Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Report and Order and Further Notice Of Proposed Rulemaking	)	FCC Docket No. 10-16
	)	
Amendment of Parts 15, 74, and 90 of the Commission's Rules Regarding Low Power Auxiliary Stations, Including Wireless Microphones	)	ET Docket No. 10-24

To: The Commission

COMMENTS REGARDING WIRELESS AUDIO DEVICES

I. Introduction

My name is Michael J. Benonis, and I am a graduate student in the Mobile and Portable Radio Research Group at Virginia Tech. Among other topics, my research interests include the use of high-quality wireless audio links in the television bands and how these links can coexist with the recently approved "white-space devices." In addition to my research and coursework, I have worked in the theatrical and broadcasting industries for the past seven years. I currently serve as a staff engineer at WUVT-FM Blacksburg, a student-run radio station licensed to Virginia Tech. I have also managed large-scale wireless microphone systems at the University of Virginia.

I have thought about the issue of wireless microphones for some time now, especially with the shift to digital television broadcasting and the approval of TV Band devices (TVBD's). I have come to the conclusion that the Commission should extend the provisions under Part 74, Subpart H of the Rules to permit some users of wireless microphones to operate with a license, and to afford these users protection from harmful interference. However, I believe that only

users who operate large-scale systems or entities that operate as rental companies of a large number of systems should qualify for licenses. The remainder of users can be accommodated under Part 15 of the Rules.

I have carefully read and responded to many of the questions raised by the Commission in the Further Notice of Proposed Rulemaking. In order to organize my responses, I have responded by paragraph number below.

II. Unlicensed Operation under Part 15

111. Many users of wireless microphones may find that operation under Part 15 will sufficient for their needs. In particular, as the Commission notes, many users operate only a few wireless microphones at a time and there is likely to be sufficient spectrum available for such use. Users with more stringent requirements for the number of units or the quality of service (QoS) may not find the provisions under Part 15 sufficient, however.

112. I believe that the Commission's proposed terminology is a sufficient description of the devices intended to be covered under the proposed rules. In fact, I have used the term Wireless Audio Devices repeatedly in the past to describe the same equipment. As the Commission may be aware, commonly used Wireless Audio Devices include wireless microphone systems, in-ear monitoring systems (IEM systems, also referred to as interruptible fold back, or IFB, systems), and wireless intercom systems. All of these systems should be considered under Wireless Audio Devices. Wireless microphone systems and IEM/IFB are very similar devices in that they are both primarily concerned with establishing a one-way wireless audio link over a short distance (usually less than 100 meters, though it is occasionally important to establish links up to 500 meters in large venues such as stadiums).

Wireless intercom systems are also occasionally used in the same venues as wireless microphone and IEM/IFB systems. These systems establish, by definition, two-way full-duplex audio links over short distances for the purpose of coordinating shows. In some ways, these devices operate in a similar manner to a cordless telephone, though their construction is often more rugged and the systems are capable of interfacing with traditional wired intercom systems and not with the Public Switched Telephone Network (PTSN). While some intercom systems are still used in the TV bands (often the so-called T-band, extending from channel 14-20), many new systems[1] are now being manufactured for the 902-928 MHz and 2.4 GHz bands, as well as the 1.8 GHz DECT band. These bands may prove sufficient for many users of intercom systems. The Commission should seek comment on whether such intercom systems should be considered under this proceeding.

The commission proposes that Wireless Audio Devices should be limited to transmitting "short data strings such as recognition codes necessary to ensure the functionality of a system."[2] I submit that this definition may be too limited. Many Wireless Audio Devices currently transmit telemetry to the receiver, including information such as a coded squelch tone[3] and battery state information. Future developments in cognitive and smart Wireless Audio Devices may see a need to transmit additional telemetry to the receiver about the current operating condition of the transmitter and even information on spectrum use (for example, wireless microphone transmitters could include spectrum sensing technology in the future). Such telemetry should be allowed under the Commission's rules. In addition, the proposal that Wireless Audio Devices should be limited to one-way operation may also limit development on cognitive and smart audio devices. I submit that Wireless Audio Device receivers should be

[1] ClearCom manufactures such systems under the Tempest and CellCom names.
[2] See FCC 10-16, Paragraph 112.
[3] Shure and Lectrosonics use such a system, for instance.

permitted to transmit low-data-rate telemetry back to a transmitter in some fashion, either co-channel to the transmitter or on another frequency under the proposed rules. Such information could control the transmitter's operating state and adjust settings such as operating frequency, power output, audio gain, and other parameters. It may be possible for a system consisting of multiple transmitters and receivers within the same frequency block to use a single frequency for a return data link (i.e., from receiver to transmitter).

It will be important for the Commission to choose its language very carefully to ensure that consumer-grade devices do not get branded as Wireless Microphones in order to achieve greater operating power than necessary.

115. I do not believe that the proposed co-channel operation requirements set forth in Paragraph 115 and Appendix E of the Further Notice of Proposed Rulemaking[4] (FNPRM) are appropriate for Wireless Audio Devices. In particular, many Wireless Audio Devices are operated in buildings or other structures that significantly attenuate signals from licensed TV stations. I submit that the Commission should allow operation co-channel to TV stations if the received signal strength of the TV station is, on average, below -110 dBm[5] (or some other value sufficiently low that television signal reception would be considered reasonably difficult), within the operating radius of the wireless microphone.

116. I believe that a limit of 50 mW, applied to the antenna, is sufficient for wireless microphones that will operate under the proposed Part 15 rules. However, as I will discuss later in these comments, this power level may not be sufficient for licensed operators. With respect to external antennas, I believe that the Commission should require microphone transmitters

[4] Docket 10-16, January 15, 2010.

[5] In the case of digital TV, this value would be the total power measured across the 6 MHz channel. In the case of NTSC analog, operation should permitted if the wireless microphone will not interfere with the visual, aural or chroma carriers. It has been common practice in the past to "sneak" wireless microphone signals into the space between carriers and at the edge of the NTSC signal.

certified under the proposed Part 15 rules to have a non-detachable antenna. The Commission has stipulated this for other radio services, most notably the Family Radio Service.

With respect to IEM/IFB systems, and other systems that traditionally rely on external antennas, the Commission should prohibit the use of external amplifiers while permitting the use of external gain antennas, such as Log-Periodic Dipole Arrays and Yagi-Uda arrays. Additionally, the Commission should permit higher power levels to be used if the user holds a license under Part 74.

120. The newly adopted rules for TV Band Devices are not suitable for Wireless Audio Devices for the reasons specified by the Commission. However, the Commission's assessment that Wireless Audio Devices and TV Band Devices should not have a significant advantage over one another is incorrect. The new TV Band Devices will operate with a total power output of 40 mW, spread over 6 MHz. Assuming that this signal is approximately flat over the allocated bandwidth, this produces a power spectral density (PSD) of 6.67 nW/Hz, or -51.7 dBm/Hz. In contrast, a wireless microphone system using a frequency modulation technique will see the vast majority of its power concentrated within a bandwidth of approximately 150 kHz (and often less due to the nature of audio signals). At 50 mW total power output, this produces a PSD of 333 nW/Hz, or -34.7 dBm/Hz. From this analysis, it is clear that a Wireless Audio device will have, at worst, a 17 dB advantage over a TV Band Device. Because of this, it is not likely that a TV Band Device will significantly interfere with a wireless microphone (though the converse may not be true).

I submit to the Commission that this disparity is acceptable for two reasons. First, Wireless Audio Devices are often used in situations where the signal quality is of the utmost importance. Second, portable, frequency agile TV Band Devices are likely to be used by

consumers for recreational use and not for mission-critical applications like Wireless Audio Devices are.

123. I do not see a reason to adjust any other technical requirements for operation under Part 15. As the Commission has noted[6], Wireless Audio Devices have been used for years with little to no harmful interference to licensed users of the band.

III. Licensed Operation under Part 74

General Comments. The use of Wireless Audio Devices ranges from simple, single-device operation at small events and for ENG operation to large-scale sports, cultural, and political events where over 40 systems may be in use at the same time by multiple operators. These users have vastly different requirements, and should be treated differently by the Commission. I submit that users of Wireless Audio Devices to whom uninterrupted and interference-free operation is critical should be permitted to obtain a license under Part 74 of the Rules, and that other users should be permitted to operate under Part 15 of the Rules.

It is necessary to further define which users will be permitted to obtain a license under Part 74. I submit that entities who meet one or more of the following requirements be permitted to obtain a license:

(a) Entities who are currently eligible for a license under Part 74.

(b) Entities who own and operate eight (8) or more Wireless Audio Devices within the same system or facility.

(c) Entities who function, as their primary business, as a provider of Wireless Audio Devices by rental or other similar contractual arrangement.

[6] Previously in 10-16.

Entities who obtain a license must be held to higher technical standards than users who operate under Part 15 of the Rules. In particular, users should be required to perform the following tasks regularly:

(a) Coordinate Wireless Audio Device operating frequencies within their system and with any other users in the vicinity to avoid harmful interference to any Wireless Audio Device system.

(b) Ensure, through the use of built-in or external test equipment, that Wireless Audio Devices are not interfering with the operation of broadcast television stations or any other licensed user of the band.

(c) Operate at the minimum power necessary to ensure a robust connection to the receiver free of dropouts and other harmful problems.

Users who cannot perform the above tasks should not be eligible for a license under Part 74.

135. It is my opinion that users who obtain a license under Part 74 of the Rules should be required to conform to the current requirements, such as coordination. If users are unable to perform these tasks, I submit that they are not qualified to operate wireless equipment that is protected from interference from other users.

138. I believe that a license term of ten (10) years from the date of issue or renewal is sufficient and would not burden licensees unnecessarily.

144. If the Commission expands Part 74 eligibility, then it is my opinion that first sale of equipment that is only certified under Part 74 of the rules (and not under Part 15) should be restricted to users who can show a current or pending license for operation. Equipment that is

certified under Parts 15 and 74 should come with a label explaining that no protection will be granted for interference unless the user holds a license under Part 74 of the Rules.

IV. Possible Longer-term Solutions

147. Wireless microphone signals are unique in that there are often a large number of transmitters operating within a close proximity on a relatively narrow part of the band. As the commission notes, coordination is often required to ensure that systems do not interfere with one another, and such coordination often results in poor spectral density. Within the confines of an analog frequency-modulation system, one way to reduce the amount of "wasted" spectrum is to simply require manufacturers to ensure that their receivers are of a higher quality than they are now—thus reducing intermodulation and adjacent-channel interference problems. Many two-way radio systems are capable of rejecting very strong adjacent-channel signals, and it stands to reason that wireless microphone manufacturers could achieve a similar level of performance.

148. As the Commission is aware, wireless microphone systems must stand up to a very stringent set of requirements. In particular, microphone systems must have very low latency, a high dynamic range in terms of audio amplitude and audio frequency range, have a very low amount of distortion from end-to-end, and have a long battery life while continuously transmitting to be useful in most situations. It is extremely difficult to design a digital system to meet these requirements. However, manufacturers should be encouraged to work toward developing new technologies to enable the use of digital communications for wireless microphones.

V. Licensed Operation under Part 90

151. It is my personal belief that operation under Part 90 is sparse due to a lack of protection from other users and a lack of professional equipment similar to that available for use

in the TV bands. Additionally, the limited number of frequencies makes operation unappealing to many users in high-density environments such as New York City.

I believe that a combination of licensing under Part 15 and Part 74 is the most logical and simple mechanism for bringing the vast majority of users into compliance. The Commission may also wish to increase the power restrictions for wireless microphones under Part 15 that operate in the 90 MHz, 2.4 GHz, 3.6 GHz, and 5.8 GHz bands. This may spur development of systems that can operate in these bands and thus reduce the amount of clutter in the television bands. While such systems are unlikely to be used by professionals, consumers and other similar users may find the performance adequate for things such as "garage bands."

VI. Conclusion

I would like to thank the commission for reading my comments on this very important issue, and hope that the Commission will consider these comments as it devises new regulations regarding Wireless Audio Devices.

Respectfully submitted,

Michael J. Benonis
Ph.D. Student in Electrical Engineering
Virginia Polytechnic Institute and State University
1201 Patrick Henry Drive, Apt. K
Blacksburg, VA 24060
(703) 577-3788

February 21, 2009