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

In the Matter of	)	
	)	
Promoting Spectrum Access for Wireless Microphone Operations	)	GN Docket No. 14-166
	)	
	)	
Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions	)	GN Docket No. 12-268
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COMMENTS OF AEROSPACE AND FLIGHT TEST RADIO COORDINATING COUNCIL, INC.

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SUMMARY

AFTRCC commends the Commission for initiating this proceeding to review the future needs of and spectrum options for wireless microphone operations. AFTRCC Members utilize wireless microphones in a variety of ways in their business operations and recognize the public interest in making sure adequate spectrum is available for them. AFTRCC's primary interest in the Commission's notice of proposed rulemaking ("*NPRM*"), however, is in its role as advocate for the aerospace industry on matters affecting spectrum policy and as non-Federal Government coordinator for flight test spectrum. The *NPRM* identifies the 1435-1525 MHz Aeronautical Mobile Telemetry ("AMT") band as a potential spectrum home to accommodate certain wireless microphone operations on a secondary basis. The 1435-1525 MHz band is allocated on a primary basis to AMT and has long been used for flight testing at test ranges throughout the United States and is essential to safe and efficient flight testing for both manned aircraft and missiles. Any consideration of wireless microphone operations in the 1435-1525 MHz band on a licensed basis must account for the need to protect critical flight testing operations from harmful interference, a condition which the *NPRM* recognizes.

The Commission's proposal for accommodating only professional wireless microphone users in the 1435-1525 MHz band with a need for a large number of microphones at a given venue on a secondary basis may be worth consideration but the Commission must also consider the potential for use by ineligible operators, as well. Historically, the Commission has granted authority for these operations on a case-by-case basis by Special Temporary Authority following coordination by AFTRCC and the federal government to permit video and audio communications at specific locations for short periods of time. The *NPRM* proposes to expand that authority to allow more extensive and flexible use, albeit still subject to limits. Licensed

operation of wireless microphones will require a different approach to coordination and more rigorous controls to ensure operation is limited to specific times and places since wireless microphones operating in the 1435-1525 MHz band have the potential to create significant interference to AMT operations. Any regulatory framework in this band must also consider and account for potential secondary buyers of wireless microphones that can come from a wide range of persons and organizations, not just the limited class of users the Commission proposes to designate as eligible users, *i.e.*, the professional users who have the need for a large number of microphones and whose needs cannot be accommodated in other spectrum bands. AFTRCC agrees with limiting users eligible for licenses to the definition proposed by the FCC.

The *NPRM* properly recognizes that it is not enough for it to simply allocate some or all of the 1434-1525 MHz on a secondary basis. While point of sale requirements might be advisable to help ensure only eligible users purchase the equipment, such measures are not enough to protect AMT operations. Because of the potential for resale or repurposed use of wireless microphones, advance coordination with AFTRCC and the federal government should be coupled with an integrated control mechanism in the equipment itself to prevent operation prior to registration of the equipment's location and successful coordination, and to ensure that the equipment can operate only in coordinated places and at coordinated times. AFTRCC submits that key components of the protections must be integrated directly into the wireless microphone equipment itself, regardless of the user. Since any microphone equipment operating in the 1435-1525 MHz band would require this internal control capability, existing devices on the market today would not be eligible for coordination in this band, absent an update that brings them into compliance, once the new rules go into effect. However, a limited transition period for such users and existing equipment might be appropriate subject to further study. But entities that

own such equipment that pre-dates the rules should be precluded from reselling the equipment, since the equipment could not, once new rules are effective, be properly certified.

AFTRCC is pleased to offer its preliminary comments on the possible option of permitting licensed wireless microphone operation by professional users in the 1435-1525 MHz band. Much work remains before the Commission can conclude that wireless microphones will be able to operate in the band successfully under a licensing framework without creating the potential for harmful interference to safety-of-life AMT operations. The record has not yet been developed to determine how the band would be used by wireless microphones, what equipment would be available, and the power level and bandwidth allowances, among other parameters. AFTRCC anticipates reviewing and evaluating the initial comments concerning operation in the 1435-1525 MHz band with interest and addressing any proposals by wireless microphone manufacturers and advocates in its replies.

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To: The Commission

COMMENTS OF
AEROSPACE AND FLIGHT TEST RADIO COORDINATING COUNCIL, INC.

Aerospace and Flight Test Radio Coordinating Council, Inc. ("AFTRCC") hereby submits its Comments in response to the Notice of Proposed Rulemaking in the above-captioned proceedings.[1] In the *NPRM*, the Commission is considering how to accommodate the future needs of wireless microphone users in the face of a changing spectrum regulatory environment. Of particular interest to AFTRCC and its Members is the Commission's identification of the 1435-1525 MHz band (also referred to herein as L-Band AMT Spectrum), which is allocated on a primary basis for aeronautical mobile telemetry ("AMT") and is essential to safe, efficient flight testing, as one of several bands which might become a potential home for future operation of wireless microphones on a secondary basis under certain conditions. AFTRCC offers its preliminary views on this option and explains that any consideration of the 1435-1525 MHz band

[1] *Promoting Spectrum Access for Wireless Microphone Operations*, GN Docket No. 14-166, and *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, Notice of Proposed Rulemaking, FCC 14-145 (released Sep. 30, 2014) ("*NPRM*").

for secondary wireless microphone use must ensure that rules are put into place to provide adequate protection to primary AMT safety-of-life operations, including coordination and control mechanisms integrated into equipment manufactured and marketed for use within the band.

I. BACKGROUND

As the Commission's records reflect, AFTRCC is a Delaware non-profit corporation comprised of its Members, including the nation's principal aerospace manufacturers (*see* Attachment A). AFTRCC was founded in 1954 as an association (and more recently incorporated) to serve as an advocate for the aerospace industry on matters affecting spectrum policy. It is also the recognized non-Federal Government coordinator for the shared Government/Non-Government spectrum allocated for flight testing. AFTRCC works closely with its Members and with Federal Government Area Frequency Coordinators in an effort to ensure that interference-free flight test operations are protected, and flight safety maximized.

In the *NPRM*, the Commission seeks comment on wireless microphone users' needs and the spectrum and technologies that might be used to address them. Of specific interest to AFTRCC, the Commission solicits comment on approximately a dozen spectrum bands that might accommodate those respective needs.[2] Among the options being considered is the 1435-1525 MHz band which is allocated on a primary basis for AMT operations.

In this Section I, AFTRCC explains the importance of real-time telemetry and both the need for protection from harmful interference to AMT operations, and the recognition for such protection within the United States as well as globally. In Section II of these comments, AFTRCC offers its preliminary views on this spectrum option and underscores the need for

[2] *Id.* ¶¶ 175-190.

appropriate coordination and equipment-based operational constraints to protect AMT systems against harmful interference should the Commission decide to make the band available for secondary operation of wireless microphones. AFTRCC anticipates reviewing the initial submissions of wireless microphone manufacturers and other interested commenters that advocate use of the 1435-1525 MHz band, and providing a detailed response on reply.

The 1435-1525 MHz band, along with the 2360-2390 MHz band, is in the critical path for aerospace research and development, and for certifying aircraft to safety standards. The AMT facilities which use the 1435-1525 MHz band for flight testing are vital to the safety and productivity of the aerospace industry, the Nation's most important contributor to a net positive balance of trade, and for numerous, national security-related test programs.[3] The 1435-1525 MHz band has long been used for flight testing in the U.S. for both manned aircraft and missiles. Aeronautical test ranges are widely dispersed across the country. A significant number of commercial test facilities are located in California and the Southwest generally, but also near Dallas-Fort Worth, St. Louis, Seattle, Washington, D.C., Wichita, Georgia and Florida.[4]

AMT describes a particular use of the mobile service ("MS") in Region 2 for the transmission from an aircraft station of results of measurements made on board, including those

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[3] For over 50 years, the aerospace industry has generated a net annual surplus in the U.S. balance of trade – the largest of any manufacturing sector. The industry is the largest net exporter and one of the largest contributors to U.S. gross exports at $118.7 billion in 2013, with a net balance of trade that year amounting to $71.3 billion, the nation's top net exporter of goods and services. Aerospace Industry Report: Facts, Figures and Outlook for the Aviation and Aerospace Manufacturing Industry. 4th ed. (in press). Daytona Beach, FL: Embry-Riddle Aeronautical University, *citing* U.S. Department of Commerce, International Trade Administration, TradeStats Express, June 18, 2014. In 2012, civil aviation accounted for 5.4% of national gross domestic product (GDP), contributing $1.5 trillion in total economic activity and supporting almost 12 million jobs. U.S. Dept of Transportation, Federal Aviation Administration, *The Economic Impact of Civil Aviation on the U.S. Economy*, June 2014, Forward.

[4] *See also NPRM*, ¶ 175.

relating to the functioning of the aircraft. Examples of AMT data include engine temperature, fluid pressure, and control surface strain gauges, among many other functions. Video is also increasingly used in flight tests.

Flight testing requires real-time data for the protection of the pilot and aircrew, the test aircraft as well as chase planes (if they are used in a particular test), and people and property on the ground. AMT data is *the* critical source of *real-time* measurement and status information transmitted from airborne vehicles during live flight tests. Spectrum used for AMT enables aerospace manufacturers to achieve material efficiencies in their test programs. It enables a test aircraft to clear multiple test points in a single flight.[5] Aircraft are put through extreme maneuvers which stress the vehicle to its maximum limits.[6] The telemetry also enables ground-based engineers to detect unsafe conditions, warn the pilot of dangerous conditions, and modify or abort the test in a timely fashion. Interference with flight test telemetry means loss of data, which can put the safety of the pilot, the aircraft, and persons on the ground at significant risk.

Interference also adversely affects productivity: throughout the duration of flight tests, a constant lock must be maintained on the aircraft involved. Data drop-outs require that maneuvers, or entire test missions, be re-flown, delaying production and increasing costs, on the

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[5] The presence of real-time telemetry greatly improves the efficiency with which a flight test program can be conducted in contrast to other data collection methods such as on-board recording. Aircraft can be cleared for multiple test points during a single flight, instead of having to return to base for data analysis before being allowed to move to the next set of test points.

[6] To be sure, not all flight testing involves the highest risk maneuvers, but even "ordinary" flight tests involve significant risk to the pilot and persons on the ground. It is for this reason that AFTRCC's Members strictly limit the number of persons who can be on-board aircraft during such tests, which use of telemetry spectrum makes possible. Moreover, from day-to-day to even hour-to-hour, the same spectrum used for a simple avionics test, for example, can be, and often is, used for more dangerous tests.

order of thousands of dollars to upwards of more than a million dollars per test flight, depending on the complexity of the program. Such delays put United States companies at a competitive disadvantage in the global marketplace, and can affect national security. Thus, test flight data must be transmitted in protected radio bands to minimize the chance of interference/interruption to critical safety communications.

In the event disaster strikes during a test and the aircraft is lost, the real-time data collected via radio telemetry enables engineers to more quickly isolate the cause, and put into effect the completion of design changes.[7] The noise-limited 1435-1525 MHz band is ideal in terms of its propagation characteristics, the maturity of technology for implementing telemetry systems, and the relatively large signal wavelengths. The latter are large enough with respect to the size of aircraft structures to minimize unwanted geometrical effects, such as signal fades and destructive multipath, due to the blockage and/or reflection of the radiated telemetry signals by aircraft structures. Extremely sensitive, large, high-gain parabolic antennas are used to gather telemetry signals from distant test vehicles, often at distances up to and, on occasion, exceeding 200 miles. To detect telemetry at these distances, tracking antennas are designed to be extraordinarily sensitive, which also renders them vulnerable to interference, even from signals as low as 1 mW, which is typical of power levels for medical mobile body area network sensors ("MBANS") whereas wireless microphones operate at powers more typically in the 50 mW range. Thus, the bands used for flight testing (such as 1435-1525 MHz, and 2360-2390 MHz) have long been protected by regulators due to their use for flight safety communications.

[7] With missile tests, the only practical means of gathering data is by means of real-time telemetry. By definition, missile test flights end with the loss of the craft.

The Commission has recognized on repeated occasions that flight test telemetry exists to enhance safety of flight in what is often a high-risk enterprise. For example, in 1984 the Commission stated that flight test telemetry "involves *the safety of life and property*" and acted "*to protect this safety service from harmful interference that could result in loss of life*."[8]

In 1989, the Commission determined that the telemetry bands should be classified as "Restricted" and protected from fundamental emissions of unlicensed devices (such as, effectively, BSNs which would be licensed merely by rule). In so doing the agency again stressed that the telemetry bands at 1435-1525 and 2360-2390 MHz "*involv[e] safety of life*."[9]

In 1990, the Commission explained:

> "[S]haring of [flight test] frequencies with unlike services is difficult at best because *schedules of telemetry flight tests are unpredictable and delays costly. Further, interference cannot be tolerated*. For example, in the event of a crash the telemetry data may be the only means available to determine the cause of the crash. In this case, *interference to the telemetry transmission could be disastrous*."[10]

Thus, for example, in that same year, the Commission concluded that secondary use of flight test frequencies for air shows could result in significant harmful interference "*impair[ing] the*

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8 *In the Matter of Amendment of Part 2 of the Commission's Rules Regarding Implementation of the Final Acts of the World Administrative Radio Conference, Geneva*, 1979, 98 FCC 2d 905, 906 (1984)(emphasis added).

9 *In the Matter of Revision of Part 15 of the Rules Regarding the Operation of Radio Frequency Devices Without an Individual License*, 4 FCC Rcd 3493, 3502 (1989) (emphasis added). *See also* 47 C.F.R. §15.205(a) (1435-1626 MHz is a restricted band).

10 *Amendment of the Frequency Allocation and Aviation Services Rules (Parts 2 and 87) to Provide Frequencies for Use by Commercial Space Launch Vehicles*, 5 FCC Rcd 493, 495 (1990) (emphasis added).

efficiency and safety of the flight test industry."[11] Further, the Commission determined that year that:

> [F]light test, telemetry, and telecommand operations are vital to the U.S. aerospace industry to produce, deliver, and operate safe and efficient aircraft and space vehicles. Because the nature of the BSS (Sound) operations is 24 hour a day ... and the test and telemetry operations are in the proximity of many major metropolitan areas, *we believe, as AFTRCC asserts, that the BSS (Sound) transmissions will cause interference to these operations and threaten safety of life and property*. Consequently, we do not believe it is feasible to share aeronautical mobile telemetering frequencies with BSS (Sound) or terrestrial broadcasting systems.[12]

Nothing has changed in the years since to alter the soundness of these conclusions. On the contrary, they are as germane as ever. In fact, the *NPRM* notes the "paramount need to protect AMT operations."[13]

The particular importance of protecting safety of life services is reflected in the definition of harmful interference, which sets a lower bar for what constitutes harmful interference in the case of safety services. Specifically, "harmful interference" is:

> Interference which *endangers the functioning of a radionavigation service or of other safety services* or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with [the ITU] Radio Regulations.[14]

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11 *In the Matter of Petition to Amend Part 87 of the Commission's Rules to Allot VHF Aeronautical Frequencies for the Coordination of Air Show Events*, Order, 5 FCC Rcd 4641, 4642 (1990) (emphasis added).

12 *Second Notice of Inquiry in GEN. Docket No. 89-554, In the Matter of An Inquiry Relating to Preparation for the International Telecommunication Union World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum*, 5 FCC Rcd 6046, 6060, ¶ 101 (1990) (emphasis added). The Commission even went on to say that "We have previously determined that aeronautical flight test and telemetry operations should not share spectrum with unlicensed devices because of the threat to safety of life." *Id.* at 6061 ¶ 102.

13 *NPRM*, ¶ 182.

14 47 C.F.R. § 2.1 (emphasis added).

In other words, for safety services, the "frequency of interruption," *i.e.*, the probability, and even the degree of the degradation or obstruction, is immaterial.

The international community, too, has long protected spectrum resources dedicated for flight testing. Prior to the 2003 World Radiocommunication Conference ("WRC-03"), the sharing possibilities between the L-band AMT Operation and Mobile Satellite Service downlinks were studied intensively. Section 2.8.1.2.1(b) to the CPM Report for WRC-03 included the following:

> Studies submitted to the ITU R show, in accordance with Recommendation ITU-R M.1459, that GSO MSS and aeronautical mobile telemetry are fundamentally incompatible under co-coverage scenarios, and that sharing is not feasible without causing harmful interference to AMT operations. AMT systems use low gain transmit antennas (~2 dBi) and high gain (30 dBi) receive antennas. GSO MSS satellites use extremely high gain (~40 dBi) downlink antennas and mobile earth stations use low gain (~2 dBi) receive antennas. This fundamental asymmetry in the competing links precludes sharing if an MSS satellite is within line of sight of an AMT ground station and exceeds the protection levels in Recommendation ITU-R M.1459. Without meeting the protection levels in Recommendation ITU-R M.1459, GSO MSS satellites in Region 1 and 3 visible to AMT ground stations in Region 2 will interfere with AMT operations.

Subsequently, WRC-03 adopted a change to Article 21, Table 21-4, which established a "pfd fence" to protect flight test centers and ranges in substance as follows: pfd limits consistent with Recommendation ITU-R M.1459 [-181 dB (W/m2) in 4 kHz at low elevation angles] to protect AMT systems west of 71° W, and more relaxed levels for AMT systems operating in Alaska, Hawaii and Puerto Rico. More specifically, RR 5.343 provides that, "in Region 2, the use of the band 1435-1525 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile service." Moreover, the U.S. took an alternative allocation for the sub-band

1452-1492 MHz on account of this.[15] Within the United States, the band 1435-1525 MHz is and will remain allocated exclusively to the mobile service for aeronautical telemetry.

Indeed, the United States, in its preparations for the 2015 World Radiocommunication Conference ("WRC-15"), has settled on a position rejecting calls to make all or a portion of the 1435-1525 MHz band available for mobile commercial service, *i.e.*, International Mobile Telephony ("IMT"). A number of administrations had proposed to the ITU-R that the L-band or major portions thereof (such as 1452-1492 MHz) be allocated for mobile broadband, or at least identified for such purposes at WRC-15. Specifically, rejecting this call for reallocation in Region 2, the U.S. position states:

> The 1435 – 1525 MHz band is essential for aerospace research and development, and for the certification of aircraft prior to commercial use. Interference-free, real-time use of the band is essential to the protection of test aircraft, payloads, flight crews, and persons and property located beneath flight test airspace. The continued use of the band 1435-1525 MHz on an interference-free basis is essential for the aerospace manufacturing industries and their many suppliers in Region 2, including Administrations in both North and South America.
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> Based on the studies introduced to date in the JTG, AMT sharing of the band with interference limited IMT services has been demonstrated as infeasible. [citing JTG 4-5-6-7/ Docs 156 (July 2013) and 4-5-6-7/291 (October 2013)]. . . . Flight test aircraft routinely fly several hundred kilometers in all directions from their AMT ground stations. This extends the impact of signals from aircraft transmitters to IMT users to distances that are well beyond the radio line of sight from the IMT user to the AMT ground station.
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> Radio Regulation 5.343 prescribes that "In Region 2, the use of the band 1435-1535 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile service."
>
> The United States proposes to retain this footnote in Region 2 in order to protect the flight safety aspects of AMT operations from domestic and cross-border interference. …

[15] *See* RR 5.344.

> For the foregoing reasons, the 1435 – 1525 MHz band should not be identified for IMT use in Region 2.[16]

In short, the U.S. has rejected calls to make the spectrum available for IMT in Region 2 in preparation for WRC-15. Although flight test maneuvers themselves are not conducted over populated urban areas, because of the proximity of flight test centers to metropolitan areas, interference from co-channel (or adjacent channel) transmitters to the extraordinarily sensitive telemetry receivers located at those centers is a real prospect from even low-powered devices located within tens of kilometers. This potential for interference is a real threat that must be accounted for in any proposed allocation action that would allow co-channel or adjacent channel operation with AMT in the 1435-1525 MHz band such as that about which the *NPRM* seeks comment.

II. PRELIMINARY RESPONSE TO THE WIRELESS MICROPHONE *NPRM*

AFTRCC lauds the Commission for commencing this proceeding and addressing the future needs of wireless microphones in a timely fashion in anticipation of a reduction in access to spectrum currently used by wireless microphone manufacturers over the coming years. The Members of AFTRCC appreciate the importance of wireless microphones and the need to accommodate them within spectrum bands where they can operate without causing interference to radio operations with higher priority to the band. AFTRCC's Members utilize wireless microphones in a variety of settings in their business operations, both within their manufacturing plants and in their corporate offices. Wireless microphones are utilized for large and small

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[16] *See United States of America Proposals for the Work of the Conference*, Agenda Item 1.1, WRC 2015, found at http://www.ntia.doc.gov/files/ntia/publications/ai_1.1_1435-1535_mhz_usa_proposal_2014-02-13.pdf (last accessed February 3, 2015).

meetings, in-company conferences, presentations, when conducting tours of facilities, and for in-plant operations, among other uses.

Many of the transmitters used with wireless microphones today come in a variety of form factors that can include hand-held, body pack, head-worn, lavalier and instrument clip-on. This means that in addition to wireless microphones, the same transmitter in other form factors can be used in a variety of ways, such as with microphones, electric guitars/basses/violins, and for acoustic instruments with an electronic "pickup."

A. Use of the 1435-1525 MHz on a Secondary Basis by Professional Users Only May Be Worthy of Consideration but the Commission Must Account for the Potential for Use by Ineligible Operators As Well

The Commission proposes as "one option" for accommodating wireless microphone users' future needs the coordinated secondary operation of wireless microphones in the 1435-1525 MHz band that meet certain criteria. In the past, in limited circumstances, AFTRCC, in conjunction with Government Area Frequency Coordinators and operators of flight test facilities, has coordinated temporary shared use by professional organizations in the 1435-1525 MHz band for video and audio communications at specific locations for short periods of time. The applicants for such use include professional sound engineering companies responsible for major event productions using specially designed or modified equipment. Relatively speaking, these coordinated uses through grants of Special Temporary Authority ("STA") have been limited in scope, and coordination has proceeded on a manual, case-by-case basis, with proposed users approaching AFTRCC directly to commence coordination. As the *NPRM* notes, "[p]rior to grant of each STA, the applicants must demonstrate that they have fully coordinated their proposed spectrum use with AFTRCC."[17]

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[17] *NPRM*, ¶176, n. 214.

The *NPRM* contemplates possible secondary use of the 1435-1525 MHz band by wireless microphones in a manner for which the historic grant of a relatively modest number of STAs in the band fails to serve as a relevant precedent. Indeed, were that not the case, the Commission need not consider rule changes or a reallocation.[18] Instead, as before, the potential users of the band could continue to make applications for temporary use of the spectrum on an as needed basis. What the *NPRM* contemplates, however, is a more extensive and flexible use of the band by wireless microphones which requires a different approach to coordination. The record, however, on how this band might be used and what the equipment might look like – the Commission solicits comments on what types of microphone use in the band would be suitable, what types of equipment could be used, what power levels and bandwidths should be allowed – has yet to be developed, and AFTRCC expects to review and evaluate the initial comments with interest and address them in its reply.[19]

Nonetheless, AFTRCC submits preliminary comment that any consideration of wireless microphone operation in the 1435-1525 MHz band must permit such operation only on a limited, licensed secondary basis in order to protect AMT operations from harmful interference. The *NPRM* recognizes "the importance of ensuring that the AMT systems are protected against harmful interference, and given that most wireless microphone operations can be accommodated within other spectrum, we propose that use of this band [*i.e.*, 1435-1525 MHz] be limited to

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18 *See NPRM*, ¶ 178 (recognizing that the contemplated secondary allocation would result in more extensive use of the band by wireless microphones than the uses that have occurred pursuant to issuances of STA).

19 *Id.*, ¶ ¶ 179, 187.

licensed professional users at specified locations and times, *and include specified safeguards designed to protect AMT use of the band*."[20]

Wireless microphones operating in the 1435-1525 MHz band could create potential for significant interference to AMT operations. Adequate protections must be in place and integrated directly into the equipment itself to control the time and place where such microphones can be used. More widespread use of wireless microphones in L-band AMT Spectrum, relatively speaking,[21] even if on a licensed basis, creates the opportunity for potential mischief, because the universe of potential users – meaning both eligible users and others who, though not eligible, could derive benefit from using the L-band microphones and might obtain them on a secondary market basis – would expand.

There is a widespread marketplace for the resale of wireless microphones.[22] Secondary buyers of wireless microphones can be expected to come from a wide range of persons and

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20 *NPRM* ¶ 177.

21 In the *NPRM*, the Commission notes that it is not proposing "widespread or . . . itinerant uses throughout the nation." ¶ 182. AFTRCC concurs in the need for measures that preclude widespread or itinerant uses. As discussed below, each use of equipment should be registered during set up, requiring an acknowledgment and prior completion of coordination and deactivation of use controls before operation can commence.

22 A simple Internet search for "used wireless microphones" reveals this. *See, e.g.*, ebay, http://www.ebay.com/sch/i.html?_odkw=wireless+microphones&_osacat=0&ssPageName=GSTL&_from=R40&_trksid=p2045573.m570.l1313.TR0.TRC0.H0.Xused+wireless+microphones&_nkw=used+wireless+microphones&_sacat=0 (2,562 results)(searched Jan. 26, 2015); Guitar Center, http://www.guitarcenter.com/Search/Default.aspx?internal=1&browser=&fsrc=used%20wireless%20microphones&src=used%20wireless%20microphones (78 results) (searched Jan. 26, 2015); BH Photo & Video, http://www.bhphotovideo.com/c/search?Ntt=used+wireless+microphones&N=0&InitialSearch=yes&sts=ma&usedSearch=1&Top+Nav-Search= (45 results)(searched Jan. 26, 2015); Adorama, http://www.adorama.com/searchsite/default.aspx?searchinfo=wireless+microphone&category=1000100 (41 results)(searched Jan. 26, 2015); Sam Ash,

organizations, not just the professional users the Commission proposes to designate as eligible users. Some, if not many, of these secondary buyers would likely be unaware of the requirement to obtain licenses, to operate only on a secondary basis and to protect primary AMT operations, and others may simply choose to ignore that requirement. History has shown, as the Commission has observed in prior proceedings, that wireless microphone use in a given band often extends well beyond the bounds of eligibility set by the Commission. While the Commission in 2010 sought to stem the unauthorized use of wireless microphones in the 700 MHz band by adopting a new framework that included steps to legitimize the unlicensed use by non-professional organizations, it understood that it must remain vigilant regarding the prospects for use by non-eligible users in bands limited to certain professional users.[23]

For example, as the Commission observes in the *NPRM*, the Commission sought comment in the *TV Bands Wireless Microphones R&O and Further Notice* whether to limit manufacturers to direct marketing of Part 74-certificated low power auxiliary station ("LPAS") devices to parties eligible to operate them; whether to require manufacturers to track the parties to whom their products are marketed; whether to require manufacturers to provide a label visible at the time of purchase or instructions in the user manual advising purchasers of the requirement to obtain a license; and whether to prohibit manufacturers and distributors from selling devices

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http://used.samashmusic.com/results.php?type=live%20sound&cat=wireless%20microphones (12 results)(searched Jan. 26, 2015)

[23] *See In the Matter of Revisions to Rules Authorizing the Operation of Low Power Auxiliary Stations in the 698-806 MHz Band; Public Interest Spectrum Coalition, Petition for Rulemaking Regarding Low Power Auxiliary Stations, Including Wireless Microphones, and the Digital Television Transition; Amendment of Parts 15, 74, and 90 of the Commission's Rules Regarding Low Power Auxiliary Stations, Including Wireless Microphones*, 25 FCC Rcd 643 (2010) ("TV Bands Wireless Microphones R&O and Further Notice").

certificated under Part 74 unless the sale is to a party that has committed in writing that it is a bona fide reseller or eligible for a license under Part 74.[24] This series of questions on which the Commission sought comment in order to control the distribution and use of LPAS is an all but tacit acknowledgment of the difficulties in limiting wireless microphone users to those the Commission designates as eligible.

The Commission is considering in this proceeding whether, in addition to limiting the eligible wireless microphone users in the L-band to "professional users, including broadcasters, professional television and cable programmers, and professional sound engineering companies, and operators at major venues that manage and coordinate wireless microphone operations,"[25] it should adopt point of sale and similar restrictions to help protect against interference to AMT operations.[26] As an initial matter, AFTRCC concurs in the proposal that the rules limit the eligibility to a small class of professional users, consistent with "the entities eligible for licensed LPAS operations in the TV bands."[27] This restriction would be a good start, and *help* to minimize the potential for operation that poses a threat of harmful interference to AMT applications by persons unaware of the meaning of secondary status. The categories of users making up the proposed eligible pool are among those types of entities that have sought and received STAs for use of the L-band in the past following coordination through AFTRCC in conjunction with Federal government coordination.

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24 *See NPRM* ¶ 110 n. 108, *citing TV Bands Wireless Microphones R&O and Further Notice*, 25 FCC Rcd at 689 ¶ 100.

25 *NPRM*, ¶ 186.

26 *Id.* ¶ 185.

27 *Id.* ¶ 186.

But the Commission should not lose sight of the potential for resale of wireless microphone equipment as noted above. While initial sales at full retail price might be limited to buyers that are eligible users, perhaps through certifications at the point of sale,[28] AFTRCC submits that this potential for resale renders any point-of-sale requirement limiting sales to eligible users a partially effective measure at best. Nonetheless, as a first line of protection, it is a measure that should be imposed on the marketing of the equipment. Yet, while point of sale measures may serve as the best means of advising consumers of their rights and obligations with regard to the equipment they are buying, it is questionable whether those requirements would be followed as closely on the secondary market. More important, where operation of an uncoordinated device may cause interference that endangers safety of life and property, as in the case of interference to AMT operations, the limited effectiveness of eligibility and point-of-sale measures becomes all the more plain. Although AFTRCC is not suggesting that such measures may not serve some purpose as part of an effective overall framework for notifying users of the secondary nature of the operations they seek to engage in and their obligation to not cause harmful interference, these measures cannot be relied upon to ensure coordination takes place or to prevent harmful interference. If the Commission is to consider secondary operation of wireless microphones in the 1435-1525 MHz band on an expanded basis, it must adopt more effective, technologically-based measures to ensure the equipment cannot operate in circumstances where it might cause harmful interference to primary, safety-of-life flight test telemetry.

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[28] *Id.*, ¶ 185.

B. Integrated Technology-Based Controls Limiting Operation Until Coordination Is Complete Is Essential Should the 1435-1525 MHz Band Be Made Available for Wireless Microphones

The *NPRM* properly recognizes that it is not simply enough for it to allocate some or all of the 1434-1525 MHz on a secondary basis but that coordination and technological-based controls integrated into the equipment would be required to protect AMT operations from interference.[29] As a possible model for sharing within the L-band between primary AMT operations and secondary wireless microphone operations, the Commission notes that it has recently adopted rules that would permit, on a coordinated basis, secondary, low power short-range devices to share another primary safety-of-life AMT band. Specifically, in 2012, the Commission authorized Medical Body Area Network ("MBAN") devices to operate in the 2360-2390 MHz portions of the 2360-2400 MHz AMT band.[30]

This MBANS rules benefitted considerably from long-term efforts by AFTRCC and several major medical telemetry device developers/manufacturers to reach a regulatory framework that imposed limitations on the deployment of MBAN devices to ensure that they could only be operated *indoors* following a professional, coordinated installation on the premises of qualified health care providers. The rules provided that operation of an MBANS device must cease in the absence of a control message, such as an electronic key, from the controller, which is

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29 *NPRM* , ¶178 ("in this instance we believe that frequency coordination with federal and non-federal users is critical and is consistent with the practice that already has been used for STAs in this band, although on a more limited basis. In addition, we believe it is necessary to ensure that a mechanism must be established to ensure that wireless microphone systems marketed for use in this spectrum can only be operated after successful coordination, such as through an electronic key or other means.")

30 *See generally* Amendment of the Commission's Rules to Provide Spectrum for the Operation of Medical Body Area Networks, ET Docket No. 08-59, *First Report and Order and Further Notice of Proposed Rulemaking*, 27 FCC Rcd 6422 (2012) ("*MBANS First R&O"*) on recon 61 CR 83 (rel. Aug. 21, 2014)

a means of ensuring the devices cannot be operated out of doors. The Commission developed rules that limited the eligible locations where MBAN systems could operate on a co-channel basis to AMT pursuant to a process between AFTRCC and a designated MBANS coordinator to ensure that primary AMT operations would be protected from interference.[31]

AFTRCC believes that the MBANS framework, while it might provide some valuable general guidance and insights, does not provide a precise roadmap on how sharing might best occur in the 1435-1525 MHz band between primary AMT operations and secondary wireless microphone uses.[32] As discussed below, the Commission should limit the locations where wireless microphone use is authorized in the 1435-1525 MHz band to those where harmful interference will not occur to AMT ground stations but must recognize the challenges to be overcome in connection with enforcing such geographic limitations given the ability of numerous categories of persons and organizations to utilize wireless microphones absent automatic controls built into the equipment itself. As a result, unlike the MBANS rules, if wireless microphones are permitted in the band, the Commission should specifically *require* an electronic key or an equivalent coordination control mechanism before any equipment designed for operation in the band can commence operation. Moreover, while the details of any such technology-based control mechanism requires further consideration, any such control mechanism

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31 *See id.*

32 Among other things, given the history of broadcasters and other professional users in obtaining coordination from AFTRCC (acting in conjunction with the federal government Federal Government Area Frequency Coordinators and federal users) in the course of seeking STAs for operation in the 1435-1525 MHz band, as noted in the *NPRM*, AFTRCC's preliminary view is that there may not be a need for an independent wireless microphone coordinator. Rather, coordination can efficiently and effectively proceed directly through AFTRCC under a new licensed regime, if one is adopted.

should be time-limited and provided by AFTRCC through a network or Internet interface following a successful request for coordination.[33]

In principle, AFTRCC agrees with the Commission's proposal that wireless microphone use, if permitted in the 1435-1525 MHz band be "restricted to specific fixed locations, such as large venues (whether outdoor or indoor), where there is a need to deploy large numbers of microphones, *e.g.*, 100 or more."[34] Eligible operators should be allowed to utilize the band only to the extent that resources in other available bands are insufficient at that location, and an additional condition to any license should be that the fixed locations be coordinated in advance with AFTRCC (and the federal government)[35] before operation can commence.[36]

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33 Of course, AFTRCC recognizes that tests may be required with wireless microphone manufacturers to prove out the concept of an electronic key as described herein, and that further conditions may possibly be required to protect the primary service. AFTRCC looks forward to comments provided by equipment manufacturers in response to the Commission's solicitation of views on the feasibility of systems that would ensure that operation only occurs at "locations and times where authorized through the coordination process." *NPRM*, ¶ 183. AFTRCC welcomes the opportunity to meet with and work with wireless microphone manufacturers that have designed or are considering designing equipment for the 1434-1525 MHz band.

34 *NPRM*, ¶ 182.

35 References in the remainder of these comments to AFTRCC coordination should be construed to refer to coordination by coordination performed by AFTRCC in conjunction with Federal Government Area Frequency Coordinators and federal government users.

36 The Commission asks whether wireless microphones should be tunable across the band. *See NPRM*, ¶ 189. AFTRCC submits that any microphones operating in the 1435-1525 MHz band, in addition to the other requirements discussed herein, should be frequency selectable to help facilitate coordination with AMT in a broader variety of instances. The Commission should also encourage manufacturers to ensure that devices designed to operate in this band should be capable of using other wireless microphone bands in the first instance, if available. Further, channels of smaller bandwidth should be encouraged as a device using smaller bandwidth channels may, in practice, be accommodated more easily pursuant to coordination than channels of wider bandwidth.

However, because of the potential for resale or repurposed use of wireless microphones, advance coordination should be coupled with some sort of control mechanism integrated into the equipment itself preventing operation prior to registration of the intended location of the equipment's operation with AFTRCC (using GPS or other reliable and suitable method for location awareness) and receiving an electronic acknowledgment of coordination (for example, through an Internet interface) from AFTRCC based on its (and as appropriate the federal government's) review of potentially affected AMT operations. Any time and place protections should be controlled by an electronic key or equivalent which the equipment must receive when set up at the location for which coordination by AFTRCC was obtained within the time period covered by the coordination. Unless the controls governing and demonstrating coordination for the specific time and place are confirmed when the microphone equipment is set up, and unless operation of the equipment is inherently dependent upon them, a requirement for coordination may be unlikely to safeguard interference-free operation.[37] For multi-day events, registration and confirmation of coordination using the electronic control mechanism should be required at least once every twenty-four hours as AMT operations could change, due to altered weather conditions, scheduling conflicts, or other testing program-specific requirements.[38] The existence

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[37] Once devices are successfully coordinated, they should be rendered inoperable if they are moved, absent a further registration and coordination. In other words, the location capability must be inherent in the equipment and must be functioning for registration. *Cf* 47 C.F.R. § 95.628(c) (MBANs devices must be rendered inoperable in the 2360-2390 MHz band in the absence of a controller message.) Where proposed locations are indoors, the equipment must be able to accommodate an interconnected device capable of determining the location accurately, reliably and securely, and which must remain connected at all times during operation or self-disable within a suitable time period after disconnection from the tether.

[38] *See* n. [39], *infra*.

of or relocation of temporary AMT ground stations[39] could thus be factored into responding to any attempt by a wireless microphone licensee to set up following coordination. Based on authorized power in the rules and other maximum parameters of wireless microphones that may be licensed in the band, matters the Commission has yet to determine and which AFTRCC expects will be informed by initial comments of manufacturers, AFTRCC would be able to develop a suitable coordination methodology.[40]

Implementing such a technological control is necessary and appropriate.[41] For one thing, it would bolster the coordination process, which is vital to help ensure only eligible users, *i.e.*, professional organizations, have access to the band. Under such a new regime, the frequency of use might increase considerably, and protections must be in place.

Prior to seeking a license to operate at a specific location and committing to purchasing L-band microphones, an eligible party could contact AFTRCC to determine if the site raises

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39 Aerospace manufacturers require the flexibility in appropriate circumstances to conduct flight tests at new and temporary test locations in order to respond to changing weather conditions, scheduling conflicts, and other program-specific requirements.

40 In order to maximize the potential use of wireless microphones in the 1435-1525 MHz band, the Commission should adopt the minimum power limits that the minimum the industry demonstrates would be acceptable. Coordination should be predicated on ensuring to ensure protection of the AMT ground stations consistent with the power flux density limit in ITU-R M.1459.

41 These automated requirements should be mandated in the Commission's rules, and parties seeking certification of L-band equipment should be required to demonstrate to the Telecommunications Certification Bodies ("TCBs") that the controls are present, are working properly, and cannot be modified or turned off by the user. As the Commission has required in the case of MBANS devices, TCBs processing applications for equipment authorization for wireless microphones that seek to operate in the 1435-1525 MHz band should be required to go through pre-approval guidance procedures (*e.g.*, "permit but ask") in coordination with the Office of Engineering and Technology before certifying specific devices

concerns about successful coordination or not.[42] AFTRCC could provide a response to verify whether the location can be coordinated and under what conditions without actually activating the control enabling the equipment to operate at that location. Utilizing this pre-coordination review, a potential licensee could obtain some level of assurance about the ability to operate at the location using L-band frequencies, rather than other spectrum bands, before applying for a license and seek formal coordination.[43]

Absent such a technology-based use control, it likely would not be difficult by a user that is unaware of or chooses to ignore the need to coordinate to set up a single microphone or small group of microphones without a license and without coordination. While the *NPRM* contemplates operations by professional eligibles only, and thus seems to contemplate expensive sophisticated equipment that only certain users can afford, it is the experience of AFTRCC Members that even the best wireless microphone systems are "scalable."[44] The largest expandable wireless microphone systems can still operate on a standalone basis with a single

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[42] A request for AFTRCC coordination should include the specific frequencies to be used, if known, the type of wireless microphone device to be used, the location of the devices (provided by GPS or other reliable and suitable method), and point of contact information regarding the entity responsible for the proposed wireless microphone operations. AFTRCC, in analyzing coordination requests, should be free to presume that the maximum power and other parameters permitted under the rules will be used and the entire band will be used.

[43] Since AMT sites, even mobile ground stations, are generally at or near airports, professional users considering L-band operation within a reasonable distance of an airport should have reason to know that coordinated use of wireless microphones in the AMT band at such a location may be problematic.

[44] AFTRCC, based on the experience and research of its Members, does not agree with the suggestions in the *NPRM* that there is a clear distinction between high-end expensive equipment purchased by professional organizations and those wireless microphones used by churches, karaoke bars, etc. *See NPRM*, ¶ 21. While professional organizations may be more likely to purchase high-end equipment new, other users may find that they can obtain such equipment on a secondary market for a fraction of its cost.

microphone and receiver according to the User Guides that are available online.[45] Typically, a user can do setup at the transmitter and receiver without having to buy separate software, networking, and controllers that do automated interference monitoring and spectrum management. For example, a singer or musician using only a single transmitter (in appropriate form factor) and receiver could setup and use the microphone themselves, anywhere, anytime, unless a control mechanism is integrated directly within the equipment that requires registration and an approval from a coordinator. For example, the user manual for Shure's high end UHF-R system that can be used for events requiring dozens of microphones includes instructions how to set up only a few microphones, *or even one*, without the use of network, computer interface and software.[46] On the secondary market, so-called professional equipment might become available at a fraction of the cost. Absent an integrated set of use controls inherent in the equipment itself and the requirement of a network interface with AFTRCC, at a minimum, the potential for interference to AMT systems is plain, and the Commission would be unable to ensure that its rules "would be effective in preventing the use of these devices at any other location or time [apart from one coordinated in advance] without authorization."[47]

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45 *See, e.g.*, http://www.shure.com/americas/products/wireless-systems/uhfr-systems. (last accessed February 3, 2015).

46 *See* Shure, Model UHF-R® Wireless Systems User Guide, pp. 11, 14-16 (excerpts appended hereto as Attachment B) (instructions for operator to set up a single receiver (or many receivers) manually without the use of computer software or controller; after the channel or channels are selected, the operator can setup and sync the transmitter manually).

47 *NPRM*, ¶183.

C. Existing Equipment Should Be Precluded from Operation in the Band

The *NPRM* asks to what extent it should permit any devices already on the market today to access the 1435-1525 MHz band.[48] Because the wireless microphones permitted in the band, as AFTRCC argues above, should have an integral control capability that requires registration at the location where operation has been coordinated and an electronic acknowledgment provided by AFTRCC confirming that such use has been successfully coordinated for that time and place, equipment on the market today should not be permitted to access the band unless they are modified and recertified by a TCB to comply with these requirements. Operation by non-compliant devices in the band would increase the potential for harmful interference to AMT operations, with risk to life and property.

At a minimum, existing owners of such equipment should be allowed for a limited period of time after the adoption of new rules to operate such equipment pursuant to STAs issued after coordination with AFTRCC using the same procedure that is employed today. Moreover, entities that own such equipment that pre-dates the rules should be precluded from reselling the equipment, since the equipment could not, once new rules are effective, be certified.[49] In addition, once resold, it may be virtually impossible to pull these devices out of circulation on a verifiable basis. To the extent that such equipment is owned by professional users, there may be some assurance that such restrictions will be honored, particularly if a transition period is provided with some accommodation, albeit time-limited, for future use.

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48 *Id. at* ¶ 187.

49 *See* 47 C.F.R. §2.803 (rule prohibiting the marketing of equipment that is not or cannot be authorized).

In short, wireless microphones already on the market today should be permitted to utilize this band in the long-run only if the equipment is first modified and recertified to meet the technical requirements that will ensure operation can occur only after successful coordination via registration and electronic acknowledgment as described herein. Interim access before such protections are place should not be permitted. However, at a minimum, resale of such existing equipment should be precluded and its use should be subject to pre-coordinated STAs issued by Commission to professional users on a case-by-case basis as is the case today.

III. CONCLUSION

AFTRCC is pleased to offer its preliminary comments on the possible option of permitting licensed wireless microphone operation by professional users in the 1435-1525 MHz band. Much work remains before the Commission could conclude that wireless microphones will be able to operate in the band successfully without creating the potential for harmful interference to safety-of-life AMT operations. At a minimum, however, the Commission should restrict the entities eligible for such operation and implement point of sale restrictions as a first step. However, adequate protection of flight test operations requires technological means integrated into all transmitters authorized to use the band by which prior coordination is required and can be confirmed with use controls each time a wireless microphone configuration is being set up, so as to ensure that the microphones operate only in times and at locations where harmful interference to AMT operations will not be threatened. AFTRCC looks forward to reviewing the submissions of any proponents of using the 1435-1525 MHz band for wireless microphone use and exploring the feasibility of potential coordinated co-channel, secondary operation by wireless microphones in the band.

Respectfully submitted,

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ATTACHMENT A

AFTRCC Members

Aerospace and Flight Test Radio Coordinating Council Members

ATTACHMENT B

Excerpts from Shure Model UHF-R Wireless Systems User Guide (Highlights added)

SHURE®

Model UHF-R® Wireless Systems
User Guide

27A20019 (Rev. 2)
Printed in U.S.A.

N108 CE

Feature Overview

The UHF-R® Wireless Microphone System uses the latest wireless technology, delivers outstanding audio clarity, and is rugged and reliable. It is easy to set up and operate with advanced features for professional installations requiring multiple wireless microphone systems.

Frequency Band Selection

Shure offers wireless systems in a selection of bands that conform to the different government regulations of specific nations or geographic regions. These regulations help limit radio frequency (RF) interference among different wireless devices and prevent interference with local public communications channels, such as television and emergency broadcasts.

The system's band and frequency range are identified on the face of the receiver and transmitter. For example, "H4 518–578 MHz."

For information on bands available in your area, consult your local dealer or phone Shure. More information is also available at Shure's website (www.shure.com).

Groups and Channels

To transmit audio through a wireless system, the transmitter and receiver must be set to the same radio frequency, or channel. A wide selection of channels allows more microphones to be used at the same time, since each microphone must operate on a different channel. It also provides a greater choice of open channels—those that are free from interference from television broadcasts, electronic devices, or other wireless systems.

A *group* is a selection of compatible channels. Wireless microphones work better together when set to channels in the same group.

Automatic Frequency Selection

The following features scan the RF environment to find the best group and channel settings for a particular installation.

- **Group Scan**—finds the group with the most open channels, then sets all networked receivers to channels in that group.
- **Channel Scan**—finds the first open channel in the currently selected group and sets the receiver to that channel.

Follow the steps on page 11 for instructions on using these features.

Automatic Transmitter Sync

This feature automatically transfers the group and channel settings from a receiver to a transmitter. You can also program other transmitter settings on a receiver and transfer those settings too. See page 16.

Interface Lock

This feature locks the receiver and transmitters so that users cannot change settings. The transmitter power switch can also be disabled so that the transmitter remains on if the power switch is accidentally toggled during a performance.

Audio Gain Structure

The following settings allow you to adjust audio gain throughout the system:

- **Sensitivity** (bodypack only). A 25 dB range of gain adjustment at the bodypack transmitter input.
- **Transmitter Gain.** A 30dB range of audio gain adjustment within the transmitter (affects audio level at the receiver, as indicated by the **Audio** LEDS.)
- **Output Level.** 32 dB of attenuation at the receiver output, plus a mute setting.
- **Mic/Line switch.** –30 dB pad for matching audio levels at the receiver XLR output.

Networking

Each receiver has an RJ-45 port on the back for connecting to other receivers over an Ethernet network. Networking receivers allows you to automatically set channels for all the receivers with a single group scan command. You can also control and monitor all networked receivers through the Shure Wireless Workbench PC software.

RF Distribution Ports

Use the RF distribution ports to share the signal from a single pair of antennas with up to 10 single or dual receivers within the same frequency band. The RF ports eliminate the need for antenna splitters or distribution amplifiers. Active circuitry minimizes insertion losses, preserving signal quality. Input filtering keeps the signal free from out-of-band interference. Distr bution circuitry is active only when additional receivers are connected to the RF distribution ports. When not used, the port circuitry is bypassed, allowing the receiver to be used as a stand-alone component.

Shure Wireless Workbench Software

The Shure Wireless Workbench software on the supplied CD includes a variety of useful tools for installing and managing multiple wireless systems. Simply install the software on your computer and connect it to a network of receivers to monitor and control receivers and transmitters throughout the network. (See page 12 for more information on networking).

Instructions on using the Wireless Workbench software are available in the online help files after you install the software.

Automatic Frequency Selection

Follow these steps to use the channel scan and group scan features.

Before you begin...

- Install the receivers in the location where they will be used and power them on.
- Mute all inputs on mixing devices connected to receivers.
- Turn off all bodypack or handheld transmitters for the systems you are setting up.
- Turn on potential sources of interference such as other wireless systems or devices, computers, CD players, effects processors, and digital rack equipment so they are operating as they would be during the presentation or performance.

Single Receiver

1. Select Radio > Sca > C a Sca using the **Navigate** keys on the receiver LCD interface.
2. Turn the **Control** wheel to select a group.
3. Press C a Sca . The display indicates that the receiver is searching. Once it has finished, it displays the selected channel.
4. Press the flashing **ENTER** button to accept the suggested channel.
5. Sync the transmitter (see page 16).

Networked or Dual Receivers

With networked or dual receivers, you can take advantage of the group scan feature to set group and channel settings for all the receivers at the same time. (See page 12 for instructions on networking.)

Perform a group scan from any receiver...

1. Select Radio > Sca > Gro p Sca using the **Navigate** keys on the receiver LCD interface. The display indicates that the receiver is searching (Scan In Progress). Once it has finished, it displays the group with the most open channels.
2. If you wish, turn the **Control** wheel to change groups. The number of open channels for each group is displayed.
3. Press the flashing **ENTER** button to set all receivers to open channels in that group.

   NOTE: The group scan feature only works for receivers in the same frequency band. For example, if you did a group scan on a “H4” band receiver, all “H4” band receivers would be set up, but not “J5” band receivers.

Multiple Receivers—Not Networked

If your receivers are not networked (or in different bands), the group scan cannot automatically set their group and channel settings. However, you can still take advantage of the group scan feature to find the group with the most open channels and the channel scan feature to find open channels in that group.

Find the group with the most open channels...

Perform a group scan using the steps for a networked receiver (above). However, make a note of the selected group before pressing the flashing **ENTER** button to accept it.

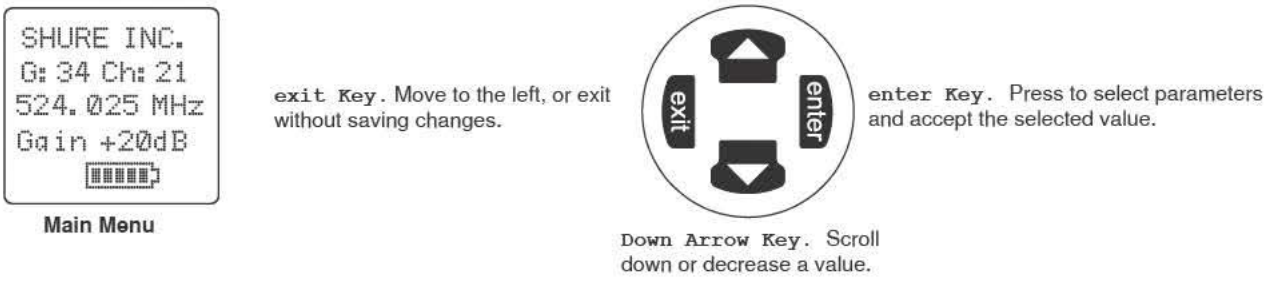
Set the receivers to open channels in that group...

Perform a channel scan on the remaining receivers using the steps for a single receiver (above). Make sure to select the same group for each receiver before performing the channel scan.

IMPORTANT: After setting the channel for the first receiver, immediately sync the transmitter for that receiver and leave it on so that the next receiver detects that channel during its channel scan. Otherwise, all the receivers will be set to the same open channel.

NOTE: Receivers in different bands (H4, J5, L3, etc.) do not need to be set to the same group.

Transmitter LCD Interface



Transmitter Batteries

Transmitters operate on standard AA batteries. Turn off the transmitter before changing the batteries.

The battery fuel gauge displayed on the transmitter LCD gives an indication of remaining battery life, as shown below.

UR1, UR2:

Transmitter Display	Approximate Hours Remaining (alkaline batteries)		
	UR1/UR2 (Normal Power)	UR1/UR2 (High Power*)	UR1M
	7.5 to 9.5	5 to 6	5
	5.75 to 7.5	4 to 5	4
	4 to 5.75	3 to 4	3
	2 to 4	1.5 to 3	2
	15 minutes to 2 hours	10 minutes to 1.5 hours	1

* High power setting not available with models sold in countries that prohibit its use.

Transmitter Parameters

Press ENTER from the main menu to access the following parameters:

[redacted] and Channel #). Must match the receiver's settings.

[redacted] Manual frequency selection in 0.025 MHz increments.

[redacted] i). Adjusts audio level from –10 dB to +20 dB

[redacted] (Se s) [redacted]

Sets audio input to +15 dB, 0 dB, or –10 dB recommended for guitars.

Name Display. 12-digit ASCII.

Use the following key combinations to access additional features and parameters:

LCD Panel

Changes LCD Panel

Frequency Lock

Toggles setting. When enabled, frequency cannot be changed, and a transmitter sync will not overwrite the frequency setting.

Power Lock

Toggles power lock. When locked, power switch does not turn off transmitter.

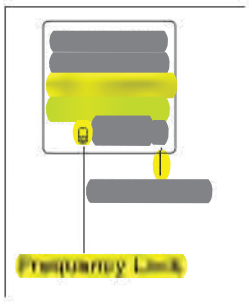
RF power level setting*

Use the arrow keys to select normal (10 mW) or high power (50/100 mW**). Use the normal power setting to conserve batteries or prevent RF overload at the receiver.

* High power setting not available with models sold in countries that prohibit its use.

** High power value varies with model.

Lock Indicators



Setting Transmitter Gain

Adjust the transmitter gain and input sensitivity so that the **Audio** LEDs on the receiver peak within the yellow range during use. On the bodypack transmitter, you can change the sensitivity setting to compensate for different audio levels when connecting different instruments or microphones to the input.

To adjust gain, turn on the transmitter and press the **enter** button. Scroll down to the Gai parameter or the Se s parameter (bodypack only) and press enter again. Use the arrow keys to adjust the setting and press **enter** to save it (**Exit** cancels without saving).

RF Safety Mode

This special feature temporarily mutes RF broadcast. This allows you to change frequency settings on a transmitter without accidentally "cutting in" on a channel being used by another transmitter.

1. Turn the transmitter off.
2. Hold down **exit** key while turning on the transmitter power (for handheld microphones, you need to pull the battery cover off the handle). The LCD flashes while the unit is in RF safety mode.
3. Change group and channel settings as you normally would—the transmitter will not broadcast.
4. Power the transmitter off and on to exit RF safety mode.

Automatic Transmitter Sync

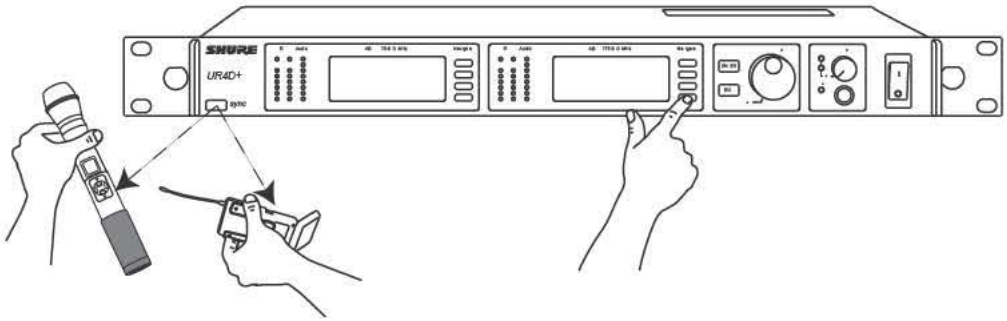
This feature automatically updates a bodypack or handheld transmitter's group and channel settings to match those of a selected receiver.

To perform a transmitter sync...

1. Open the transmitter battery cover to display the infrared (IR) port.
2. With the IR port exposed to the receiver, select Sy c > sy c from the receiver LCD interface.

The display on the receiver indicates whether the sync was successful. If the sync fails, try again, making sure that the IR port on the transmitter is exposed and directly faces the IR port on the receiver.

NOTE: Close the battery door before performing a sync on other transmitters.



To transfer other transmitter settings...

Optionally, you can transfer other transmitter settings from a receiver when you perform a sync. Use the following steps:

1. Select Sy c > Set p from the receiver LCD interface.
2. Turn the Control wheel to change parameter settings.
3. Push the Control wheel to move to the next parameter.
4. Push the flashing ENTER button to save the settings.

The transmitter settings you set on the receiver remain for future syncs.

NOTE: If you don't want the sync to send a setting, set the parameter to o C a ge

Available Settings...

The following settings are available from the Sy c > Set p menu:

- Sensitivity (Se s) bodypack only
- Gain (Gai)
- RF Power (P r)
- Power and Frequency Lock (Loc), which has the following values:
  - Power lock only: (P r O ly)
  - Frequency lock only: (Freq o ly)
  - Both: (Freq a d P r)
  - Neither: (U loc ed)
- Custom Groups (CG):
  - On (O): Send custom groups to transmitters during sync
  - Off (OFF): Do not send custom groups (reduces sync time)