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Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of ARINC INCORPORATED Application for Blanket Authority to Operate Up to One Thousand Technically Identical Ku-Band Transmit/Receive Airborne Mobile Stations Aboard Aircraft Operating in the United States and Adjacent Waters	File No. SES-LIC-20030910-01261

Int'l Bureau

DEC 01 2003

Front Office

RESPONSE OF ARINC INCORPORATED

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SUMMARY

Both Boeing and PanAmSat commented on ARINC's application to provide SKYLink AMSS service, but neither party opposed grant of the application. Instead, Boeing and PanAmSat proffer many questions, but fail to raise new or substantial concerns. PanAmSat largely repeats its unjustified concerns about interference from Ku-band AMSS. Worse still, Boeing's filing appears designed to delay or prevent competition to Boeing's existing AMSS offering—even at the risk of undermining its own positions in pending proceedings.

The SKYLink application and the Technical Exhibit attached hereto demonstrate that PanAmSat's and Boeing's concerns are unfounded. First, the SKYLink System complies with Recommendation ITU-R M.1643 as well as FCC precedent and policies, neither of which forbid contention protocols. Second, SKYLink's design, while not identical to Boeing's approach, provides the same level of control, monitoring, and protection for co-frequency users. Third, the SKYLink design enables ARINC to identify and disable a malfunctioning AES. The fact that AES will operate in burst mode does not impair this capability. Fourth, ARINC's calculations of aggregate off-axis e.i.r.p. take into account all variables identified by Boeing. These conservative calculations clearly demonstrate that the aggregate off-axis e.i.r.p. for the SKYLink System complies with FCC requirements for routine processing. Finally, ARINC acknowledges its obligation not to cause interference to government users or satellite operators adjacent to AMC-1 and has taken all necessary steps to coordinate with them.

The Commission should not let the conclusory statements or unfounded concerns of PanAmSat or Boeing delay the introduction of competition in the provision of AMSS services. Accordingly, for the reasons noted above and discussed more thoroughly below, ARINC urges the Commission to expeditiously approve the SKYLink application.

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RESPONSE OF ARINC INCORPORATED

ARINC Incorporated, by its attorneys, hereby responds to the comments submitted by The Boeing Company ("Boeing") and PanAmSat on ARINC's application for authority to provide aeronautical mobile satellite service ("AMSS") service in the 14-14.5 GHz band. Neither party opposed grant of ARINC's SKYLink application. PanAmSat's filing[1] largely repeats its unjustified concerns—raised in numerous other proceedings—about interference from Ku-band AMSS. Boeing's submission[2] appears designed to delay or deter competition to Boeing's existing AMSS offering—even at the risk of undermining its own demonstration that AMSS can share the Ku-band and thus should be eligible for routine licensing.

Neither PanAmSat nor Boeing raises any new or substantial concerns; ARINC addressed all the technical claims in its SKYLink application.[3] Further, PanAmSat's questions about

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1 Comments of PanAmSat, File No. SES-LIC-20030910-01261 (filed Nov. 14, 2003) ("PanAmSat Comments").

2 Comments of Boeing Co, File No. SES-LIC-20030910-01261 (filed Nov. 14, 2003) ("Boeing Comments").

3 ARINC Application for Blanket Authority, File No. SES-LIC-20030910-01261 (filed Sept. 2, 2003) ("SKYLink Application").

routine licensing have been asked and answered—most recently by the International Telecommunication Union ("ITU") World Radiocommunication Conference 2003 ("WRC-03") and the Federal Communications Commission's ("Commission" or "FCC") speedy implementation of the AMSS allocation adopted at that conference. Seeing specters at every turn, Boeing asks phantom "questions," invokes ITU requirements and FCC policies that do not exist, and conjures imaginary protection requirements. Attached hereto as Exhibit 1 is a Technical Exhibit that addresses all technical issues raised, and demonstrates that SKYLink complies fully with ITU Recommendations, FCC expectations, and co-frequency user protection requirements. The Commission should not permit PanAmSat's unfounded, repetitive concerns, or Boeing's thinly veiled attempts to hamper a potential competitor, to postpone competition in the AMSS marketplace. Accordingly, ARINC urges the Commission expeditiously to grant the SKYLink AMSS application.

I. AS PANAMSAT AND BOEING NOTE, WAIVER OF SECTION 2.106 IS NO LONGER NECESSARY.

In the SKYLink application, ARINC sought a waiver of the FCC rule setting forth the U.S. Table of Frequency Allocations[4] to permit it to offer AMSS in the 14.0-14.5 GHz band. ARINC noted that waiver was justified, in part, because the WRC-03 had just added a secondary AMSS allocation in the band. Since that time, the Commission has conformed the U.S. Table of Allocations to the WRC-03 results, allocating the 14-14.5 GHz band for use by AMSS on a

4 47 C.F.R. § 2.106 (2003).

secondary basis.[5] Both PanAmSat and Boeing acknowledge that this eliminates any need for waiver;[6] and ARINC agrees that this issue is now moot.

II. THE SKYLINK DESIGN AND ACCESS PROTOCOLS CONFORM TO ITU STANDARDS AND FCC POLICIES.

Boeing's licensed AMSS system uses so-called "positive control" to ensure that its operations cause no harmful interference to other users of the 14-14.5 GHz band. ARINC's SKYLink System design, while not identical to Boeing's approach, provides the same level of control and monitoring of airborne earth station ("AES") transmissions through an equivalent ground based Network Management System ("NMS"). Elevating form over substance, however, Boeing intimates that ARINC's approach departs from Recommendation ITU-R M.1643, violates FCC policy, and increases the risk of interference to co-frequency users. Each of these assertions is false. Indeed, Boeing's desperate patchwork of concerns and questions about SKYLink represents an astonishing about-face from Boeing's own AMSS licensing rules, which would enshrine routine processing.[7] Boeing's comments thus sacrifice engineering realities and syllogistic logic for an additional few weeks shelter from competition.

First, the SKYLink contention protocol access scheme is consistent with Recommendation ITU-R M.1643.[8] Importantly, Boeing cites no clause in Recommendation

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5 *See Amendment of Parts 2, 25, and 87 of the Commission's Rules to Implement Decisions from World Radiocommunication Conferences Concerning Frequency Bands Between 28 MHz and 36 GHz and to Otherwise Update the Rules in this Frequency Range*, Report and Order, FCC 03-269 (Nov. 4, 2003) ("Allocation Report and Order").

6 *See* PanAmSat Comments at 2 & n.1; Boeing Comments at 3.

7 *See Boeing Petition for Rulemaking*, RM-10800 at 23-24 (filed July 21, 2003) (stating that Ku-band AMSS operations that "operate within the off-axis e.i.r.p. levels of [sic] routinely authorized VSATs" do not have the potential to cause harmful interference to adjacent satellite operators" and that "comprehensive ITU-R technical studies over the last several years have definitively established the ability of Ku-band AMSS systems to protect primary FSS operations" and proposing that the Commission "extend … ALSAT authority to Ku-band AMSS licensees") ("Boeing Petition for Rulemaking").

8 *See* Technical Exhibit at 1 & Attachment 1.

M.1643 that forbids ARINC's approach—because no such prohibition exists. Contrary to Boeing's allegation,[9] neither the Final Acts of WRC-03, nor Recommendation ITU-R M.1643, address "positive" or "negative" control, much less endorse or forbid either.

As the FCC well knows, ITU Recommendations normally establish interference protection requirements, not enshrine any particular technology. For example, the most relevant portion of the Recommendation states:

> AES should be subject to the monitoring and control by an NCMC [network control and operating center] or equivalent facility. AES should be able to receive at least "enable transmission" and "disable transmission" commands from the NCMC. AES should cease transmissions immediately on receiving any "parameter change" command, which may cause harmful interference during the change, until it receives an "enable transmission" command from its NCMC. In addition, it should be possible for the NCMC to monitor the operation of an AES to determine if it is malfunctioning.[10]

ARINC's application demonstrated that the NMS monitors and controls all AES transmissions, can enable or disable an AES (which would immediately cease transmitting) and detects an AES malfunction.[11] SKYLink thus is in full compliance with Recommendation M.1643.

Second, Boeing suggests that the Commission implicitly has required all AMSS systems employ positive control.[12] Yet the provisions Boeing cites, from its own license, create no such requirement. Indeed, they authorize Boeing's design "or equivalent facility,"[13] which covers the

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9 *See* Boeing Comments at 4.

10 Recommendation ITU-R M.1643, Annex 1, Part A, 4 (definition of NCMC acronym added in block quote above).

11 The Technical Exhibit, particularly Attachment 1, sets forth each relevant criterion from Recommendation ITU-R M.1643 along with a citation to the section of the SKYLink application addressing that capability.

12 Boeing Comments at 5, 6 & n.17.

13 The relevant clause merely requires that "AMSS mobile [be] monitored and controlled by a ground -based Network Control and Monitoring Center (NCMC) or equivalent facility." *See The Boeing Company: Application for Blanket Authority to Operate Up to Eight Hundred*

SKYLink design. Further, as shown in the Technical Exhibit, the most important condition on Boeing's license was that it comply with a Draft New Recommendation formulated by ITU-R Working Party 4A, which ultimately became Recommendation ITU-R M.1643.[14] To the extent that ordering clauses in Boeing's authorization bind others, they mandate compliance with Recommendation ITU-R M.1643—which SKYLink achieves.

Third, Boeing claims that ARINC's design is forbidden by dicta from a nearly 15-year-old licensing order that prohibited Qualcomm from employing a contention protocol to access its leased transponder.[15] However, the *Qualcomm* decision is inapposite: Qualcomm requested 20 times more earth stations than does SKYLink, in the *land* not *aeronautical* mobile satellite service. This application was the first large-scale deployment of commercial mobile services via fixed satellite, at a time when the FCC had little experience with contention protocols and international bodies had not yet considered technical standards.

Since then, the technology has advanced, and the SKYLink design embodies a decade-and-a-half of engineering improvements. Most importantly, SKYLink will operate within the new international and domestic AMSS allocation, and will adhere to a carefully developed ITU Recommendation (crafted in part by Boeing; championed by the United States) designed to protect co-frequency users from harmful interference. Simply put, for Ku-band AMSS, Recommendation ITU-R M.1643 essentially supersedes the *Qualcomm* precedent.[16]

Technically Identical Transmit and Receive Mobile Earth Stations Aboard Aircraft in the 14.0-14.5 GHz and 11.7-12.2 GHz Frequency Bands, Order and Authorization, 16 FCC Rcd 22645, 22654 (¶ 19(h)3) (2001).

14 *See* Technical Exhibit at 1.

15 *Qualcomm, Inc.*, 4 FCC Rcd 1543 (1989).

16 In other contexts, Boeing recognizes that Recommendation ITU-R M. 1643 embodies the technical standards for AMSS licensees. *See* Boeing Petition for Rulemaking at 7.

Finally, Boeing hints that SKYLink's contention protocol can never provide sufficient interference protection in the band. As explained in the Technical Description and the Technical Exhibit, the NMS includes a sufficient level of proactive control to reduce the probability of interference towards zero. At the outset, ARINC notes SKYLink allows undirected power increases only for log-in bursts. All other AES transmissions (*i.e.*, those from logged-in AES) are subject to the positive power control of the NMS. Boeing's entire claim, therefore, rests on its assertion that short (less than 20 ms) log-in requests could overwhelm a system designed to accommodate numerous simultaneous transmissions. That is simply wrong; as explained in the Technical Exhibit, ARINC has fully accounted for log-in bursts in calculating the maximum spectral density, and will control AES transmissions to stay below the threshold for routine licensing.[17]

In particular, as set forth in ARINC's application and the attached Technical Exhibit, SKYLink can accommodate several dozen simultaneous transmissions per transponder—log-in bursts or transmissions by logged-in AES[18]—at aggregate power levels below the VSAT mask.[19] Given the expected traffic per aircraft, the NMS will not permit more than 214 AES to be logged-in and using the same transponder at the same time,[20] which ensures that the probability

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17 *See* Technical Exhibit at 2-3.

18 Log-in bursts and other transmissions all occur within the same channel.

19 Thus, contrary to Boeing's assertions, Boeing Comments at 7, the aggregate e.i.r.p. density calculations set forth in the Technical Description take the e.i.r.p. of AES log-in bursts into account. ARINC notes that, while the log-in process may involve increasing power at each attempt, the maximum power applied is always consistent with the maximum power permitted for logged-in AES transmissions. Because the SKYLink System accounts for log-in bursts as well as logged-in AES transmissions, there should be no concerns about the fact that AES may continue to transmit log-in bursts at higher powers up to the maximum power permitted for logged-in AES transmissions, regardless of the length of time the AES makes those transmissions. *See* Boeing Comments at 7.

20 The NMS controls the log-in process via a "bulletin board" that it broadcasts to all AES approximately every 250 milliseconds. This bulletin board lists the available time-slots for log-in requests or informs AES that no time-slots are currently available.

of more than 38 simultaneous transmissions by logged-in AES (*i.e.*, the probability that the threshold set forth in Section 25.134(a) will be exceeded) is less than 0.001 percent.[21] The NMS continually monitors the current actual number of simultaneous log-in and other transmissions and uses this information and its "bulletin board" forward link transmissions to the AES to control the probability of return link transmissions, including log-in bursts.[22] In other words, the NMS monitors system operation and adjusts the contention protocol parameters for individual AES and groups of AES in order to ensure that transmissions by logged-in and logging-in AES stay within the regulatory limits.

Boeing's complaints about SKYLink ignore decades of well-documented experience with contention access schemes, especially the Aloha protocol developed in the 1970s. Many FCC-licensed systems, offered by Spacenet Inc., StarBand, and Hughes Network Systems, employ contention protocols. Indeed, the agency recently reviewed contention protocols for VSAT networks, and proposed permitting VSAT operators to use contention protocols[23] because they:

> enable VSAT remote terminals to transmit simultaneously ... [and thus] enable VSAT networks to carry more traffic than they could without using contention protocols, and so increase their efficiency.[24]

There is no possible public interest in forbidding such efficiencies in Ku-band AMSS.

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21 ARINC notes that this probability is consistent with—and, indeed is less than—that previously found acceptable by the FCC. *See 2000 Biennial Regulatory Review—Streamlining and Other Revisions of Part 25 of the Commission's Rules Governing the Licensing of, and Spectrum Usage by, Satellite Network Earth Stations and Space Stations*, Further Notice of Proposed Rulemaking, 17 FCC Rcd 18585, 18618 (2002) ("2000 Biennial Regulatory Review FNPRM").

22 In such situations, the NMS reduces the number of requests made, lengthens the duration of AES quiescence. Consequently, even during peak loading periods, simultaneous transmissions from AES will not cause the overall aggregate off-axis e.i.r.p. density to exceed the FCC limit for routinely licensed systems more than 1 percent of the time.

23 *See 2000 Biennial Regulatory Review FNPRM.* ARINC notes that the typical VSAT network is quite similar to the network used to provide the SKYLink Service.

24 *Id.*, 17 FCC Rcd at 18618.

In sum, Boeing castigates nearly everything in SKYLink that differs from its Connexion system. According to Boeing, the ITU and FCC already have mandated a single technical approach—Boeing's—and every future Ku-band AMSS licensee must deploy networks essentially identical to Boeing's. In reality, while ITU Recommendations and FCC policies are designed to prevent harmful interference, they leave the choice between contention protocols and positive control to system engineers. Boeing's twisted reading of ITU Recommendations, FCC policy and basic engineering cannot mask its attempt to stifle innovation and smother competition from the outset. Although this may serve Boeing's private interest, it does not serve the public interest.

III. THE AGGREGATE OFF-AXIS E.I.R.P. OF THE AES COMPLIES WITH THE FCC REQUIREMENTS FOR ROUTINE PROCESSING.

ARINC's calculations take into account the variables identified by Boeing. Based on ARINC's calculations, which used conservative assumptions, it is clear that the aggregate off-axis e.i.r.p. complies with the FCC requirements for routine processing. A complete response to Boeing is contained in the Technical Exhibit, and is summarized below.

Contrary to Boeing's assertion,[25] ARINC's application specifically accounted for the off-axis e.i.r.p. of the forward link. The Technical Description explicitly stated: "[w]ith the Forward link operating near saturation, the maximum outbound downlink effective isotropic radiated power (EIRP) spectral density for digitally modulated signals complies with the requirements of 25.202(f)."[26]

Moreover, ARINC calculated the aggregate off-axis e.i.r.p. using the maximum off-axis e.i.r.p. for all AES (*i.e.*, the off-axis e.i.r.p. for Bangor, Maine, the worst area of the AMC-1

25 *See* Boeing Comments at 11.

26 *See* ARINC Technical Description at 3.

footprint) and thus made the most conservative estimate possible.[27] Thus, the Commission should disregard Boeing's concerns that ARINC's computation of the "equation ... which ARINC uses to compute the aggregate power spectral density" treats every AES "as having the same [power spectral density] and thus makes no allowance for e.i.r.p. variation."[28]

Finally, ARINC accounted for antenna misalignment using a conservative pointing error of 0.6 degrees in its calculations.[29] Even assuming that all AES mispoint by 0.6 degrees in the same direction at the same time (an event extraordinarily unlikely to occur), ARINC determined that any resulting increase in off-axis e.i.r.p. density would not exceed FCC limits for VSAT networks eligible for routine processing.[30]

IV. BOEING'S OTHER TECHNICAL CONCERNS ARE INAPPOSITE.

Boeing's concerns about ARINC's ability to locate malfunctioning AES are unfounded.[31] The fact that its AES will operate in burst mode will not prevent ARINC from identifying and disabling a malfunctioning AES. Because each packet transmitted by an AES includes the IP address assigned to that AES, as necessary, the NMS can identify the AES transmitting the packet causing a transient interference event and instruct the AES to mute.[32] Moreover, if the built-in-test program of an AES detects a failure or interference event, the AES will self-mute.[33]

Boeing also inquired about band plans other than those included in the Technical Description.[34] There are two band plans for the 64 and 128 kbps data rate cases. The first plan is

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27 *See* Technical Exhibit at 5.

28 *See* Boeing Comments at 10.

29 *See* Technical Exhibit at 4.

30 *See id.*

31 *See* Boeing Comments at 8.

32 *See* Technical Exhibit at 3-4.

33 *See id.* at 3

34 *See* Boeing Comments at 12.

similar to that shown in Figure 3-3 of the Technical Description for the 32 kbps case. Under this plan, the bandwidth area is split into two frequency channels and the 10 dB bandwidths are 14.208 MHz and 13.824 MHz for the 64 kbps and 128 kbps return links, respectively.[35] The second plan places all users on the same center frequency as the forward link signal. For that plan, the 10 dB bandwidths are 28.8 MHz and 28.416 MHz for the 64 kbps and 128 kbps return links, respectively.[36] The SKYLink system is flexible and can tailor the bandwidth of the return link carriers to suit the roll-off requirements of the satellite operator.[37]

Further, the FCC should disregard Boeing's implications that ARINC inconsistently represents the amount of time the aggregate e.i.r.p. density will exceed the level specified in Rule 25.134(a).[38] The variation in percentages contained in the Technical Description is due to the inclusion of two values—the expected case and the threshold for exercising positive control—not an intent to deceive on ARINC's part. Boeing's concerns are unfounded.

Finally, ARINC notes that Boeing and PanAmSat identify a few typographical and other errors in the Technical Description. Although none of these errors is significant, ARINC has included corrected pages as Attachments 2 and 3 to the Technical Exhibit. ARINC shortly will submit these corrections as a minor amendment to the SKYLink application.[39]

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35 *See* Technical Exhibit at 5.

36 *Id.*

37 *Id.*

38 *See* Boeing Comments at 12.

39 ARINC also notes that PanAmSat identified an error in the Public Notice accepting the SKYLink application for filing. Specifically, the AMSC-1 reference in the Public Notice is the result of a typographical error by the FCC, not a misstatement in the SKYLink application. ARINC has leased transponders on AMC-1 not AMSC-1.

V. ARINC WILL COORDINATE WITH ALL OTHER USERS AS REQUIRED BY LAW.

ARINC acknowledges its obligation not to cause interference to government users in the 14-14.5 GHz band, which should resolve Boeing's concern for the interests of government users. In particular, ARINC will "coordinate its proposed operations with the National Science Foundation … to protect radio astronomy operations, and with the National Aeronautics and Space Administration … to protect space research operations."[40] ARINC already has begun discussions with government users.

In a similar vein, PanAmSat expresses concern that ARINC may not have coordinated with Telesat Canada.[41] ARINC acknowledges its obligation not to cause interference to satellite operators adjacent to AMC-1, including Telesat Canada's Anik F1 at 107.3° W.L. SES Americom and ARINC will ensure that SKYLink does not interfere with Telesat Canada.

In any event, the SKYLink system is designed to operate below thresholds set forth in Sections 25.134(a) and 25.209(a) for routine processing of VSAT applications. As a result, SKYLink also should qualify for routine processing. PanAmSat protests this on the grounds that AMSS transmissions are secondary,[42] but does not explain why it should be afforded greater protection than already entitled to under the VSAT rules.[43] PanAmSat has proffered the identical theoretical objection for years, most recently in comments on the Boeing Petition for Rulemaking,[44] which may be the most appropriate forum for this issue.

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40 *See* Boeing Comments at 14 (internal citation and abbreviations omitted).

41 *See* PanAmSat Comments at 4.

42 *Id.*

43 Routine processing is a well-accepted method of ensuring interference protection, while eliminating burdensome coordination requirements that would delay competitive entry and impede deployment of new services like AMSS.

44 Comments of PanAmSat Corporation, RM-10800, at 2 (filed Nov. 3, 2003).

VI. CONCLUSION

The concerns raised by PanAmSat and Boeing are largely moot or unfounded. Boeing's objections to ARINC's system mischaracterize the SKYLink design and ignore the plain language of ITU Recommendations and FCC orders. Moreover, without any engineering support, Boeing suggests that long-standing, well-understood contention protocols employed by other FCC-licensed networks be barred from AMSS. Boeing's scatter-shot comments appear designed to postpone licensing of a competitor, to the detriment of the public. The Commission should not let conclusory statements or unfounded concerns delay competitive entry into the AMSS market.

The vast majority of issues raised by the commenters were fully addressed in the SKYLink application, and the few remaining questions are discussed in the attached Technical Exhibit. Accordingly, ARINC urges the Commission to approve expeditiously the SKYLink application.

Respectfully submitted,

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November 28, 2003

CERTIFICATION OF PERSON RESPONSIBLE FOR TECHNICAL INFORMATION

I am the Manager of the SKYLink program at ARINC Inc. I certify that I am qualified to review the technical information contained in this Response and Engineering Exhibit, that I am familiar with Part 25 of the Commission's Rules and International Telecommunication Union Recommendation ITU-R M.1643, that I have prepared and/or reviewed the technical information submitted in this document, and that it is complete and accurate to the best of my knowledge.

My technical qualifications include over 30 years of direct experience in communications and systems engineering. I hold a B.S. in Electrical Engineering from the Virginia Military Institute and an M.S. in Computer Science from The Johns Hopkins University.

By: [signature]
William M. Kolb
Project Manager, SKYLink Program
ARINC Inc.

Dated: November 26, 2003

Sworn and subscribed to before me this 26th day of November 2003.

[signature]
Notary Public

My Commission Expires: Nov 1, 2004

EXHIBIT 1

SKYLink Technical Exhibit

Comments on ARINC's application for Ku-Band AMSS operations identified specific technical issues. This technical exhibit provides further information and clarification. However, nothing in any comment undermines ARINC's demonstration that its SKYLink AMSS would interfere with any co-frequency users.

SKYLink's Protocols are Consistent with the AMSS Allocation and ITU Recommendation M.1643

Boeing notes that its Connexion system prevents harmful interference to authorized users of the Ku-band by restricting "the number of airborne terminals operating concurrently" and by controlling "their maximum data rates, power levels and other relevant factors." [1] As ARINC's application explained, while SKYLink also incorporates transmit control functionality utilizing the parameters cited by Boeing in the airborne earth stations (AES) and Network Management System (NMS), this is not the primary mechanism for protection against co-frequency interference. The SKYLink system relies on centrally controlled protocols for AES entry into the network; controlled authorization for the AES to transmit; controlled authorization to change power or data rates; and the ability to terminate AES transmissions. As part of the SKYLink system control, the transmit power from each AES is monitored by the NMS and managed within a narrow range to ensure that the simultaneous transmissions by AES will not cause harmful interference to co-frequency operations in the 14.0-14.5 GHz band. In particular, SKYLink's Carrier Reuse Multiple Access (CRMA) random access return channel and transmit control will maintain positive control over AES so as to ensure that the aggregate e.i.r.p. does not exceed the spectral density limits required for a routinely processed VSAT networks as described in CFR 47, Sections 25.134 (a) and 25.209(a)(1).

Without quoting or referring to any particular provision, Boeing claims that the WRC-03 allocation and ITU-R Recommendation M-1643 somehow preclude the approach ARINC has selected. But, Boeing is wrong. Neither the allocation nor the Recommendation contains any requirement for positive AES control. Nowhere does the allocation or Recommendation prohibit approaches different than chosen by Boeing. Attachment 1 to this exhibit details ITU-R Recommendation M-1643 and shows how the ARINC SKYLink Application satisfies each provision of that Recommendation.

SKYLink's Design is Consistent with FCC requirements

Boeing then claims that, in granting the Connexion AMSS license, the FCC "memorialized" a positive control/transmit on-command requirement.[2] This is not true. Close scrutiny of the paragraph that Boeing cites reveals that the FCC only "memorialized" the design guidelines contained in the Working Party 4A, "Draft New Recommendation on Operation and Control of AMSS Networks in the 14.0-14.5 GHz Band Relative to FSS Networks." The FCC conditioned the Boeing Connexion authorization on compliance with the design guidelines contained in the WP 4A Draft New Recommendation. This Draft New Recommendation later evolved into what is now referred to as ITU-R Recommendation M-1643. So, the condition only requires AMSS licensees to comply with ITU-R Recommendation M-1643. Thus, SKYLink's compliance with ITU-R Recommendation M-1643 is sufficient to meet any condition applicable to AMSS licenses.

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[1] Comments of the Boeing Company, November 14, 2003, at 6.
[2] Id. at 6.

SKYLink's Contention Protocols will not Cause Harmful interference

Although not entirely clear, Boeing appears to question ARINC's SKYLink AMSS design because it employs a contention protocol. The mere fact that the SKYLink design differs from Connexion does not undermine ARINC's proposal. SKYLink uses closed loop power control and a traffic management algorithm to control the number of simultaneous accesses on the return link in real time. The NMS measures the average number of simultaneous accesses over a 250 millisecond period and broadcasts throttling parameters to all users via the forward link. This process drives the average number of simultaneous accesses to a level that provides adequate protection for co-frequency operations. Thus, instead of reacting to a potentially interfering transmission, SKYLink limits the probability of such an occurrence to an appropriately small value.

In the SKYLink system, the NMS monitors the number of simultaneous accesses (N) and compares this value with the desired number of simultaneous accesses (DAL). Using the mathematical relationship between these two values, the NMS computes an adjusted throttling parameter and broadcasts it to all AES in the network. Each AES discards a fraction of its outbound user IP packets prior to transmission based on this throttling parameter rather than transmit all packets over the satellite—thereby reducing its duty cycle and its contribution to the aggregate off-axis power flux density. Higher layer applications and protocols ensure any dropped packets are eventually retransmitted, if necessary. With this mechanism the NMS forces the average number of simultaneous accesses (N) to be less than or equal to the DAL. By selecting the DAL relative to the number of accesses that would produce the maximum allowable aggregate off-axis e.i.r.p. density (Nmax_aggregate), the NMS reduces the probability of exceeding Nmax_aggregate to the desired level for any assumed or measured traffic distribution (e.g., Poisson distribution). The number of actual accesses at a given moment coupled with the desired number of simultaneous accesses translates to an aggregate input power spectral density into the antenna that is equal to or less than the specification of –14 – Delta dBW/4kHz 99% of the time, where "Delta" is the 10.25 dB backoff that the SKYLink antenna requires to stay under the 25.209 gain versus off-axis angle mask. The SKYLink NMS actively manages the probability of exceeding off-axis e.i.r.p. density to be no greater than 1%; the actual probability of exceeding the off-axis e.i.r.p. density, however, is much less than this limit (i.e., < 0.001%) based on analysis and simulations of the expected traffic.

Given the maximum allowed aggregate e.i.r.p. density, the choice of a desired number of simultaneous accesses (DAL) depends upon the locations, data rates, and spreading factors allocated to the individual AES as well as the margin selected by the NMS to assure adequate protection for co-frequency operations. For example, referring to the link budget in Figure 4-5 of the Technical Description, the system can support a maximum of 40 simultaneous 32 kbps return link transmissions from Bangor, Maine, spread over 14.4 MHz or a total of 80 simultaneous 32 kbps return link transmissions from Bangor, Maine, spread over the two 14.4 MHz sub-bands described in Figure 3-3 of the Technical Description. Since Bangor, Maine represents the worst-case location in CONUS, this is a worst-case link budget. A realistic geographic distribution of aircraft would allow a slightly larger DAL. By the same token, a smaller DAL (e.g., 38) can be used to provide margin when modeling system performance.

Controlling the aggregate power via contention protocols (as ARINC proposes) is widespread and well understood (for example, the Aloha protocol). Qualcomm, in particular, has been designing such systems for years. Such schemes are explicitly embodied in the Ka-band rule for off-axis e.i.r.p. density management of CDMA type systems.[3] Furthermore, the SKYLink approach is consistent with the current

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[3] 25.138 Blanket Licensing Provisions of GSO FSS Earth Stations in the X–Y GHz (space-to-Earth), 19.7–20.2 GHz (space-to-Earth), A–B GHz (Earth-to-space) and 29.5–30.0 GHz (Earth-to-space) bands.

(a) All applications for a blanket earth station license in the GSO FSS in the X–Y GHz, 19.7–20.2 GHz, A–B GHz and 29.5–30.0 GHz bands that meet the following requirements shall be routinely processed:

FCC rule-making proposal to apply similar "soft exceedance" specifications in the Ku-band segment.[4] When the Commission stipulated in 1989 that "...we condition Qualcomm's operations to require that individual mobile units may transmit only on command from the hub terminal via the forward link...," they were dealing with an operation of 20,000 mobile units in the infancy of the technology for mobile units in the Ku band. Absent similar language in the ITU-R Recommendation M.1643, Annex 1 (Part A, Section 4) and the FCC adoption of that language, ARINC believes that meeting the current wording of ITU-R Recommendation M.1643, Annex 1 (Part A, Section 4) provides adequate constraint upon applicants to prevent harmful interference to authorized users of the FSS Ku-band.

ARINC Has Fully Considered AES Log-In in Calculating Aggregate Off-Axis E.I.R.P.

Boeing questions whether the off-axis e.i.r.p. of AESs trying to log-in was considered in the overall aggregate power determination. The answer is: yes. The SKYLink log-in protocol includes a simple algorithm to control the number of "logging-in" AESs that can be transmitting simultaneously. Upon receiving the forward link signal and the periodic bulletin-board information, the logging-in AES randomly selects a slot from a pool of log-in time-slots each time it transmits a log-in-request. The number of timeslots is configurable from the NMS and is set so that the probability of simultaneous transmissions from logging-in AESs do not cause the overall aggregate off-axis e.i.r.p. density to exceed the FCC limit more that 1% of the time. If its log-in attempt fails, an AES will select another random time slot and try again with an increased power level. After a configurable number of unsuccessful log-in attempts, the AES will stop trying to log-in for a "quiet period". The number of log-in attempts prior to a quiet period, the length of the quiet period and other log-in specific parameters such as the maximum power amplitude increase during log-in, are configurable by the SKYLink NMS. The NMS notifies all AESs of these log-in specific data periodically via the forward link. An AES cannot begin its log-in procedure until this log-in information message is received and processed. In addition, log-in attempts are subject to the same duty cycle controls as any other return link transmission. As a further safeguard, built-in-test (BIT) functions in the AES are used to identify a possible malfunction. If the BIT detects a failure in the transmit path, it automatically mutes the AES. In addition, every transmission from an AES is uniquely identified in the

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(i) Off-axis e.i.r.p. spectral density for co-polarized signals shall not exceed the following values, within ±3° of the GSO arc, under clear sky conditions:

$18.5 - 25\log(\theta) - 10\log(N)$	dBW/40kHz	for $2.0° \le \theta \le 7°$
$-2.63 - 10\log(N)$	dBW/40kHz	for $7° < \theta \le 9.23°$
$21.5 - 25\log(\theta) - 10\log(N)$	dBW/40kHz	for $9.23° < \theta \le 48°$
$-10.5 - 10\log(N)$	dBW/40kHz	for $48° < \theta \le 180°$

where θ is the angle in degrees from the axis of the main lobe; for systems where more than one earth station is expected to transmit simultaneously in the same bandwidth, e.g., CDMA systems, N is the likely maximum number of simultaneously transmitting co-frequency earth stations in the receive beam of the satellite; N=1 for TDMA systems.

[4] In FCC 02-257A1, the Commission said:

> we remain convinced that we should adopt some rules governing multiple access techniques such as Aloha. The current version of Section 25.134 prescribes only absolute limits on power density for 100 percent of the time, which on their face preclude the use of the Aloha access technique. We also believe, however, that it would be unreasonable to prohibit use of multiple access techniques at this time. The Bureau also determined that use of Aloha, as implemented at this time, does not cause harmful interference to other satellite systems.

packets burst on the return link. If the NMS detects a malfunctioning terminal, it will also instruct the AES to turn off.

ARINC's power spectral density calculation also considered the effect of the forward uplink on off-axis e.i.r.p. density. The forward link signal is transmitted from the ViaSat earth station facility licensed as FCC call sign E030131. This license uses a 4.5 meter ViaSat antenna model 8345, which meets or exceeds FCC part 25.209 requirements. The authorized e.i.r.p. density is 37.3 dBW/4 kHz and the antenna gain at the operating frequency is approximately 54.7 dBi. Thus the antenna flange input power density allowed is -17.4 dBW/4 kHz. From the link budgets provided in the ARINC application it can be seen that the normal operating antenna input power spectral density is -23 dBW/4 kHz. This is considerably lower than the -14 dBW/4 kHz limit allowed for a 25.209-compliant antenna in a VSAT network and does not appreciably affect adjacent satellites when included in the aggregate return link power spectral density.

Boeing asserts the link budgets do not include the considerable variation due to rain loss if the system were used on the ground. The SKYLink system does, in fact, anticipate that AESs may be used on the ground and limited uplink power control to compensate for rain attenuation is designed into the system. The extra power transmitted during such rain events is dissipated by the rain, however, and does not increase the off-axis power flux density in the geostationary satellite arc.

Another source of aggregate off-axis e.i.r.p. is antenna pointing error. Such errors can arise from INS inaccuracies, installation misalignment, calibration, and airframe flexure. Because the SKYLink antenna has a relatively broad main lobe, pointing errors have a correspondingly smaller impact. For example, a single AES antenna transmitting with a RSS pointing error of 0.1 degrees would only increase its off-axis power density by approximately 0.175 dB. This was taken into account when calculating the equivalent antenna power spectral density. ARINC conservatively set an upper limit on the maximum number of simultaneous AES uplinks to a value of 62 versus the 80 possible with the worst case link budget. This results in approximately 1.1 dB of margin, which is the antenna pattern performance difference seen at the adjacent satellite for a 0.6 degree pointing error. In other words, if an AES antenna were misaligned by 0.6 degrees exactly in the direction of the adjacent satellite, the off-axis signal transmitted in the direction of the adjacent satellite from that antenna would increase by 1 dB. Systematic mispointing of AES antennas in use is highly improbable, given that any aircraft's instantaneous traffic volume and pointing angle is statistically independent from every other aircraft, and given that pointing errors will be random in directionality as compared with bore sight. But, even were the system fully loaded and all simultaneously transmitting AESs off by 0.6 degrees aligned in the direction of an adjacent satellite, the aggregate off-axis power spectral density at the satellite would still be within FCC limits.

SKYLink Will Not Interfere with Any Ku-Band AMSS, and No Further Demonstration of Non Interference Should be Required

Boeing proposed that ARINC submit a report verifying its ability to comply with all AMSS license conditions prior to commercial operations. This makes no sense since Boeing itself showed that AMSS systems should be capable of sharing the band so long as they stay below the VSAT emission mask, and recently proposed AMSS rules based on exactly that assumption. Boeing now inconsistently claims it's entitled to more protection than it proposes to provide to Ku FSS operations or to ARINC's SKYLink system. If Boeing is correct in its reasoning, then the rules it has suggested are wrong. But, of course, neither is true. Because SKYLink is designed to operate below the VSAT emission mask, it will not cause harmful interference to any co-frequency service, including other AMSS systems.

The SKYLink Application Fully Addresses Other Technical Issues

Boeing claimed it was not clear that ARINC's techniques for monitoring individual AES transmit power support adequate control of the aggregate off-axis e.i.r.p. SKYLink utilizes a ground transmitter with the same return link waveform as the AES and which is co-located with the hub ground earth station to calibrate, track, and maintain the accuracy of each AES's e.i.r.p. It should also be noted, in this regard, that the reference return link transmitter utilizes a larger 25.209-compliant antenna. The return link e.i.r.p. of the AES is determined by the operating SFD and G/T of the satellite transponder in the direction of the AES. When estimating the aggregate off-axis power spectral density across the SKYLink coverage area, a variation of 5 dB in SFD and G/T was used. The SKYLink application included link budgets for the defined edge of coverage around CONUS. These points were chosen because they represent the worst 10% of the footprint, with Bangor, ME being the worst case. Coverage elsewhere in the CONUS is considerably better than the worst case values used in the application. At beam center, the pattern is improved by 5 dB over the Bangor, ME. Thus, all of the variations in AES e.i.r.p. are accounted for.

For reasons that are unclear, Boeing requested spectrum band plans for the alternative transmission data rates discussed in the Technical Description filed with the SKYLink license application wherein return link data rates of 32, 64 and 128 kbps are mentioned and a band plan for the 32 kbps data rate is shown. For the 32 kbps case in Figure 3-3 of Exhibit 3, the 10 dB bandwidths are 14.4 MHz each. The band plan for the 64 kbps return link uses 14.208 MHz for the two 10 dB bandwidths, and the 128 kbps return link uses 13.824 MHz for the two 10 dB bandwidths. Other plans are also possible. For example, all users could be on the same center frequency as the forward link signal in the center of the transponder. In this case, the 64 and 128 kbps data rates would have 10 dB bandwidths of 28.8 MHz and 28.416 MHz respectively. The SKYLink system is rather flexible in this regard and can tailor the bandwidth of the return link carriers to suit the roll-off requirements of the specific satellite operator.

As Boeing correctly points out, the discussion in Section 5.2.1 of the Technical Description incorrectly uses the terms 'E.I.R.P.' and 'input PSD'. The value -24.25 dBW/4 kHz is more appropriately defined as the aggregate input power spectral density limit and not an e.i.r.p. density limit. This number is derived from the FCC limit in 25.134(a) which defines an antenna input power spectral density limit of -14 dBW/4 kHz. Because the AES antenna falls short of meeting the FCC 25.209(a)(1) mask by 10 dB at its worst point, 10 dB plus 0.25 dB additional margin was subtracted from the -14 dBW/4 kHz antenna input limit to yield an effective antenna input limit of -24.25 dBW/4 kHz. Corrections to the relevant figures and text in Section 5.2.1 of the Technical Description are included as Attachment 2 to this exhibit.

Boeing also correctly points out that calculations supporting the Radio Astronomy discussion in Sections 5.2.2 and 5.24 of the Technical Description incorrectly omitted the 30.96 dB antenna gain. Corrections to Sections 5.2.2 and 5.24 of the Technical Description are included as Attachment 3 to this exhibit. Even with this additional gain, the SKYLink antenna meets National Radio Quiet Zone restrictions for a minimum antenna elevation of 10 degrees at all aircraft altitudes of 10,000 feet or higher. The SKYLink antenna pattern does not allow us to categorically claim that radio astronomy stations are protected by the system design – even when airframe masking is taken into account. Radio Astronomy sites are, however, protected as long as the aircraft is operating at or above a 30,000 cruising altitude and the SKYLink system is using only transponders 5 through 21.

To protect radio astronomy stations operating in the 14.47 to 14.5 GHz band, AESs operating with an uplink center frequency above 14.44 GHz within line-of-sight of these stations will cease transmissions. SKYLink thus complies with the Aug. 13, 2003 MoU between the FCC and NTIA that addresses AMSSs in the 14.0-14.5 GHz band. The SKYLink application will be coordinated with federal users through the IRAC process, and that process has begun. In the course of federal clearance, concurrence will have to be obtained from NSF and NASA. This coordination should be completed expeditiously, since the WRC now has spoken. Because this coordination is underway and is being accomplished in parallel with the FCC review, there is no reason to delay the SKYLink application.

Coordination with adjacent satellite providers, including PanAmSat and Telesat Canada (Anik F1 at 107.3° WL), is also well underway.

Attachment 1

Comparison of ITU-R Recommendation M-1643 and the ARINC SKYLink Application

For brevity, the appropriate paragraphs of the SKYLink application are referenced rather than repeated in their entirety.

The Technical and operational requirements for aircraft earth stations of AMSS networks in the band 14-14.5 GHz (Earth-to-space) are contained in Part A of ITU-R M 1643. The "essential requirements" related to the protection of fixed-satellite service networks are as follows:

1. AMSS networks should be coordinated and operated in such a manner that the aggregate off-axis e.i.r.p. levels produced by all co-frequency AES within AMSS networks are no greater than the interference levels that have been published and coordinated for the specific and/or typical earth stations pertaining to fixed-satellite service networks where FSS transponders are used.

The SKYLink system clearly meets this requirement in section 5.2.1.2 Off-Axis Aggregate e.i.r.p. Spectral Density Control.

2. The design, coordination and operation of an AES (AIST) should, at least, account for the following factors which could vary the aggregate off-axis e.i.r.p. levels generated by the AIST:

2.1 Mispointing of the AIST antenna. Where applicable, this includes, at least effects caused by bias and latency of their pointing systems, tracking error of closed loop tracking systems, misalignment between transmit and receive apertures for systems that use separate apertures, and misalignment between transmit and receive feeds for systems that use combined apertures.

The SKYLink system addresses these issues in sections 3.1.2.2 Transmit Patterns, 3.1.3.1 Antenna Installation and Calibration and 3.1.3.2 Operational Antenna Pointing.

2.2 Variations in the antenna pattern of the AES. Where applicable, this includes, at least, effects caused by manufacturing tolerances, ageing of the antenna and environmental effects. AMSS networks using certain types of AES antennas, such as phased arrays, should account for variation in antenna pattern with scan angles (elevation and azimuth). Networks using phased arrays should also account for element phase error, amplitude error and failure rate;

The SKYLink system addresses these concerns in sections 3.1.1 Antenna description, 3.1.2 Antenna Patterns and 3.1.3.1 Antenna Installation and Calibration

2.3 Variations in the transmit e.i.r.p. from AES. Where applicable, this includes, at least, effects caused by measurement error, control error and latency for closed loop power control systems. Network control and monitoring centres (NMCS) that calculate the e.i.r.p. of AES based on the received signal need to take into account error sources and latency in this calculation. NMCS that calculate the e.i.r.p. of AES based on input power must account for measurement error and reporting latency.

The SKYLink System addresses these concerns in section 2.4.4 Return Link Power Control.

3. AES that use closed loop tracking of the satellite signal need to employ an algorithm that is resistant to capturing and tracking adjacent satellite signals. AES must

immediately inhibit transmission when they detect that unintended satellite tracking has happened or is about to happen.

The SKYLink System addresses these concerns in sections 2.1.1.3 Antenna Control Unit, 3.1.2.2 Transmit patterns, 3.1.3 Antenna Control, 3.1.3.2 and Operational Antenna pointing.

4. AES should be subject to the monitoring and control by a Network Control and Monitoring Centre (NCMC) or equivalent facility. AES must be able to receive at least "enable transmission" and "disable transmission" commands from the NCMC. AES must automatically cease transmissions immediately on receiving any "parameter change" command, which may cause harmful interference during the change, until it receives and "enable transmission" command from its NCMC. In addition, it should be possible for the NCMC to monitor the operation of an AES to determine if it is malfunctioning.

The SKYLink System meets these requirements as described in Section 2.2.2.2 Network Operations Center and Section 2.4 Network Management.

5. AES need also to be self-monitoring and, should a fault which can cause harmful interference to FSS networks be detected, the AES must automatically mute its transmissions.

The SKYLink System addresses these requirements in section 2.5 Fault Management and 2.5.1 Aircraft Terminal Fault Management

PART B

Essential requirements related to the protection of the Fixed service.

The SKYLink System Application addresses this issue in section 5.2.2 Terrestrial Services

PART C

Essential requirements related to sharing with the Radio Astronomy Service.

The SKYLink System application addresses this issue in section 5.2.4 and separately in a pending coordination agreement with the US National Science Foundation.

PART D

Essential requirements related to sharing with the Space Research Service.

The SKYLink System Application addresses this issue in section 5.2.4 and separately in a pending coordination with the National Aeronautics and Space Administration (NASA).

ANNEX 2

Derivation of a lower hemisphere e.i.r.p. mask from a pfd mask.

This Annex is an expansion on Annex 1 Part B which addresses the essential requirements related to the protection of the fixed service and is covered in section 5.2.2 of the SKYLink Application.

Attachment 2

Page for Page Corrections to Section 5.2.1 of the Technical Description
[Pages 43 and 44]

To avoid harmful interference to other FSS systems from the Return link, the ARINC SKYLink℠ System will manage the aggregate EIRP spectral density of the AISTs in the plane of the GSO arc to the levels required for a routinely processed VSAT network as described in Sections 25.134(a) and 25.209(a)(1) of the Commission's Rules. That is, the aggregate EIRP spectral density of all aircraft transmitting simultaneously on the same frequency will not exceed the mask defined by an input power density of -14 dBW/4 kHz into an antenna with the sidelobe levels of Section 25.209(a)(1). This "EIRP Mask" is shown in Figure 5-1 below and has a main lobe value of +15 dBW/4 kHz. The "Aggregate EIRP Limit" shown in Figure 5-1 is defined by backing off the maximum effective isotropic radiated power spectral density from a SKYLink antenna (with a pattern comprised of the maximum of the 14.0, 14.25, and 14.5 GHz patterns in Figure 3-2) by 10.25 dB, as described in Section 3.1.2.2. The resulting EIRP spectral density has a main lobe value of +4.75 dB..

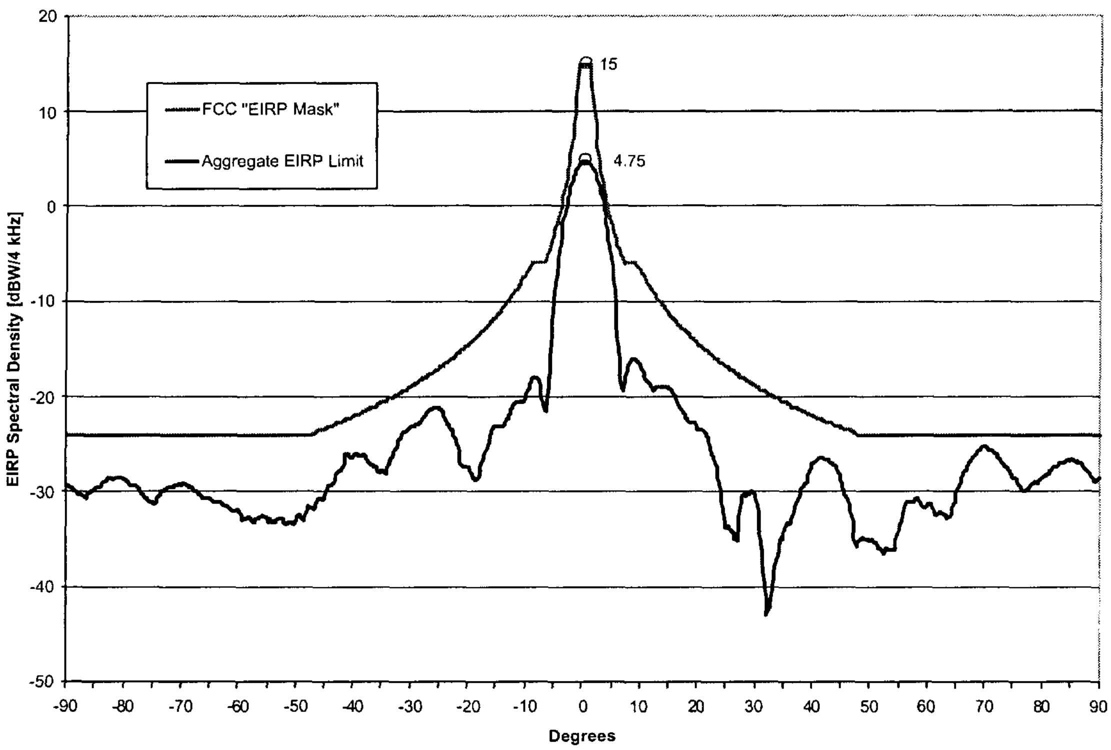

Figure 5-1 Off-Axis Aggregate EIRP Limit and "EIRP Mask"

5.2.1.1 Off-Axis Antenna Gain Patterns

Off-axis emissions requirements are defined by 25.209(a)(1). The SKYLink℠ System utilizes an 11.5" parabolic dish reflector for the Return link antenna. Due to the small diameter, the antenna by itself cannot meet the requirements of 25.209(a)(1). However, by limiting the on-axis aggregate EIRP spectral density to 4.75 dBW/4 kHz, the system will operate at least 1 dB below the "EIRP Mask" and meet the intent of the requirement. The following Figure 5-2 expands the scale of Figure 5-1 to illustrate the 1dB margin. The SKYLink℠ antenna's sidelobe powers all remain below the mask. Figure 5-2 also includes a plot of the output of a typical AES for comparison.

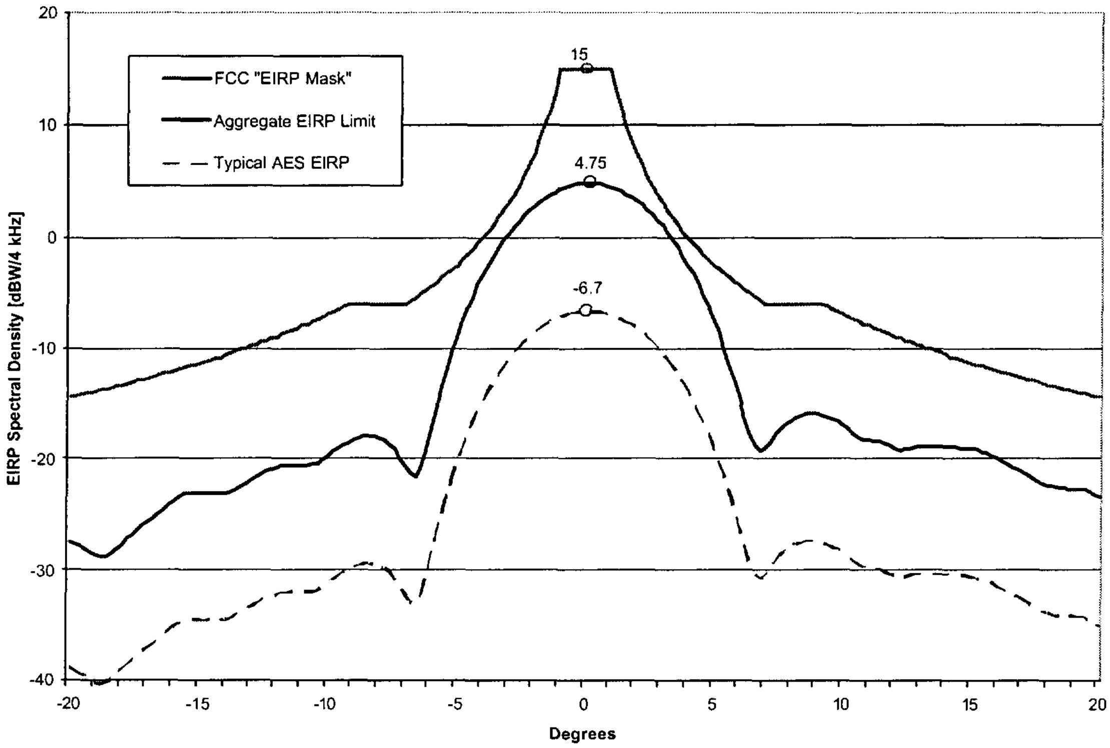

Figure 5-2 Expanded Off-Axis Aggregate EIRP Limit and "EIRP Mask"

In addition, as specified in the Recommendation, ARINC has taken the various factors that can cause the aggregate off-axis e.i.r.p. levels to vary (*i.e.*, mispointing of AES antennas, variations in the antenna pattern of AES and variations in the transmit e.i.r.p. from AES) into account.[4] In terms of pointing accuracy, the ACU corrects for aircraft attitude changes based upon aircraft INS data, without waiting for degradation in received signal strength. *See* Sections 2.2.1.3 and 3.1.3.2. Variations in the antenna pattern of AES and variations in the transmit e.i.r.p. from AES are addressed by the AES transmit power back-off. *See* Section .3.3.1.

Further, as recommended, ARINC's antennas, which use both open and closed loop tracking of the satellite signal, are inherently resistant to capturing and tracking adjacent satellite signals and immediately will cease transmission if they detect unintended satellite pointing has happened or is about to happen.[5] *See* Sections 2.4.4 and 2.4.5. Finally, ARINC has incorporated fault management into both the AISTs and ground support equipment.[6] *See* Section 2.5.

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4 Recommendation ITU-R M.1643, Annex 1, Part A, ¶ 2.

5 Recommendation ITU-R M.1643, Annex 1, Part A, ¶ 3.

6 Recommendation ITU-R M.1643, Annex 1, Part A, ¶¶ 4, 5.

<u>Attachment 3</u>

Page for Page Corrections to Sections 5.2.2 and 5.2.4 of the Technical Description
[Pages 47, 48, and 49]

ITU-R M.1643.[7] These limits are: $-132 + 0.5 \cdot T$ dB(W/m^2)/1 MHz for $T \leq 40°$; and -112 dB(W/m^2)/1 MHz for $40 < T \leq 90°$. The SKYLink℠ System complies with the recommendation when the aircraft antenna is pointed 30° above horizontal (worst case for CONUS) and the aircraft is at 30,000 feet or higher. See Figure 5-4, which includes the effects of airframe masking and has the scale expanded to include the main lobe pointing 30 degrees above the horizontal.

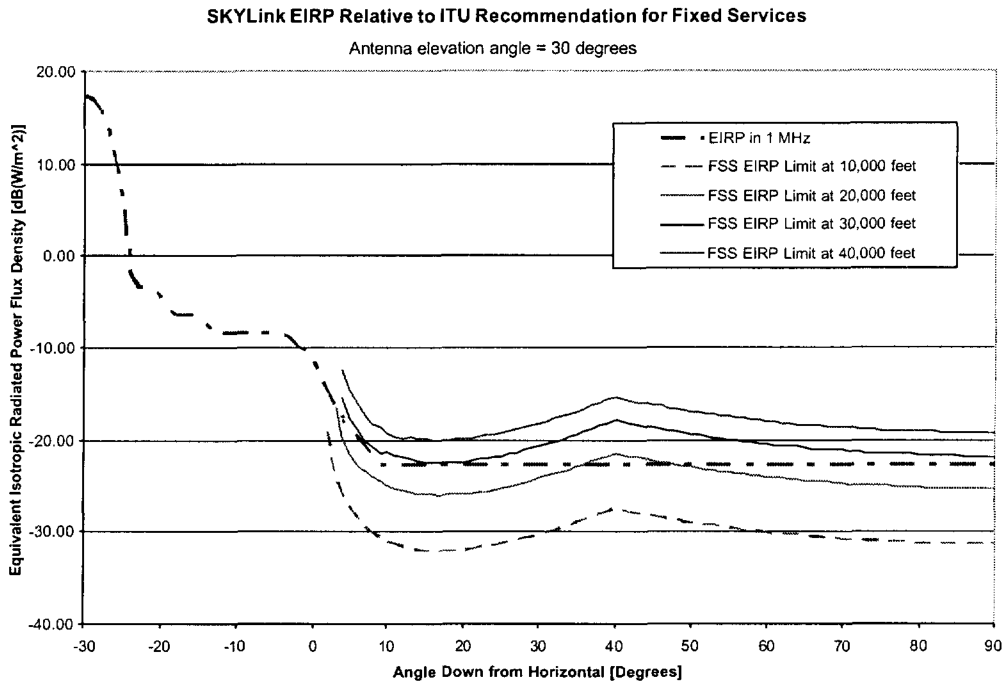

Figure 5-4 SKYLink℠ Output Relative to FSS Recommendation ITU-R M.1643

5.2.3 Land and Maritime Mobile Satellite Services

Both the Land Mobile Satellite Service (LMSS) and Maritime Mobile Satellite Service (MMSS) use GSO FSS satellite transponders. ARINC's demonstrated compliance with the requirements for protection of FSS networks also ensures that the SKYLink℠ System will not cause unacceptable interference to authorized LMSS and MMSS systems even if such systems employed co-frequency transponders on adjacent FSS satellites—which they do not. The CPM Report to WRC-03 supports ARINC's conclusion. It concluded that sharing between an AMSS network and an MSS network "is feasible."[8]

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7 Recommendation ITU-R M.1643, Annex 1, Part B.

8 Report of Conference Preparatory Meeting for WRC-2003, § 2.4.1.3.4.

Specifically, the forward link of the LMSS and MMSS systems employ a spread spectrum signal that is designed to prevent harmful interference to signals received by adjacent FSS satellites. Reciprocally, the mobile terminals of LMSS and MMSS systems must be able to tolerate interference from high power, wideband co-frequency signals of adjacent GSO FSS satellites. The forward link signal of the SKYLink℠ System is indistinguishable from a wideband, high power digital signal on an FSS satellite. Thus, ARINC's forward link signal will not cause unacceptable interference to the receive terminals of LMSS and MMSS systems in the U.S. even if such systems employed co-frequency transponders on adjacent FSS satellites—which they do not.

5.2.4 Government Services

ARINC, with its years of experience of coordinating frequency allocations globally among airlines, is aware that the 14.0 to 14.05 GHz segment of spectrum has been allocated to the U.S. Government for space research and the 14.47 to 14.5 GHz segment has been allocated for radio astronomy. Recommendation ITU-R M.1643 specifies how AMSS should protect both of these services.

To protect radio astronomy, when operating on transponders with an uplink center frequency above 14.44 GHz within the line-of-sight of a radio astronomy station operating in the 14.47 to 14.5 GHz band, the AISTs will cease transmissions in this band. When operating on transponders with an uplink frequency at or below 14.44 GHz, ARINC will ensure that emissions in the 14.0 to 14.47 GHz band meet the PFD limits set forth in the Recommendation.[9] These limits are $-190 + 0.5 \cdot T$ $dB(W/m^2)/150$ kHz for $T \leq 10°$; and -185 $dB(W/m^2)/150$ kHz for $10 < T \leq 90°$. As shown in Figure 3-4, the out-of-band emissions from an AIST are at least 65 dB down at frequencies more than 30 MHz from the band edge. With the antenna elevation adjusted down to 30° above horizontal (worst case CONUS) and the aircraft operating above 30,000 feet, the SKYLink℠ System, operating at or below 14.44 GHz, complies with the recommendation . See Figure 5-5, which includes the effects of airframe masking and out-of-band frequency attenuation.

9 Recommendation ITU-R M.1643, Annex 1, Part C.

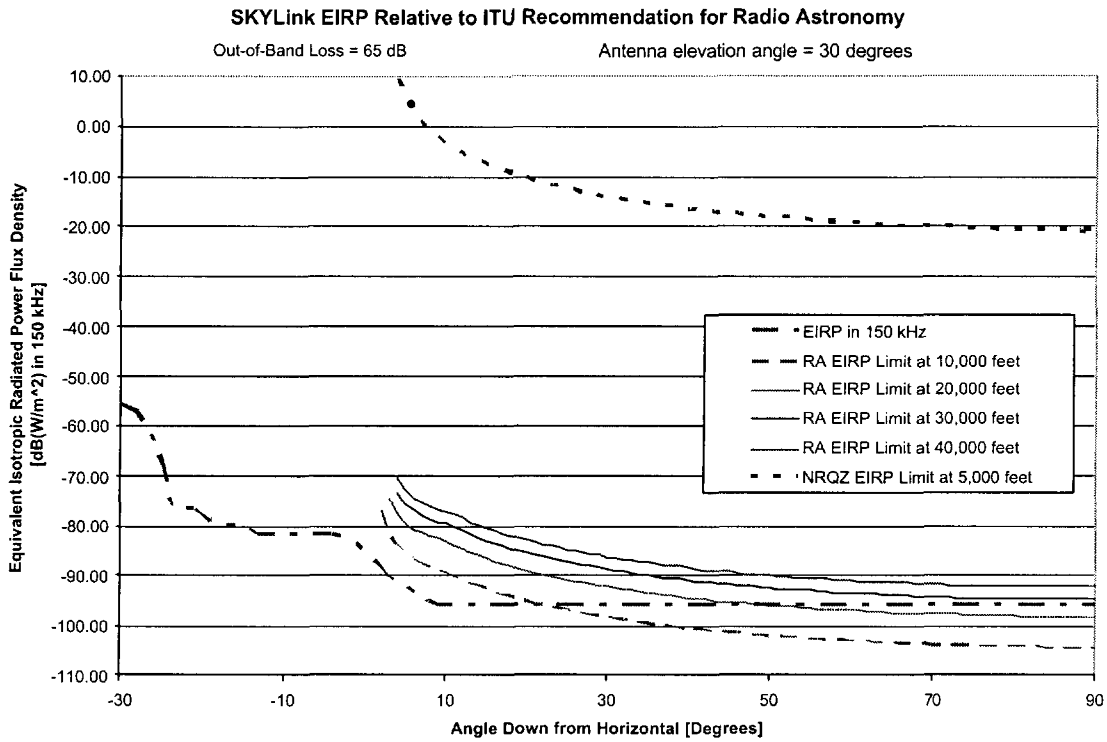

Figure 5-5 SKYLink℠ Output Relative to Radio Astronomy Recommendation ITU-R M.1643

To protect the space research service, ARINC will enter into coordination agreements with space research systems operating in the 14.0 to 14.5 GHz band.[10]

5.2.5 Radionavigation

In taking the steps specified in the Recommendation to avoid interference to radioastronomy and the space research service, ARINC will avoid interference to any existing maritime radionavigation services in the U.S. In any event, there are no records in the ITU Master Register indicating use of the radionavigation allocation in the 14.0 to 14.3 GHz band by any administration. Further, the CPM Report to WRC-03 found that "consideration of compatibility matters has not revealed a problem in the use of this band by AMSS with respect to RNS."[11]

[10] Recommendation ITU-R M.1643, Annex 1, Part D.

[11] Report of Conference Preparatory Meeting for WRC-2003, § 2.4.1.2.2.

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing Response of ARINC Incorporated was sent by first-class mail, postage prepaid, this 28th day of November 2003, to the following:

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