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June 3, 2004

**BY HAND DELIVERY**

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
Office of the Secretary
445 12th Street, SW
Washington, DC 20554

JUN 9

Satellite and
Radiocommunications Division
International Bureau

**Re: Reply to Supplemental Comments of The Boeing Company ARINC Incorporated, SKYLink℠ Application, File Nos. SES-LIC-20030910-01261 & SES-AMD-20031223-01860**

Dear Ms. Dortch:

ARINC Incorporated ("ARINC") hereby replies to the Supplemental Comments of The Boeing Company filed on May 21, 2004 in the above-captioned proceeding,[1] as well as the Further Comments of The Boeing Company ("Boeing") filed on December 18, 2003 ("Further Comments")[2] and the Boeing *Ex Parte* Presentation to the Federal Communications Commission ("FCC") on March 18, 2004.[3] Below and in the Engineering Response attached hereto as Exhibit 1, ARINC demonstrates that the SKYLink℠ system satisfies all applicable technical requirements and provides more than adequate protection to others operating in the 14.0-14.5 GHz band.

Specifically, ARINC shows the following.

- SKYLink℠ system traffic will be monitored and controlled continuously and in real-time at the Network Operations Center ("NOC"). ARINC's AMSS is designed to ensure that aggregate system off-axis equivalent isotropically radiated power ("e.i.r.p.")

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1 Supplemental Comments of The Boeing Company, File Nos. SES-AMD-20031223-01860, SES-LIC-20030910-0126 (filed May 21, 2004) ("*Boeing Supplemental Comments*").

2 Further Comments of The Boeing Company, File No. SES-LIC-20030910-01261 (filed Dec. 18, 2003) ("*Boeing Further Comments*").

3 Letter from Carlos M. Nalda, Steptoe & Johnson LLP, to Marlene H. Dortch, Federal Communications Commission, File No. SES-LIC-20030910-01261 (filed Mar. 18, 2004) ("*Boeing Ex Parte*").

remains below levels routinely authorized for very small aperture terminal ("VSAT") networks *at least 99.999 percent of the time.*

- Although neither FCC regulations nor ITU Recommendations require all AMSS systems to mimic Boeing or employ positive control, SKYLink℠ fully conforms to FCC rules and ITU Recommendations. Most importantly, and contrary to Boeing's contention, the SKYLink℠ system ensures that airborne earth stations ("AES") cannot transmit before receiving and decoding NOC traffic commands. Moreover, ARINC's SKYLink℠ system design properly accounts for potential pointing and other inaccuracies.

Consistent with its seemingly ceaseless stream of filings, Boeing's recent comments foretell flaws in SKYLink℠'s design and hypothesize potentially harmful interference to FSS networks and radio astronomers. Yet, ARINC already completed coordination with *all* adjacent Ku-band providers, and is negotiating with the National Science Foundation on a coordination agreement much like Boeing's. Radio astronomers and FSS operators can speak for themselves; their agreement or silence to date[4] undermines Boeing's gloomy prophecy.

Boeing's sole aim is manipulating the licensing process to delay competition in AMSS. Although delaying authorization of a competitor serves Boeing's private interest, the Commission should not confuse Boeing's objectives with the interests of the public. With this filing, ARINC has addressed and refuted all possible technical concerns.[5] Given that ARINC's application has been pending for nearly nine months, the Commission should expeditiously license the SKYLink℠ AMSS system.

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4 PanAmSat, the only FSS operator to comment on the SKYLink℠ application, "has no objection to ARINC's proposed operations at 103 W.L., and is prepared to sign a coordination agreement to that effect." Comments of PanAmSat Corp., File No. SES-LIC-20030910-01261, at 4 (filed Nov. 14, 2003). PanAmSat, ARINC and SES Americom have since completed coordination; and the final agreement is attached as Exhibit 2.

5 Other concerns raised by Boeing are addressed in the attached Engineering Response; none are realistic or justified. *See* Exh. 1.

## I. The SKYLink[SM] System Will Not Exceed the Off-Axis Equivalent Isotropically Radiated Power for Routinely Authorized VSAT Networks.

More than a year ago, the U.S. successfully secured a secondary AMSS allocation in Ku-band. At this juncture, no one disputes AMSS operations can avoid interfering so long as the aggregate off-axis e.i.r.p. density for all AES transmissions is no greater than the level authorized for VSAT earth stations. Indeed, Boeing insists[6]—and ARINC agrees[7]—the FCC should *routinely license* AMSS AES that meet the VSAT emission mask.[8]

That was then; this is now. Since its Connexion AMSS already has a license, Boeing contrives multiple, uncorroborated technical concerns already "asked and answered." The ironic result is that Boeing itself has ensured licensing SKYLink[SM] has been anything but routine. As detailed in the Engineering Response, the FCC should not be distracted by Boeing's dilatory tactics.

Boeing first insists "the SKYLink[SM] system is designed to comply with the applicable off-axis e.i.r.p. limits for only 99% of the time."[9] This is incorrect. As ARINC previously noted, SKYLink[SM] will *limit aggregate AES emissions under the mask 99.999 percent of the time*. This level of protection "is consistent with—and, indeed is greater than—that previously found acceptable by the FCC,[10] is 10 times

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6 The Boeing Company, Petition for Rulemaking, RM No. 10800, at 22-24 (filed July 21, 2003).

7 Comments of Aeronautical Radio Inc. in Support of Boeing's Petition for Rulemaking, RM No. 10800, at 6 (filed Nov. 3, 2003).

8 That mask is defined by the input power density specified in Section 25.134(a) of the FCC's rules (*i.e.*, -14 dBW/4 kHz) into an antenna with the sidelobe levels specified in Section 25.209(a)(1).

9 *Boeing Further Comments* at 5.

10 Response of ARINC Inc., File No. SES-LIC-20030910-01261, at 7 n.21 (filed Nov. 28, 2003) ("*ARINC Response*") (*citing 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*, 17 FCC Rcd 18585, 18618 (2002) (Further Notice of Proposed Rulemaking)).

better than Boeing demands, and an order of magnitude better than the Connexion AMSS now provides.

Boeing's analysis confuses the SKYLink$^{SM}$ congestion control software's initial proposed level—which is set to reduce data throughput under peak demand conditions[11]—with the total probability of exceeding the mask for any reason. In fact, the SKYLink$^{SM}$ NOC exploits sophisticated traffic algorithms to continuously monitor and control AES traffic in real-time thereby permitting SKYLink$^{SM}$ to "manage AMSS traffic to ensure that the aggregate e.i.r.p. does not exceed the mask set forth in Part 25 more than 0.001 percent of the time."[12]

The attached Engineering Response provides detailed performance predictions and validates the SKYLink$^{SM}$ design. In particular, the total probability of exceeding the VSAT mask in any one transponder was calculated using two Monte Carlo simulations. The first evaluated four sources of e.i.r.p. variation,[13] then derived the cumulative probability that any particular number of simultaneously transmitting AES would exceed the mask.[14] The second calculated the probability distribution of simultaneous transmissions[15] for different numbers of

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11 Boeing's entire traffic analysis depends on its mistaken assumption that the SKYLink$^{SM}$ NMS congestion software is the sole limitation on the probability of exceeding off-axis e.i.r.p. density and that the SKYLink$^{SM}$ system would continuously operate at a level of traffic sufficient to trigger the congestion controller.

12 Engineering Response at 1, attached as Exh.1.

13 The simulation permits SKYLink$^{SM}$ to account for variations resulting from fluctuations in power (e.i.r.p.) as well as amplitude variations and data rate; variations in antenna pattern and gain; and pointing error.

14 In the nominal case of only a single transmitting AES, the aggregate off-axis e.i.r.p. will not exceed the mask, even after taking into account all of the factors that cause variations in e.i.r.p. *See* Engineering Response at Figure 2, attached as Exh. 1.

15 In other words, these simulations consider the probability that a range of simultaneous transmissions at the rate of 128 kbps would exceed the mask, Engineering Response at 3-6, attached as Exh. 1, as well as, for a fixed number of active AES, the probability that a specified number of simultaneous transmissions would occur. *See* Engineering Response at 6-7, attached as Exh. 1.

logged-in AES (and the traffic expected from each).[16] The assumptions underlying ARINC's traffic control model are both reasonable and transparent.

For any given transponder, the overall probability $P_{(EM)}$ that the aggregate e.i.r.p. of a number of logged-in AES would exceed the mask is a function of:

- the number of logged-in SKYLink[SM] AES (N);
- the number of simultaneously transmitting SKYLink[SM] AES (k);
- the probability that k simultaneously transmitting AES would exceed the mask, $P_{(EM|k)}$; and
- the probability that k simultaneous transmissions occur when N AES are logged-in, $P_{(k)}$.

As previously established and shown in greater detail in the Engineering Response, SKYLink[SM] is designed to manage AES traffic in real time such that the probability of exceeding the mask is 0.001 (not 0.01) or less. The Engineering Response provides an example assuming 100 logged-in AES (*i.e.*, N = 100). The first simulation predicts only a 0.0000049 percent chance that, say, ten AES transmitting simultaneously would ever exceed the mask Then, the second simulation predicts only a 3.3 percent chance (again, assuming N = 100) that ten AES would ever transmit at the same time. The total probability that SKYLink[SM] emissions would exceed the FCC e.i.r.p. mask with 100 logged-in AES, $P_{(EM)}$, is the summed product of all such probabilities from 0 to 100 AES—on the order of only 0.00015 percent.[17] That translates to less than 6 milliseconds over the peak busy hour.

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16 The simulation assumed up to 500 active AES, and considered data rate, traffic per user, the factors affecting traffic per user (*i.e.*, business usage and business usage profile versus recreational usage and recreational usage profile), and number of users per aircraft. The probability of a certain number of AES transmitting simultaneously depends upon the number of active AES and the probability that any given AES will transmit at a given time. Since ARINC's AMSS uses satellite capacity covering most of the continental United States, weather and/or emergency air traffic anomalies normally will be confined to narrow areas, and almost never "continental." Thus, typical AES traffic and distribution remain statistically independent for any given universe of AES. *See* Engineering Response at 4, note 5, attached as Exh. 1.

17 Engineering Response at 8, attached as Exh. 1.

Boeing's alternative Monte Carlo simulation is fatally flawed.[18] In order to forecast potential interference, Boeing *assumes ARINC's AMSS exceeds the VSAT mask 1 percent of the time—the very conclusion it claims its simulation proves.* In addition, Boeing postulates SKYLink[SM] GES power levels almost 6.5 dB above the ARINC design. And, Boeing overestimates on-orbit Ku-band spectral density by adding SKYLink[SM] AES emissions *aligned* with the geostationary arc to AES emissions *orthogonal* to the arc, though the latter do not interfere with on-board satellite receivers. The FCC should give Boeing's simulation the significance it warrants—none at all.

In sum, the SKYLink[SM] NOC will manage AMSS traffic so that the probability that the aggregate off-axis e.i.r.p. of the SKYLink[SM] system meets the mask at least 99.999 percent of the time. This is ten times better than Boeing claims ITU Recommendations require. Boeing's contrary conclusions evaporate absent its mistaken reading of the SKYLink[SM] design, and the flawed assumptions distorting the results of its simulation. Thus, the record demonstrates that SKYLink[SM] emissions will remain below the VSAT mask and thus will not interfere with adjacent FSS networks.

## II. The SKYLink[SM] Access Control System is Effective and Lawful.

Boeing asserts "the SKYLink System does not satisfy the 'essential requirement' of positive control for Ku-band AMSS operations."[19] As a consequence, Boeing insists SKYLink[SM] cannot conform to a supposed ITU Recommendation that AMSS AES "be able to receive at least 'enable transmission' and 'disable transmission' commands from the NCMC."[20] As ARINC previously has demonstrated, neither the FCC nor the ITU mandate positive control.[21]

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18 *Boeing Supplemental Comments* at Technical Appendix.

19 *Boeing Further Comments* at 7-12; *Boeing Supplemental Comments* at 6-12.

20 *Boeing Supplemental Comments* at 9 (*quoting* Recommendation IRU-R M.1643, Annex 1, Part A, Section 4).

21 *See ARINC Response* at 3-9; Letter from Carl R. Frank, Wiley Rein & Fielding LLP, to Marlene H. Dortch, Federal Communications Commission, File No. SES-LIC-20030910-01261 (filed Mar. 11, 2004).

In any event, SKYLink[SM] easily satisfies Boeing's test. Boeing fundamentally mischaracterizes the SKYLink[SM] design by ignoring ARINC's real-time, continuous control over AES transmissions. No ARINC AES can transmit even its initial log-in burst until it successfully receives an NMS message containing the Forward Link bulletin board and reconfiguration commands.[22] Put differently, each AES must receive and decode an authorization from the SKYLink[SM] NOC before "enabling transmission." Even by Boeing's definition, SKYLink[SM] employs positive control.[23] By any definition, ARINC's AMSS will not generate harmful interference.

Boeing also renews its claim that SKYLink[SM] cannot be licensed absent an NCMC to monitor and control AMSS traffic. But the ITU Recommendation Boeing cites[24] specifically contemplates an NCMC or "equivalent facility." Boeing's argument ignores the reality that ARINC's proposed NOC is entirely equivalent in function to the Connexion NCMS and thus is fully consistent with Recommendation ITU-R M.1643.

Boeing's reasoning depends on unsupported and self-serving interpretations of ITU Recommendations. The FCC need not play such word-games.[25] Nor should the agency condone Boeing's attempt to manipulate the instant licensing proceeding toward enshrining Connexion as the sole lawful AMSS design. Boeing's existing AMSS is only one possible approach, and the FCC neither claimed to mandate design standards, nor complied with the long-standing prerequisites when doing

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22 The bulletin board specifies the authorized maximum log-in power level, power search step-size, frequency uncertainty range, frequency search step-size, log-in transmit back off period and log-in quiet period. These parameters are determined in real time using an algorithm designed to maximize the probability that a log-in burst is received at the NOC using the minimum transmit power necessary to close the link. Engineering Response at 11.

23 Contrary to Boeing's claims, SKYLink[SM] AES will not cause harmful interference during system log-in. *See* Engineering Response at 12-13, attached as Exh. 1.

24 ITU-R M.1643, Part A.

25 *See* W. Shakespeare, Romeo and Juliet, Act II, scene ii ("That which we call a rose/By any other word/would smell as sweet.").

so.[26] The SKYLink[SM] design is equally consistent with FCC rules and ITU Recommendations, and thus is equally qualified for an FCC AMSS license.

* * *

Boeing's Comments depend on unsubstantiated engineering and a distorted probability analysis unconnected to SKYLink[SM]'s actual AMSS design. However, ARINC's successful coordination with *all* adjacent FSS licensees resolves any genuine technical issue. Boeing's motivation is obvious—shelter from competition in the AMSS market and a technological monopoly over AMSS system design.

The FCC should not be deceived. Though SKYLink[SM] is not identical to Boeing's Connexion, the FCC never mandated any particular AMSS technology, nor should it. Rather, as Boeing elsewhere insists, the *FCC should routinely license any and all AMSS applicants that meet the VSAT emission mask.* And ARINC has shown beyond quibble that SKYLink[SM] complies, and thus will not increase interference. Accordingly, the Commission should dismiss Boeing's claims and promptly permit SKYLink[SM] to provide commercial AMSS to the public—in competition with Boeing.

Sincerely,

Carl R. Frank/HD

Carl R. Frank
*Counsel for ARINC Incorporated*

Enclosure

cc(w/encl.): Thomas Tycz
Karl Kensinger
Robert Nelson

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[26] *See Amendment of Part 73 of the Commission's Rules and Regulations (Radio Broadcast Services) To Provide for Subscription Television Service,* Further Notice of Proposed Rulemaking and Notice of Inquiry, 3 F.C.C.2d 1, 26-27 (1966) (appending Public Notice, Revised Patent Procedures of the Federal Communications Commission (Dec. 1961)).

Frank Peace
Andrea Kelly
Shabnam Javid
Kathryn Medley
Cassandra Thomas
Fern Jarmulnek
Arthur Lechtman

**EXHIBIT 1**

File No. SES-LIC-20030910-01261
File No. SES-AMD-20031223-01860
Call Sign E030205

# ENGINEERING RESPONSE TO BOEING

This engineering exhibit clarifies and defends the Aeronautical Radio Inc. (ARINC) Technical Description contained in its application for authority to provide Aeronautical Mobile Satellite Service (AMSS). This analysis addresses certain concerns that The Boeing Company (Boeing) has raised about the SKYLink[SM] system and demonstrates that those concerns are unfounded.

ARINC already has demonstrated that SKYLink[SM] fully conforms to applicable ITU Radio Regulations and Recommendations.[1] As described in greater detail below, the SKYLink[SM] system design also conforms to Part 25 of the Commission's Rules.[2] Indeed, the SKYLink[SM] system causes less interference to Fixed Satellite Service (FSS) operations in the 14.0-14.5 GHz band than the Boeing Connexion system. Further, adjacent satellite operators have reviewed the SKYLink[SM] system parameters and have certified that they do not anticipate interference from the SKYLink[SM] system. Thus, the Commission should grant ARINC's application without further delay.

## 1.0 THE SKYLINK[SM] SYSTEM WILL COMPLY WITH THE E.I.R.P. LIMITS CONTAINED IN THE VSAT EMISSION MASK.

The SKYLink[SM] AMSS will not cause harmful interference to adjacent satellite transmissions. ARINC's application demonstrated that the SKYLink[SM] Network Management System (NMS) would, for any given Ku-band transponder, minimize the probability of emissions exceeding the FCC's VSAT mask. As SKYLink[SM] demand grows over time, ARINC explained that it will add capacity, spreading traffic over multiple transponders.

Boeing presents numerous and unsupported concerns about adjacent satellite interference. Further, as if it were the measure of all things, Boeing insists "the SKYLink[SM] system is at least 100 times more likely to exceed the off-axis e.i.r.p. limits imposed on AMSS systems to protect primary Ku-band FSS operations than the licensed Connexion system."

Boeing is incorrect and appears to intentionally confuse the SKYLink[SM] congestion control software's initial proposed level — which is set to reduce data throughput under peak demand conditions — with the total probability of exceeding the mask for any reason. The FCC should not be misled by Boeing's tactics. The SKYLink[SM] system will manage AMSS traffic to ensure that the aggregate e.i.r.p. does not exceed the mask set forth in Part 25 more than 0.001 percent of the time. Thereafter, and in addition, the SKYLink[SM] integrated congestion control software provides additional system immunity from exceeding the mask. In sum, the aggregate

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[1] ARINC's March 2004, *ex parte,* consisting of a sworn analysis authored by ITU expert Donald Jansky, fully addresses this issue, which is not further considered herein.

[2] Section 25.134(a) of the FCC rules establishes an emission mask for Ku-band VSAT earth stations defined by an input power spectral density of -14 dBW/4 kHz into an antenna with the sidelobe levels set forth in Section 25.209(a)(1).

e.i.r.p. spectral density of all airborne earth stations (AES) transmitting simultaneously on the same frequency will remain below the mask at least 99.999 percent of the time. Accordingly, not only does SKYLink$^{SM}$ fully comport with the FCC's rules for limiting interference, it is at least ten times better than Boeing's Connexion system.

The following sub-sections:

- provide the e.i.r.p. for a single transmitting SKYLink$^{SM}$ AES;
- demonstrate — through statistical analysis — the effects of statistically independent variations in antenna patterns, power amplitude and pointing accuracy;
- derive the probability that a given number (k) of simultaneous transmissions will exceed the mask, P(EM|k);
- derive — again via statistical analysis — the probability that this number of simultaneous transmissions will occur for a population of active SKYLink$^{SM}$ AES, P(k);
- rebut Boeing's traffic analysis, which is neither descriptive, nor predictive, of SKYLink$^{SM}$; and
- describe the SKYLink$^{SM}$ Congestion Control algorithm, which monitors and manages the number of simultaneous transmissions, further reducing any risk that total spectral density could exceed the VSAT emission mask.

After examining the combined effects of these factors, this section concludes that SKYLink$^{SM}$ will remain below the FCC mask at least 99.999 percent of the time.

## 1.1 Emissions From a Single SKYLink$^{SM}$ AES Fall Well Below the VSAT Mask.

Transmissions from a single SKYLink$^{SM}$ AES have a nominal main lobe value of -6.53 dBW/4 kHz. Figure 1 depicts the e.i.r.p spectral density for one SKYLink$^{SM}$ production AES. Figure 1 clearly demonstrates that the on- and off-axis e.i.r.p. from a single AES falls well below the emission mask contained in Sections 25.134(a) and 25.209(a)(1) of the FCC's rules.

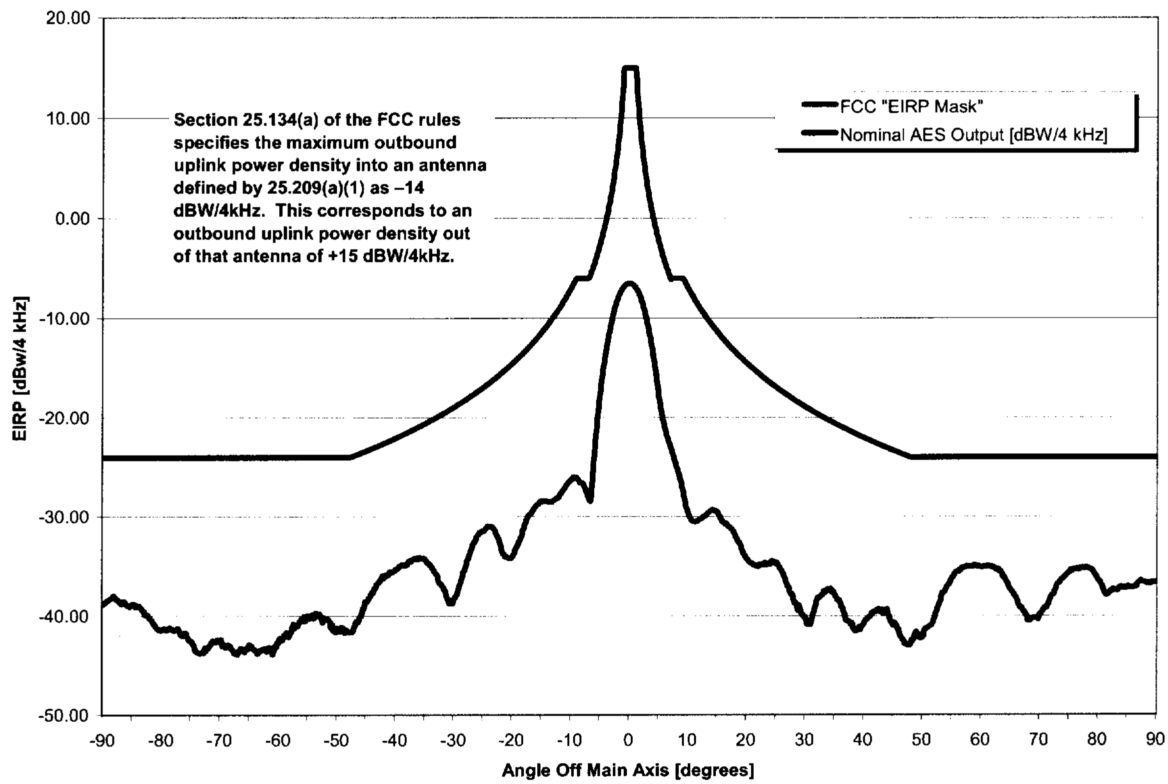


**Figure 1. Measured SKYLink$^{SM}$ AES power (e.i.r.p) (single AES).**

### 1.2 SKYLink$^{SM}$ Considers Variations in Antenna Patterns, AES Power, Spacecraft G/T, plus Pointing Errors to Predict the Probability that Simultaneously Transmitting AES Might Exceed the VSAT Mask.

The SKYLink$^{SM}$ system will deploy multiple AES, which will be assigned to transmit and receive through a common transponder. Four parameters were considered in determining the contribution of each individual AES to the VSAT mask: antenna pattern, power amplitude, pointing accuracy, and data rate. To determine the combined effects of these parameters on e.i.r.p (together with the variability or error in these parameters), ARINC performed a Monte Carlo simulation of multiple AES emissions.[3] The values assigned to each parameter and each type of error were based on the SKYLink$^{SM}$ system design and information supplied by manufacturers (for example, antenna pattern variations and airframe flexure). Where actual values were not available, ARINC used reasonable and conservative estimates. In the case of inertial navigation system pointing error, for example, ARINC simply used Boeing's worst-case assumption. In all cases, the ARINC estimates equaled or exceeded those used in Boeing's

[3] A Monte Carlo simulation repeatedly generates random values for the uncertain variables to predict a system's behavior.

simulation.[4] The distribution (normal or uniform) assumed for each error term was based on experience and the conditions surrounding the variance. As was the case in Boeing's simulation, errors were assumed to be statistically independent, which means that they vary at random from transmission to transmission and from AES to AES.

Table 1 lists the variables and the assumptions used in the simulation.

**Table 1. Factors Affecting AES E.I.R.P.**

| *Parameter* | *Error Estimates and Assumptions* |
|---|---|
| **Antenna Pattern** | ▪ Variations between AES antennas: independent, uniform amplitude variation over a range of +/- 0.4 dB.<br>▪ Greater of E-plane or H-plane values at each point on the mask. |
| **Power** | ▪ Nominal e.i.r.p. spectral density for CONUS coverage area: -6.53 dBW/4 kHz.<br>▪ Aircraft assumed uniformly distributed within the satellite transponder footprint (North American beam coverage).[5]<br>▪ Variations in transponder G/T: independent, uniform amplitude variation with a range of +/- 2 dB.<br>▪ Error in system power control: independent, uniform amplitude variation over a range of +/- 0. 5 dB.<br>▪ The contribution of the fixed Ground Earth Station to off-axis e.i.r.p. is small in comparison to a single AES and does not change over time. |
| **Pointing Errors** | ▪ Each SKYLink℠ AES: rms pointing error of 0.1 degree (ARINC License Application Exhibit 3). This is modeled as an independent, zero-mean normal distribution with a standard deviation of 0.1 degree.<br>▪ Airframe flexure: for aircraft types likely served by SKYLink℠, less than a degree, per the airframe manufacturer. This is modeled as an independent, zero-mean normal distribution, with standard deviation of 0.5 degree.<br>▪ INS "conical error": 0.71 degree (estimate supplied by Boeing in its March 16, 2004, *ex parte*). This error is modeled as an independent, zero-mean normal distribution, with standard deviation of 0.71 degree.<br>▪ Each pointing error is resolved into vector components aligned with, and orthogonal to, the satellite arc. Only the component aligned with the geostationary arc contributes to the off-axis e.i.r.p. |
| **Data Rate** | ▪ AES e.i.r.p. required to "close the link" is directly proportional to the data rate:<br>--Normal data transmission rate: 128,000 bits per second (128 kbps).[6]<br>--Log-in data rate: 32 kbps. |

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4 "A Frequency Sharing Analysis of the ARINC AMSS System With Respect to the Fixed Satellite Service," Supplemental Comments of the Boeing Company, File Nos. SES-AMD-20031223-01860 & SES-LIC-20030910-0126 (filed May 21, 2004) *("Boeing Supplemental Comments")*.

5 ARINC's use of broad-beam Ku-band capacity ensures that weather and/or emergency air traffic anomalies—which might be regional, but almost never "continental"—remain statistically independent for any given universe of AES.

6 Exhibit 3 to the SKYLink℠ Application anticipated data rates of 32, 64 and 128 kbps, with 128 kbps designated as a "premium service." Data derived from an experimental Market Study authorization (Call Sign WC2XPE), has enabled ARINC to determine that 128 kbps will be the normal Return Link data rate. As described in Section 1.5, below, the SKYLink℠ congestion control software may, in peak periods, reduce AES data rates so as to ensure compliance with the FCC emission mask.

The simulation evaluated each of the parameters listed in Table 1 for a single AES and calculated the on- and off-axis power. The net effect of the various pointing errors, power amplitude variations and antenna variations along, and orthogonal to, the satellite arc is shown for a single AES in Figure 2 below.

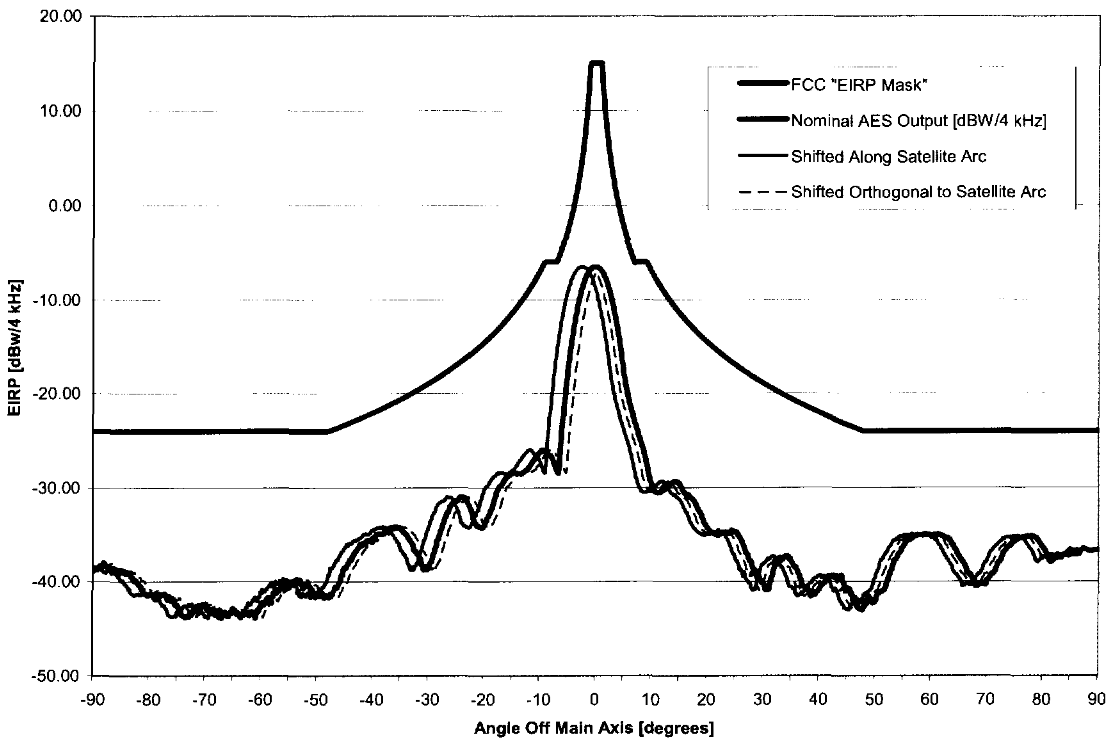


**Figure 2. Effect of E.I.R.P. variations along, and orthogonal to, the satellite arc, per AES.**

As Figure 2 shows, the statistically independent effects of antenna pattern variations, power fluctuation and pointing inaccuracies create commensurate variations in the resulting e.i.r.p. from a single AES. Nevertheless, for any given AES transmission, the cumulative effects of the variations fall well below the FCC's emission mask.

To simulate real-world conditions, ARINC added AES (with characteristics similar to those shown in Figure 2) one at a time. Because the sources of error in Table 1 are statistically independent of each other, each additional AES had its own unique on-axis and off-axis e.i.r.p., which varied from transmission to transmission. With each added AES, the simulation compared the aggregate e.i.r.p. along the satellite arc to determine the number of simultaneous AES transmissions that would exceed the e.i.r.p. mask. ARINC repeated this process *more than 33 million times* to achieve a high degree of confidence in the results of its simulation.

The result of the simulation was the probability, P(EM|k), that an assumed number (k) of simultaneously transmitting AES would generate power spectral densities exceeding the VSAT emission mask. For example, ARINC's simulation predicted that the aggregate e.i.r.p. from ten simultaneously transmitting AES would not exceed the mask more than an inconsequential 0.0000049 percent of the time, i.e., P(EM|10) = 0.000000049.[7]

## 1.3 SKYLink[SM] Continuously Monitors the Number of Simultaneously Transmitting AES in Order to Stay Below the Mask.

The SKYLink[SM] system will serve multiple AES. As demand grows, ARINC will expand its leased Ku-band capacity and assign AES to multiple transponders. Nonetheless, for any particular transponder frequency, the probability that SKYLink[SM] emissions could interfere with adjacent satellite carriers also depends on the likelihood of simultaneous AES transmissions. This, in turn, is a function of the number of installed, active and logged-in AES and the traffic offered by each.

Considering only those AES already "logged-in" to SKYLink[SM],[8] each AES may transmit brief, packetized bursts within a time period specified by the bulletin board message to the AES. To derive the probability that overlapping AES transmissions to a single transponder would exceed the mask, ARINC performed a second Monte Carlo simulation.[9] The likelihood that a given universe of AES would transmit simultaneously is a function of user demand on the system, protocol overhead, data rate and error rate.

Table 2 lists these parameters and the assumptions ARINC used in the second Monte Carlo simulation.

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7 The very small probabilities associated with ten or fewer AES transmitting simultaneously are based on a logarithmic fit to the simulation data with a correlation coefficient $r^2 = 0.9995$. Most of these probabilities contribute so little to the final result, however, they may be considered zero for all practical purposes.

8 Maximum emissions expected during SKYLink[SM] system log-on are fully addressed in Section 3.1 below.

9 In a single simulation such as that used by Boeing, the effect of errors and simultaneous transmissions tend to obscure each other. By separating the problem into independent simulations, it is not only practical to run many more trials but easier to examine the underlying probability distributions and their individual contribution to the whole.

| Table 2. Independent Variables Used to Derive Peak Demand | |
|---|---|
| *Parameter* | *Error Estimates and Assumptions* |
| **Demand per User** | • Business demand per user: patterned on 30-day monthly send and receive volume for ARINC corporate Internet traffic.<br>• Split between business use and Internet recreational use: 60/40 (based on projected use).<br>• Recreational use: assumes a 2:7 ratio of Return Link to Forward Link traffic.[10]<br>• Monthly demand: compressed into 20 days to estimate daily user demand.<br>• Daily (24 hour) demand: compressed into 4 hours to estimate busy-hour peak arrival rate.<br>• Distribution of message sizes: Gaussian, to account for infrequent but occasional very long messages.<br>• Link overhead (e.g., TCP/IP acknowledgements) included in demand. |
| **Users per AES** | • For business jets, this number is assumed to be one. |
| **Data Rate** | • Nominal data transmission rate is 128,000 bits per second (128 kbps). |
| **Error Rate** | • Maximum acceptable bit error rate: 1 in 100,000 ($1 \times 10^{-5}$). |

This Monte Carlo simulation was based on 500 active AES over 7,000,000 trials at 4 millisecond time intervals (equivalent to one Return Link packet). This produced a series of probability distributions for the likelihood of simultaneous transmissions with varying numbers of active AES. For example, with 100 AES logged-in over a single transponder, the probability of ten simultaneous transmissions is P(10) = 0.033. In other words, a population of 100 active (logged-in) AES during the peak busy hour can be expected to generate exactly ten simultaneous transmissions 3.3 percent of the time (a one-in-thirty chance).[11]

## 1.4 SKYLink℠ Actively Manages the Overall Probability of Exceeding the VSAT Mask to Stay Below 0.001 Percent.

The first Monte Carlo simulation (Section 1.2) considered four sources of e.i.r.p. variation and calculated the chance that any particular number of simultaneously transmitting AES would exceed the emission mask. The second Monte Carlo simulation considered the number of logged-in AES and each AES's expected traffic and calculated the probability distribution of simultaneous transmissions for any given number of AES. Without considering congestion control software — discussed in the next sub-section — the overall chance that SKYLink℠ could exceed the e.i.r.p. mask is a product of these probabilities over the range of possible active AES users per transponder.

Contrary to Boeing's assertions, the SKYLink℠ system has been designed to minimize the risk that multiple AES emissions could exceed the VSAT Mask. Knowing how the underlying probabilities affect system behavior permits ARINC to monitor and control SKYLink℠ emissions such that the chance of exceeding the mask is tiny. For any given

[10] The ratio of send to receive traffic is usually cited in the range from 1:3 to 1:8. A ratio of 2:7 was used based on ARINC's experience.

[11] It is also possible that exactly none, one, two, three or all 100 AES could be transmitting at the same time but most of these probabilities will be extremely small.

transponder, the overall performance of ARINC's SKYLink$^{SM}$ AMSS can be calculated using the theorem of total probability as follows:

$$P(EM) = \sum_{k=0}^{N} \{P(EM|k) \bullet P(k)\}$$

where:

1) N = number of logged-in SKYLink$^{SM}$ AES
2) k = number of simultaneously transmitting SKYLink$^{SM}$ AES
3) P(EM|k) = probability of exceeding the mask given k simultaneous transmissions
4) P(k) = probability that k simultaneous transmissions occur with N logged-in AES
5) P(EM) = probability that the SKYLink$^{SM}$ AMSS could exceed the mask

As an example, the first probability (Section 1.2) predicts only a 0.0000049 percent chance that ten AES transmitting simultaneously would exceed the mask -- P(EM|10) = 0.000000049. The probability distribution for simultaneous transmissions (Section 1.3) predicts only a 3.3 percent chance that ten AES would ever transmit at the same time with 100 logged-in AES – P(10) = 0.033. With 100 active AES, the total probability that SKYLink$^{SM}$ emissions would ever exceed the FCC e.i.r.p. mask, P(EM), is the summed product of all such probabilities from 0 to 100 AES:

$$P(EM) = \sum_{k=0}^{100} \{P(EM|k) \bullet P(k)\}$$

For 100 logged-in AES, this equates to exceeding the e.i.r.p. mask no more than 0.00015 percent of the time.

Put differently, when 100 AES are logged-in, the SKYLink$^{SM}$ system will remain below the FCC emission mask fully 99.99985 percent of the time in periods of high demand. During the busy hour, for example, the total expected duration of any transitory interference in this example would be less than 6 milliseconds.[12] At other times, the chances of exceeding the FCC emission mask will be even lower. And because digital SKYLink$^{SM}$ transmissions are both wide-band and "noise-like," such hypothetical interference is unlikely to be detected.

ARINC's SKYLink$^{SM}$ design considered a broad range of conditions associated with e.i.r.p. variation and user demand. The assumptions behind those conditions are logical and well supported. By monitoring system performance and demand, and adding satellite transponders as the number of AES grows, ARINC will manage SKYLink$^{SM}$ to the allowable e.i.r.p. interference threshold and maintain it at or below the mask 99.999 percent of the time. This does not require the brute force transmission control system that Boeing advocates.

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12 The expected value is 0.00015 percent of 3600 seconds.

### 1.5 ARINC's Congestion Control Software Further Reduces SKYLink$^{SM}$ Emissions.

The foregoing analysis shows that active and real-time control at the SKYLink$^{SM}$ system NMS is itself sufficient to ensure there is little risk of co-frequency interference. Nonetheless, ARINC's SKYLink$^{SM}$ design also includes an additional layer of protection through software congestion control. ARINC's NMS congestion controller continuously monitors the number of simultaneous accesses being made to a given transponder during each 250 millisecond interval and reduces the number of packets each AES is permitted to transmit whenever a preset threshold is reached. During non-peak periods, the congestion controller has no impact on traffic.

From the preceding section, where it was shown that the aggregate off-axis e.i.r.p. exceeds the mask less than a 0.001 percent of the time with a large number of AES, the congestion controller will not be required. However, the SKYLink$^{SM}$ congestion control software will remain enabled and intervene should transient conditions ever approach the e.i.r.p. limit.

### 1.6 Boeing's Simulation Uses Erroneous Assumptions to Derive Incorrect Results.

Boeing's Supplemental Comments include a description of a Monte Carlo simulation it performed to model SKYLink$^{SM}$ demand and estimate aggregate e.i.r.p. emissions. Unsurprisingly, Boeing's analysis concludes that the SKYLink$^{SM}$ system poses significant interference risk and will exceed the FCC mask as much as 10 percent of the time. But Boeing's simulation hinges on assumptions that range from unrealistic to untrue and completely disregards the positive control features in SKYLink$^{SM}$. The FCC should dismiss the inferences Boeing draws from its analysis for reasons that follow.

Modeling SKYLink$^{SM}$ demand requires, among other things, a value for the operational duty cycle of each AES, in order to determine the probability of exceeding the aggregate off-axis e.i.r.p. Boeing estimates the SKYLink$^{SM}$ AES duty cycle[13] by working backwards from a particular number of logged-in aircraft (214) and number of simultaneous accesses (38) that would create a 1 percent chance of exceeding the aggregate input power of -24.25 dBW/4kHz.[14] Of course any duty cycle so calculated will always exceed the mask 1 percent of the time. Put differently, Boeing's analysis *assumes the very conclusion it claims to derive from the simulation.* Had Boeing been concerned with actual AMSS operations, it would have used the correct duty cycle of 0.001 percent. By locking its simulation to its repeated (but unproven) assertion that SKYLink$^{SM}$ will exceed aggregate off-axis e.i.r.p. 1 percent of the time, Boeing forfeits any pretense of objectivity or accuracy.

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13 AES duty cycle is the percent of time an AES is transmitting. The ARINC simulation expresses this in equivalent terms as per AES demand during the busy period in order to estimate the maximum probability of exceeding the mask. Boeing neglects to mention that the probability they calculate assumes peak demand conditions and that there is a far lower probability of exceeding the e.i.r.p. limit at other times.

14 *Boeing Supplemental Comments,* Technical Appendix, at 4.

Boeing then incorrectly assumes the SKYLink$^{SM}$ Ground Earth Station (GES) antenna operates at the maximum authorized on-axis output power of 76.4 dBW[15] when, in fact, it runs 6.4 dB below that maximum power, as stated in the link budget submitted with ARINC's FCC license application.[16] This wrongly overstates the contribution of the GES by a factor of at least four.

Finally, Boeing's simulation conflates off-axis e.i.r.p. in the direction of the satellite arc with e.i.r.p. orthogonal to the satellite arc.[17] Thus, the Boeing analysis pre-supposes pointing inaccuracies line-up solely in the direction of other satellites whereas real-world pointing errors are just as likely to steer the antenna in a direction that has no affect whatever on adjacent satellites. For this reason, ARINC's more precise simulation considered both the magnitude *and* direction of each pointing error, resolved into one component in the direction of the satellite arc, and a second component orthogonal to the arc. Only error components aligned with the satellite arc have any potential to interfere with co-frequency satellite networks and the effects of these errors decrease rapidly with even a slight orthogonal mispointing. By accounting for orthogonal errors, SKYLink$^{SM}$ can carry nearly twice the traffic Boeing estimates without exceeding the aggregate e.i.r.p. limit. Boeing's primitive approach considerably exaggerates possible interference, and fatally undermines the simulation's conclusion.

## 1.7 Conclusion.

Boeing claims that the SKYLink$^{SM}$ system will exceed the applicable e.i.r.p. limits 1 percent of the time.[18] But its argument erroneously assumes the sole limit on SKYLink$^{SM}$ composite emissions is ARINC's congestion control software. This just isn't so. Boeing ignores the overall SKYLink$^{SM}$ design, which has been shown to perform better than Boeing's system through Monte Carlo simulations of e.i.r.p. variations (including pointing error) and conservative demand and traffic projections. More importantly, the SKYLink$^{SM}$ system monitors and controls interference levels directly, dynamically and proactively in real-time to ensure an extraordinarily low potential for what is essentially undetectable co-frequency interference. The SKYLink$^{SM}$ system congestion controller software, set initially at 1 percent, is simply additional protection.

ARINC is and will remain a good neighbor in the Ku-band. During experimental flights of the SKYLink$^{SM}$ AES, technicians monitored adjacent GSO satellites for evidence of interference. None was found. Since then, ARINC and its satellite provider have coordinated with adjacent satellite network operators. A full year after system trials and nine months after ARINC first applied for a permanent license, Boeing alone continues with a campaign to delay FCC action.

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15 *Id.*, 7.
16 *See* Section 3.6 below.
17 *Id.*, 5-6.
18 A value of 10 percent was given in *Boeing Supplemental Comments,* Technical Appendix at 4. This appendix, however, is fraught with incorrect assumptions and completely ignores the effects of positive control.

The FCC should move forward with grant of the ARINC application. ARINC's SKYLink[SM] AMSS will operate within the FCC's e.i.r.p. mask more than 99.999 percent of the time. This is not only fully consistent with the FCC's rules, but is an order of magnitude *less* likely to exceed the FCC's emission mask as compared with the already-licensed Connexion system.

## 2.0 THE SKYLINK[SM] SYSTEM CONTROLS AES TRANSMISSIONS CONSISTENT WITH ITU RECOMMENDATIONS.

Boeing claims that the SKYLink[SM] design is based on "negative control," and then asserts that such systems are forbidden by ITU Recommendations. Even ignoring the fact that ITU "Recommendations" are neither binding on the FCC nor mandatory, the first part of Boeing's argument is wrong.

ARINC's design is consistent with Recommendation ITU-R M.1643, Part A of which describes monitoring and control performed by an NCMC or "equivalent facility." Section 2.4 of the Technical Description, appended to ARINC's AMSS Application, describes the SKYLink[SM] Network Operations Center (NOC), an equivalent facility, which provides multi-tiered, positive control over the system at all times. Boeing seemingly ignores the fact that ARINC's NOC is entirely equivalent in function to Boeing's NCMS.

Boeing continues to claim the SKYLink[SM] design does not provide "positive control" without explicitly defining what this means. Instead, Boeing offers several pages of random quotes[19] hinting that "positive control" requires AMSS AES be able to receive network enable and disable transmission commands[20] and not transmit if misaligned.[21]

The SKYLink[SM] access control system fully passes any such test. No AES will be enabled to transmit until and unless it unambiguously receives and successfully interprets NMS bulletin board control protocols. Thus, SKYLink[SM] demonstrably controls all AES and can command any AES to either commence or cease transmission. By any meaningful interpretation of positive control, the SKYLink[SM] system is in compliance.

Boeing takes particular exception to the SKYLink[SM] system log-in protocol, which it claims would allow "an AES to transmit a log-in burst at any time and with increasing power levels once it receives the Forward Link without authorization of the Network Management System…."[22] This is not so. Instead, every SKYLink[SM] AES attempting to log-on — whether on the ground or airborne — must successfully complete a series of actions:

19 *Boeing Supplemental Comments* at 8-12.

20 *Id.* at 9, citing Recommendation IRU-R M.1643, Annex 1, Part A, Section 4.

21 Further Comments of the Boeing, File No. SES-LIC-20030910-01261, at 9 (filed Dec. 18, 2003) ("Existing LMSS and MMSS systems use a transmit-on-command system. This assures that the antenna is properly pointed when transmitting, *since it will not receive a command if the system is not pointing towards the correct satellite…*"), citing ITU-R Document 4A/28.

22 *Id.* at 13.

- Determine that no alarms have been detected upon power up;
- Locate the assigned satellite and transponder;
- Receive at least one complete NMS configuration message (bulletin board) through the assigned transponder; and
- Implement the correct configuration requirements contained in the bulletin board message (center frequency, data-rate, spreading factor, spreading code, authorized transmission power, frequency step-size, amplitude step-size, frequency search and amplitude search limits, etc.).

Any AES that fails any of these conditions — including a mispointed AES — will not receive the bulletin board and thus will not be authorized to transmit log-in bursts. Once the authorized AES log-in request burst is received at the NMS, the AES transmission is then under the direct control of the NMS power-control and congestion control algorithms. But in either circumstance, AES will be under SKYLink$^{SM}$ control so as not to interfere.

## 3.0 OTHER ISSUES.

### 3.1 The SKYLink$^{SM}$ System Minimizes Simultaneous Log-In Bursts.

The SKYLink$^{SM}$ system minimizes the probability that logging-in AES transmit their log-in requests simultaneously. The system employs:

- a two-dimensional search algorithm over frequency and amplitude;
- requires each AES to transmit a single log-in request at a random time during a specified interval; and
- requires an AES to go quiet if it completes the two-dimensional search algorithm but has not successfully logged-in.

The SKYLink$^{SM}$ system uses a "bulletin board" to transmit the relevant search limits (such as authorized maximum log-in power level, power search step-size, frequency uncertainty range and frequency search step-size), the interval over which to randomize a log-in transmission ($T_{backoff}$), and the log-in quiet period to an AES.[23]

The two-dimensional search algorithm requires each AES to first alter the frequency at which it is transmitting, if it does not receive a response from the NMS to its log-in burst. Only after searching all frequencies and receiving no response from the NMS does the algorithm permit an AES to alter its power level. Specifically, each AES will begin its log-in attempt using the initial amplitude and frequency sent in the bulletin board. The initial power level at which the AES will transmit is the *minimum* power necessary to close the link under clear-sky

[23] As noted above, only after receiving a complete bulletin board message from the NMS may an AES attempt to log-in to the SKYLink$^{SM}$ network subject to the conditions defined in that message.

conditions at the best possible location in the link budget analysis. If the AES receives no response from the NMS within 1 second of the expiration of the $T_{backoff}$ interval, the amplitude level remains fixed, the frequency is moved to the next incremental value and the AES transmits another log-in request burst after a randomly chosen period during the next $T_{backoff}$ interval. If the AES again receives no response, the process will repeat until the frequency uncertainty has been eliminated at the minimum power level before proceeding to increment the power setting by ~1 dB. This process continues until the maximum authorized power level is reached.

As a result, the SKYLink^SM login protocol ensures that the *maximum* authorized AES power level is no greater than that necessary to close the link to the Ground Earth Station (GES) under adverse (*e.g.*, rainy) conditions from the worst location in the link budget analysis. This sequential procedure ensures that log-in requests use the minimum transmit power to close the link.

## 3.2 The SKYLink^SM System Prevents Errant Transmissions.

The SKYLink^SM system employs fault management both at the Ground Earth Station (GES) and the AES. Through these safeguards, ARINC ensures that the system does not exceed the limits imposed on all users of the FSS 14.0-14.5 GHz-band.

The GES actively monitors for faults and sends a shutdown command to each malfunctioning AES (or a shutdown command to all active AES simultaneously). When the shutdown command originates at the GES, it will take the link latency time of about 250 milliseconds to be received and executed by each AES.

Each AES has built-in-test (BIT) diagnostics that are activated upon power-up and run periodically thereafter. Any faults detected by the BIT that could cause out-of-tolerance transmissions will trigger immediate shutdown and alarm conditions, with no satellite link latency. Further, a failure in the AES rendering it unable to decode the bulletin board will likewise inhibit the transmission function.

## 3.3. The SKYLink^SM System Will Locate, and Quarantine, Any Malfunctioning AES.

Boeing questions how ARINC will identify a failed AES and prevent it from transmitting, implying that transmissions from malfunctioning SKYLink^SM AES could interfere with co-frequency users of the 14.0-14.5 GHz band. At the outset, ARINC noted that a single failed AES is extremely unlikely to cause any perceptible interference problem on an adjacent satellite system. This is so because the maximum antenna flange power density that a single AES can achieve with its power amplifier at maximum output is quite low. In fact, the maximum emissions from any single, hypothetical errant SKYLink^SM AES could be no more than -29.06 dBW/4 kHz spread over 14.4 MHz when operating at 32 kbps and -32.07 dBW/4 kHz spread over 28.8 MHz when operating at 128 kbps.

Further, ARINC notes that, in the unlikely event that an AES failure is not detected at the NMS or by the BIT and that it continues to transmit on the assigned transponder, the NMS will simply monitor and control it as one of the aggregate users on the transponder so that the total e.i.r.p. is under the mask. A single AES does not have sufficient capacity to cause interference to adjacent satellites under that condition.

Finally, if an FSS operator or customer detects interference in a co-frequency system, the FSS operator will notify adjacent satellite operators, who then take steps to identify the source of the interference and eliminate it. Thus, hypothetically, if a rogue SKYLink$^{SM}$ AES caused harmful interference, SKYLink$^{SM}$ NOC personnel will work with adjacent satellite operators to identify the source of the interference by muting each AES in turn. This will permit the adjacent satellite services operators to monitor their systems and inform the SKYLink$^{SM}$ NOC if the interference disappears, thereby identifying and shutting down a faulty AES.

### 3.4 Issue of the "Worst Case."

ARINC selected Bangor, Maine as representative of a worst case AES site for several reasons. Based upon the contours for that transponder upon which testing has been conducted, that location represents both the worst-case e.i.r.p. and G/T values for the footprints. Further, Bangor is representative of the routes over which AES equipped aircraft would be leaving CONUS coverage on trans-Atlantic flights. Regardless of whether or not Bangor, Maine is the worst case in CONUS, the SKYLink$^{SM}$ NMS continuously and dynamically controls each AES so that the aggregate input power of the system at the geostationary arc is maintained below −24.25 dBW/4 kHz.

### 3.5 Radio Astronomy.

ARINC is working with the National Science Foundation to develop a coordination agreement for all U.S. Radio Astronomy sites NSC operates that make observations in the 14.47 to 14.50 GHz-band. Similarly, ARINC is also coordinating with NASA to avoid conflicts in the portion of the spectrum they share with FSS operators.

### 3.6 Forward Link Antenna Contribution to Off-Axis E.I.R.P.

The Boeing Further Comments assert that the "SKYLink$^{SM}$ Forward Link uses a Section 25.209-compliant antenna that is authorized for an input power of -17.4 dBW/4 kHz, resulting in an off-axis e.i.r.p. of as little as 3.4 dB below the applicable limits without factoring in any AES transmissions."[24] ARINC notes that while the antenna is so authorized, all SKYLink$^{SM}$ Forward Link budgets are based on an antenna flange power density of only -23.01 dBW/4 kHz, leaving a 9 dB margin to the FCC limit of -14 dBW/4 kHz.

The GES Forward Link antenna fully complies with the FCC 25.209 requirements, having a 3 dB beamwidth of 0.3 degrees and a 10 dB beamwidth of 0.5 degrees. At 2 degrees off axis, the gain is down approximately 40 dB. This antenna was professionally pointed to

[24] *Id.* at 19.

center of box and is non-tracking, so any pointing error will be both static and small in comparison to the off-axis limiting contribution of simultaneously transmitting AES.[25]

Since Boeing claims to be concerned that SKYLink[SM] could impair its operations on AMC-4 at 101° West, ARINC calculated the off-axis contribution of its GES to the adjacent AMC-4 satellite — which was *30 dB below the FCC mask.* In fact, the licensee of Boeing's space segment capacity—SES—already concluded that its aMC-4 satellite will not be adversely affected by the SKYLink[SM] system.[26] Boeing's contention therefore does not undermine ARINC's demonstration that the SKYLink[SM] Forward Link does not significantly increase the off-axis e.i.r.p. measured at adjacent satellites.

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[25] *See* Section 1.7.

[26] *See* Exhibit 2.

**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 Reply to Supplemental Comments of The Boeing Company and Engineering Response to Boeing, 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: William M. Kolb

William M. Kolb
Project Manager, SKYLink Program
ARINC Incorporated

Dated: June 3, 2004

Sworn and subscribed to before me this 3rd day of June 2004.

Charlotte L. Mitchell

Notary Public

My Commission Expires: May 1, 2008

CHARLOTTE L. MITCHELL
NOTARY PUBLIC
ANNE ARUNDEL COUNTY, MD
MY COMMISSION EXPIRES: MAY 1, 2008

**EXHIBIT 2**

SES AMERICOM

An SES GLOBAL Company

April 6, 2004

Federal Communications Commission - International Bureau
445 12th Street, S.W.
Washington, D.C. 20554

Subject: Engineering Certification of SES Americom, Inc.

To Whom It May Concern:

This letter certifies that SES Americom Inc. ("SES") is aware that ARINC has before the Federal Communications Commission ("FCC"), the FCC File No. SES-LIC-20030910-001261 (the "Application") as amended, for authority to operate a transmit/receive steerable antenna for Aeronautical Mobile-Satellite Services. ARINC is seeking FCC authorization to utilize the SES Americom satellite AMC-1 at 103 degrees W.L. licensed by the FCC.

SES Americom understands that, as described in ARINC's application, the transmit/receive reflector antenna is an Aeronautical Mobile-Satellite Service steerable antenna manufactured by ViaSat, Inc. The aperture dimensions of the reflector antenna are 29.2 cm by 29.2 cm with a transmit gain of 30.96 dBi at 14.2 GHz and a receive gain of 28.94 dBi at 12.0 GHz. These antennas will operate with an rms pointing accuracy of +/- 0.1 degrees

When communicating with the AMC-1 satellite, ARINC will operate its reflector antenna within the 14-14.5 GHz FSS uplink band, 11.7-12.2 GHz FSS downlink band with a maximum e.i.r.p. of 37.72 dBW, and a maximum total power at the antenna flange of 4.75 W. ARINC will operate direct sequence spread spectrum, offset QPSK at reduced power so that the aggregate off-axis e.i.r.p. transmissions are always equal to or less than that of routinely authorized VSAT transmissions. Specifically, ARINC will operate its system so that the aggregate off axis e.i.r.p. of all antenna transmissions along the geostationary orbital arc shall not exceed:

| Angle off-axis | Maximum e.i.r.p. in any 4 kHz band |
|---|---|
| $1.0° \leq q \leq 7.0°$ | 15 - 25 log q dBW |
| $7.0° < q \leq 9.2°$ | -6 dBW |
| $9.2° < q \leq 48°$ | 18 - 25 log q dBW |
| $q > 48°$ | -24 dBW |

ARINC will maintain these off-axis e.i.r.p. values, by maintaining tight control of the system operation which includes:

1) controlling power in 0.25 dB steps to maintain aggregate e.i.r.p 1 dB below the entire mask
2) control of the number and data rates of users on each transponder to insure that the probability of exceeding that 1dB margin is $< 0.001\%$
3) maintaining rms pointing error to be $\leq 0.1$ degree from Inertial Navigational data every 20 ms
4) network management that inhibits transmission within 250 ms of receive link loss from same transponder
5) fault detection system that terminates transmissions when out of tolerance conditions are detected
6) continuous monitoring/oversight by ground network operations center

SES Americom acknowledges that the use of the above referenced transmit/receive reflector antenna by ARINC, installed and operated in accordance with the above conditions and/or any other operational requirements as specified in the FCC authority granted to ARINC, should not cause unacceptable interference into adjacent satellites operating in accordance with FCC's 2-degree spacing policy. Furthermore ARINC agrees that it will accept interference from adjacent satellites to the degree to which harmful interference would not be expected to be caused to an earth station employing an antenna conforming to the reference patterns defined in Section 25.209 of FCC rules. If the use of this antenna should cause interference into other systems, ARINC has agreed that it will terminate transmissions immediately upon notice from the affected parties.

Sincerely,

J. Londono

Jaime Londono
Satellite Market Development, Director
SES Americom, Inc.

Acceptance by ARINC:

William Kolb
SKYLink Program Manager
ARINC Inc.

Acceptance by PanAmSat:

PanAmSat agrees to operation of the above reflector antenna, ViaSat, Inc 29.2 cm by 29 2 cm reflector antenna, with the technical parameters described herein, and set forth more fully in the underlying FCC earth station application, with respect to the Galaxy-4R satellite at 99 ° W.L. which has a separation of 4 degrees with respect to AMC-1 at 103° W.L.

Mohammad Marashi
Vice President
Customer Support Engineering
PanAmSat Corporation

**CERTIFICATE OF SERVICE**

I hereby certify that a true and correct copy of the foregoing Reply was sent by first-class mail, postage prepaid, this 3rd day of June 2004, to the following:

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