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March 28, 2002

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William F. Caton
Acting Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, DC 20554

MAR 28 2002

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Re: 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; Petition for Extension of Waiver

Dear Mr. Caton:

On behalf of AirCell, Inc. ("AirCell"), and its cellular licensee partners, we are filing an original and four (4) copies of a Petition for Extension of Waiver in the above-referenced matter. We are also enclosing a CD-ROM that contains the technical exhibits found at Attachment H of the Petition.

If there are any communications regarding this matter, please contact the undersigned directly.

Sincerely,



Ronnie London
Counsel for AirCell, Inc.

Enclosures

cc: Jay Jackson
L. Andrew Tollin

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

In the Matter of

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

To: Wireless Telecommunications Bureau

WT 02-86
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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

PETITION FOR EXTENSION OF WAIVER

Michele C. Farquhar
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Attorneys for AirCell, Inc.

Dated: March 28, 2002

AirCell[®]

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Washington, D.C. 20554

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Washington, D.C. 20004-1109
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Attorneys for AirCell, Inc.

Dated: March 28, 2002

EXECUTIVE SUMMARY

AirCell, Inc. ("AirCell") and its cellular licensee partners submit this Petition to request that the Commission extend the waiver of the "airborne cellular rule" granted to AirCell and the partners. Extensions are requested to allow AirCell and its partners to operate the AirCell system: (1) indefinitely or, in the alternative, for a ten-year waiver period; (2) on 19 cellular channel pairs rather than the six pairs currently authorized; and (3) on frequencies used for digital terrestrial cellular operations in addition to those used for analog terrestrial service. Extension of the waiver in these respects is necessary to allow evolution of the AirCell system as an ongoing business, and to ensure continued availability of the public interest benefits inherent in AirCell's unique cellular technology.

The waiver extensions are supported largely by findings already made by the Wireless Telecommunications Bureau and affirmed by the full Commission, and that have survived appellate review. Specifically, the Bureau and Commission found, after thorough testing and analysis, that unlike standard cellular handsets, airborne operation of AirCell's specially-designed mobile terminals in conjunction with AirCell base station equipment does not cause harmful interference to terrestrial cellular service. The Commission granted the original waiver based on this special circumstance, and on multiple public interest benefits promised by AirCell's system, including enhanced air-ground safety-related voice communications; in-flight access to safety-related data like real-time weather, navigation and air traffic; possible in-flight airframe and engine operation monitoring; and FAA and NTSB recognition that technology like AirCell's would have significant public safety benefits.

The requested waiver extensions are supported by these findings, by exhaustive testing that shows the AirCell system does not interfere with digital terrestrial cellular operations, and by the fact that, in the many years the AirCell system has operated, there has been not one instance of reported interference.

Extending the waiver as requested by AirCell and its partners will provide all the public interest benefits the Commission has already recognized, and facilitating expanded AirCell operations will provide even greater public interest benefits.

These include:

- continued provision of airborne “911” service that works in the event of an aircraft systems failure to automatically connect pilots through the AirCell network to the closest air traffic control emergency operations officer;
- commercial aviation applications, such as pilot-to-ground and crew-to-ground communications, real-time “black box” and aircraft systems monitoring, and cockpit and cabin video surveillance for aircraft security;
- introducing competition and providing additional communications service to commercial aviation passengers, whose needs are currently unmet or likely to be unmet by the sole remaining 800 MHz air-ground provider; and
- participation with JetBlue in the FAA Enhanced Aviation Security Program to test new aircraft security procedures and systems.

The public interest will also be advanced by continued and new use of the AirCell system by a range of existing and prospective federal and state government clients, including state and local executive, administrative, and law enforcement agencies; federal entities like the U.S. Army Special Operations Command, the U.S. Navy Engineering Logistics Group, and the Tennessee Valley Authority; and agencies such as the Bureau of Reclamation, the U.S. Coast Guard, U.S. Customs, Forest Services, the FBI, the DEA, and Civil Air Patrol.

There is a real, demonstrable need for extension of the waiver to allow continued service and expanded operation of AirCell’s system in the public interest.

As to the duration of the waiver, AirCell's viability as a going concern – and thus its ability to provide continued and expanded service in the public interest – will be gravely limited as long as it faces imminent termination of its authority to operate. AirCell must have sufficient regulatory certainty in order to enter into and maintain relations with suppliers, customers and investors. Requiring AirCell to repeatedly come before the FCC to engage in protracted, expensive proceedings for only limited waiver extension periods is neither commercially feasible nor in the public interest.

As to the complement of authorized channels and the “digital exclusion,” the need for additional channel capacity becomes more and more critical as the demand for AirCell service grows and the company explores expanded and new applications. The combined force of restrictions against using more than six cellular channel pairs per base station, and against operating on channels used by neighboring licensees for digital terrestrial cellular service, has the potential to hamstring AirCell's ability to provide its corporate, government and private customers the high-quality service they expect. Indeed, the importance of removing the digital exclusion cannot be overstated – as more cellular providers convert their terrestrial systems from analog to digital service, it is already increasingly difficult for AirCell to identify a set of analog channels to use at many sites.

In sum, based on the Commission's well-reasoned and well-supported grant of the original waiver, three years of real-world operating experience under the waiver, additional testing with respect to the digital exclusion, and the growing public interest and demand served by AirCell's service, the Commission should grant the extensions of the AirCell waiver requested herein.

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A	Procedural History: FCC Approval of the AirCell System
B	List of AirCell Cellular Licensee Partners
C	Cellular Licensee Partner One-Year Reports
D	Washington Post Article: "American Airlines Says 'Buh-Bye' to Phones"
E	Letter from Members of House Transportation and Infrastructure Committee, to Hon. Norman Y. Mineta, Secretary, Department of Transportation, Feb. 27, 2002
F	Herb Harris Affidavit
G	Mehran Nazari Affidavit
H	Digital Test Report
	Appendix I Cross-Technology Interference Test
	Appendix II AirCell/TDMA Compatibility Test
	Appendix III AirCell/CDMA Compatibility Test

**Before the
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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

To: Wireless Telecommunications Bureau

PETITION FOR EXTENSION OF WAIVER

AirCell, Inc. ("AirCell"), and its cellular licensee partners, pursuant to Sections 1.3 and 1.925 of the Commission's rules, 1/ hereby respectfully request that the Commission extend the waiver of the "airborne cellular rule" 2/ granted to AirCell and its partners. 3/ The Petitioners request extension of the waiver to allow them to operate the AirCell system: (1) indefinitely or, in the alternative, for a ten-year waiver period; (2) on 19 cellular channel pairs rather than the currently authorized six pairs; and (3) on frequencies used for digital terrestrial cellular operations in addition to those used for analog terrestrial cellular operations.

1/ 47 C.F.R. §§ 1.3, 1.925.

2/ 47 C.F.R. § 22.925 ("Section 22.925" or the "airborne cellular rule").

3/ *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*, 14 FCC Rcd 806 (WTB 1998) ("*AirCell Bureau Order*"), recon. granted in part, denied in part, 14 FCC Rcd 19430 (WTB 1999) ("*AirCell Reconsideration Order*"), app. for rev. denied, 15 FCC Rcd 9622 (2000) ("*AirCell Commission Order*") (together the "*AirCell Waiver Orders*"), pet. for rev. granted in part, denied in part sub nom. *AT&T Wireless Svcs., Inc. v. FCC*, 270 F.3d 959 (D.C. Cir. 2001), pet. for reh'g denied Jan. 29, 2002.

I. INTRODUCTION

While airborne operation of standard cellular handsets is prohibited by the airborne cellular rule, AirCell and its nearly two-dozen cellular licensee partners were granted a waiver of the rule after extensive FCC examination found that they could provide airborne cellular service by re-using terrestrial cellular spectrum in a non-interfering manner. As with the initial waiver request, this Petition meets the FCC's standard for a waiver, which holds that a rule may be waived if either unique or unusual circumstances make its application inequitable, burdensome, or contrary to the public interest, or its underlying purpose would not be served or would be frustrated by application, and a waiver would serve the public interest. ^{4/}

"Special circumstances" exist with respect to the instant request to extend the waiver because AirCell's specially designed system allows airborne cellular communications without causing harmful interference to terrestrial cellular calls, unlike airborne operation of ordinary cell phones. The FCC already verified this result with respect to AirCell's operations on analog channels and, as shown in this Petition, exhaustive testing shows that the same holds true for digital channels. The Commission therefore can extend the waiver term and authorize AirCell to operate on additional channel pairs, yet still be assured that no harmful interference will befall terrestrial cellular operations. Extending the waiver will also provide all of the many public interest benefits recognized upon grant of the initial waiver request, as well as others made possible by allowing AirCell to expand its operations.

^{4/} 47 C.F.R. § 1.925(b)(3); also *Northeast Cellular Telephone Co. v. FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990) (FCC may waive any rule for good cause where strict compliance is inconsistent with the public interest); *WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir. 1969), *cert. denied*, 409 U.S. 1027 (1972).

Thus, based on further testing and three years of real-world operating experience under the waiver, as well as increased marketplace demand, AirCell seeks extension of the waiver. Specifically, AirCell and its partners ask the Commission to:

- extend the term of the waiver, which is due to expire this June, to allow continued business planning efforts and the certainty of ongoing service to AirCell's partners, customers and potential investors, and to secure for the future the public interest benefits of AirCell's system;
- increase the number of cellular channel pairs at each base station on which AirCell is authorized to operate, to allow expanded government, public safety, and commercial airline applications; and
- remove the restriction on AirCell's operations which currently limit use to cellular channels used for terrestrial analog operations, to allow AirCell a larger potential universe of cellular channels on which to operate at each base station.

These requests are supported by the showing in this Petition, as well as findings already made by the Bureau, affirmed by the full Commission, and sustained on appeal on all but one minor technical point. ^{5/} The requests are further supported by the fact that in the many years AirCell has operated, there has been not one instance of reported interference during normal operations. AirCell recognizes that FCC action prior to the waiver's current June 9, 2002, termination date may not be possible as to the extension requests herein regarding the number of channels on which AirCell is authorized to operate and the digital exclusion. In that event, AirCell requests that the Commission expedite consideration of the petition to extend the waiver under its current terms and conditions for as long as AirCell continues to operate without causing harmful interference to terrestrial

^{5/} See *AT&T Wireless v. FCC*, *supra* note 3. The full procedural history of FCC approval of AirCell's system and grant of a waiver is set forth at Attachment A.

cellular service (or for ten years) as described below, and subsequently address the remaining requests.

II. BACKGROUND

The Commission is by now well aware of AirCell's pioneering efforts to seek innovative, lower-cost ways to meet the overwhelming demand for airborne telecommunications. AirCell's roots lie in the desire to bring the benefits of the wireless telecommunications revolution to the aviation industry, in an affordable manner not requiring the construction of expensive new networks or dedicated spectrum allocations. AirCell ultimately developed a solution with far-reaching public safety and public interest benefits.

AirCell designed a system that currently operates under the *AirCell Waiver Orders* to make use of extremely low-power terminals owned by AirCell's customers, working in conjunction with existing cellular base stations owned and operated by AirCell's partners, without causing harmful interference to terrestrial cellular calls. The system allows AirCell to leverage the existing terrestrial cellular infrastructure by deploying mobile units that rely on cellular technology, in partnership with cellular operators (particularly rural carriers), to offer a unique air-ground service. The cellular partners furnish system capacity for the provision of cellular service on a secondary, conditional basis to airborne terminal units using the AirCell-developed technology. As such, AirCell's system required neither the

allocation of scarce spectrum resources, nor grant of a license to AirCell, because AirCell is simply a facilities-based reseller of commercial mobile radio service. ^{6/}

AirCell uses a cellular mobile unit approved by the Federal Aviation Administration (“FAA”) that features special antenna and software modifications, ^{7/} in conjunction with collocated base station components at licensee partner cell sites, where AirCell customer traffic is interconnected with the public switched network. The mobile units operate at extremely low power levels relative to ground cellular phones. ^{8/} AirCell extensively tested its system to ensure its calls are virtually undetectable by terrestrial cellular base stations other than those in the AirCell system. This included not only extensive pre-waiver testing under experimental licenses, but also joint tests ordered by the Office of Engineering and Technology

^{6/} The regulatory model for AirCell is not significantly different from traditional cellular resale arrangements. See *AT&T Wireless*, 270 F.3d at 964-65 (citing *GTE Airfone*, *GTE Railfone*, and *GTE Mobilnet*, 8 FCC Rcd 6171 (1993)); cf., *Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993 (6th Annual CMRS Report)*, 16 FCC Rcd 13350, Table 9 (2001) (showing AirCell as one of the nation’s Top 20 mobile telephone resellers).

^{7/} See *infra* Attachment A, Procedural History, at 4 n.16.

^{8/} AirCell terminals function at this level due to specialized base station antennas, which can easily maintain line-of-sight connectivity with airborne phones, and several critical features built into the base station and mobile system, including up-tilted base station antennas, use of “smart” directional base station antennas where necessary, horizontal polarization, and non-standard control channels, as well as the dynamic power control (“DPC”) used by all cellular systems. See *AirCell Bureau Order*, 14 FCC Rcd at 808-09. Using DPC, cellular base stations automatically adjust mobile unit power levels to sustain call quality but avoid self-interference. If the signal is lower than the desired signal strength, DPC either attempts to raise the mobile unit’s transmitter power to improve the call quality, hands off to another cell where the signal is stronger, or maintains the call if there is no other option (with call quality degrading as signal strength fades, until the signal is so weak the call is dropped). AirCell’s DPC characteristic operates at much lower power levels than normal handsets, which allows base stations to instruct AirCell mobile units to power down to very, very low levels in view of the ease of maintaining line-of-sight connectivity. The maximum power of the mobile terminals is only 75 mW.

“OET”), 9/ held with non-participating cellular carriers AT&T Wireless Services, Inc. (“AT&T Wireless”), BellSouth Cellular Corp. (“BellSouth Cellular”), and GTE Wireless Products and Services (“GTE Wireless”). 10/

The empirical results of these tests showed conclusively that AirCell’s special combination of design features provide the required isolation and protection from terrestrial cellular frequencies, and that AirCell’s system thus does not cause harmful interference. 11/ This allowed the Commission to conclude that:

AirCell service operates at a power level and in a manner that poses little or no threat of harmful interference to primary cellular service. Indeed, the evidence indicates that the AirCell signal is undetectable in most circumstances. * * * * [T]he AirCell system . . . can operate with their corresponding ground stations without causing harmful interference to primary cellular services. 12/

The Commission also recognized that AirCell’s system provides vital public interest benefits that justify waiving the airborne cellular rule. 13/ Perhaps most tangibly, AirCell makes available life-saving and significant safety-enhancing

9/ See *infra* Attachment A, Procedural History, at 3.

10/ AirTouch Communications, Inc. also was invited to participate in the joint tests but declined to do so.

11/ See *AirCell Bureau Order*, 14 FCC Rcd at 811-12, ¶¶ 12-14. The FCC cellular rules forbid mobile licensees from causing “interference that significantly interrupts or degrades a radio service[.]” 47 C.F.R. § 22.352. Other sections of the rules define “harmful interference” as that which “seriously degrades, obstructs, or repeatedly interrupts” service. 47 C.F.R. § 2.1; see also 47 C.F.R. §§ 5.3(h), 15.3(m), 18.107(b), 21.2, 76.613(a), 97.3(a)(22), 101.3; Part 95, Subpart E, Appendix 1. This standard is important, because it does not ban all interference, but only that which has a *significant* impact on radio service, which is precisely what the Commission has found AirCell’s system does not do. See *Bureau Order*, 14 FCC Rcd at 812, ¶ 14; see also, e.g., 47 C.F.R. § 22.352(c)(2), (3), and (5) (no protection from mobile-to-mobile or mobile-to-base interference, or from anomalous or infrequent propagation modes).

12/ *AirCell Commission Order*, 15 FCC Rcd at 9628, ¶ 13.

13/ *Id.* at 9643-44, ¶ 43; *AirCell Bureau Order*, 14 FCC Rcd at 812-14, ¶¶ 15-17.

communications for aircraft used in general aviation, such that, due to relatively low cost and weight, AirCell is the first practical platform for essential safety-related data, wireless telephony, and related services. 14/ AirCell is also the first competitive alternative to 800 MHz air-ground services currently licensed by the Commission. Finally, consistent with federal policy on spectrum efficiency and flexibility, AirCell allows cellular licensees – particularly rural operators – to re-use spectrum to join in a new, innovative, revenue-generating service. 15/

AirCell's network is currently supported by 21 cellular licensees who participate actively in the AirCell service, including some of the country's premiere wireless telecommunications service providers. 16/ Four of the nations' largest

14/ AirCell's mobile terminals are much smaller than pre-existing technology, thus allowing its customers to use the system without incurring a substantial space or weight penalty. Moreover, AirCell charges its customers far less than air-ground communications currently provided on commercial aircraft.

15/ We discuss in detail at Section III.A, *infra*, the public interest benefits of the AirCell system that support extension of the waiver.

16/ A complete list of AirCell's cellular licensee partners is included as Attachment B. *See also infra*, Attachment A, Procedural History, at 6 n. 23 (listing grants of waivers to AirCell and its partners). Notably, as demonstrated in the Original Waiver Petition and the one-year reports solicited by the AirCell Order, *see infra* Attachment A at 5, these cellular licensee partners have recognized that the AirCell system does not interfere with their own terrestrial cellular systems. *See* AirCell Petition for Waiver filed October 9, 1997, at 35-37; Exhibits A-2, A-3, A-4, and A-5 ("Original Waiver Petition"); *see also* Attachment C, Cellular Licensee One-Year Reports. It should be noted that in the time since the FCC granted the original AirCell waiver, cellular licensee partner Vanguard Cellular Financial Corp. was acquired by AT&T Wireless, one of the opposing carriers that challenged the waiver, and Comcast Cellular Communications was acquired by Cingular, successor-in-interest to former opposing carriers BellSouth and SBC Wireless. These parties have ongoing contractual obligations to AirCell. AirCell expects that they will operate pursuant to those obligations and consistent with the original waiver conditions and/or any extension. These parties have informed AirCell they do not join the instant Petition. It is significant that AirCell's other cellular licensee partners that have joined this waiver extension request do so in confirmation of their belief that AirCell's system does not cause harmful interference.

wireless carriers – Alltel Communications, United States Cellular Corporation (“US Cellular”), Western Wireless Corporation (“Western Wireless”), and Centennial Communications – have agreements with AirCell, as do a number of smaller, largely rural cellular carriers. AirCell currently has 130 cell sites in operation, covering over 95% of the continental United States.

AirCell’s system is used chiefly by general aviation aircraft to receive and send voice and data communications, including up-to-the-minute weather and air traffic data. AirCell terminals safeguard lives by giving pilots real-time data that helps them avoid weather-related accidents, and they permit vastly improved air-ground communications – for the first time, small aircraft operators have access to a critical air-ground communications link for an initial investment of as little as \$2,000 plus the cost of installation. And AirCell has developed products not just for corporate jets, but equipment suitable for numerous types of aircraft, from the smallest general aviation aircraft to commercial airliners.

AirCell is, in fact, exploring the many potential uses of its technology in the commercial aviation sector. AirCell has been approached about and/or has under consideration the use of its service for such purposes as pilot-to-ground and crew-to-ground communications, real-time “black box” and aircraft systems monitoring, and cockpit and cabin video surveillance for aircraft security. AirCell is also a prime candidate to serve the communications needs of commercial aviation

passengers, which are currently unmet by the existing, expensive 800 MHz air-ground service, which is about to lose one of its two service providers. 17/

In all the years since AirCell first began testing its system under the experimental licenses, through commercial operations under the *AirCell Waiver Orders*, no one has ever identified a single concrete instance of harmful interference during normal operation of the AirCell system. The one-year reports submitted by the cellular licensee partners all confirm AirCell's system operates exactly as AirCell and its partners expected – and the FCC confirmed – it would. 18/

The FCC nevertheless acted cautiously in granting the initial AirCell waiver, in that it set a two-year waiver term, limited operations to six channel pairs at each cellular licensee partner base station, and restricted operation to only those cellular channels used for analog terrestrial service. 19/ See Attachment A for a detailed history of the Commission and court proceedings involving the AirCell Waiver. This Petition requests that the Commission extend these waiver terms, consistent with their underlying intent, to allow AirCell's system to evolve from a fledgling technology operating on a provisional basis to full commercial operation of air-ground wireless communications that promises to serve and benefit the public well into the future. Notably, AirCell proposes no other changes to the waiver's conservative operating parameters, so all of the special operating conditions established by the Commission remain intact. As shown below, the FCC can and should

17/ See Attachment D, Keith L. Alexander, *American Airlines Says "Buh-Bye" to Phones*, WASH. POST, February 6, 2002, at E1 (copy attached) ("AT&T Wireless said the company was leaving the in-flight phone business.").

18/ See *AirCell Commission Order*, 15 FCC Rcd at 9652, Special Condition 9.

19/ See Attachment A at 4-5.

grant the requested extensions consistent with the original waiver grant, the FCC's waiver standards, and the public interest.

III. EXTENDING THE WAIVER AS REQUESTED WILL SATISFY THE COMMISSION'S WAIVER STANDARDS

Extending the waiver of the airborne cellular rule as requested herein will satisfy Sections 1.3 and 1.925 of the FCC rules. ^{20/} As shown below, prolonging the duration of the AirCell waiver and allowing operation on additional channels will serve the public interest in myriad ways, and exceptional circumstances exist given AirCell's ability to expand operations without causing harmful interference to terrestrial cellular service.

A. The Commission Has Recognized, and Experience Confirms, the Many Public Interest Benefits of the AirCell System

The waiver extensions requested herein to allow expanded AirCell operations will provide both the same public interest benefits the Commission relied upon in granting the waiver, and additional public interest benefits as a result of expanded operations. Since the Commission has already found the existing public interest benefits inherent in AirCell's system sufficient to support a waiver, the fact that the requested extensions will only reinforce and enhance those benefits compels a grant of the waiver extension request. Along with this ample support for grant of the instant request, extending the waiver will also foster the provision of new public interest benefits as well.

^{20/} See *Northeast Cellular Telephone Co. v. FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990); *WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir. 1969), *cert. denied*, 409 U.S. 1027 (1972); see also 47 C.F.R. § 1.925(b)(3) (FCC may waive a rule if either underlying purpose would not be served or would be frustrated by rule's application

AirCell demonstrated in its Original Waiver Petition that its system offers unique and substantial public interest benefits. The AirCell system can save lives and thus has improved air safety by providing the first general aviation transmission facility offering real-time data on changing weather conditions, navigation, telemetry, and aircraft operations. AirCell also has introduced air-ground telecommunications to markets that were unserved or inadequately served due to weight or cost limitations of pre-existing technologies. In addition, AirCell's system advances FCC policies encouraging flexibility, re-use and efficiency in spectrum management by allowing participating cellular operators to use otherwise fallow excess spectrum and base station capacity to carry additional traffic and derive new revenue streams therefrom. ^{21/} Each of these public interest benefits is equally applicable to the instant requests for extension of the waiver of the airborne cellular rule.

AirCell's goal of improving aviation safety is an important one. In granting the waiver, the Wireless Bureau observed that:

Federal agencies . . . primarily charged with aviation safety have indicated that the availability of technology such as AirCell's would have significant public safety benefits. For example, the [NTSB] has noted that there is a lack of an economically feasible data link which precludes general aviation's in-flight access to graphic display of potential weather hazards[, and NTSB] states that the availability of a low-cost airborne cellular radio data link has the potential to reduce accidents in general aviation operations. Similarly, the [FAA] has indicated that information such as graphic weather, terminal and en-route traffic information as well as airport and runway status can be up-linked, and notes that a low cost data link for general aviation will have a

and waiver would serve the public interest, or unique or unusual circumstances make application of rule inequitable, burdensome, or contrary to public interest).

^{21/} See Original Waiver Petition at 17-39.

substantial impact on improving aviation safety. Further, the National Association of State Aviation Officials . . . agrees with the importance of improved access to in-cockpit weather, navigation and air traffic information, stating that an affordable and accurate communications and data link technology is vital to aviation safety. In light of the conclusions by these aviation safety experts, as well as other entities concerned with safety precautions for the aviation industry, the Bureau believes that the public interest supports authorizing AirCell's secondary operations. 22/

The Commission agreed, holding that "evidence indicates that the AirCell system offers public interest benefits such as safety to general aviation." 23/ It also stated "we find few viable alternatives that may provide safety-related voice communications between pilots and emergency personnel, and can be used to uplink in-cockpit, up-to-the-minute weather and air traffic information [and] potentially provide in-flight monitoring of airframe and engine operations, serving to better inform ground personnel of aircraft operations." 24/

One vital service AirCell provides its customers, under arrangements with the FAA, is a "911" service that can be used in the event of an aircraft systems failure. This feature of AirCell's service allows customers to dial 911 on their AirCell phone (which operates separately from the aircraft's radio, so it will function even if the radio is down), and have the AirCell network automatically connect the pilot to the closest Air-Route Traffic Control Center ("ARTCC") emergency operations officer. In this regard, the AirCell system can truly be a lifesaver in an emergency situation.

22/ *AirCell Bureau Order*, 14 FCC Rcd at 813, ¶ 16 (footnotes omitted).

23/ *AirCell Commission Order*, 15 FCC Rcd at 9629, ¶ 17.

24/ *Id.* at 9644, ¶ 43 (citation omitted).

In addition, AirCell has developed several innovative products for its unique airborne cellular platform. AirCell's FlightGuardian is a software package designed for Compaq handheld computers that, when used together with an AirCell transceiver, allows pilots to download current weather images. 25/ AirCell also has developed a "virtual radar" product that allows customers to use UPS Aviation software that includes moving maps and allows precise data on the aircraft's position via global positioning system ("GPS") to be used in conjunction with weather data provided through AirCell's transceivers. 26/

Similarly, AirCell's system has also fulfilled its promise – and will continue to do so under the requested waiver extensions – of bringing the public interest benefits of its unique technology to government aircraft. AirCell systems are used by a range of government users, such as state and local executive, administrative, and law enforcement agencies, 27/ as well as federal entities like the U.S. Army Special Operations Command, the U.S. Navy Engineering Logistics Group, the Tennessee Valley Authority ("TVA"), and the U.S. Bureau of Reclamation. Other potential users currently evaluating the AirCell service include the FAA, the

25/ The system relies upon Nexrad Mosaic weather images based on Data Transformation Corporation's ("DTC") Direct User Access Terminal ("DUAT") website, www.duat.com. DTC is one of two DUAT vendors that provide an FAA-approved means of obtaining a preflight briefing and filing a flight plan via the Internet or dialup.

26/ When the pilot requests weather information from a menu, the application dials the AirCell data center, which downloads and transmits radar data around the aircraft's position. Software then converts this data into a format that can be overlaid on the aircraft position, thereby providing the pilot with "virtual radar."

27/ Law enforcement agencies in New York, Florida, Pennsylvania, Missouri, Kansas, Arkansas, Indiana, and Wisconsin all use AirCell systems in their aircraft.

U.S. Coast Guard, U.S. Customs Service, U.S. Forest Services, Federal Bureau of Investigation, the U.S. Drug Enforcement Administration, and Civil Air Patrol.

Moreover, as the events of September 11, 2001, have brought new urgency to the development of communications links to commercial aircraft, AirCell intends to play a major role under the Aviation and Transportation Security Act, which includes provisions aimed at “enhanc[ing] instant communications and information between airborne passenger aircraft and appropriate individuals or facilities on the ground.” 28/ New air-ground links are being contemplated for several purposes, including wireless voice and text communications for federal applications, down-linking black-box data in emergency situations, and wireless communications for airline pilots and crew. 29/ Consistent with this intent, AirCell was selected by JetBlue Airlines to participate in the FAA’s Enhanced Aviation Security Program to test new aircraft security procedures and systems. Specifically, JetBlue selected AirCell to provide video-linking between ground security facilities and on-board cameras.

At the same time, AirCell seeks to continue its evolution into a competitive provider of air-ground service to commercial aviation passengers. The Commission’s staff have already explicitly noted that AirCell is particularly well-

28/ See S.1447, 107th Cong. § 109(a)(8).

29/ Notably, several members of Congress have recognized the potential of AirCell’s service in post-September 11 efforts, and have requested the Department of Transportation to “expeditiously evaluate” AirCell’s system in this regard. See Attachment E (Letter from Members of House Transportation and Infrastructure Committee, to Hon. Norman Y. Mineta, Secretary, Department of Transportation, Feb. 27, 2002).

sued to provide such service, 30/ and the Commission recognized, when establishing the 800 MHz air-ground service with which AirCell seeks to compete, that “only the existence of competitive terrestrial air-ground systems can produce the lowest prices and highest quality service.” 31/ Therefore, use of AirCell technology on commercial airlines will advance the public interest in fostering lower prices, more rapid deployment of advanced technologies, and improved service, convenience and productivity for travelers.

The air-ground service is currently a duopoly, 32/ and is on the verge of losing one of the two existing providers. 33/ Service from GTE Airfone, which will be the sole remaining provider, currently costs approximately \$3.99 for call set-up, plus \$3.99 per minute, 34/ prices unlikely to drop when there is only one provider left in the market. On the other hand, AirCell can provide air-ground service under the waiver for much less. This will allow passengers to send and transmit voice and data at a much lower cost. It will also likely spur greater use – and thus enhanced utilization of scarce spectrum resources – because of AirCell’s lower price, as well as

30/ *Federal Communications Commission Biennial Review 2000*, Staff Report, Appendix IV at 47 (“Another potential source of competition in the air-ground sector may be provided by AirCell, which does not operate on [air-ground] frequencies, but was granted a waiver . . . to provide air-ground service using specialized equipment that operates on cellular frequencies.”) (citations omitted).

31/ *Allocation of the 849-851/894-896 MHz Bands*, 5 FCC Rcd 3861, 3868, ¶ 61 (1990); see also *Federal Communications Commission Biennial Review 2000*, Staff Report, Appendix IV at 47.

32/ See Original Waiver Petition at 32.

33/ See *supra*, note 17 & *infra* Attachment D (Washington Post article *American Airlines Says “Buh-Bye” to Phones*).

34/ See http://www.airfone.com/airfone/general_rates.html. The net result is that the first minute of a call is a sky-high \$7.98, a price that could surely drop in the face of competition from a lower-priced service.

lower prices generated in response by any competing service providers. In the wake of September 11, it is now more important than ever that the public feel connected with – and are able to make calls to – contacts on the ground.

Finally, by extending the AirCell waiver as requested in this Petition, the Commission will ensure the continued efficient re-use of cellular spectrum. The cellular licensees operating in rural areas with which AirCell typically partners often have excess capacity on their systems, which means that these scarce spectrum resources are being underutilized. In addition, for smaller cellular licensee partners, the ability to offer AirCell service brings in valuable additional revenue, which can be used to expand and improve the licensees' networks for providing traditional cellular service. Allowing AirCell to expand its services, which can only occur through grant of the requested waiver extensions, will further advance the public interest in both greater use of scarce spectrum resources, 35/ and additional revenue streams for small businesses providing cellular service in rural areas.

B. AirCell's Ability to Operate Without Causing Harmful Interference to Terrestrial Cellular Communications Constitutes Special Circumstances Justifying Extension of the Waiver

It is now well-settled that AirCell operations that do not cause harmful interference to terrestrial cellular service constitute special circumstances that support waivers of the airborne cellular rule. The Commission has already found

35/ The Commission has pointedly recognized the high value of efficient re-use of scarce spectrum resources. See, e.g., *Nextel Communications, Inc., Request for Waiver to Operate 800 MHz Canadian Primary Frequencies in U.S./Canadian Border Area Region 3 on a Secondary Basis*, 16 FCC Rcd 7892, 7896, ¶ 8 (2001) (finding Nextel's waiver petition to permit use of the requested frequencies "on a secondary basis will promote spectrum-efficient, seamless frequency re-use . . . and [as such] a waiver is warranted in the public interest.").

that AirCell's system does not cause harmful interference to analog terrestrial cellular communications, and real-world experience has reaffirmed that conclusion, as demonstrated below. In addition, extensive testing by AirCell confirms that its system will not cause harmful interference to digital terrestrial cellular communications, nor would extending the waiver term or allowing AirCell to operate on additional channel pairs. Thus, the waiver extensions requested in this Petition satisfy the exceptional circumstances prong of the FCC waiver standard.

1. The Prior FCC Finding of No Harmful Interference Supports Extending the Waiver Period and Permitting AirCell to Operate on Additional Analog Terrestrial Cellular Channels

The Commission has already found that, unlike standard airborne cellular operations, AirCell technology does not cause harmful interference to analog terrestrial cellular operations. ^{36/} The Commission based this finding on the results of extensive testing and agency proceedings that included analysis by OET, the Wireless Bureau and the full Commission, and review of that process by the D.C. Circuit. Thus, as the Commission has already concluded, the purpose of the airborne cellular rule would not be undermined by allowing AirCell to operate. ^{37/} The purpose of the rule is to avoid the potential for harmful interference posed by airborne use of ordinary cellular phones. This potential derives from an enhanced transmitting range due to elevation-based increases in propagation associated with line-of-sight, combined with frequency reuse, a key technical feature of cellular

^{36/} *AirCell Commission Order*, 15 FCC Rcd at 9629-32, ¶¶ 18-21.

^{37/} *Id.* at 9629, ¶ 17.

networks. 38/ However, the special design features of the AirCell system, along with the special conditions imposed by the *AirCell Waiver Order*, protect against these effects and therefore prevent harmful interference. Such non-interfering operation, the Commission held, constitutes “unique circumstances . . . that justify the grant of a waiver of Section 22.295,” 39/ and this supports both the original waiver and the extensions requested herein.

The non-interfering nature of AirCell’s system has been thoroughly examined and confirmed. As the Commission held, “the Bureau based the waiver on careful examination of the technical design of the AirCell system and analysis of its potential effects on cellular services offered by other carriers” and properly crafted the waiver “to offer non-participating licensees adequate, indeed redundant, interference protection.” 40/ Notably, the two crucial points of redundant protection

38/ *AirCell Bureau Order*, 8 FCC Rcd at 810-11, ¶ 11 (citing *Airborne Use of Cellular Telephones and the Use of Cell Enhancers in the Domestic Public Cellular Radio Service*, 7 FCC Rcd 23 (1991) (“*Airborne Use of Cellular Telephones*”). The Bureau rejected the opposing carriers’ contention that Section 22.925 is aimed at prohibiting not just interference that is defined as “harmful” but all interference, noting that the FCC rules specify the type of interference prohibited as that which “seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service.” *Id.* at 810 n.21 (citing *Airborne Use of Cellular Telephones*, 7 FCC Rcd at 23, ¶ 5; 47 C.F.R. §§ 2.1, 22.352).

39/ *See AirCell Commission Order*, 15 FCC Rcd at 9629, ¶ 17.

40/ *Id.*; *see also id.* at 9630 n.60 (“AirCell chose a ‘worst case’ scenario for site location, *i.e.*, the tests were conducted in a rural area where there was no urban noise to mask the AirCell signal, . . . the AirCell airborne mobile unit was close to the ‘victim’ site and far from the AirCell partner site, . . . [and] the mobile ha[d] to emit its highest power level in order to reach its partner site. Even under this configuration, the data . . . show [] there is little likelihood of harmful interference.”).

the Commission cited – the AirCell system’s secondary status and a notification procedure to non-participating carriers 41/ – are not implicated by this Petition.

AirCell’s satisfaction of the FCC waiver standard, its experience over the initial two-year waiver term, and the one-year reports submitted by AirCell’s cellular licensee partners all favor extending the waiver. The purpose of the initial waiver’s two-year limit was to protect against what the Commission called “substantial uncertainties” of AirCell’s novel technology. Any “uncertainty,” however, has now been dispelled through a “reasonable period of actual operation,” as contemplated by the limitation. 42/ As noted above, even after commencement of commercial operations, there continue to be no reports of harmful interference, as AirCell, its partners and the Commission all predicted. Moreover, none of the carriers that opposed the Original Waiver Petition have brought to the Commission any complaints or evidence of interference from AirCell’s system. Clearly this experience supports extension of the waiver.

The one-year filings by AirCell’s cellular licensee partners, which all report interference-free airborne operations, support this outcome. For example, US Cellular reports that:

USCC has neither recorded any incidents of interference owing to AirCell transmissions nor have such incidents been reported to USCC by neighboring carriers. In short,

41/ *Id.* at 9629, ¶ 17.

42/ *AirCell Commission Order*, 15 FCC Rcd at 9646, ¶ 46; *see also AirCell Bureau Order*, 14 FCC Rcd at 819 (“after some operating experience is gained, [we] will be able to determine whether an extension of this waiver authority is warranted”).

insofar as USCC has knowledge of its operations,
AirCell's system has worked as it is intended[.] 43/

Altogether, all cellular providers with a potential interest in reporting incidents of harmful interference from AirCell's operations have indicated that there is no evidence of harmful interference from AirCell's system, or have filed no complaints or allegations of such interference.

Finally, it is clear that extending the waiver term will not impact AirCell's ability to operate without causing harmful interference, and allowing AirCell to operate on additional channel pairs at each ground station will likewise not result in harmful interference to terrestrial cellular service. AirCell's system will not cause harmful interference to terrestrial cellular service, regardless of whether it operates on one channel pair, six channel pairs, or a hundred channel pairs. Moreover, there are hundreds of channels in each cellular market. 44/ Increasing the number of channel pairs on which AirCell is authorized to operate from six to 19 will still result in AirCell's use of only a handful of the available

43/ Letter from Peter M. Conolly, Counsel for US Cellular, to Magalie Roman Salas, Secretary, FCC (June 14, 2001); *see also* Letter from Gene DeJordy, Vice President, Regulatory Affairs, to Magalie Roman Salas (July 5, 2001) ("Western Wireless has received no interference complaints from its customers or neighboring cellular providers, nor have there been any harmful interference incidents related to these operations. Western Wireless's customers remain satisfied with their high quality of terrestrial mobile services[.]"); Letter from David Carter, Director, RF Engineering, Centennial Communications, to Magalie Roman Salas (June 14, 2001) ("Centennial has not received any complaints of interference to either our own network or the networks of neighboring providers. Centennial's monitoring of the AirCell system has not noted any problems with its performance or with its impact on our ground based services"); Letter from James Lienau, Vice President of Corporate Technical Services, New-Cell, Inc., dba CellCom, to Magalie Roman Salas (June 11, 2001) (same). All one-year reports filed by AirCell's cellular licensee partners pursuant to Special Condition 9 of the *AirCell Bureau Order* and *AirCell Commission Order* are attached hereto as Attachment C.

channels, as was the case when the Commission granted the initial waiver. 45/ Thus, extending both the duration of the waiver and the number of channels it authorizes satisfies the special circumstances prong of the FCC waiver standard.

2. Additional Tests Support Extending the Waiver to Allow Operation on Digital Terrestrial Cellular Channels

AirCell has successfully concluded extensive tests showing that the same special circumstance supporting a waiver of the airborne cellular rule for AirCell operation on analog cellular channels – absence of harmful interference from AirCell’s system – applies equally to channels used for terrestrial digital cellular service. When the Wireless Bureau imposed the digital exclusion, it noted that “it is possible that the AirCell system does not interfere with digital cellular systems.” 46/ The restriction was imposed only because the Wireless Bureau could not make a definitive conclusion to this effect based on the then-current record. 47/ As shown below, further testing confirms that the Bureau’s supposition was correct.

AirCell conducted many weeks of tests, which were preceded by months of preparation, to evaluate the potential for co-channel interference on operational

44/ See 47 C.F.R. § 22.905.

45/ *AirCell Commission Order*, 15 FCC Rcd at 9652 (Special Condition 6). It should be noted that AirCell does not intend to install 19 channel pairs at each and every site. However, AirCell and its cellular licensee partners need FCC authorization to install as many as 19 channel pairs at any site, at their discretion, to match network capacity to demand, as is done for terrestrial cellular. AirCell and its partners will, of course, use only as many channels (up to 19) at each base station as customer demand for AirCell’s service warrants. Thus, if the demand does not continue to grow as AirCell anticipates (as described herein), its channel needs – and usage – will not vary significantly from present. If the demand does increase, however, it will not only trigger the need for authorization to operate on up to 19 channels, it will demonstrate the substantial public interest and demand in AirCell’s system being allowed to do so.

46/ *AirCell Bureau Order*, 14 FCC Rcd at 817.

TDMA and CDMA digital cell sites. AirCell's tests were extremely well-designed and thorough, having been designed by two separate engineering consulting firms. 48/ A conservative approach was taken wherever the opportunity to do so was presented. As reflected in the AirCell Cross-Technology Interference Test, AirCell/TDMA Compatibility Test and AirCell/CDMA Compatibility Test reports appended to this Petition as Attachment H and summarized in this section ("Digital Test Report"), the tests conclusively demonstrate that the likelihood of harmful interference to terrestrial digital service from the AirCell system is *even less* than in the case of terrestrial analog cellular service. These test results provide sufficient record information to allow the Wireless Bureau to conclude that use of AirCell's technology on digital channels will not cause interference and, as such, to find that special circumstances justify extending the waiver to allow AirCell operations on digital cellular channels. 49/

a. TDMA-CDMA Test: Introduction

The Digital Test Report sets forth the results of AirCell's extensive testing of its system to show that it will not cause harmful interference to terrestrial

47/ *AirCell Recon. Order*, 14 FCC Rcd at 18435.

48/ Two additional independent experts have reviewed the test results and reports, and have confirmed the efficacy of the tests, the reliability of the results, and the soundness of the conclusion that operation of AirCell's system will not cause harmful interference to TDMA or CDMA terrestrial cellular service, the predominant technologies for terrestrial digital cellular operations. See Attachment F (Affidavit of Herbert C. Harris); Attachment G (Affidavit of Mehran Nazari). Also included at Attachment G is a letter from Agilent Technologies to Mr. Nazari confirming the accuracy of the equipment used to take measurements during the test of AirCell's system.

49/ Cellular licensee partner Western Wireless does not join this Section III.B.2 of the instant Petition for Extension of Waiver, as its review of the Digital Test Report was still ongoing at the time of filing.

digital service. Appendix I, entitled, "AirCell Cross-Technology Interference Test," provides a relatively short but comprehensive overview of the detailed reports found in Appendices II and III. Appendices II and III provide detailed information regarding the steps and procedures used in gathering data for evaluation, as well as comprehensive analyses of AirCell airborne AMPS operations on TDMA (IS-136) and CDMA (IS-95), respectively. Appendices II and III were prepared by Wireless Systems Engineering, Inc. ("WSE"), whom AirCell contracted to determine whether AirCell's AMPS signals would cause interference to TDMA and/or CDMA cellular operations.

As part of the tests on TDMA and CDMA operations, WSE utilized the airborne data that was collected in 1997 in support of the previous AirCell waiver. That data provided hours of airborne measurements taken at different heights, altitudes and distances from the base station used to collect the data. The decision to utilize the 1997 data was based upon the fact that the companies that opposed AirCell operations were allowed to witness those tests, along with FCC staff, 50/ and the data formed part of the basis for the grant of AirCell's current waiver.

The test procedures set forth in Appendix II and III were designed by AirCell and WSE, with the primary objective being to measure the effects of AirCell's airborne AMPS signals on the reverse channel of digital terrestrial systems. Great care was taken in designing the test to guarantee the accuracy of the test measurement data, as well as to ensure the tests bore repeatable results. Significant efforts were taken to measure and document all facets of the test, to utilize

50/ See Attachment A, Procedural History, at 1-2.

quality laboratory test equipment and maintain a laboratory environment wherever possible, and to record and account for all losses introduced by the test setup. AirCell also drew upon industry leaders to review and comment on the test procedures. The test results, as summarized below, show there will be no harmful interference to either TDMA or CDMA operations from AirCell's airborne AMPS operations.

b. TDMA Tests

The TDMA tests were run at a "typical" rural cellular facility operated by US Cellular. The site, identified by US Cellular as "Lena," is located in north-west Illinois. Nortel Networks manufactured the cellular base station equipment deployed at the Lena site. No alterations were made to this equipment. From this location US Cellular provides analog and TDMA digital service to its subscriber and roamer traffic. Site operating parameters were measured, and actual versus theoretical coverage from Lena was compared prior to commencing the tests in order to document "normal" operation from the site. The site was found to be operating properly with coverage being "as expected."

The tests employed a methodology designed to overstate the risk of interference that AirCell may cause TDMA systems. ^{51/} First, the AMPS signal used was modulated with a supervisory audio tone ("SAT") in order to produce the

^{51/} The test configuration is explained in greater detail in the WSE Report (Appendix II) and depicted in Figure 3.1 of that Report, and used the following equipment: a Hewlett/Packard Signal Generator, Model HP8656, which modulated and supplied the AMPS test signal (the "interferer"), a Noise/Com Precision Noise Generator, Model PNG7112, which simulated background noise, a HP8921A Test Set with HP83204A TDMA adapter, which supplied the TDMA signal, a Directional Coupler, Model HP778, which accepted on one input the TDMA signal and the interferer and noise on the second input, and then fed the output to the receiver port of the Nortel Base Transceiver System ("BTS"). Visual confirmation of operation was observed on a HP8591 that was left on and monitored during data collection.

most disruptive interferer, even though a signal from a “real world” AMPS interferer would be expected to be less disruptive.

Second, the test used a more stringent Bit Error Rate than necessary. Bit Error Rate (“BER”) is a common metric used in IS-136 TDMA cellular operations to judge call quality and system performance. In the TDMA Report, WSE states that the IS-641 Algebraic Code Excited Linear Predictive (“ACELP”) vocoder used in today’s IS-136 TDMA phones provides good speech quality in systems using a 2% to 3% BER design goal. It further states that “TDMA cellular carriers have, both in published papers and in the direct experience of the authors, consistently adopted a 2% BER as their system performance target.” 52/ Significantly, “[t]his is a bit more stringent than the 3% BER that EIA standards imply to be adequate. . . . Therefore, for the purposes of this test, AirCell considered 0-2% BER as the target for ‘good’ voice quality during calls.” 53/

Third, other assumptions and equipment used in the tests were designed to increase substantially the likelihood of potential airborne AMPS interference to TDMA in order to make the test results extremely conservative, as detailed in the Report. For example, cell site loading was 10 times higher than expected for a mature system, DPC was de-activated so that it could not be used to overcome an interfering signal and improve BER, and all AirCell “subscribers” were assumed to fly directly over a co-channel terrestrial site.

Subject to these assumptions, and in order to simulate the BER “control” baseline under conditions without AirCell operations, WSE evaluated a TDMA signal

52/ WSE Report at 9, ¶ 5.

as it would be expected to occur in four (4) environments, (*i.e.*, rural, suburban, urban and dense urban, which respectively were represented by a -118, -115, -107, and -100 dBm noise floor, as used in the 1997 filing). The noise floor associated with each environment was simulated using a wideband noise generator, and a TDMA signal was applied and increased, in one dB increments. The resulting BERs were recorded. An AMPS interferer was then injected and the BERs were once again recorded over a full range of TDMA signals. Testers then increased the AMPS interferer and again recorded BERs over a full range of TDMA signal levels. This procedure was repeated until there was a full matrix of “static” data for analysis.

After the data for each of the four simulated environments as well as “real world” TDMA subscriber call data were collected, 54/ testers ran computer simulations using the 1997 AirCell flight data and assessed interference potential (Appendix II, Section 5 & 6). Figure 8, taken from Appendix I, is included here to offer a visual representation of the impact of an AirCell interferer on a TDMA call.

53/ *Id.*

54/ As part of the test, BER was measured for reverse signal data over a 24-hour period, which was intended to characterize TDMA signals in a rural environment. (The received signal histogram from these measurements can be seen in Figure 2.5 of Appendix II.) Although the “static” data shows the absolute best performance of the receiver to yield a BER of approximately 2% at -109 dBm, the real world data collected would suggest this operating point to be 5 to 9 dB higher.

AirCell Airborne Flight Data Comparison with TDMA Cell Data

All Altitudes, All Flights-All Sites
All Serving Antennas
All Receiving Antennas
July 10, 1997 DPC-on
Red Bar Graph

← Compared
to

Rural IS-136 TDMA ITL**
TDMA Cell Site tests
May 2000*
1 AMPS Interferer
1 TDMA Call

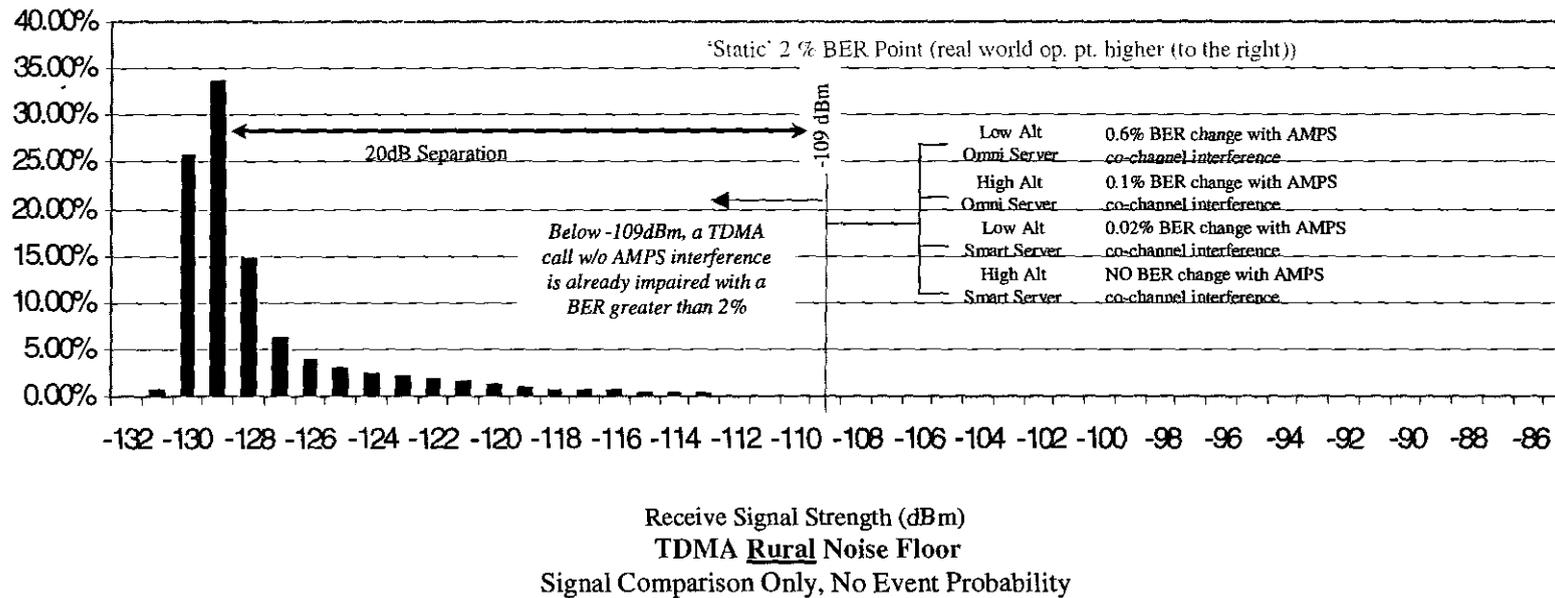


Figure 8

Plot Notes: Worst case configuration:

1. Aircraft at maximum range from AirCell serving cell (74 miles).
2. Aircraft directly over flies Madill site and Waurika site.
3. Aircraft signal measurement made in extremely low N + I Environment.
4. Non-fading environment tested (TDMA call maintained at minimum transmit power level).
5. AirCell simulated interference with SAT only modulation (worst case interference impact on TDMA modulation).

* Reference Tables 5.10—5.13
 WSE TDMA Report, Filed February 2002

** ITL = Interference Threshold Level

This case illustrates the “static” performance of a TDMA base station with a rural noise floor and does not include any event probability. The bar graph displays the AirCell data and signal strengths in relation to the Interference Threshold Level (“ITL”) of the TDMA call. Significantly, the “real world” TDMA call data would move this operating point further to the right and thereby reduce the impact of the AirCell signal even further. As shown here, even the worst case condition of an aircraft flying at low altitude with the AirCell base station utilizing an omnidirectional antenna produces an insignificant change in BER of 0.6%.

In the interest of brevity, we have included this one figure only. However, as the figure illustrates the environment in which airborne AMPS signals would have the most likelihood of effecting TDMA calls, and as the AMPS interferer has a mean signal level of only -129.6 dBm and is below -121 dBm virtually all (97 percent) of the time, it is clear that AirCell operations will have no discernible effect on a terrestrial TDMA call. ^{55/} Moreover, given the statistical probabilities of terrestrial call distribution, AirCell traffic loading (the test assumed, again for worst case scenario purposes, a load equal to 10 times the projection for a mature system), the aircraft being within 10 miles of the terrestrial site, and the assumption of co-channel operation, there is a projected BER impact of approximately 0.000041 percent, or less than one-ten thousandth of a percent. See Appendix I, Table 3.

Even when using the perfect “static” TDMA comparison against the AirCell 1997 Acceptance Flight Test Data, the change in BER caused by the AirCell signal is completely insignificant. In this assessment, actual AirCell flight data

was compared to logged actual TDMA 24+ hour call data, and Event Probabilities were included to determine the “Composite Probability” of harmful interference being caused by the analog AirCell signal to a TDMA digital terrestrial operation. The reported results conclusively show no material impact on terrestrial TDMA operations from airborne AMPS operations.

c. CDMA Test

Similar to the TDMA tests, the CDMA tests were conducted at a “typical” rural cellular facility. The cellular base station equipment manufacturer was Lucent Technologies. The particular test site consisted of a tri-sector equipped base station with two sectors active, which left one remaining sector available for AirCell's CDMA tests. 56/

The very nature of a CDMA system requires it to tolerate its own self-generated interference that increases with subscriber load. As subscriber load fluctuates, CDMA cell sites “breathe,” *i.e.*, the effective service area increases or decreases depending on system load – essentially, the permissible path loss between the cell site and subscriber changes. Accordingly, CDMA cells traditionally employ prudent guidelines for capacity, interference, and expected path loss in order to deliver a certain capacity under certain interference conditions with certain

55/ See Appendix I, Figures 9-11 for illustrations of the impact of airborne AMPS on TDMA calls in other environments.

56/ The test used the following equipment: 12 QCP-820 CDMA handsets mounted in RF shielded enclosures powered by 12V 10AH gel cell cells (10 instrumented, 2 for traffic loading only); 3 HP-8648D signal generators and associated control PCs used for the narrowband interference sources; 1 Noise/Com PNG 7112 generator used as a source of random background noise; 2 HP-8594E Spectrum Analyzers; and SAFECO Walkabout data collection computers. Lucent Autoplex Call Trace Data. See WSE Report, Figure 3.1 for a complete summary of the facility's test configuration.

path loss characteristics. Once these conditions are exceeded, service can be degraded and calls may even be dropped.

Here, the intended assessment of the interference impact of AirCell operations on the path from the handset to a CDMA base station required three components: (1) a theoretical calculation that estimates the effect of AMPS signals on the CDMA self-generated noise floor; (2) empirical analysis and proof of this theoretical formula in “real-world” conditions; and (3) comprehensive statistical assessment of the likelihood that an AirCell AMPS signal would be present at a sufficient magnitude to cause any noticeable interference to a CDMA system. (Although an interference evaluation of a CDMA system typically looks to three critical metrics – (1) Frame Erasure Rate (“FER”); (2) the ratio of bit energy on the traffic channel to cumulative noise plus interference (Energy per bit/Noise, or “Eb/No”); and (3) CDMA handset transmitter power – only the last is a useful measure in this context because the tested mobile station had additional transmitter power available and CDMA power control algorithms would increase the power to keep the FER and Eb/No within carrier-specified limits to the extent possible under all loading scenarios evaluated.)

As with the tests of TDMA systems, AirCell adopted a test design that overstated the risk of interference caused by its proposed operations. First, AirCell chose a SAT modulated interferer, which resulted in an increased power spectral density, thereby increasing the interference potential to the CDMA system. Second, much of the data collected involves interference sources substantially stronger than what would be experienced during normal AirCell operations. Third, forward link values were maintained at higher than expected Eb/No levels in order to eliminate

any downlink influence that might affect the data. Thus, any forward link power limitations attributed to cell loading were essentially eliminated. Fourth, channel fading characteristics were not simulated in the collected data. Fifth, any benefits to the robustness of the CDMA system from the use of soft or softer handoff techniques were not considered in the analysis.

The fourth and fifth points merit further explanation. In normal system operations, particularly at the uplink receive levels monitored during the tests, typical channel fading characteristics could cause the call to drop, or to have been significantly degraded, before any impact from the AirCell analog operation would be experienced. For example, in the rural case without the presence of AirCell operations or other potential interference sources beyond the environmental noise and interference generated by the CDMA system itself, calls begin to significantly degrade in the presence of 140-141 dB of path loss for all loading conditions. See Appendix III, Figures D.7 through D.12. At this path loss, the handset is powered up to its maximum transmitter power of 23 dBm in an attempt to sustain the call, which results in corresponding E_b/N_0 values in the range of 1 to 2 dB. The primary way to improve the signal energy to noise value (or, alternatively, to increase the acceptable level of path loss), is to reduce the number of calls in a particular cell. From a calculated theoretical link budget (see Table 1), which matches the test conditions in Appendix III, a targeted 2 dB E_b/N_0 with one call would yield a 141.3 dB allowable path loss while twelve calls would yield an allowable path loss of 140.3 dB. This calculated result agrees closely with the measured results in Appendix III.

Of course, real-world CDMA systems often seek to achieve E_b/N_0 values of around 7 dB to assure reliable calls, a demarcation point that is of significantly higher quality than what the equipment actually can sustain. Given the same link budget using a 7 dB E_b/N_0 assumption, the allowable path loss drops to 136.2 dB for a single call and 131.7 dB for twelve calls. If these path loss values are not exceeded for this rural case, FER remains at zero percent and all calls remain in progress even in the presence of a 2 dB pathological interferer. ^{57/}

Transmitter Power	23.00	23.00	23.00	23.00	dBm
Environmental Noise Density	-162.00	-162.00	-162.00	-162.00	dBm/Hz
Mean voice activity factor	1.00	1.00	1.00	1.00	
Cell interference factor	0.00	0.00	0.00	0.00	
Data rate of traffic channel	14400	14400	14400	14400	bps
System Bandwidth	1.2288	1.2288	1.2288	1.2288	MHz
Processing Gain	19.31	19.31	19.31	19.31	dB
Required E_b/N_0	2.00	2.00	7.00	7.00	dB
Pole point of sector	54.84	54.84	18.03	18.03	
Number of users per sector	1	12	1	12	
Receiver Interference Margin	0.08	1.07	0.25	4.76	dB
Total Effective Noise plus Interference Density	-161.92	-160.93	-161.75	-157.24	dBm/Hz
Information Rate - $10\log R$	41.58	41.58	41.58	41.58	dB
Receiver Sensitivity	-118.34	-117.34	-113.17	-108.66	dBm
Maximum Path Loss	141.34	140.34	136.17	131.66	dB

Table 1: Theoretical Link Budget

Additionally, by not simulating call fading characteristics, the AirCell tests included calls with extreme path loss values that would, in a real system, have been dropped or degraded already, regardless of the presence of AirCell's operations.

Likewise, by failing to simulate the benefits of a soft or softer handoff function, which is a key (and common) operational criterion to a successful CDMA

^{57/} It should be noted that the 2 dB impact cases set forth in the report were largely for academic purposes to gauge the viability of the theoretical calculations on how an AMPS interferer would impact a CDMA call since the interference levels required to perturb the CDMA noise floor were far in excess of those present during normal AirCell operations.

system, the potential for interference was not diminished by the presence of multiple serving cells each with potentially higher path loss characteristics to the subject AirCell interference source and lower path loss characteristics to the CDMA subscriber handset, which otherwise could reduce degradation or interference. As an example, referencing the WSE Report, AMPS interference levels for the rural case were evaluated at -114.9 dBm and -108.1 dBm (assuming *three* simultaneous AMPS interferers existed at the same time at the same level, an extremely unlikely event in itself). These interference levels produced a measured CDMA impact of 0.2 dB and 1.8 dB, respectively, at the relevant handset when a *single* CDMA call was in progress. However, the mean for measured AirCell signals operating in a rural environment actually were -129.6 dBm (as measured in the 1997 flight data), which is lower by 14 to 21 dB from the interference levels that were evaluated in the Report. In other words, the experimental results assumed an interference level far in excess of a typical AirCell call signal strength. Assuming all three AirCell AMPS “interferers” were operating at these elevated levels would only further exaggerate the expected impact.

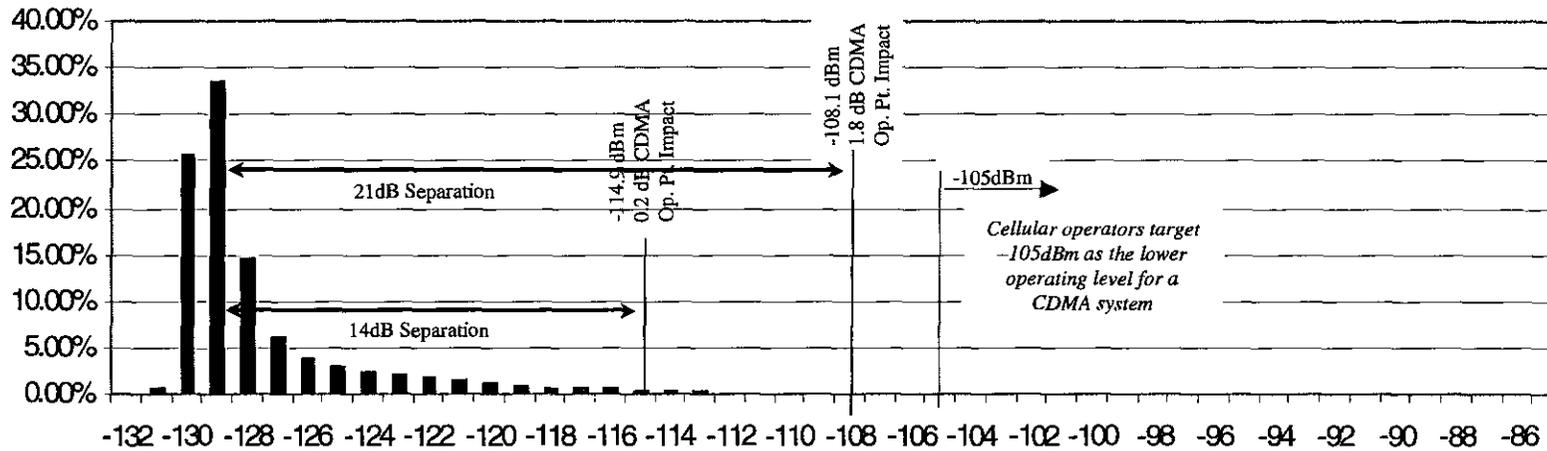
Despite such conservative methodology, the test results indicate that AirCell operations should not pose a material risk of interference to CDMA systems. Even the interference case that was 21 dB worse than the typical AirCell signal resulted in only a limited (0.2 dB) affect when the cell became loaded with a total of twelve CDMA calls. To illustrate the above analysis, Figure 4 from Appendix I is included below. Similar results were found in the other environments evaluated. See Appendix I, Figures 5-7.

AirCell Airborne Flight Data Comparison with CDMA Cell Data

All Altitudes, All Flights-All Sites
All Serving Antennas
All Receiving Antennas
July 10, 1997 DPC-on
Red Bar Graph

← Compared
to

Rural IS-95 CDMA ITL**
CDMA Cell Site tests
January 2001*
3 AMPS Interferers
1 CDMA Call



Receive Signal Strength (dBm)
CDMA Rural Noise Floor
 Signal Comparison Only, No Event Probability

Figure 4

Plot Notes: Worst case configuration:

1. Aircraft at maximum range from AirCell serving cell (74 miles).
2. Aircraft directly over flies Madill site and Waurika site.
3. Aircraft signal measurement made in extremely low N + I Environment.
4. Only one CDMA call in place (no CDMA self-interference).
5. Three simultaneous AirCell interferences (simulated).

* Reference Tables 3.1 and 5.1
 WSE CDMA Report, Filed February 2002

** ITL = Interference Threshold Level

Essentially, the CDMA system itself masked the effect of an already exaggerated interference case through its own self-generated interference as it became loaded with terrestrial traffic. In fact, the statistical analysis completed by WSE concludes that, as a result of AirCell operations:

The probability of reaching 0.5 dB impact [on a CDMA system] is between zero and 2.7×10^{-6} during any 2 second period of a typical terrestrial CDMA call, regardless of aircraft altitude, terrestrial CDMA site polarization, or AirCell serving site antenna configuration. 58/

WSE further states:

When AirCell subscribers are operating at high altitude, the probability of reaching a 2 dB impact is zero, unless the CDMA site uses horizontal polarization; then the probability is less than one in a million during any 2 second period of a typical CDMA call.

Figure 4, which is taken from Appendix I, is included here to provide a simple visual representation of the impact of an AirCell interferer on a CDMA call. 59/

In light of the foregoing, it is extremely unlikely that normal operation of the AirCell system will result in harmful co-channel interference to a terrestrial based CDMA call.

3. Conclusion

The Digital Test Report conclusively demonstrates the AirCell system poses an even lower likelihood of interference to terrestrial digital signals than to terrestrial analog signals. Moreover, as with the tests relied upon in the *AirCell Waiver Orders*, it shows that AirCell's system will not cause *any* harmful interference

58/ Appendix III at 68.

to terrestrial digital cellular operation. The Commission has already concluded that such a showing suffices as special circumstances justifying a waiver of the airborne cellular rule. ^{60/} As such, given the public interest benefits of the AirCell system outlined above, the Commission should extend the AirCell waiver to allow it to operate on cellular channels used for digital terrestrial service.

IV. EXTENDING THE WAIVER IS NECESSARY TO FACILITATE CONTINUATION OF THE PUBLIC BENEFITS INHERENT IN AIRCELL'S SYSTEM

The Commission should grant the waiver extensions requested herein to allow AirCell to expand its operations and build on the public interest benefits of its unique air-ground system. AirCell is in the process of expanding its operations and exploring new applications for its technology. At the same time, the demand for its service is significant and increasing. AirCell already has installed its system on hundreds of aircraft. The system is in use by numerous federal and state government entities, and by the private sector as well, including both business and personal users. AirCell projects that, barring regulatory impediments, its service will grow substantially over the next several years. AirCell's use projections include not only safety-enhancing service to general aviation, but also public safety, security and telecommunications applications, including use on commercial aircraft.

In view of AirCell's success, however, the short duration of the waiver and the two channel-related limitations threaten AirCell's continued vitality. The

^{59/} See Appendix I, Figures 9-11 for illustrations of the impact of airborne AMPS on CDMA calls in other environments.

^{60/} E.g., *AirCell Commission Order*, 15 FCC Rcd at 9629-32, ¶¶ 17-21.

waiver's two-year term, set to expire shortly on June 9, 2002, 61/ and the limited number of channels on which AirCell is authorized to operate, are both tight constraints on AirCell's efforts. As to the latter, AirCell is limited both by the restriction of its operations to no more than six channel pairs per base station, 62/ and the prohibition against operating on cellular channels used for terrestrial digital service. 63/ Notably, none of these limitations are among the special conditions which ensure that AirCell does not cause harmful interference to terrestrial cellular service. As such, the Commission has ample flexibility to extend the waiver to alleviate these constraints, consistent with AirCell's needs and the public interest benefits fostered by its service.

A. The Duration of the Waiver Directly Impacts the Business Planning Necessary for Continued AirCell Operations

The Commission should extend the waiver term to allow AirCell to feasibly continue commercial operations in the public interest. The FCC waived the airborne cellular rule for AirCell and its cellular licensee partners because AirCell demonstrated that it could become a viable provider of specialized cellular services. Real-world experience shows that the AirCell system delivers as promised: general aviation aircraft now have real-time access to critical flight-safety information; government agencies now have new options for vital air-ground communications; business travelers can now enjoy increased productivity while airborne; and there

61/ See *id.*, 15 FCC Rcd at 9646, 9652, ¶ 46 & Appendix, Special Condition 9.

62/ *Id.* at 9652, Appendix, Special Condition 6 (“Each ground station may use no more than six paired channels . . .”).

have been no reported instances of harmful interference from properly operating AirCell units.

For AirCell to continue offering its service and the related public interest benefits, the waiver term must extend sufficiently into the future to allow AirCell to engage in business, financial, and operational planning, as well as other efforts. Both the current general aviation uses and future commercial aviation applications of AirCell's system require that it be authorized to operate well into the future. Existing customers, as well as prospective customers weighing the purchase of AirCell equipment and signing up for service, need assurances they are not investing in an offering or technology that has only a limited lifespan.

For general aviation, AirCell's mobile terminals and the associated equipment require an outlay of only a fraction of what existing 800 MHz air-ground systems cost, yet such purchases still represent a significant investment by aircraft owners. In addition, once a customer installs AirCell equipment, any switch to another communications option necessitated by expiration of the waiver will entail changeover costs. Thus, even though AirCell service promises clear and abundant safety-enhancing – and potentially life-saving – benefits, aircraft owners need assurances that those benefits will be available for a meaningful period of time.

The longer the duration of the AirCell waiver, the more likely it is that aircraft owners will invest in AirCell's safety-enhancing system. Since initial grant of the waiver, AirCell has installed its system on hundreds of aircraft. AirCell's

^{63/} *Id.*, Appendix, Special Condition 7 (“Channels that may be used at each ground station are limited to those that either are [unused or] used . . . to provide compatible analog cellular service . . .”).

customers include large corporations, 64/ institutional users, 65/ and individual consumers. As noted, AirCell's service is also used by a range of government users. 66/ Extending the waiver for a significant period is critical to provide certainty to each of these classes of AirCell customers.

The certainty afforded by extension of the waiver is also critical in the commercial aviation context. AirCell technology lends itself to a host of beneficial commercial aviation uses that will advance the public interest. Specifically, along with the same safety-enhancing functions found in general aviation, AirCell service can provide pilot-to-ground and crew-to-ground communications, real-time aircraft systems monitoring, and cockpit and cabin video surveillance for security purposes. And, of course, as discussed above, AirCell can not only serve the communications needs of commercial aviation passengers, it can do so in a manner that will allow less expensive – and thus likely more frequent – use by the public. Extension of the waiver term is thus necessary to allow airlines to explore and deploy these options.

AirCell's viability as an ongoing commercial concern, and therefore its ability to provide continued and expanded service in the public interest, is gravely limited so long as it faces imminent termination of its authority to operate. In order to engage in business planning efforts and meaningfully negotiate and enter agreements with investors, vendors, customers, affiliates and potential cellular licensee

64/ AirCell's corporate customers include, among many others, Boeing, Con Agra, Cargill, Northrup Grumman, Chevron, and United Parcel Service ("UPS") Aviation.

65/ Rapid City's (South Dakota) Regional Lifeflight air ambulance, the University of Nebraska flight department, and the Choctaw and Seminole Indian reservations all use AirCell's system.

66/ See *supra* at 13-14.

partners, it is imperative that AirCell have the assurance of a reasonable term of operation. The current two-year period has been a straightjacket on AirCell's long-term ability, limiting financial and customer investment. AirCell's success, despite this impediment, reflects the substantial market need and demand for its service.

The FCC has long recognized that, for wireless telecommunications, a "relatively long period [of authorization] and high renewal expectancy provide a stable environment that is conducive to investment." 67/ It has also found that "the provision of high quality cellular service requires enormous capital expenditures and . . . requires that cellular systems evolve and grow if cellular companies are to continue providing beneficial service." 68/ In addition, cellular providers must be able to "provide assurance to investors and other sources of financing that their funds will not be placed in unreasonable jeopardy." 69/ In order for AirCell to sustain its operations and continue to grow as a business, a substantial extension beyond the waiver's current June 9, 2002 termination date is needed. 70/

AirCell respectfully submits that, given the need for regulatory and commercial certainty, the waiver should extend for as long as AirCell continues to operate without causing harmful interference to terrestrial cellular service. Such an extension would be consistent with the Commission's holding that for "as long as

67/ *Amendment of the Commission's Rules to Establish New Personal Communications Services*, 8 FCC Rcd 7700, 7753, ¶ 131 (1993).

68/ *Amendment of Part 22 of the Commission's Rules Relating to License Renewals in the Domestic Public Cellular Radio Telecommunications Service*, 7 FCC Rcd 719, 720, ¶ 6 (1991).

69/ *Id.*

primary cellular service is protected,” the public interest benefits of AirCell’s system “support[] grant of the waiver with the safeguards the Bureau has imposed.” ^{71/} At a minimum, the waiver should be extended for a ten-year term, which tracks the period for which the Commission authorizes cellular service providers to operate under their licenses. ^{72/} The initially granted two-year term, or any other similarly abbreviated operating authority, is simply far too short for reasonable commercial operations. Indeed, requiring AirCell to repeatedly come before the Commission to engage in protracted, expensive proceedings for only limited waiver extension periods is neither commercially feasible nor in the public interest. Only significant extension of the waiver term will enable AirCell to continue providing the aviation-safety, government-use, and other public interest benefits its system offers.

B. AirCell Has a Significant Operational Need for Authority to Operate on Additional Channels

AirCell’s success during the initial waiver term in serving the intense demand for affordable airborne telecommunications has begun to tax the relatively few analog channels on which it is authorized to operate. The combined force of restrictions against using more than six cellular channel pairs per base station, and against operating on channels used by neighboring licensees for digital terrestrial cellular service, has the potential to hamstring AirCell’s ability to provide its corporate, government and personal users the high-quality service they expect. Since

^{70/} It should be noted that AirCell has contracts of varying terms with each of its licensee partners and renewal of these contracts are negotiated notwithstanding the term of the waiver.

^{71/} *AirCell Commission Order*, 15 FCC Rcd at 9644, ¶ 43.

^{72/} See 47 C.F.R. § 1.955.

many existing and prospective AirCell applications implicate public safety and/or security, limiting its system to insufficient capacity disserves the public interest.

The new and next generation of AirCell offerings, such as the FlightGuardian offering described above, require increased capacity in the form of additional authorized channels for AirCell's system. ^{73/} AirCell's expected participation with JetBlue in the FAA's Enhanced Aviation Security Program, and other new commercial airline applications, will further drive the need for additional channels. ^{74/} The same is true of commercial airline passenger applications, as AirCell endeavors to fill the void left by AT&T's departure from that important market segment.

While increasing the number of channel pairs at each base station on which AirCell may operate is critical, the importance of removing the digital exclusion cannot be overstated. As more and more cellular providers convert their terrestrial systems from analog to digital service to increase system capacity and efficiency, it is already increasingly difficult for AirCell to identify a set of analog channels to use at many sites. ^{75/} Between the growing use of digital channels for terrestrial service, and the FCC's consideration of deleting the analog requirement

^{73/} See *supra* at 12-13

^{74/} See *supra* at 14.

^{75/} At present, some sites have only one or two voice channels available for AirCell's use because a full six channel pairs not used for digital operations somewhere within the 84-mile radius around the site could not be found. Absent removal of the digital exclusion, AirCell will soon be unable to identify *any* channel sets for many sites.