well known that adjacent channel spurious emissions are limited by power amplifier nonlinearities, making it difficult to achieve this kind of suppression in the adjacent channel by simple filtering. Rather, it is common practice to establish channels in such a way as to allow a transition band from the channel edge to the band edge so that spurious

emissions can be properly attenuated. Thus, it would be a simple matter (and consistent with standard practice) to design a system that avoids such a stringent adjacent channel attenuation requirement. Surely, given their familiarity with standard practice, and their history of producing successful wireless systems, this option should be well-known to Motorola.

The essential point is that the Commission should establish appropriate and reasonable out-of-band spurious emissions limits to protect public safety. Manufacturers of equipment designed to operate in the guard bands adjacent to public safety bands would then do what is necessary to provide the required attenuation.

Claim #4: Interference from indoor units is a major problem that power control cannot solve.

Fact: Such interference is improbable, and power control is very effective in reducing the probability of occurrence. Furthermore, there is no guarantee in the Motorola proposal that such interference will not occur with PMRS units.

Towards the end of the section entitled "Site Isolation," Motorola's November 11 letter speculates about the impact of FreeSpace's use of indoor antennas and attempts to paint a scenario of "a very real worst-case near-far situation."

Indoor applications require very short ranges, and because of the distances involved, it is important that units operating indoors employ power control *on both uplink and downlink*. Motorola speculates in its letter that power control could not be used with base transmitters because "this would make mobility management much more difficult." This is nothing more than speculation about the intention of the FreeSpace proposal. To be perfectly clear, FreeSpace proposes that *all units* incorporate power control, even base transmitters. This is quite possible, despite Motorola's characterizations to the contrary.

With power control, indoor units will operate on power levels far below the proposed emissions limits. Furthermore, interference in this situation would require a coincidence of circumstances that make it improbable. Namely, the victimized public safety mobile unit would have to be in the same room as, and in fact very close to, the offending transmitter, in an indoor environment where power control is ineffective, at a time when the unit is on, and at a location near the edge of the coverage region of the public safety system. The coincidence of all of these events would be unusual, making Motorola's "worst-case scenario" more hypothetical than real. It is also worth noting that Motorola does not explain why PMRS systems operating under its proposal are not just as likely to create the same scenario.

Claim #5: FreeSpace has not provided enough technical detail to evaluate its claims of protecting public safety operations.

Fact: FreeSpace's previous submissions to the FCC detail how its proposal will protect public safety communications from interference.

Motorola's November 11 letter at a number of points asserts that FreeSpace has not provided enough detail to evaluate its claims of protecting public safety operations. Motorola's letter, however, ignores or mischaracterizes the information FreeSpace has previously submitted in an apparent effort to buttress its efforts to have the Commission set aside the guard bands for exclusive private radio use.

FreeSpace's November 8 *ex parte* submission and its previous FCC filings confirm that its proposal provides a clear and effective way to protect current and future public safety operations based on a number of technical operation parameters, centered upon low power spectral density transmit limits. FreeSpace has also met with the Commission staff and a number of representatives of the public safety community to discuss its proposal in detail and has offered to answer any questions the Commission or the public safety community may have.

Emissions Masks and PMRS Interference: Comparing the Motorola and FreeSpace Plans

Missing from Motorola's November 11 letter is a detailed assessment of how its proposed PMRS/frequency coordination approach will protect pubic safety operations relative to the approach proposed by FreeSpace. A careful comparison of the two approaches reveals that the FreeSpace proposal will provide protection that is equal to, and in some cases better than, the Motorola proposal.

In any discussion about interference issues, it is important to keep in mind that interference can arise from a number of different sources. The techniques for mitigating these different sources are correspondingly different, and it is crucial to keep their differences in mind when considering detailed arguments about what measures are or are not effective.

Figure 1 illustrates a simplified emissions mask that one might encounter in a typical wireless system. For the present discussion, the figure illustrates spurious emissions of two varieties: adjacent channel spurious emissions (sometimes called spectral regrowth), and broadband noise emissions.

Adjacent channel emissions arise due to power amplifier nonlinearities that produce third-order intermodulation products. An attenuation of about 30dB for this type of emission is commonly achieved in modern systems. Fortunately, these emissions are typically restricted in bandwidth with most of their energy confined to the immediately adjacent channels. As a result, an effective approach for preventing interference due to

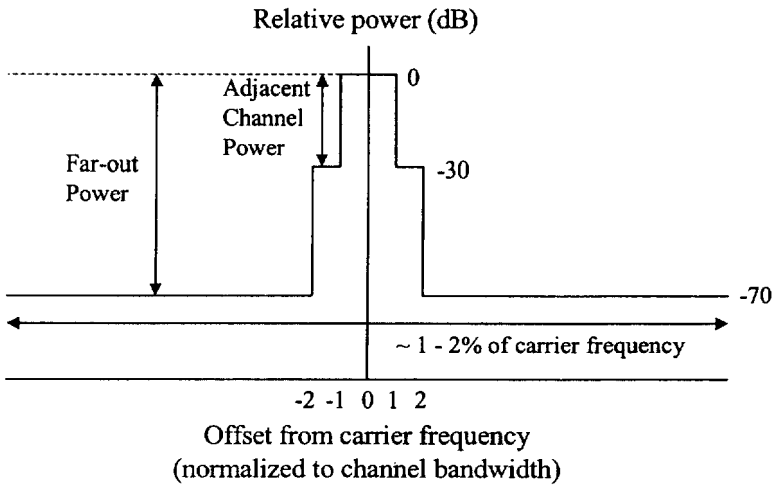

Figure 1: Example of a Transmitter's Emissions Mask

these emissions is to employ frequency coordination and/or frequency planning to prevent operation on adjacent channels of systems that are geographically close to one another. Indeed, as alluded to in the Motorola filing, frequency coordination has traditionally been used quite effectively within the PMRS community to solve this problem (and also to prevent co-channel interference between distinct systems). As Motorola correctly observes, "...frequency coordination between physically nearby users will prevent inappropriate [*i.e.,* adjacent] channels from being used." Motorola's letter encourages "frequency coordination across the band edge" between the guard band and the adjacent public safety band for this reason.

As FreeSpace has stated previously, a limit on out-of-band emissions to adjacent public safety spectrum is a technical mechanism for achieving the same result that frequency coordination provides in addressing adjacent channel emissions. With frequency coordination, judicious channel selection prevents situations where adjacent channel emissions would interfere between geographically close systems that use channels near their respective band edges. Similarly, out-of-band emissions limits would force manufacturers to establish the necessary guard bands to attenuate interference into the neighboring public safety spectrum. In practical terms, both approaches prevent interference due to adjacent channel emissions.

Broadband noise emissions, on the other hand, are determined by the output noise floor of the power amplifier. These emissions are typically very broad in frequency, compared to the adjacent channel emissions, and can only be attenuated by applying a filter to the power amplifier output. Unfortunately, realizable transmit filters have bandwidths that are on the order of 1-2% of the operating frequency. Thus, the noise emissions of typical

UHF power amplifiers span several megahertz with roughly constant power spectral density. Because the breadth of these emissions exceeds the width of the proposed guard bands, it is difficult with frequency coordiation to mitigate this type of interference. In fact, the best way to reduce this interference source is by limiting transmit power and imposing specific limits on out-of-band spurious emissions, as in the FreeSpace proposal.

An example illustrates the potential for interference from broadband noise emissions of PMRS units under a frequency coordination approach. Let us assume that a PMRS transmitter operates on 100W of transmit power in a 6.25kHz bandwidth. This power level is typical of PMRS systems, although transmit powers can, in some cases, be much higher. This is equivalent to a power spectral density in-band of 12dBm/Hz. In comparison, the power spectral density of a transmitter in the FreeSpace proposal would have to be less than 4mW/kHz, or –24dBm/Hz. The difference in transmit power spectral densities is at least 36dB, in this example. Assuming a 70dB attenuation for broadband noise emissions results in interference powers of –58dBm/Hz (12dBm/Hz – 70dB = –58dBm/Hz) from the PRMS transmitter and –94dBm/Hz (–24dBm/Hz – 70dB = –94dBm/Hz) for the transmitter operating under FreeSpace's proposal. Motorola is currently arguing for an interference power limit of –57dBm in the first 6.25kHz Public Safety channel (–95dBm/Hz) when 75dB of site isolation is assumed, yielding a desired interference level no greater than –170dBm/Hz (–95dBm/Hz – 75dB = –170dBm/Hz). To fall below this level of interference in the first adjacent public safety channel requires 112dB site isolation (–58dBm/Hz – 112dB = –170dBm/Hz) in the PMRS case but only 76dB site isolation (–94dBm/Hz – 76 = –170dBm/Hz) under FreeSpace's plan. Not surprisingly, the 36dB difference in transmit power spectral density has translated into a 36dB difference in the required site isolation. As a result, *the PMRS transmitter will have an interference radius of at least 6 – 60 times that of the FreeSpace low power transmitter*, depending on assumptions about propagation. Furthermore, the interference radius of PMRS transmitters may yet be *even larger* due to a possible difference in antenna heights, an effect that is not accounted for in this example. In addition, because broadband noise emissions are proportional to transmit power, PMRS sites transmitting more than 100 watts will have yet again even larger interference radii.

Given the result above, one can expect near-far situations to occur between PMRS and public safety units, even with frequency coordination. This is especially the case given the very high transmit powers and antenna heights that may be used for those systems. Regardless of frequency coordination, there will be situations in which PMRS systems potentially create interference holes, and these holes can be quite large indeed when one considers the transmit powers involved. The FreeSpace proposal, in contrast, does not present this problem given the power spectral density limits and other safeguards it employs.

Motorola's Proposed "Alternatives"

In its conclusion to its November 11 letter, Motorola suggests alternatives it believes FreeSpace could pursue rather than bidding for spectrum in the 746-764 and 776-794

MHz bands. First, it raises the question of whether "the unlicensed bands can be used ...." These bands, however, are clearly not a viable alternative given that they are currently very congested with existing uses and that this congestion will only increase in coming years. The difficulty of building a successful service business, particularly a wireless communications network, in an unlicensed band should come as no surprise. Interference is a major concern (there are nearly 70 million households with cordless phones in the U.S., many of which operate in the unlicensed bands), and any network operator would be considered a secondary user of the band, with no recourse for resolving interference. The result would be a system that is subject to interference and thus unsatisfying for consumers. Clearly, it is much better to operate in licensed spectrum.

Motorola further speculates that "if FreeSpace believes it has a technology which will allow it to offer wireless access to underserved populations . . . it seems reasonable to ask why disagreggation of spectrum from an existing cellular or PCS license holder is not an option. That these areas are underserved implies that those carriers are not using spectrum in those regions." Again, this is not a viable alternative. Motorola ignores the fact that while FreeSpace's system offers the advantage of promoting service to underserved communities, it seeks to provide a *nationwide* wireless broadband network that reaches all communities, bringing competition to areas that are currently served and new service to those that are not. FreeSpace is not aware of any spectrum bands suitable for its system and such a nationwide network that are available for disagreggation.

Conclusion

FreeSpace simply seeks the opportunity to bid for the "guard band" spectrum adjacent to the public safety bands. Motorola's letter attempts to prevent this by making unfounded and inaccurate claims that any commercial use of these guard bands would cause interference to public safety operations. This is not the case. Motorola's frequency coordination approach may be one method of protecting public safety, but FreeSpace has proposed a set of stringent operational requirements, including power spectral density limits, that the Commission could adopt to provide similar or better protection to current and future public safety operations. This would not only allow the Commission to fulfill its statutory mandate of protecting public safety, but also permit entities to bid for this spectrum to provide commercial services that can greatly benefit consumers. Afterall, it is important to keep in mind that section 337(a)(2) of the Communications Act designates that these bands be allocated for such "commercial use."[6]

[6] 47 U.S.C. § 337(a)(2).

LAWLER, METZGER & MILKMAN, LLC
1909 K STREET, NW
SUITE 820
WASHINGTON, D.C. 20006
PHONE (202) 777-7700
FACSIMILE (202) 777-7763

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OFFICE OF THE SECRETARY

November 8, 1999

By Hand

Thomas J. Sugrue, Chief
Wireless Telecommunications Bureau
Federal Communications Commission
445 Twelfth Street, S.W. – Third Floor
Washington, D.C. 20554

Re: Written *Ex Parte* Communication
Service Rules for the 746-764 and 776-794 MHz Bands,
And Revisions to Part 27 of the Commission's Rules
WT Docket No. 99-168

Dear Mr. Sugrue:

FreeSpace Communications (FreeSpace) submits this letter to respond to a October 29, 1999 letter filed by Motorola, Inc. in the above-referenced rulemaking proceeding.[1] FreeSpace has proposed that the Commission establish guard bands in the bands adjacent to public safety spectrum that would be subject to power spectral density limits to protect public safety communications from interference. FreeSpace, which has developed an innovative broadband wireless communications systems, has also proposed that *any* interested party be permitted to bid for a license to operate in these guard bands provided it complies with power limits and other technical rules to prevent interference to pubic safety communications. FreeSpace has opposed Motorola's guard band proposal under which 6 MHz of the 36 MHz of spectrum at issue in this proceeding would be set aside for exclusive private radio use.

In its October 29, 1999 letter, Motorola speculates that the FreeSpace system could possibly cause interference to public safety communications depending on its deployment and type of emission. This speculation is unfounded and incorrect. FreeSpace has been actively working with representatives of the pubic safety community to inform them of the details of the FreeSpace system. We note that one such party that FreeSpace has contacted, the Association of Public-Safety Communications Officials-

[1] Letter of Steve B. Sharkey, Motorola, Inc. to Magalie Roman Salas, FCC Secretary, WT Docket No. 99-168 (filed Oct. 29, 1999).

International, Inc (APCO), has recently filed a letter with the Commission that states that the "FreeSpace proposal appears to provide excellent interference protection for public safety."[2]

To provide further details confirming APCO's statement, FreeSpace submits the attached technical description of its how its proposal would provide effective interference protection for pubic safety communications. FreeSpace is submitting this additional information to APCO as well as Kathleen Wallman, Chair of the National Coordination Committee.

Motorola's October 29, 1999 letter makes a number of other statements regarding the appropriate use of the 36 MHz of spectrum at issue in this proceeding that are worth noting. As noted above, Motorola has proposed that the Commission set aside 6 MHz of this spectrum for exclusive private radio use, with only private radio band managers eligible to bid for the spectrum. In an October 27, 1999 letter to the Commission, FreeSpace urged the Commission to reject this proposal for an exclusive private radio set aside as contrary to section 337(a)(2) the Communications Act, which requires that this spectrum be allocated for "commercial use." Motorola's October 29 letter makes clear that it seeks an exclusive set aside for private radio that directly contradicts the Act.

In particular, Motorola's October 29 letter states that "Motorola disagrees that the spectrum immediately adjacent to pubic safety is appropriate for commercial use" and "that commercial operations, such as the one proposed by FreeSpace, can be accommodated in bands designated for commercial services." The letter goes on to urge the FCC to license 30 MHz of spectrum in the 746-764 and 776-794 MHz bands for "commercial use" and the remaining 6 MHz of spectrum in these bands for "private uses."

Motorola's proposal flatly contradicts section 337(a)(2) of the Communications Act, as amended. This section states that the Commission "*shall* allocate ... 36 megahertz [of the spectrum in the 746-806 MHz band] for *commercial use* to be assigned by competitive bidding ...." 47 U.S.C. § 337(a)(2) (emphasis added). This section consequently designates the *entire* 36 MHz for "commercial use." The Commission does not have the authority to license any portion of this spectrum for exclusive "private uses," as advocated by Motorola. The Commission must consequently reject Motorola's proposal.

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[2] Letter of Robert M. Gurss, Attorneys for APCO, to Magalie Roman Salas, FCC Secretary, WT Docket No. 99-168 (filed Oct. 22, 1999).

Please direct any questions concerning this filing to the undersigned.

Respectfully submitted,

Ruth M. Milkman
Charles W. Logan

Counsel to FreeSpace Communications

Attachments

cc:

James D. Schlichting	Kathleen Ham
Ari Fitzgerald	Mark Schneider
Peter Tenhula	Adam Krinsky
Bryan Tramont	Christopher Wright
Kris Monteith	Stanley Wiggins
Marty Leibman	Joel Kaufman
Jane Halprin	Gregory Vadas
Jane Phillips	Robert Pepper
Dale Hatfield	

PROTECTING CURRENT AND FUTURE PUBLIC SAFETY OPERATIONS IN THE 700 MHz BAND: THE FREESPACE PROPOSAL

Pursuant to Section 337 of the Communications Act,[1] the Federal Communications Commission has reallocated 24 MHz in the 764-776 MHz and 794-806 MHz bands to public safety services. It has also reallocated 36 MHz in the 746-764 MHz and 776-794 MHz bands for commercial use as required by the Act. In the pending *Notice of Proposed Rulemaking* in WT Docket No. 99-168, the Commission is considering proposals regarding licensing rules for these commercial uses.

In devising rules for the commercial services that will operate in the 746-764 and 776-794 MHz bands, the Commission is required by the Act to "establish rules insuring that public safety services licensees [in the 746-806 MHz band] shall not be subject to harmful interference from television broadcast licensees."[2] In addition, the legislative history of these provisions states that the Commission should "ensure that public safety service licensees continue to operate free of interference from any new commercial licensees."[3] A number of public safety parties have emphasized the vital need to carry out the statutory mandate to protect public safety communications from interference, and have suggested the creation of a guard band to do so.[4]

FreeSpace Communications (FreeSpace) has proposed that the Commission establish guard bands adjacent to public safety spectrum that would be subject to stringent power spectral density limits. These limits would provide strong protection against interference to current *and* future adjacent-channel public safety systems. Indeed, the Association of Public-Safety Communications Officials-International, Inc. has recently filed a letter with the FCC that states that the "FreeSpace proposal appears to provide excellent interference protection for public safety."[5]

Under the FreeSpace proposal, the Commission would establish guard bands adjacent to public safety spectrum in the 700 MHz band (*i.e.*, guard bands at 762-764 MHz, 776-778 MHz, and 792-794 MHz). Licensees in these guard bands would be required to comply

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[1] 47 U.S.C. § 337(a).

[2] *Id. at* § 337(d)(4).

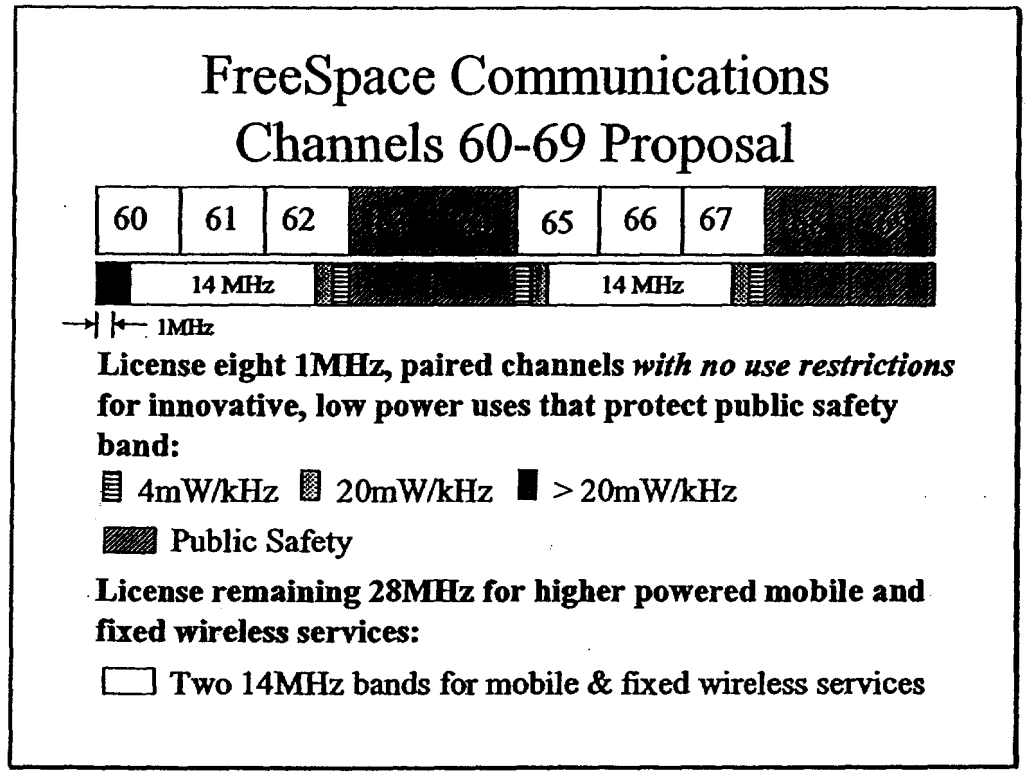
[3] Balanced Budget Act of 1997, Conference Report to Accompany H.R. 2015, 105th Cong., 1st Sess., Report 105-217, at 580 (July 30, 1997).

[4] Comments of Association of Public-Safety Communications Officials-International at 3. *See also* Letter from Kathleen M. H. Wallman, Chair, National Coordination Committee, to Chairman Kennard, WT Docket No. 99-168 (Aug. 25, 1999).

[5] *See* Letter of Robert Gurss, Wilkes, Artis, Hedrick & Lane, to Magalie Roman Salas, FCC Secretary, WT Docket No. 99-168 (filed Oct. 22, 1999).

with strict power spectral density limits to protect public safety communications.[6] Protection to public safety operations under this plan is due to two factors: the use of the 1MHz bands as guard bands separating public safety operations from high power mobile and fixed services, and the specification of in-band power spectral density emissions limits.

The details of this band plan are depicted below. This letter describes in technical detail how FreeSpace will provide superior protection to public safety operations under the proposed plan.



Guard Bands Protect Public Safety from Nearby High Power Services

The first and most fundamental way that the proposed band plan protects public safety operations is by establishing guard bands between the public safety bands and high power mobile and fixed services. As argued by Motorola and other parties to this proceeding, there is potential for interference between high power services such as traditional CMRS systems and public safety systems. A primary source of interference is out-of-band emissions from the base stations of high power services. Motorola has estimated that a

[6] *See* Letter of Ruth Milkman, Lawler, Metzger & Milkman, to Thomas J. Sugrue, Chief, Wireless Telecommunications Bureau, at 2-6 (filed Oct. 13, 1999 in WT Docket No. 99-168).

minimum of 1.5MHz should be allocated to provide separation between high power services and public safety bands so that the high power licensee's out-of-band emissions from the channel nearest the public safety band can be sufficiently attenuated. The FreeSpace plan would exceed this proposal by specifying a 2MHz separation, thereby providing a greater degree of protection to prevent interference to public safety communications.

Power Spectral Density Limits Establish a Bound on Interference Power

With the proper set of restrictions, it is possible to make use of the guard band spectrum for wireless services. However, it is essential when doing so to establish rules that maintain protection to the adjacent public safety bands. There are a number of modes by which interference can arise. Two of the dominant modes are blocking and spurious emissions.

"Blocking" occurs when a strong out-of-band interfering signal that lies too close in frequency to a weak desired signal desensitizes a receiver, thereby preventing the reception of an otherwise acceptable signal. The ability of a receiver to reject these blocking signals typically improves with frequency separation. It is particularly difficult and costly to implement receivers that are selective enough to reject strong blockers in immediately adjacent spectrum. Thus, in the interest of providing maximum protection to public safety units, the FreeSpace band plan would specify stringent limits on transmit power in the bands adjacent to the public safety bands. Specifically, FreeSpace's proposal calls for a power spectral density limit of 4mW/kHz in the 1MHz bands directly adjacent to the public safety bands, and a power spectral density limit of 20mW/kHz in the 1MHz bands that are "second adjacent" to the public safety bands (*i.e.*, the 1MHz bands that are adjacent to the 1MHz bands subject to the 4mW/kHz limit). The use of power spectral density limits rather than peak power limits specifically would prohibit any use of the band that would concentrate power into a narrow bandwidth and present a blocking hazard to public safety operations. The proposed limit would only permit a maximum of 4W (36dBm) in the immediately adjacent 1MHz bands if the entire 1MHz band were used for a single channel. If multiple, narrower channels are used, then the aggregate power across *all* such channels may not exceed 4W. This clear restriction to low-power usage provides strong, effective protection to adjacent public safety bands. Additional protection is achieved by limiting the power spectral density in the "second adjacent" 1MHz bands to 20mW/kHz (43dBm).

The second mode of interference is caused by out-of-band spurious emissions, especially those due to broadband transmitter noise and nonlinearities. A limit on in-band power, such as proposed by FreeSpace, is effective in limiting these emissions, because their power depends directly on the carrier power. The Commission has proposed that out-of-band spurious emissions be attenuated by $43+10\log_{10}(P)$ dB, where P is the transmitter power in watts, or 80dB, whichever is less. Two public safety parties -- the International Association of Fire Chiefs, Inc. (IAFC) and the International Municipal Signal Association (IMSA) --have filed comments with the FCC expressing the concern "that if the interfering transmitter exceeds 1000W of power or the power of the pubic safety

mobile radio system's base station is less than 1,000 watts, the proposed standard would be insufficient to protect the mobile radio receiver."[7] To address this concern, IAFC/IMCA recommend "that the out-of-band emissions limitation should be $43+10\log_{10}(P$, in watts) decibels transmitter power attenuation *or -13 dBm maximum output power, whichever represents the lower out-of-band power*, for any emission or all frequencies outside the licensee's authorized spectrum."[8]

FreeSpace agrees with the concern expressed by these parties and with their recommendation. FreeSpace's proposed guard band plan would eliminate the high power uses in the spectrum adjacent to the public safety bands. In fact, the maximum transmit power in the adjacent guard band under the proposed power spectral density limit is more than two orders of magnitude smaller than a transmitter operating at 1000 watts. With these power spectral density limits, an attenuation of, at most, 49dB would be required for any radio licensed to operate in the 1MHz guard bands adjacent to public safety bands. This level of attenuation is readily achievable and current emissions masks often exceed it. For these reasons, FreeSpace is confident that its system can exceed the proposed FCC emissions requirements, and would support a more stringent requirement on out-of-band emissions such as that proposed by IAFC/IMSA. In addition, as explained in the next section, the fact that the FreeSpace system will be using low antenna heights will provide even greater interference protection that far exceeds the FCC's proposed standard.

In addition to meeting concrete power spectral density limits and spurious emissions limits, FreeSpace technology incorporates active power control mechanisms that cause each unit to operate on the minimum transmit power required at any given time. This further reduces the potential for interference into other systems, and FreeSpace would support a requirement that units operating in the guard bands adjacent to public safety operations incorporate active power control. Public safety units themselves are already required, under amended Part 94 rules, to incorporate power control to reduce interference problems. Such a requirement on systems operating in adjacent bands would provide similar benefits.

Low Antenna Heights Provide Even Greater Protection

The systems that most naturally meet FreeSpace's proposed power limits in the guard bands address short range, low antenna height applications. Not only does a short range system reduce the potential for interference, but the use of low antenna heights brings the transmitters into more obstructed environments where propagation effects attenuate radiated signals more rapidly with distance. Mathematically, signal power is attenuated in

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[7] Comments of International Association of Fire Chiefs, Inc. and International Municipal Signal Association at 2, WT Docket No. 99-168 (filed July 19, 1999).

[8] *Id.* at 2-3 (emphasis in original).

proportion to the fourth power of distance in such environments.[9] This situation is typically referred to as a "fourth-law roll-off" to distinguish it from unobstructed propagation where signal powers fall off only with the square of distance.

A simple example illustrates how a fourth-law roll-off aids isolation and results in even greater interference protection. Assuming a maximum transmit power of 4W (36dBm) and using the proposed out-of-band emissions requirement that specifies attenuation of all out-of-band emissions by $43+10\log_{10}(P)$, where P is in watts, yields a required attenuation of 49dB. FreeSpace reiterates that this requirement could be improved to provide attenuation beyond 49dB, but as we will show, even with 49dB of attenuation adequate protection to public safety operations can be ensured. By meeting the 49dB attenuation requirement, the out-of-band power in a 1MHz bandwidth would be less than -13dBm, or -73dBm/Hz.[10] Considering the fourth-law propagation environment separating a FreeSpace site from a public safety site, we can determine the approximate distance at which the interference falls below noticeable levels. An empirical expression relating distance to the attenuation between two dipole antennas that is based on field measurements is,

$$L = -26 + 45\log(d) - 40\log(\lambda),$$

where d is the distance between transmitter and receiver in meters, λ is the wavelength of the carrier frequency in meters, and L is the isolation or path loss in dB.[11] Based on this formula, a path loss of 91dB occurs for a distance of only 170m at 775MHz. With 91dB of path loss, the out-of-band emissions would have a power spectral density of less than –164dBm/Hz, *which is only 10dB above the background thermal noise floor.*

The majority of FreeSpace sites will typically be located at distances much greater than 170m, which will result in even more path loss, thus providing complete protection against harmful out-of-band emissions. FreeSpace would support a requirement that users of the low power guard bands immediately adjacent to public safety bands locate their base stations designated distances from public safety sites in order to achieve the necessary path loss and provide additional protection against interference from out-of-band emissions. Public safety communications would thus benefit from even greater protection than that provided by the FCC's proposed $43+10\log_{10}(P)$ dB attenuation requirement.

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[9] D.M.J. Devasirvatham, et al, "Four-Frequency CW Measurements in Residential Environments for Personal Communications," IEEE International Conference on Universal Personal Communications, San Diego, CA 1994, pp. 140-143.

[10] 47 CFR § 27.53(a)(4).

[11] D.M.J. Devasirvatham, et al, "Four-Frequency CW Measurements in Residential Environments for Personal Communications," IEEE International Conference on Universal Personal Communications, San Diego, CA 1994, pp. 140-143.

Furthermore, internetworked systems, such as the FreeSpace system, could be designed to automatically avoid situations that may lead to interference. For example, by making a database of public safety site locations available over the network, those units that find themselves positioned too close to a public safety site could automatically switch channels or shut down to avoid interference. This would require a unit to know its own position, which could easily be accomplished through the use of an embedded Global Positioning System (GPS) receiver, or by having a technician log the location of the unit in a network database upon installation. Future public safety systems could then be accommodated by simply updating the public safety database to include new installations. This is one example of how modern technologies might be applied to further improve the protection of public safety systems.

TDMA Technology Prevents the Accumulation of Power from Multiple Units

An additional benefit of the FreeSpace system arises through the use of TDMA technology. In TDMA systems, the radio channels are time-shared between different units. When combined with specific limits on transmit power spectral densities, the use of TDMA techniques guarantees that the *aggregate* power of units operating in the same vicinity will never exceed the limit for a single radio. It follows that the total transmit power present in each 1MHz guard band adjacent to a public safety band will never exceed 4W, *regardless of how many units may be operating in close proximity.* To further the goal of protecting public safety operations from harmful interference, FreeSpace Communications would support a restriction specifying the use of TDMA or other technologies that achieve this effect in the guard bands adjacent to public safety bands.

Nationwide Licenses Simplify Coordination and Resolution of Interference Issues

As set forth above, FreeSpace's proposed low power guard band would provide robust interference protection for pubic safety services. In the event a pubic safety operator nonetheless has a concern about the potential for interference, it will be important for licensees in this guard band to coordinate with public safety officials to expediently resolve these concerns as they arise. To this end, FreeSpace believes that the issuing of nationwide licenses simplifies coordination and resolution of interference problems by making a single party responsible for operations in each guard band. Should interference arise, the affected public safety organization would know immediately who to contact to resolve the problem. As a licensee of the spectrum in the guard band, FreeSpace, which will have complete information about the location of all the base stations and customer units that make up its wireless network, would be committed to working cooperatively and quickly to resolve interference concerns raised by public safety licensees.

In sum, FreeSpace's guard band proposal would provide clear, effective interference protection for current and future public safety operations and provide a means for the Commission to carry out its statutory mandate to protect these operations.