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

In the Matter of	)	
	)	
Amendment of the Commission's Rules to	)	WT Docket No. 04-435
Facilitate the Use of Cellular Telephones and	)	
Other Wireless Devices Aboard Airborne Aircraft	)	

COMMENTS OF THE BOEING COMPANY

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SUMMARY

The Boeing Company ("Boeing") supports the Commission's proposal to permit the use of cell phones and other wireless devices onboard airborne aircraft in connection with airborne picocell systems and separate off-board communications links. As the Commission recognizes in the Notice of Proposed Rulemaking in this proceeding, allowing the use of wireless devices during flight will provide significant public benefits to passengers, airlines and service providers alike. However, any permitted use of wireless devices onboard aircraft must not create the potential for harmful interference to terrestrial wireless operations. Boeing believes that the use of appropriately designed airborne picocell systems, subject to associated interference control measures, would facilitate the introduction of economically viable airborne wireless services and effectively address the interference concerns that have been traditionally associated with the in-flight use of wireless devices.

To ensure the development of the most efficient, flexible and pro-competitive regulatory regime governing the use of airborne wireless devices, the Commission should adopt comprehensive service rules applicable to the operation of airborne picocell systems in all commercial mobile radio service ("CMRS") spectrum bands, including the cellular, PCS, WCS and SMR bands. Such rules should be driven by the following fundamental considerations.

First, any entity technically and financially capable of providing in-cabin wireless services should be authorized to do so on an unlicensed basis, subject to Federal Aviation Administration rules and the technical requirements adopted by the Commission to avoid the potential for harmful interference to co-channel terrestrial services. Existing CMRS licensees should not have exclusive authority to provide such services. Unlicensed status would serve the public interest by promoting the rapid introduction of airborne wireless services, and equipment certification requirements would ensure that airborne picocell systems comply fully with

technical requirements designed to prevent harmful interference to terrestrial wireless networks. As with all other services provided within an aircraft, selection of the airborne wireless service provider should be left to each airline or aircraft operator.

Second, airborne picocell systems should be accessible to any wireless customer in good standing with its home provider if the customer is using equipment that is technically compatible with the airborne picocell system. Access to airborne wireless services can be viewed as "roaming" similar to the roaming privileges that wireless subscribers otherwise enjoy when located in the service area of another terrestrial wireless carrier. As is the case with terrestrial wireless providers, however, airborne wireless service providers should not be required to implement airborne picocell systems that are compatible with all technologies and CMRS spectrum bands. Rather, market forces should be relied on to ensure widespread compatibility of airborne picocell systems with passengers' wireless equipment.

Third, although the potential for interference from airborne picocell operations to terrestrial wireless systems is slim, the Commission should adopt appropriate technical standards and operational requirements for the provision of airborne wireless services. Boeing believes that aggregate airborne picocell system emissions should be permitted to raise the noise floor experienced by terrestrial wireless networks by no more than 1 dB under worst-case assumptions. As discussed herein, however, the potential impact of airborne picocell system operations will be significantly less than this worst-case value. Nevertheless, as part of its airborne picocell system rules, the Commission may also want to consider implementing mechanisms to resolve any complaints in the unlikely event of interference and ensure that interfering operations are ceased pending resolution.

Finally, Boeing believes that the use of the 800 MHz band and other CMRS spectrum for off-board communications links would not be appropriate in the context of airborne wireless services. Access to CMRS spectrum outside the aircraft cabin would not be necessary to operate a picocell system onboard an aircraft. To the contrary, the use of this spectrum for off-board links would complicate the interference environment and substantially increase the potential for interference from airborne wireless operations into the terrestrial wireless network. At a minimum, the Commission should defer broader consideration of the potential use of CMRS spectrum for off-board communications links to a subsequent proceeding and, in the interim, institute a temporary freeze on further use of CMRS spectrum for this purpose.

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COMMENTS OF THE BOEING COMPANY

The Boeing Company ("Boeing") hereby submits its comments in response to the Notice of Proposed Rulemaking ("*NPRM*") issued by the Commission in the above-captioned proceeding regarding the use of cell phones and other wireless devices onboard aircraft.[1/] As the world's leading aerospace company, Boeing is focused on the development of new products and services to meet the needs of its aviation customers and the flying public. In this connection, not only has Boeing introduced innovative communications features in its new versions of commercial aircraft to "E-enable" airlines and passengers, it also operates the global Connexion by Boeing[SM] Aeronautical Mobile-Satellite Service ("AMSS") system to provide advanced broadband connectivity for commercial, government and private aircraft customers.

The ability of passengers to utilize cell phones and other wireless devices onboard aircraft in flight will be an important element of a comprehensive aeronautical communications services offering. Boeing supports the Commission's efforts to develop a new and flexible regulatory framework that will enhance competition and facilitate the provision of advanced wireless communications services onboard aircraft, and believes that such services can be

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1/ *Amendment of the Commission's Rules to Facilitate the Use of Cellular Telephones and Other Wireless Devices Aboard Airborne Aircraft*, 20 FCC Rcd 3753 (2005) ("*NPRM*").

provided in an economically viable manner that adequately protects existing commercial mobile radio service ("CMRS") operations.

Boeing acknowledges, however, that the Federal Aviation Administration ("FAA") – through the RTCA study process in which Boeing is a leading participant – is independently examining aviation safety issues associated with the use of cell phones and other wireless devices onboard aircraft, which is expected to conclude sometime in 2006; and that any regulatory changes that would facilitate the use of wireless devices onboard aircraft cannot be implemented before these studies are completed. Thus, the Commission should use this proceeding to examine fully the complex technical and policy considerations associated with the use of wireless devices onboard aircraft. As discussed herein, Boeing believes that the Commission can adopt a regulatory regime that balances the interests of consumers, aeronautical communications service providers and CMRS licensees, and facilitates the introduction of new and innovative communications services onboard aircraft in flight.

I. INTRODUCTION

The Commission recognizes in the *NPRM* that allowing the use of wireless devices during flight will provide significant public benefits to passengers, airlines and service providers alike.[2/] In particular, consumers will benefit from increased access to mobile telephone and data services during flight, and airlines will have another important amenity - the ability for passengers to access wireless services - to attract customers. Boeing supports the Commission's initiative to facilitate access to these important airborne communications services.

Upon careful examination and consultation with CMRS service providers and equipment manufacturers, Boeing believes that the Commission's proposed airborne picocell system

2/ *NPRM* ¶ 10.

concept, along with associated interference control measures, offers the best solution to support the use of wireless devices on aircraft. Airborne picocell systems have the ability to prevent harmful interference to airplane systems and terrestrial communications networks, permitting them to operate in the confines of an aircraft cabin using the same spectrum bands used by terrestrial wireless systems on the ground. Operating within prescribed technical limits, the airborne picocell system would serve as one link in the complete air-ground communication system that an airline furnishes to its passengers.

As discussed herein, the Commission's rules governing airborne picocell systems should be driven by several fundamental considerations: (i) any technically qualified entity chosen by an airline or other aircraft operator should be permitted to provide airborne wireless services on an unlicensed basis subject to compliance with applicable technical rules and equipment certification requirements; (ii) airborne wireless services should be accessible by any wireless subscriber in good standing if operating equipment compatible with the airborne picocell system; (iii) technical and operational requirements governing airborne picocell operations should be designed to prevent harmful interference into terrestrial wireless networks and obviate the need for coordination with individual terrestrial wireless carriers; and (iv) additional off-board communications from aircraft in flight should not be permitted in terrestrial CMRS spectrum.

These considerations are consistent with the potentially ubiquitous and mobile nature of airborne communications services that may be implemented throughout the U.S. commercial aircraft fleet, and with the *de minimis* interference potential from low-power operations conducted within the confines of aircraft cabins at altitudes above 10,000 feet. These considerations are also consistent with the pro-competitive, deregulatory initiatives embodied in the report of the Spectrum Policy Task Force and other recent Commission proceedings. As

discussed herein, these fundamental considerations can be implemented in a comprehensive regulatory regime governing airborne picocell system operations that facilitates the introduction of these new services while fully protecting terrestrial wireless carriers from harmful interference.

II. THE COMMISSION SHOULD ADOPT A REGIME THAT PROMOTES EFFICIENT AND COMPETITIVE PROVISION OF SERVICE TO CELL PHONES AND OTHER WIRELESS DEVICES

The provision of wireless service to passengers onboard aircraft in flight should be considered separate from traditional terrestrial wireless operations. Significantly, low-power airborne picocell systems would be confined to communicating with wireless devices located within an aircraft cabin – a small, mobile and insular area that is the exclusive province of airlines and other aircraft operators – without a direct connection to terrestrial wireless networks. As a result, it would be possible for the Commission to allow entities other than terrestrial licensees to provide airborne wireless services if selected by an aircraft operator.

A. The Commission Should Permit Any Entity that Has the Technical Capability to Provide Airborne Wireless Services on an Unlicensed Basis

The Commission has recently taken significant steps to deregulate and streamline its spectrum management policies to foster the rapid and competitive deployment of new wireless services and technologies.[3/] As part of these efforts, the Commission has attempted to move away from "command and control"[4/] regulation in favor of an approach that allows "unlimited

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[3/] *Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets*, 19 FCC Rcd 17503, ¶ 8 (2004) (spectrum policy changes are intended to improve "spectrum access, efficiency, and innovation by removing unnecessary regulatory burdens and implementing more market-oriented policies").

[4/] The "command and control" model is the traditional process of spectrum management in the United States, and is currently used for most spectrum within the Commission's jurisdiction. Under this model, allowable spectrum uses are limited based on regulatory judgments. *See Spectrum Policy Task Force Report*, ET Docket No. 02-135, at 5 (rel. Nov. 2002) ("*Spectrum Policy Task Force Report*").

numbers of unlicensed users to share frequencies, with usage rights that are governed by technical standards or etiquettes but with no right to protection from interference."[5/] New and innovative wireless services have flourished under this model.

Application of a similar regulatory approach to airborne wireless services will likewise facilitate the growth of such services. Given the mobile, nationwide and ubiquitous nature of airline traffic, and thus of airborne wireless services, the rules governing airborne picocell system operations must be national in scope and minimize the regulatory burdens associated with implementing these ground-breaking services for consumers. As the Commission's Spectrum Policy Task Force recognized, new advances in technology have significantly increased the wireless service offerings available today, which has increased the overall demand for spectrum-based services and devices.[6/] To ensure that all Americans have the opportunity to benefit from existing and planned airborne wireless services, the Commission should develop rules that afford service providers the maximum possible flexibility, "subject only to those rules that are necessary to afford reasonable opportunities for access by other spectrum users and to prevent or limit interference among multiple spectrum uses."[7/]

To this end, the Commission should permit any entity to provide airborne wireless services on an unlicensed basis, as long as the operator complies with the technical standards adopted by the Commission in this proceeding. Under such a regime, airborne wireless service providers operating consistent with the Commission's rules would be permitted to provide service pursuant to a general authorization rather than being required to obtain an individual

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5/ *Spectrum Policy Task Force Report* at 5.

6/ *Id.* at 12.

7/ *Id.* at 16.

license. Boeing recognizes that certain changes to the Commission's rules may be required to permit the unlicensed operation of airborne picocell systems.[8/]

The Commission should not adopt special eligibility restrictions for the provision of airborne wireless services or permit only terrestrial wireless providers to operate airborne picocell systems.[9/] Rather, any entity that has the technical capability to provide airborne wireless service in accordance with the rules adopted by the Commission should be permitted to do so. Allowing a wide range of companies to provide such services will help ensure that services can be tailored to meet the demands of individual airlines and other aircraft operators, and will encourage the development of niche providers. The rules governing the operation of airborne picocell systems will prevent harmful interference to terrestrial wireless networks, and compliant operation of airborne picocell systems will have the same *de minimis* interference impact whether or not the operator is a terrestrial wireless licensee.

Further support for unlicensed treatment of airborne wireless services is the fact that airborne picocell systems are analogous to in-building wireless systems and essentially act as a "a low power cellular base station installed in the aircraft for the purpose of communicating with (and controlling the operations of) cellular handsets or other cellular devices brought on the

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[8/] Alternatively, if the Commission concludes that unlicensed status is not appropriate, it should consider instituting a non-exclusive, nationwide blanket licensing scheme for airborne picocell systems. There is serious question whether terrestrial, geographically-limited CMRS licenses afford their holders pre-emptive rights to the cabins of aircraft in transit miles above the surface of the Earth.

[9/] *Cf. NPRM* ¶¶ 17-18 (proposing that existing cellular licensees should have "the right to operate pico cell systems" and asking "whether" other parties should have rights to airborne use of CMRS spectrum).

aircraft."[10/] As the Commission has previously recognized, licensing is not necessary in the context of low-power devices.[11/]

Allowing the unlicensed operation of airborne picocell systems does not eliminate the Commission's ability to identify clearly the particular entity providing airborne wireless services.[12/] In order to meet the Commission's "paramount" concern of preventing interference to terrestrial cellular systems, any entity providing an airborne wireless service should be required to register its airborne picocell system operations with the Commission. Such a registry could be used to determine the identity of providers not complying with the Commission's technical rules, and control and mitigate any interference they may cause.[13/]

Importantly, the Commission's regulations require that equipment used in wireless services meet appropriate technical standards and be authorized for use by the Commission. For example, Section 15.201(b) of the Commission's rules generally requires that unlicensed equipment be certificated for use pursuant to Commission procedures before that equipment may be marketed.[14/] A similar requirement for airborne picocell systems will ensure that their

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10/ *NPRM* ¶ 13.

11/ *Revision of Part 15 of the Commission's Rules Regarding Ultra Wideband Transmission Systems*, 17 FCC Rcd 7435, ¶ 19 (2002) ("These products, in general, will operate with very low power making licensing unnecessary.").

12/ *NPRM* ¶ 19 (seeking comment on whether picocells should be subject to blanket licenses, individual licenses, or some other form of registration).

13/ The Commission has used similar processes in the past with other types of wireless services. For example, the Commission recently adopted registration requirements in connection with the use of spectrum in the 3650-3700 MHz band. *See Wireless Operations in the 3650-3700 MHz Band, et al.*, ET Docket No. 04-151, *et al.*, Report and Order and Memorandum Report and Order, FCC 05-56 (rel. Mar. 16, 2005) ("*3650 MHz Order*").

14/ 47 C.F.R. § 15.201(b). While Subpart J of Part 2 of the Commission's rules specifies the procedures under which the certification process must be completed, the conditions under which certificated devices must operate are contained in the rules governing the service under which devices operate. 47 C.F.R. 2.901(a). Accordingly, the technical parameters under which various classes of

operations comply with applicable technical rules designed to prevent harmful interference to terrestrial wireless networks.

B. Each Airline or Other Aircraft Operator Should Be Permitted To Choose its Preferred Airborne Wireless Service Provider

As the entity responsible for aircraft safety and operations, the airline or other aircraft operator should have full discretion to choose the airborne wireless service provider that will serve its passengers. Airlines should be free to contract with the entities that they select based on their individual needs and requirements, subject to the airborne wireless system providers' compliance with Commission and FAA rules governing airborne picocell system operations.

Permitting the airlines to designate the airborne wireless service provider is consistent with airline control of the other services and amenities provided to passengers onboard its aircraft. Just as each airline may choose the entity it wants to provide catering services (and may decide not to provide meals at all), the airline is in the best position to decide on the entity with whom it will establish a business relationship for the provision of airborne wireless service. Airline choice of service providers also is consistent with the current practice under which each airline regulates the use of portable electronic devices ("PEDs") on individual aircraft based on the potential for the portable device to interfere with the aircraft's communications and navigation systems,[15/] and with airline selection of its off-board communications link provider (*e.g.*, air-to-ground or satellite link). Thus, while airline passengers are the ultimate beneficiaries of the wireless services made possible by an airborne picocell system, the airline is the primary

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unlicensed devices may be operated are included in Part 15 itself. *See, e.g.*, 47 C.F.R. § 15.257, which specifies the operating parameters for unlicensed systems in the 92-95 GHz band.

15/ *NPRM* ¶ 9; *see also* 14 C.F.R. §§ 91.21, 121.306, 125.204, 135.144.

customer for the airborne picocell system itself and should have the ability to choose among all qualified service providers.

III. ALL WIRELESS CUSTOMERS SHOULD BE ABLE TO USE AIRBORNE WIRELESS SERVICES IF THEIR EQUIPMENT IS TECHNICALLY COMPATIBLE WITH THE AIRBORNE PICOCELL SYSTEM

The Commission correctly recognizes that allowing the use of wireless devices during flight gives airline passengers increased opportunity to access mobile telephone and data services while traveling, and gives service providers enhanced flexibility to meet the increasing consumer demand for these services.[16/] As the Commission has stated, "[c]ompetition thrives in circumstances in which as many players as possible are given an opportunity to make business decisions regarding the development of new technologies, the entry into new markets, and the design and provision of new or enhanced services to consumers."[17/] The Commission's pro-competitive policies would not be served by the creation of unnecessary regulatory barriers that would stifle some providers' ability to offer innovative airborne wireless services to consumers.

The airborne wireless service provider is closely analogous to any other roaming partner of a terrestrial carrier, separated in altitude rather than by horizontal geography from the home system but utilizing the same frequencies as the home system. Accordingly, wireless customers should expect their wireless devices to work during flight regardless of the provider of the airborne picocell system as long as that customer is using a wireless handset that is technically compatible with the airborne picocell system.

16/ *NPRM* ¶ 10.

17/ *Rulemaking To Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, To Reallocate the 29.5-30.0 GHz Frequency Band, To Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services, et al.*, 13 FCC Rcd 4856, ¶ 42 (1998).

Such an approach is consistent with the Commission's existing roaming rule, which requires terrestrial wireless providers to provide service to all subscribers in good standing to the services of any other carrier while such subscribers are within the terrestrial wireless provider's service area when the subscriber is using a wireless device that is technically compatible with the terrestrial provider's system.[18/] The purpose of this rule, as articulated by the Commission, is to ensure seamless service to wireless customers outside of their home service areas, and to prevent wireless carriers from restricting competition and consumer choice.[19/] The Commission's requirements have given rise to numerous contract-based roaming agreements between terrestrial providers to facilitate the provision of seamless wireless services to their customers. In fact, most cellular carriers have reached automatic roaming agreements among themselves, even though the Commission's rule mandates only manual roaming.[20/]

Application of a roaming-like rule to airborne wireless services is in the public interest. The same public interest concerns underlying the Commission's adoption of its terrestrial roaming rule support the application of these principles to airborne wireless services. Consistent with the Commission's goal of encouraging competition and consumer choice, to the extent a passenger's wireless device is technically compatible with the airborne picocell system, that passenger should have the opportunity to use his wireless device during flight.

Nor do there appear to be any technical impediments to the implementation of roaming-like requirements onboard aircraft. As the Commission has noted, the roaming rule is "minimally intrusive" because it does not require providers to reconfigure their systems to

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18/ 47 C.F.R. § 20.12(c).

19/ *The 2004 Biennial Regulatory Review*, 20 FCC Rcd 124, Wireless Telecommunications Bureau Staff Report at 45 (2005) ("*2005 WTB Staff Report*").

20/ *2005 WTB Staff Report* at 45.

support technically incompatible roaming.[21/] Rather, the rule only requires wireless systems to provide service to roaming subscribers in cases in which the technology is compatible.[22/] From a technical perspective, roaming onboard a picocell-equipped aircraft should not significantly differ from terrestrial roaming.

Moreover, given that roaming has become "commonplace" and "widespread"[23/] -- as reflected by the large number of intra-provider agreements that evolved from the Commission's terrestrial roaming rule -- there is no reason to think that the same type of agreements would not be implemented for airborne wireless services. To the extent ubiquitous airborne "roaming" does not develop in the same manner as terrestrial roaming, the Commission previously has made clear that it will intercede as appropriate to ensure the development of roaming, and that it has the authority to impose a roaming requirement under Sections 303(r) and 309 of the Act.[24/]

Finally, to ensure the usability of the greatest number of mobile phones aboard aircraft, any rules adopted by the Commission for 800 MHz cellular band should also govern the provision of airborne wireless services operating on PCS and broadband SMR frequencies, subject to approval by the FAA.[25/] While many wireless telephones are dual-band phones capable of operating in both the cellular and PCS spectrum,[26/] some handsets only operate on PCS frequencies. There is no reason to preclude consumers with PCS-only devices from using

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21/ *2005 WTB Staff Report* at 46.

22/ *Year 2000 Biennial Regulatory Review - Amendment of Part 22 of the Commission's Rules to Modify or Eliminate Outdated Rules Affecting the Cellular Radiotelephone Service and other Commercial Mobile Radio Services*, 16 FCC Rcd 11169, ¶ 21 n.33 (2001).

23/ *Automatic and Manual Roaming Obligations Pertaining to Commercial Mobile Radio Services*, 15 FCC Rcd 21628, ¶ 13 (2000).

24/ *Interconnection and Resale Obligations Pertaining to Commercial Mobile Radio Services*, 11 FCC Rcd 9462, ¶ 10 (1996); *see also* 47 U.S.C. §§ 303(r), 309.

25/ *NPRM* ¶ 21.

26/ *NPRM* ¶ 21.

their devices during flight when the aircraft is equipped with a PCS-compatible airborne picocell system. Similarly, airborne wireless service providers should be permitted to operate on SMR channels to accommodate customers of terrestrial SMR carriers. As discussed above, however, the type of airborne picocell system available on an aircraft should depend on the demands of the individual airline, not regulatory dictates.

IV. AIRBORNE PICOCELL SYSTEMS SHOULD BE SUBJECT TO TECHNICAL AND OPERATIONAL REQUIREMENTS DESIGNED TO AVOID HARMFUL INTERFERENCE INTO TERRESTRIAL WIRELESS SYSTEMS

The development of suitable technical standards for the provision of airborne wireless services will avoid the potential for harmful interference to terrestrial wireless licensees and avoid the need for prior coordination. Boeing's research and analysis to date demonstrates that a combination of technical solutions (*e.g.*, transmit power reduction, attenuation from the aircraft fuselage, etc.) and operational procedures (*e.g.*, altitude restrictions on wireless device usage, prevention of direct off-board communications by wireless devices, etc.) will allow an airborne wireless services provider to meet the non-interference requirement. The use of technical standards to mitigate interference also will obviate the need for coordination with individual terrestrial wireless licensees, and is more feasible than individual coordination given that picocell systems installed on aircraft will be mobile, ubiquitous and operate throughout the United States and beyond.

A. Deriving a Maximum Level of In-Band Emissions for An Individual Airborne Picocell System

An airborne picocell system is comprised of the picocell base station and associated wireless devices, as well as interference mitigation measures designed to limit the potential for interference into terrestrial wireless networks. Interference mitigation may be provided by signal attenuation from aircraft fuselage and additional aircraft shielding, control of unsupported

handset transmissions and other techniques. In addition, operational procedures including altitude restrictions and other measures limit the potential for interference from airborne picocell operations.

In the attached Technical Appendix, Boeing sets forth an analytical construct for deriving a maximum in-band radiated emissions level for an individual airborne picocell system such that aggregate emissions of all airborne picocell systems would not cause harmful interference to terrestrial wireless networks. Defining a maximum permissible power level for an individual airborne picocell system under worst-case conditions and using conservative assumptions would create an easily administered requirement that would facilitate operation of airborne picocell systems on a non-harmful interference basis.

Boeing is continuing to refine its specific proposals to reflect ongoing consultations with the wireless industry, the results of aircraft testing and the latest analyses of addressing the use of wireless devices onboard aircraft. Below, however, Boeing describes its analytical approach to assist the Commission in developing an appropriate technical framework for deriving maximum permissible emissions limits for individual aircraft picocell systems. Boeing expects that more specific proposals, as well as input from other interested parties, will be forthcoming during the course of this proceeding.

1. Identifying a Worst-Case Level of Permissible Interference

An important element of defining a power limit for an individual airborne picocell system is identifying a permissible aggregate level of interference resulting from all airborne picocell system operations. Boeing believes that the Commission may accept a 1 dB increase in the noise

floor to wireless base stations, under worst-case conditions and using conservative assumptions, in deriving an individual airborne picocell system power limit.[27/]

Under the Commission's rules, "harmful interference" is defined as interference that causes serious detrimental effects as opposed to interference that is merely a nuisance or annoyance that can be overcome by appropriate measures.[28/] The Commission previously has determined that "it is a fundamental reality that every radio communication system must work in the presence of some amount of RF noise and interference,"[29/] and communications systems must therefore include some "reasonable margin" for acceptable performance in a changing environment.[30/]

The value for permissible interference from airborne picocell system operations identified herein is consistent with the levels of interference previously found by the Commission to be acceptable. For example, in the *UWB* proceeding, the Commission rejected arguments that a 1 dB increase in the noise floor of a mobile receiver is indicative of harmful interference.[31/] The Commission found that "[a]ny signal level, no matter how small, will result in some increase in

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[27/] Because the aggregate level of permissible interference is based on such conditions and assumptions, however, the 1 dB level may never be reached even in the most extreme real-world conditions. Moreover, temporal fluctuations in aircraft traffic and regional variations in air traffic density confirm that the maximum potential interference from airborne picocell system operations would occur only for short periods of time and in limited geographic regions. At all other times and in all other regions, the potential for interference from airborne picocell system operations is substantially less than the maximum permissible value.

[28/] 47 C.F.R. § 2.1 ("harmful interference" is interference that "endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service").

[29/] *Establishment of an Interference Temperature Metric to Quantify and Manage Interference and to Expand Available Unlicensed Operation in Certain Fixed, Mobile and Satellite Frequency Bands*, 18 FCC Rcd 25309, ¶ 27 (2003) (*"Interference Temperature NOI & NPRM"*).

[30/] *Interference Temperature NOI & NPRM* ¶ 27.

[31/] *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, 18 FCC Rcd 3857, ¶ 77 (2003) ("*UWB Order*").

the receiver noise floor," and therefore "[m]obile systems normally must accommodate a much higher increase in the receiver noise floor that 1 dB for the signal to be considered harmful interference."[32/] In other proceedings, the Commission also rejected arguments that a 1 dB increase in the noise floor would result in objectionable interference, finding that such assumptions were "unduly pessimistic," "unreasonable and overly restrictive."[33/]

Accordingly, Boeing believes that use of the 1 dB value as a starting point for deriving an individual airborne picocell system emissions limit, particularly in connection with the conservative worst-case analytical construct discussed herein would be reasonable.

2. Minimum Operational Restrictions for Airborne Picocell Systems

Boeing believes certain fundamental operational restrictions must be imposed on airborne picocell system operations to prevent harmful interference into the terrestrial wireless network. At a minimum, these include prevention of direct off-board communications by wireless devices and minimum altitude restrictions.

a. Prevention of Direct Off-Board Communication by Wireless Devices

An airborne picocell system should be designed to prevent onboard wireless devices from directly connecting to terrestrial wireless networks. As discussed in the Technical Appendix, wireless devices communicating directly with terrestrial wireless networks typically transmit at

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[32/] *UWB Order* ¶ 77; *see also id.* ¶ 14 ("To our knowledge, no correlation has ever been made between this slight rise in the noise floor [1 dB] and actual GPS harmful interference.").

[33/] *Service Rules for the 746-764 and 776-794 MHz Bands, and Revisions to Part 27 of the Commission's Rules; Carriage of the Transmissions of Digital Television Broadcast Stations; Advanced Television Systems and Their Impact upon the Existing Television Broadcast Service*, 16 FCC Rcd 1239, ¶¶ 7-8 (2001); *see also AirCell, Inc.; Petition, Pursuant to Section 7 of the Act, for a Waiver of the Airborne Cellular Rule, or, in the Alternative, for a Declaratory Ruling*, 18 FCC Rcd 1926, ¶ 22 (2002) (finding that harmful interference would be indicated only by a very substantial excess, such as 7dB or more, over the interference threshold level given the Commission's standard for "harmful interference"), *aff'd AT&T Wireless Services, Inc. et al. v. FCC*, 365 F.3d 1095 (D.C. Cir. 2004).

or near their highest power state, while communications with airborne picocell base stations occur at an extremely low power state.[34/] Because these higher power operations would exceed the permissible levels associated with airborne picocell system operations, and because wireless devices on aircraft can "see" a large number of base stations simultaneously, direct off-board communications by wireless devices onboard aircraft in flight can cause harmful interference to terrestrial wireless networks and must be avoided. Accordingly, Boeing believes that airborne picocell systems should be designed to prevent direct off-board communications of both supported wireless devices (those using technology compatible with the onboard picocell) and unsupported wireless devices (those using technology incompatible with the onboard picocell).

Various solutions to prevent direct off-board communications are being examined in several forums (*e.g.*, RTCA, WAEA and ECC) to force wireless devices into a quiescent state in which they do not transmit. Reducing the signal-to-noise ratio ("SNR") of the forward link signal received from terrestrial networks by wireless devices onboard aircraft in flight is one method to prevent off-board communications.[35/] Other technical approaches are also under consideration to address this issue.

b. Minimum Altitude Restrictions

Boeing notes that, for safety reasons during take-off and landing, the FAA currently requires that all portable electronic devices (including wireless devices) be turned off and stowed below an altitude of 10,000 feet. Boeing believes that the Commission's airborne picocell

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34/ Technical Appendix at 2-3.

35/ Below a threshold SNR level, the wireless device will stop transmitting because it is out-of-range of the base station. By reducing the signal level (*e.g.*, attenuation from the aircraft fuselage or additional shielding) and/or increasing the noise level in the aircraft cabin (*e.g.*, using RF management units), the SNR can be reduced below the threshold at which the cellular device can receive the forward link transmissions from terrestrial base stations.

system rules should reflect the FAA's requirement and prohibit airborne picocell system operations below 10,000 feet. However, most commercial aircraft cruise at altitudes approaching 25,000-30,000 feet (depending on flight route) and the actual effects of airborne picocell system operations at such altitudes may be taken into account in deriving a permissible individual operating limit.

3. Factors Affecting the Derivation of an Individual Airborne Picocell System Limit

Within a starting point of a permissible level of interference under worst-case conditions, as well as certain fundamental operational restrictions, it is possible to develop an analytical construct to derive an emissions limit for an individual airborne picocell system operated onboard an aircraft in flight. A number of factors affect the derivation of a limit on individual picocell system emissions. These include: (i) terrestrial base transceiver station ("BTS") receive antenna gain in the direction of airborne picocell system transmissions and slant angle; (ii) path loss associated with altitude effects; (iii) atmospheric attenuation; (iv) aircraft attenuation; and (v) the aggregate impact of multiple picocell-equipped aircraft. Each of these factors is examined in detail in the attached Technical Appendix and discussed briefly below.

a. BTS Antenna Gain in the Direction of Airborne Picocell System Transmissions and Slant Angle

There are hundreds of BTS antenna models in use throughout the United States. As conservative assumptions in deriving an individual airborne picocell emissions limit, a high-gain BTS antenna should be considered and the effect of the down-tilt of BTS antennas (typically on the order of 3°) should be ignored. In addition, based on FAA flight track data and the potential interference case geometry, Boeing has concluded that more than 99 percent of all aircraft within the radio horizon of a BTS receiver are at an elevation angle of 10° or less and thus are all within

the main beam of the antenna. BTS antenna gain and path loss associated with the distances (or "slant range") between a BTS base station and a picocell-equipped aircraft must be taken into account in deriving an individual airborne picocell system emissions limit. As discussed in the Technical Appendix, however, Boeing believes that BTS antenna gain and path loss associated with slant range can be considered together in a single L_p/G_r term because variations in these values effectively cancel each other out.[36/]

b. Path Loss Associated With Altitude Effects

An analysis of potential interference from aggregate airborne picocell system operations must account for altitude effects. As noted above, Boeing proposes that airborne picocell systems not be permitted to operate below 10,000 feet above ground level. However, most commercial aircraft cruise at an altitude substantially higher than 10,000 feet and are at lower altitudes only for brief periods during climb and descent. It is possible to take actual altitude effects into account in deriving individual airborne picocell system operating limits by examining air traffic altitude data, and Boeing is in the process of evaluating such data to provide additional information on path loss associated with altitude effects.

c. Atmospheric Attenuation

Because the vast majority of aircraft visible within the radio horizon of a BTS receiver are located at very low elevation angles and fly at an altitude approaching 30,000 feet, the slant ranges between potentially interfering airborne picocell systems and BTS receivers on the ground are extremely long. As a result, atmospheric attenuation may significantly affect the interfering signal. Boeing is evaluating available information on atmospheric effects to provide a conservative estimate for use in deriving an individual airborne picocell system power limit.

[36/] Technical Appendix at 5-8.

d. Aircraft Attenuation

As discussed in the Technical Appendix, Boeing's preliminary work with airborne picocell systems and testing of aircraft radiofrequency ("RF") attenuation generally, as well as that of other investigators, indicates that the radiated emissions from an airborne picocell system will be attenuated by the aircraft itself. Because more than 99 percent of all BTS receivers are within a narrow 10° range below the plane of the wings (due to geometry and the length of the radio horizon), Boeing believes that evaluating aircraft attenuation within a 10° range below the plane of the wings would provide a conservative estimate of aircraft attenuation effects. Boeing is in the process of evaluating test data regarding aircraft attenuation at 800 MHz and 1900 MHz for inclusion in the record of this proceeding.

Boeing believes, however, that given the large number of aircraft that could be located within the radio horizon of a BTS receiver under worst-case conditions and the likelihood that the relative headings of those aircraft toward any BTS will be uniformly distributed over all angles, the Commission should utilize an average aircraft attenuation over all angles (*i.e.*, 360° around the aircraft in the horizontal plane) to derive an individual airborne picocell system emissions limit.

There is a strong basis to argue that aircraft attenuation averaged over all angles should apply. The worst-case potential effects of airborne picocell system operations (highest density of picocell-equipped aircraft, highest number of potentially affected BTS receivers and lowest altitudes -- below 10,000 feet during take-off and landing) occur when an aircraft is heading toward and away from BTS receivers located near an airport. An aircraft heading toward or away from a BTS will present its nose or tail, which are the aircraft regions with significantly

higher attenuation. Analysis of flight track data confirms a bias toward fore and aft headings.[37/] Since the average radiated emissions over all angles is greater than the radiated emissions in the fore and aft direction, the use of average aircraft attenuation over all angles is a conservative assumption.

e. Multiple Aircraft Factor

Deriving a limit for individual airborne picocell system emissions requires estimating the maximum number of picocell-equipped aircraft within the radio horizon of any BTS.[38/] Boeing first analyzed the gross number of aircraft within a BTS radio horizon using aircraft flight tracks over the continental United States over a one-week period. Boeing determined that during peak, worst-case periods there may be approximately 180 aircraft within the radio horizon of BTSs in limited regions of the Northeast, Midwest and near Denver.

Of course, not all aircraft within the radio horizon of a BTS receiver will be equipped with airborne picocell systems. As a result, the Commission should include a "market penetration" or "deployment" factor in deriving a limit on individual airborne picocell system emissions. The picocell-equipped aircraft value should be initially set at a conservative level to protect terrestrial wireless systems from interference and could be increased over time, thereby decreasing the individual emissions limit on airborne picocell systems. As explained below, the introduction of wireless handsets with Wi-Fi capabilities and the potential reduction of GSM minimum power levels could make it easier to meet reduced lower limits.

Finally, Boeing believes that sectorized BTS antennas do not materially affect the multiple aircraft factor. In surveying BTS antennas, Boeing found that the gain of BTS antennas

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37/ Technical Appendix at 13.

38/ Technical Appendix at 15-17.

is generally inversely proportional to their azimuthal beamwidth. For example, antennas with a 3 dB narrower beamwidth generally had 3 dB higher gain. Of course, a narrower beamwidth reduces the number of aircraft within the field of view[39/] but the reduction in potential interferors is cancelled out by higher the antenna gain. As a result, the multiple aircraft factor essentially remains constant in the context of sectorized antennas.

B. The Commission Should Address Other Potential Obligations of Airborne Picocell System Operators

In addition to establishing a core set of technical and service characteristics for airborne picocell systems, the Commission must address certain operational issues regarding airborne picocell systems. At a minimum, these issues include resolution of interference events, the operation of airborne picocell systems on foreign-registered aircraft within U.S. airspace and the operations of picocell systems on U.S.-registered aircraft outside the United States.

1. The Commission Should Adopt Interference Resolution Mechanisms

For example, the Commission should consider implementing a mechanism for resolving any interference complaints. While operation of picocell systems within appropriate technical parameters should limit such complaints, those that arise must be resolved in an efficient and timely manner. This could be accomplished through the required use of location logs along with the availability of specific contact persons that are accessible around-the-clock. This process is similar to the one adopted by the Commission for other mobile transmitters.[40/]

39/ For example, a 60° beamwidth (6-sector) BTS antenna can only see one-sixth of the total number of aircraft within the radio horizon, and a 120° beamwidth (3-sector) BTS antenna would see one-third of the total.

40/ *Procedures to Govern the Use of Satellite Earth Stations on Board Vessels in the 5925-6425 MHz/3700-4200 MHz Bands and 14.0-14.5 GHz/11.7-12.2 GHz Bands*, IB Docket No. 02-10, *Report and Order*, FCC 04-286, ¶ 121 (rel. Jan. 6, 2005) (*"ESV Order"*).

Similarly, airborne picocell system operators should implement some means for terminating in-cabin wireless service until the interference issue can be resolved. The Commission has adopted similar rules in connection with the unlicensed operations permitted under Part 15 of its rules. Those rules require unlicensed devices to cease operations upon notification from the Commission that the device is causing harmful interference, and prohibit the unlicensed operator from resuming operations until the interference issue is resolved.[41/] Application of the current Part 15 interference notification and resolution process, or a similar process tailored specifically to airborne picocell systems, would help the Commission limit the potential for harmful interference to existing terrestrial operations from the use of wireless devices during flight.

2. The Commission Should Permit Airborne Picocell System Operations on U.S.-Registered Aircraft Traveling Outside the United States

As noted by the Commission in the *NPRM*, the ability to access airborne wireless services will provide substantial public interest benefits to passengers and crew members onboard aircraft in flight.[42/] However, these benefits do not cease at U.S. territorial boundaries. Rather, they extend to all geographic areas in which U.S. aircraft may operate, including over international waters and the territory of foreign countries. Accordingly, the Commission should ensure that its airborne picocell system rules provide for operation of such systems on U.S.-registered aircraft operating outside the United States.

Section 301(e) of the Communications Act, with a limited exception not relevant here, grants the Commission jurisdiction to license the operation of radio stations "upon any vessel or

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41/ 47 C.F.R. § 15.5(c).

42/ *NPRM* ¶ 10.

aircraft of the United States."[43/] The Commission's jurisdiction over aircraft of the United States under Section 301(e) is in no way limited by the geographic location of the aircraft. Moreover, when Congress enacted Section 301(e) of the Act, it specifically eliminated the geographic restriction on aircraft radio licensing jurisdiction previously established by Section 1 of the Radio Act of 1927, the provision on which Section 301 is based.[44/] This evidences Congress's clear intent to grant the Commission jurisdiction to authorize radio stations on U.S. aircraft regardless of their geographic location. Thus, the Commission plainly has statutory authority to regulate radio stations aboard U.S. aircraft whether operating within or outside the territorial boundaries of the United States.

Authorizing airborne picocell system operations aboard U.S.-registered aircraft located outside the United States is also consistent with general principles of international law. In this connection, the Convention on International Civil Aviation (to which the United States is a Signatory) explicitly recognizes that "appropriate authorities" of the nation in which an aircraft is registered retain licensing authority over radio stations aboard that aircraft even when located above the territory of a foreign nation, provided such aircraft's radio stations are operated in accordance with the regulations of that foreign nation.[45/] Thus, the Commission retains full and

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[43/] 47 U.S.C. § 301(e). The limited exception, set forth in Section 303(t) of the Act, does not constrain the substantive jurisdiction of the Commission over radio stations aboard U.S. aircraft, but rather authorizes the Commission to enter into agreements with foreign governments by which it shall recognize radio station and operator licenses issued to foreign aircraft operators that utilize U.S.-registered aircraft. 47 U.S.C. § 303(t). The Commission also has the explicit authority to license "any other mobile stations within the jurisdiction of the United States." 47 U.S.C. § 301(f).

[44/] Radio Act of 1927, P.L. No. 632, 69th Cong., § 1 (Feb. 23, 1927). Section 1 of the Radio Act granted licensing authority over radio stations "(e) upon any vessel of the United States, or (f) upon any *aircraft or mobile stations within the United States. . .*"). *See id.* (emphasis added).

[45/] Convention on International Civil Aviation at Art. 30 (signed Dec. 7, 1944) ("*Chicago Convention*") (Aircraft radio equipment). While Annex 10 to the *Chicago Convention* primarily relates to safety and non-public correspondence communications, Article 30 by its terms is not so limited.

exclusive jurisdiction over a U.S. aircraft equipped with an airborne picocell system that is located in international airspace.[46/] However, to the extent that U.S. aircraft enters the airspace of another nation, the airborne picocell system could also be subject to the right of that country to exercise jurisdiction over radio station operations above its territory.[47/] Accordingly, U.S. airborne wireless services providers should be required to comply fully with the rules and regulations of any foreign nation within whose airspace its picocell-equipped aircraft are operating, including any separate licensing requirements that may be imposed.[48/]

Finally, Boeing would note that airborne picocell system operations pose no potential interference threat whatsoever to terrestrial wireless systems when aircraft are flying over open ocean areas in international airspace. Thus, even if outstanding technical issues remain regarding the appropriate individual airborne picocell emission limit for operations within the continental United States, the Commission could permit airborne wireless services to be provided in U.S.-registered aircraft flying in international airspace.

3. The Commission Should Permit Airborne Picocell Operations on Foreign-Registered Aircraft in U.S. Airspace

Boeing believes that the public interest would be served by allowing airborne picocell systems on foreign-registered aircraft operating in accordance with the Commission's rules to

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46/ 47 U.S.C. § 301(e); *see also* ITU-R Radio Regulations, Chapter VIII (Aeronautical Services) (acknowledging, among other things, that aeronautical stations (including aircraft earth stations) are subject to the authority of responsible administrations along international routes).

47/ In this regard, the *Chicago Convention* generally provides that "[t]he contracting States recognize that every State has complete and exclusive sovereignty over the airspace above its territory." Chicago Convention at Art 1. The *Chicago Convention* further provides that: "Aircraft of each contracting State may, in or over the territory of other contracting States, carry radio transmitting apparatus only if *a license to install and operate such apparatus has been issued by the appropriate authorities of the State in which the aircraft is registered*. The use of radio transmitting apparatus in the territory of the contracting State whose territory is flown over shall be in accordance with the regulations prescribed by that State." *Id.* at Art. 30. (emphasis added).

48/ *See, e.g., ESV Order* ¶¶ 47-52..

operate within the United States. As a preliminary matter, an airborne picocell system authorized by another administration onboard a non-U.S. aircraft would be subject to the Commission's jurisdiction whenever it flies in U.S. airspace.[49/] Assuming full compliance with applicable rules, including operation in U.S. CMRS spectrum bands and adherence to technical requirements deigned to prevent harmful interference into terrestrial wireless networks, there is no basis for prohibiting airborne picocell system operations on foreign-registered aircraft.

The Commission should be more cautious, however, with respect to airborne picocell system operations in non-U.S. spectrum bands. Although wireless devices that do not operate in U.S. CMRS spectrum would not attempt direct off-board communications because there is no compatible terrestrial wireless network with which to connect, onboard low-power communications with the airborne picocell base station could present interference concerns and should only be permitted if the Commission concludes that harmful interference will not be caused to the other users of those bands.

C. Future Reduction of Potential Interference from Airborne Picocell System Operations

A number of technological advances, coupled with opportunities to update existing standards, offer the potential to reduce currently proposed airborne picocell system interference levels dramatically. Because mobile handsets have unusually high technology migration statistics (with users upgrading a handset every 18 months on average), shifts in technology

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[49/] 47 U.S.C. § 301(f). Section 87.191(a) of the Commission's rules also provides that "[a]ircraft of member States of the International Civil Aviation Organization may carry and operate radio transmitters in the United States airspace only if a license has been issued by the State in which the aircraft is registered," but that "[t]he use of radio transmitters in the United States airspace must comply with [the Commission's] rules and regulations." 47 C.F.R. § 87.191(a). Section 87.191(b) of the rules extends this treatment to U.S.-registered aircraft operated by foreign carriers pursuant to the authority granted in Section 303(t) of the Communications Act. 47 C.F.R. § 87.191(b).

standards or practices could have an appreciable effect on the interference potential from airborne picocell systems over time.

1. Commanding Reduced Power Levels for GSM Devices

Airborne picocell system interference with terrestrial networks is essentially a function of the power levels utilized by the mobile handsets and picocell base station. Testing of airborne picocell base station functionality within the aircraft cabin has shown that wireless devices can communicate effectively with both units operating at extremely low power levels. The power levels attainable by wireless devices are determined by industry standards and vary by technology.

CDMA standards require handsets and base stations to be able to manage power levels to extremely low levels – the handsets can be commanded to an output power level of -50 dBm. Testing has shown that CDMA handsets will operate with an airborne picocell base station at or very near these lowest power levels, which reduces the risk of terrestrial interference dramatically. GSM handsets, on the other hand, can only be commanded to a minimum power level of 0 dBm, which implies a requirement for an additional 50 dB of isolation between the picocell and the terrestrial network to achieve the isolation potential of CDMA handsets.

Boeing believes that it may be possible to improve GSM handset manageability by reviewing the GSM standards with an objective of harmonizing commandable power levels with the CDMA standards. This additional functionality will not only serve as a long-term benefit to terrestrial wireless operators and airborne wireless service providers seeking to lower interference from airborne picocell systems, but also to enhance terrestrial wireless operators' ability to architect terrestrial micro-cells in high traffic locations which may currently require

additional spectrum assignments. Boeing also notes that this preliminary suggestion does not imply that the sensitivity of GSM base stations must be modified in any way.

2. Wi-Fi/Wireless Handset Convergence

Boeing is active in numerous industry and standardization groups, including the Wi-Fi Alliance ("WFA"), an industry group that works to improve the interoperability and functionality of 802.11 wireless LAN ("WLAN") equipment. The WFA is currently working on developing approaches to adapting 802.11 networks to reliably carry voice traffic, and integrating this technology with current wireless handsets.

Dedicated voice-over-wireless LAN ("VoWLAN") handsets and wireless handsets with built-in Wi-Fi capabilities offer the possibility of reducing potential interference from airborne picocell system operations, but substantial market penetration of such devices for CMRS applications may not occur for five to ten years or more. Given this deployment delay, Boeing believes that the Commission cannot wait until Wi-Fi capable handsets achieve "critical mass" before authorizing the provision of airborne wireless services. Instead, the Commission should adopt rules at this time for airborne wireless services in traditional CMRS bands, subject to protection of terrestrial wireless networks, with the recognition that future transition to Wi-Fi capable handsets can only improve the interference environment going forward.

V. THE COMMISSION SHOULD NOT PERMIT OPERATION OF OFF-BOARD COMMUNICATION LINKS IN CMRS SPECTRUM

Boeing believes that the use of traditional CMRS spectrum for off-board communications links would not be appropriate in the context of airborne wireless services. Use of this spectrum outside the cabin is not necessary to operate an airborne picocell system and therefore should not be considered part of an authorization. To the contrary, the use of this spectrum for off-board

links would complicate the interference environment and substantially increase the potential for interference from airborne wireless operations into the terrestrial wireless network.

At a minimum, the Commission should defer consideration of the potential use of CMRS spectrum for off-board communications links to a subsequent proceeding so as not to delay the adoption of rules for airborne picocell systems. In the interim, the Commission should institute a temporary freeze on the use of the traditional CMRS bands for off-board communication links until it has fully examined associated technical and regulatory issues and adopted rules for airborne wireless services.

VI. CONCLUSION

For the foregoing reasons, Boeing respectfully requests that the Commission adopt rules consistent with these comments to permit the use of airborne picocell systems onboard aircraft to facilitate the use of cell phones and other wireless devices during flight.

Respectfully submitted,

THE BOEING COMPANY

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