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

In the Matter of	)	
	)	
FINAL ANALYSIS COMMUNICATION SERVICES, INC	)	File Nos 25-SAT-P/LA-95 76-SAT-AMEND-95 79-SAT-AMEND-96 151-SAT-AMEND-96 7-SAT-AMEND-97
	)	
Order and Authorization to Construct, Launch and Operate a Non-Voice, Non-Geostationary Mobile Satellite System in the 148-150.05 MHz, 400.15-401 MHz, and 137-138 MHz bands	)	

To: The Commission

APPLICATION FOR CLARIFICATION AND REVIEW

FINAL ANALYSIS COMMUNICATION SERVICES, INC.

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SUMMARY

Final Analysis Communication Services, Inc. requests that the Commission clarify and review the *Bureau Order* granting it a license to construct, launch and operate a Little LEO system under entirely new operational and spectrum parameters reached by industry settlement. The *Bureau Order* erroneously denies as major amendments certain features of Final Analysis's application submitted to conform to the requirements of the settlement. The resulting license is for a regulatory hybrid design which imposes new restrictions on Final Analysis but precludes technical modifications essential to ensure that the system technically works and has the capability to provide robust competition in this new market.

The *Bureau Order* also unreasonably and unjustifiably applies a different standard to Final Analysis than to other settlement participants, denying many of Final Analysis's proposals outright while approving nearly the exact same modifications by others, or permitting potential interference to be addressed in post-license coordination.

The *Bureau Order* erred in concluding that certain aspects of Final Analysis's Little LEO constellation as requested in its Amendment were not necessary to conform to the spectrum assignments made pursuant to the industry settlement and implementing rulemaking. As valid conforming changes, Final Analysis's amendments should have been unconditionally accepted. Final Analysis's proposed modifications address very specific operational constraints imposed by the settlement: (1) service outages created by timesharing obligations; (2) altered frequency assignments; and (3) a priority to use and reliance upon future allocated spectrum of unknown amount and characteristics.

Even if the amendments were not to be required by the settlement, the Bureau erroneously denied them as major amendments under Section 25.116 of the Rules. The record does not support a finding that the proposed amendments create additional potential interference.

Denial of these amendments is inconsistent with Commission precedent and the treatment of other Little LEO licensees. Final Analysis's proposed constellation changes actually result in a net decrease in system-wide interference potential. Proposals for increased downlink power do not exceed FCC/ITU levels that require coordination. Proposed additional uplink receivers are a design feature that does not involve activation of additional uplink channels. Increased subscriber uplink power, without which the system will not function, is well below a threshold that would impact any other operator.

The *Bureau Order* also appears to "deny" modifications that Final Analysis has not requested, including high data rates and increased downlink subscriber and feeder links and increased uplink feeder links. These aspects of the *Bureau Order* require clarification.

The *Bureau Order* also includes procedural anomalies. It improperly relies upon informal communications from government agencies that do not constitute appropriate inter-agency coordination. It also imposes on Final Analysis coordination requirements for which no notice was given in the underlying rulemaking.

Final Analysis respectfully requests that the Commission clarify and review the *Bureau Order* to approve its entire Amendment. In the alternative, the Commission must declare the settlement to be null and void and to require the Bureau to reopen the second Little Leo processing round for resolution of mutually exclusive applications.

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APPLICATION FOR CLARIFICATION AND REVIEW

I. INTRODUCTION

Final Analysis Communication Services, Inc. ("Final Analysis"), by its attorneys, submits this Application for Clarification and Review, pursuant to Section 1.115 of the Commission's Rules, 47 C.F.R. § 1.115, of the above-captioned order issued on delegated authority.[1] The *Bureau Order* denies portions of an application amended to conform to entirely new "Little LEO" frequency and operational requirements implementing an industry settlement[2]. The resulting license is a regulatory hybrid design that does not work technically and, contrary to the objectives of this proceeding, does not permit implementation of a competitive system.

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[1] *Final Analysis Communication Services, Inc., Order and Authorization*, DA 98-616 (Int'l Bur. rel. April 1, 1998) ("*Bureau Order*").

[2] *See Amendment of Part 25 of the Commission's Rules to Establish Rules and Policies Pertaining to the Second Processing Round of the Non-Voice, Non-Geostationary Mobile Satellite Service ("NVNG MSS" or "Little LEO")*, Report and Order, IB Docket No. 96-220 (rel. Oct. 15, 1997) ("*Second Round Report and Order*") (adopting as an industry settlement a "Joint Proposal" for a frequency band plan mutually agreed upon by E-SAT, Inc. ("E-SAT"), Final Analysis, Leo One USA Corp. ("Leo One"), Orbital Communications Corp. ("ORBCOMM") and Volunteers in Technical Assistance ("VITA")).

The *Bureau Order* contains errors in both fact and law leading to unreasonable and unsupported determinations that Final Analysis's proposals are major amendments under Section 25.116(b) of the Commission's rules, 47 C.F.R. § 25.116(b). There is a complete lack of record support for denial of the amendments on the basis of the creation of greater potential interference. On the other hand, the *Bureau Order* ignores compelling evidence that the amendments must be accepted as required to conform to the *Second Round Report and Order* or as falling within other exemptions under the Commission's rules.[3] The *Bureau Order* also inexplicably and unreasonably accords Final Analysis significantly different treatment than that given other second round licensees on similar issues, applying different standards to reject Final Analysis's application and to grant other similarly situated applications.[4]

Additionally, the *Bureau Order* is internally vague and inconsistent in several respects. This makes it difficult in some cases to determine what actually has been licensed, and appears in other cases to deny amendments that Final Analysis has not even requested.

Finally, in denying certain amendments, the *Bureau Order* improperly relied upon informal inter-agency communications made prior to the completion of the record. This has led to the anomalous and unreasonable result that certain decisions denying crucial amendments were made, not based upon the full record and normal inter-agency coordination, but upon incomplete analyses that did not include consideration of record evidence.[5] Moreover, in some

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[3] 47 C.F.R. §§ 25.116(c)(1) and (4).

[4] *See United States Telephone Association v. FCC*, 28 F.3d 1232, 1235 (D.C. Cir. 1994); *Melody Music, Inc. v. FCC*, 345 F.2d 730, 732 (D.C. Cir. 1965).

[5] The NOAA fax cited at n.86 of the *Bureau Order* is a prohibited *ex parte* communication because it is directed to the merits, was not served on Final Analysis, *and* is not exempt under Section 1.1204(a)(5) as a communication between agencies that "share jurisdiction."

cases the *Bureau Order* relied upon overstatements of the concerns expressed in these informal communications, when under a fair reading they do not require such a result.

For these reasons, Final Analysis respectfully requests that the Commission reverse the *Bureau Order* and find all of Final Analysis's proposals acceptable. In the event that the Commission does not reverse the *Bureau Order* and approve Final Analysis's Amendment, Final Analysis believes it may be compelled to decline the license, in which case the entire industry settlement resolving mutual exclusivity in this proceeding would be invalidated as being incapable of implementation.

Final Analysis respectfully requests expedited consideration of this Application for Review. Final Analysis's closest second round competitor, Leo One, was granted a far more advantageous license well before Final Analysis. Continued uncertainty concerning Final Analysis's license places it at an untenable competitive disadvantage. As a result, regulatory processes, rather than the market, will determine which new entrant will succeed.

II. BACKGROUND

A. Final Analysis Was Compelled to Accept Unforeseen and Severely Limiting Design Constraints to Avoid Mutual Exclusivity in the NVNG MSS Second Round

This proceeding, and all of the circumstances leading up to the filing of Final Analysis's Amendment, are the very definition of "unforeseen circumstances." Virtually all of the technical assumptions upon which Final Analysis's proposed system were based – frequencies, interference conditions and operational parameters – were changed.

After two years of failed effort to accommodate all second round applicants within the limited available spectrum, and due to the necessity of sharing frequencies with government

users,[6] the Bureau finally proposed timesharing with NOAA and DoD, the exclusion of first round licensees, and auctions for the remaining applicants. However, the applicants submitted extensive analyses and market data demonstrating, among other things, that the public would best be served by increasing entry in near-real time markets through the licensing of at least two additional large constellations to compete with an already licensed Little LEO system, ORBCOMM. Only Final Analysis and Leo One ultimately proposed such large constellations. It was not until 1997, however, when two applicants withdrew, that a resolution that could achieve these objectives became possible. With the assistance of the Bureau staff, the remaining applicants identified a band plan which accommodated first round licensees and permitted licensing of three new systems:

- System 1 – a "large" FDMA/TDMA constellation operating primarily in the 400 MHz band to be timeshared with DoD
- System 2 – a "large" FDMA/TDMA constellation operating primarily in the 137–138 MHz band to be timeshared with NOAA (as well as several foreign systems), with 2 downlink service channels in the 400 MHz band (timeshared with VITA) and a priority on assignment of future allocated spectrum for up to 7 additional downlink service channels
- System 3 -- a "small" CDMA system operating in the 137-138 MHz band

System 2 suffers from many limitations, including: (1) far more complicated timesharing with multiple U S and foreign systems, (2) spectrum in the 400 MHz band sufficient only for 2 service links, and (3) reliance upon unspecified future spectrum to round out a full complement of 9 service links. Consequently, both Final Analysis and Leo One desired System 1.

Leo One had consistently stated that it could not implement its business plan in the frequencies included in System 2, and had declared that settlement discussions would fail unless

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[6] Second round Little LEO spectrum is shared with the meteorological satellite systems operated by the National Oceanic and Atmospheric Administration ("NOAA") and the Department of Defense ("DoD")

it was awarded spectrum in the 400 MHz band. In September 1997, Final Analysis was advised by Bureau staff that it would be assigned to System 2. Consequently, although Final Analysis had stated clearly and consistently on the record that it also required the 400 MHz band service link spectrum included in System 1 to implement its system, it was compelled to accept the significantly inferior System 2 to avoid resolution of mutual exclusivity by auction, an outcome vehemently opposed by every applicant but Leo One. Subsequently, a Joint Proposal agreed to by all applicants assigning System 1 to Leo One, System 2 to Final Analysis and System 3 to E-SAT was filed with the FCC and formally accepted in the *Second Round Report and Order*. The *Bureau Order* officially assigned System 2 to Final Analysis.

B. The *Bureau Order* Forces on Final Analysis an Unworkable Regulatory Hybrid Design

To date, Final Analysis has spent about $40 million in building and testing satellites and ground systems under experimental licenses. Based upon this experience, the modifications proposed in Final Analysis's Amendment were developed to conform fully to the constraints imposed by the settlement while ensuring the implementation of an efficient system close to the company's original design. Final Analysis's conforming Amendment includes a modified constellation design to compensate, among other things, for: (1) 35% outages never originally contemplated but now mandated by timesharing with NOAA, (2) the change in service links from VHF to primarily UHF spectrum and (3) the need to build in flexibility to use spectrum of unknown frequency, quantity and characteristics.

In denying several of Final Analysis's proposed changes, the *Bureau Order* completely ignored the significance of many of the constraints placed upon Final Analysis by the *Second Round Report and Order* band plan and forced Final Analysis into a hybrid design that permits implementation of *neither* Final Analysis's original proposal *nor* System 2. The following chart summarizes the significance of these changes:

	1994 Application	2nd Round R&O	1997 Amendment	Bureau Order
Satellites	26 satellites Fulltime	Timesharing	32 satellites Timeshared	26 satellites Timeshared
Availability	85%	N/A	<85%	55%
Receivers on Board	14 (1996 Amend:28)	N/A	40	12? 14? 28? 40?
Uplink Power	10W	N/A	20W	10W
VHF Transmitters	78	N/A	32	78
Downlink Power	12.7dBW	N/A	17.8Dbw	12.7dBW
Service Channels	9 VHF	2 UHF 7 unknown	2 UHF 7 unknown	2 UHF 7 unknown

The hybrid system design resulting from the *Bureau Order* reflects regulatory rather than engineering concerns. This is completely at odds with the Bureau's assertions elsewhere in this proceeding that it intends to leave design decisions to licensees.[7] In fact, the system authorized by the *Bureau Order* simply does not work:

- Limit to 26 satellites in the original constellation configuration at 55% availability (e.g., half the time) precludes service to the near-real time market.
- Downlink power of 12.8 dBW precludes communication to subscriber terminals
- Uplink power of 10W precludes closure of subscriber uplinks and makes subscriber link access to the satellite impossible.
- Prohibition of built-in capability for redundant receivers and operations at higher data rates precludes the use of the future spectrum to which System 2 has a priority.

In summary, the *Bureau Order* requires Final Analysis to design and build a system which it would not choose to build on its own. In fact, contrary to the central policy objective of the *Second Round Report and Order*, the limited availability system authorized in the *Bureau Order* absolutely prevents Final Analysis's from serving as a robust near-real time competitor to the other two large NVNG MSS constellations, Leo One USA and ORBCOMM. Even if all the technical problems are resolved, the system as specified by the *Bureau Order* is a non-

[7] "Indeed, the Commission attempts, when possible, to leave spacecraft design decisions to the space station licensee because the licensee is in a better position to determine how to tailor its system to meet the particular needs of its customers." *E-SAT, Inc.*, Order and Authorization, DA 98-619 at ¶ 26 (rel. Apr. 1, 1998) (citing *Big LEO Notice of Proposed Rulemaking*, 9 FCC Rcd 1094 (1994) at ¶ 11.

commercially viable 26 satellite system able to address virtually the same limited, intermittent service markets as E-SAT's small 6 satellite system. Customers in near-real time market segments that will benefit most from vigorous competition will be denied it.

III. ARGUMENT

A. The *Bureau Order* Erred in Not Concluding That Final Analysis's Amendments Are Necessitated by System 2

The Bureau directed second round applicants to submit conforming amendments, and stated that it would accept unconditionally "only amendments that are necessary to bring an application into conformance with any rules and policies that are adopted in the [*Second Round*] *Report and Order*."[8] In the context of the total interdependence of NVNG MSS system design and market plans, the *Bureau Order* fundamentally erred in applying this test. The Bureau also applied the test to other licensees with opposite results on substantially similar issues.

The *Second Round Report and Order* adopted a frequency plan, but necessarily left virtually all other implementing details to the applicants. The *Bureau Order* states that it was assumed that, other than the changes specified in the Joint Proposal, applicants would operate under originally proposed parameters.[9] However, this is completely unrealistic. The *Second Round Report and Order* imposed substantially different spectrum utilization than contemplated when the original applications were filed. Each applicant in fact found it necessary to make changes not expressly called for by the new band plan. For example, Final Analysis, Leo One (and effectively E-SAT)[10] all proposed increased downlink effective isotropic radiated power ("EIRP") to maintain the ability to provide usable subscriber links despite changes in frequencies and constellation designs. Each of these applicants proposed increases in downlink power

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[8] *Second Round Report and Order* at ¶ 131.

[9] *Bureau Order* at ¶ 63

resulting in power flux density ("pfd") levels within ITU established limits. In the case of other applicants, the Bureau did not presume to second guess the necessity of such changes, but in Final Analysis's case, the changes were denied.

As demonstrated in the record, all of Final Analysis's proposed design changes were required to conform its original proposal to the new features of System 2 not anticipated in 1994:

- Timesharing – Increase of number of satellites, along with changes in orbital planes and inclinations, required to recover most of the availability lost due to timesharing outages to preserve function and commercial viability as a "large" constellation.
- Altered frequency assignments – Increase in satellite downlink power required to adjust for different operational characteristics,[11] while maintaining pfd within ITU limits; and increase in uplink transmitter power required to adjust for "noisiness" of assigned spectrum.
- Expectation of future spectrum – Adjusted satellite design required to include redundant receivers and higher data rate capabilities for unknown future spectrum.

Thus, the *Bureau Order* erred in concluding that Final Analysis's entire Amendment was not required to conform to the *Second Round Report and Order*.

B. The Bureau Erred in Denying Final Analysis's Proposed Modifications as Major Amendments

Pursuant to Section 25.116(b) of the Commission's rules, the *Bureau Order* concludes that several of Final Analysis's proposed changes constitute "major amendments" as a result of an increase in potential interference.[12] As demonstrated below, these conclusions are in error.

(Cont.)

[10] E-SAT's reduction in orbit altitude effectively increases downlink power.

[11] For example, communications in UHF frequencies (400 MHz band) have greater signal (space) loss than communications in VHF frequencies (137 MHz band) and the same subscriber downlink communication would require either an increase in satellite transmit power or the use of a more directional and expensive antenna.

[12] Section 25.116(b)(1) sets forth three alternative and exclusive definitions of a "major amendment" as one that either (1) changes orbital locations; (2) changes the proposed frequencies, or (3) increases the potential for interference. In the context, of this Little LEO round, where orbital location, alone, is not meaningful and frequency changes have been

(Cont...)

1. Constellation Design

Final Analysis's Amendment proposes an increase from 26 to 32 operational satellites and a decrease in the inclination of the satellite's orbital planes from 66° to 51°. In determining that these changes would increase the potential for interference, the *Bureau Order* mistakenly relied upon comments raised by two parties, NOAA and Leo One. However, relevant technical analyses, applied consistently with prior Commission treatment of similar issues for other licensees, requires the conclusion that no greater potential for interference is created.

First, the *Bureau Order* refers to concerns raised by NOAA that a larger number of satellites will create greater footprint overlaps.[13] This reflects an overly simplified assessment of the impact of the change. In fact, as stated in Final Analysis's Interference Probability Study, in a timeshared context, the addition of satellites can create a greater potential for interference to NOAA only if two conditions are present: (i) a greater number of footprint overlaps are created between the Final Analysis and NOAA systems, and (ii) the overlapping satellites transmit at the same time on the same frequency.[14]

(Cont.)
mandated by rulemaking, only the third alternative definition, an increase in potential for interference, is applicable.

[13] *See Bureau Order* at n 86 (citing Memorandum from Frank Eng and Bill Daniels of CSC to Dave McGinnis of NOAA, Office of Systems Development, Regarding "Graphs on the Visibility of Final Analysis Satellites" dated January 30, 1998 (the "NOAA Footprint Overlap Study")) Procedural issues arising from the *Bureau Order's* reliance on these communications are discussed below

[14] *See* Final Analysis Opposition to Leo One Petition to Deny, filed on Dec. 15, 1997 at Appendix A "A Probability Study of the Effect on Potential Interference to NOAA Satellites from the Modification to the FAISAT Constellation Design" ("Final Analysis Interference Probability Study") To be consistent with Commission standards for analyzing radio signals for measuring the probability of interference, a study must take into account all specific factors affecting signal propagation in a specific wireless service, such as variation in terrain, population density, or geographic market boundaries *See Florence MetroNet, Inc.*, 67 Rad. Reg. 2d (P&F) 767 (Com. Car. Bur. 1990); *Houston Cellular Tel. Co.*, 72 Rad. Reg. 2d (P&F) 388 (Com. Car.

(Cont...)

As an initial matter, it must be stressed that the relevant comparison for measurement of the potential effect of the change is between (i) Final Analysis's 1994 Application, including the originally proposed constellation design at the originally requested frequencies and (ii) the Amendment, including the reconfigured constellation operating under the frequency constraints of System 2. A proper analysis comparing these two system demonstrates that the overall potential of interference to NOAA has actually decreased.

As summarized in the table below, Final Analysis originally proposed 26 satellites, transmitting over three (3) VHF transmitters (each transmitter operating within FCC/ITU pfd limits). Under its Amendment, Final Analysis's 32 satellites will be operating with only one (1) VHF transmitter[15] operating within FCC/ITU pfd limits. Thus, whereas Final Analysis's originally proposed system would operate in the VHF bands shared with NOAA with the equivalent of 78 transmitters. (26 x 3 =78), its proposed system as amended would operate with the equivalent of only 32 transmitters (32 x 1 = 32).

1994 Application	26 satellites 3 VHF transmitters	**78** VHF transmitters
1997 Amendment	32 satellites 1 VHF transmitter	**32** VHF transmitters

(Cont.)
Bur. 1993), *Pikes Peak Broadcasting Co.*, 77 Rad. Reg. 2d (P&F) 1448 (Cable Services Bur. 1995)

[15] In its Amendment, Final Analysis states that it will operate a maximum of 9 service downlinks, but that it would have 10 service transmitters on board each satellite, of which one (1) is for VHF transmissions, two (2) are for UHF transmissions, and seven (7) are reserved for future spectrum. In the event that all 9 service downlinks can be accommodated in UHF and other future spectrum, the VHF downlink transmitter will only be used for feeder links. For purposes of timesharing NOAA/VHF spectrum, only the VHF transmitter can possibly cause interference by transmitting in the NOAA footprint. This discussion is more fully explained in the attached Appendix I, which also considers the effect of timesharing, which is not considered above

The Commission has previously deemed such a change to be a minor amendment. Specifically, in the *ORBCOMM First Round Authorization Order*, the Commission approved an increase in satellites from 20 to 36 – almost a two-fold increase – as a minor amendment. Due to ORBCOMM's reduction in the number of transmitters per satellite, the Commission found that the modification reduced system-wide pfd levels:

> This channel reduction, even taking into account the increase in EIRP, will actually result in a significant net decrease in power flux density from the original proposal. This reduction....will more than offset the effects of higher satellite visibility and lower satellite orbit, and thereby reduce the potential interference into the STARSYS system.[16]

There is absolutely no justification for applying a different evaluation to Final Analysis. The effort in the *Bureau Order* at ¶15 to distinguish the ORBCOMM decision actually makes Final Analysis's case. In the case of both the ORBCOMM and Final Analysis amendments, the combined effects of the increase in satellites with the reduction in service downlink channel spectrum is a net decrease in potential interference.

Thus, NOAA's expressed concern with footprint overlaps is a false issue. In any event, the NOAA inputs relied upon in the *Bureau Order* regarding footprint overlaps cannot reasonably support the conclusion that the change in constellation design creates greater potential interference. First, NOAA's expression of "concern" cited in the *Bureau Order*[17] was only preliminary, as it was transmitted to the FCC on December 4, 1997, prior to Final Analysis's December 16, 1997 Opposition to Leo One's Petition to Deny ("Opposition"), which contained technical analyses demonstrating no increase in potential interference. Furthermore, the NOAA Footprint Overlap Study dated January 30, 1998 simply set forth a comparison as to the number of NOAA and FAISAT satellites in view with respect to footprint overlaps at different

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[16] *ORBCOMM First Round Authorization Order*, 9 FCC Rcd at 6749 ¶ 19

elevations. NOAA recommended coordination requirements rather than denial of Final Analysis's proposal for a larger constellation, and in fact observed that a problem would only occur if the satellites actually failed to operate as proposed.[18] NOAA also never reached any conclusion as to the probability of interference.[19]

Final Analysis has demonstrated on the record that, for a probability analysis to be meaningful, a mean number must be combined with an appropriate standard deviation.[20] In this regard, the statement in the *Bureau Order* that Final Analysis's proposed modifications "will not increase the standard deviation" but will increase the "mean number" of overlaps makes no sense. As indicated in Table 2 of the attached Appendix I, the mean, considered alone, has a confidence level of only 50% -- in layman's terms about as reliable as a coin toss. The same Table also shows that mean +1 sigma has a confidence level of 84% and mean +3 sigma has a confidence level of 99.9%. Using the highest confidence level of mean +3 sigma, there is no

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(Cont.)

[17] *Bureau Order* at ¶¶ 47, 50.

[18] The chief communication from NOAA on which the Bureau relies in concluding that Final Analysis's satellite increase will increase the potential for interference to NOAA consists of a pair of one-paragraph memoranda evidently e-mailed from NOAA contractor Frank Eng to Dave McGinnis of NOAA which are dated, respectively, December 4 and December 15, 1997 (collectively, the "Eng Memoranda"). *See Bureau Order* at n.86 (citing Letter from Jim Vorhies, NTIA to Harry Ng, FCC, dated December 29, 1997 attaching the Eng Memoranda).

[19] The NOAA Footprint Overlap Study cited at n.86 of the *Bureau Order*, which is defective in several respects, is analyzed in detail in Appendix I, attached hereto. It also bears emphasizing that the Final Analysis level of footprint overlaps with a 32 satellite system in any case is significantly less than NOAA had already necessarily accepted when it agreed to the timesharing proposal put forth in the *1996 Second Round NPRM*, IB Docket No. 96-220, FCC 96-426 (rel. Oct. 26 1996), which contemplated the possibility that NOAA would share with other second round applicants, including Leo One with a 48 satellite system.

[20] *See* Final Analysis Opposition filed on Dec. 16, 1997 at Appendix A, Probability Study.

increase in the probability of footprint overlaps, either globally or between 35° to 55° elevation, between NOAA and the reconfigured Final Analysis constellation.[21]

Second, Final Analysis's proposed constellation reconfiguration also will create no increased potential of interference to Leo One with respect to uplinks in the 148 MHz band. Leo One claims that "an increase in the number of operational satellites in lower orbital inclination would increase the number of satellites in view contending for uplink DCAAS channels in the 148-149.9 MHz band."[22] This argument plainly contradicts the position taken in the record below where Leo One itself proposed a timesharing agreement that would have required a greater number of satellites to share uplinks in a smaller section of the 148 MHz band.[23]

In any event, there is no correlation between the number of satellites in a Little LEO constellation and the level of demand on uplink spectrum. As the Bureau stated in the *ORBCOMM Second Round Authorization Order*, where the assigned downlink spectrum capacity naturally limits the amount of data that can be transferred by a system:

> The proposed modifications will increase the geographic coverage of each satellite, but will not increase the amount of data the system can transfer in a given time because it is limited by the downlink spectrum. Accordingly, the proposed modifications will not increase ORBCOMM's utilization of the uplink spectrum that it shares with the other narrowband Little LEO systems and thus

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[21] *See* Figure 1 and Table 3 of the attached Appendix I. As the NOAA communications relied upon in the *Bureau Order* raise a new concern regarding footprint overlaps in latitudes below 50°, the Attached Appendix I also calculates the potential for increased footprint overlaps for latitudes 35° to 55°, the most populated areas.

[22] *See Bureau Order* at ¶ 47 (citing Leo One Petition to Deny at 8).

[23] In its system "A-B" band-sharing plan submitted in the *Second Round* Report *and Order* proceeding, Leo One proposed to share an even narrower segment of the 148 MHz band with Final Analysis as well as ORBCOMM, E-SAT and the (now withdrawn) systems of CTA and GE/Starsys, constituting a total of 132 satellites. In comparison, presently, even if Leo One were required to share with the additional proposed Final Analysis satellites, it would only have to share with a total number of 86 satellites in a wider segment of the 148 MHz band than was available when Leo One proposed its A-B Band-Sharing Plan. *See* Comments of Leo One USA Corp., filed in IB Docket No. 96-220 on Dec. 20, 1996 at 32-6, Appendix F.

will not impact the amount of uplink spectrum available to other Little LEO systems. (Emphasis added.)[24]

In other words, messages will not be sent up if there is not enough spectrum to get them down. The capacity of downlink spectrum available limits use of uplink spectrum to the same amount. Notably, in considering the ORBCOMM's request in the first round to increase its number of satellites from 20 to 36, the Commission did not even consider the impact of an increase in satellite number on use of the uplink spectrum. Although there is no technical difference in the effect of ORBCOMM's and Final Analysis's proposals, the former was accepted and the latter was unreasonably and inexplicably denied.

2. Increased Downlink EIRP

The *Bureau Order* erred in determining that Final Analysis's proposal to increase the maximum downlink transmit power level (the EIRP) from 12.8 dBW to 17.8 dBW (an increase of 5 dBW) constitutes a major amendment. The *Bureau Order* is actually internally inconsistent on this issue, finding in ¶¶ 30 and 44 that Final Analysis has certified operations within acceptable pfd levels in the 137 MHz and 400 MHz bands respectively, but stating in ¶ 67 that "[a]lthough Final Analysis argues that this impact [of its proposed power increase] should be 'comfortably in the acceptable range,' it will nontheless result in increased potential for interference." The Bureau's disposition of Final Analysis's amendment on this point is not supported by international standards, is starkly at odds with its approval of the exact same proposals made by other licensees, and is not required by the record.

The relevant measure of whether a proposed power increase causes increased potential interference is the resulting pfd level on the ground.[25] Under ITU standards accepted and

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[24] *See Orbital Communications Corp.*, Order and Authorization, DA 98-617 at ¶ 24 (Int'l Bur. rel. Mar. 31, 1998) ("*ORBCOMM Second Round Authorization Order*") (emphasis added).

[25] *See* 47 C.F.R. § 25.142(a)(2) (ref. Table of Frequency Allocations footnote 647B).

applied by the FCC, a pfd of −125.0 dB(W/m^2/ 4 kHz) is the benchmark established for coordination of MSS systems. Final Analysis's proposed downlink power level results in a pfd of −127.8dBW in the UHF bands and −126.0dBW in the VHF bands. In both cases, the resulting pfd levels are well within the accepted international margin. The *Bureau Order* completely fails to explain why the change should nonetheless be considered a major amendment.[26] The result in the *Bureau Order* is even more inexplicable in comparison to the treatment of other licensees:

Company	Amendment	Pfd Level	Bureau Action
Final Analysis	12.8dBW to 17.8dBW	-127.8dBW (UHF) -126.0dBW (VHF)	Denied
Leo One	12.7dBW to 21dBW	-125.1dBW	Approved
E-SAT	Satellite altitude reduced	Increased pfd	Approved
ORBCOMM	No limit specified	-125 dBW	Approved

Leo One's proposed power increase from 12.7dBW to 21dBW in the UHF band (an increase of 8.3 dBW, much higher than Final Analysis's proposed increase) was approved, even though the resulting pfd was −125.1dBW, only marginally within the ITU limit.[27] Rather than finding its downlink EIRP increase to be a defective major amendment, as it did with respect to Final Analysis, the Bureau approved Leo One's request, merely conditioning its authorization on completion of downlink adjacent channel frequency coordination with Final Analysis, NOAA and foreign systems operating in the downlink band.

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[26] In its Opposition, Final Analysis submitted detailed results of several years of R&D based both on lab tests and actual flight hardware measurement demonstrating that its out-of-band emission is even well within the limits established in the voice-sensitive cellular industry, which are more stringent than required. Notably, the *Bureau Order* does not dispute that Final Analysis's use of Gaussian Minimum Shift Keying ("GMSK") modulation provides a sufficient emission mask to suppress out-of-band emissions and minimize the threat of adjacent channel interference resulting from its increased EIRP. *See* Final Analysis Adjacent Channel Out of Band Emission Study, attached to Opposition to Leo One Petition to Deny, filed on December 15, 1997, at Appendix B.

Similarly, the Bureau found that E-SAT's proposed reduction in satellite altitude was not necessary to conform to the System 3 spectrum assigned to it in the *Second Round Report and Order*, but concluded that because the resulting increase in pfd should be within the same level as that previously allowed in the GE-Starsys system, it was not a major amendment.[28]

Finally, with regard to alleged degradation of CDMA systems, denial is not supported by the record. The record, and the *Bureau Order* itself, shows that Final Analysis will operate within acceptable pfd limits Moreover, the only CDMA system at issue, E-SAT, did not complain of any increased potential interference.[29]

3. "Increased" Uplink Channels

The *Bureau Order* mistakenly rejects as a major amendment Final Analysis's proposal to build additional uplink receivers into its satellite design. This decision is also inconsistent with prior Commission determinations that the use of uplink channel scanning techniques as well as downlink channel constraints obviate the need for *a priori* limitations. Finally, it is contradicted by the treatment of E-SAT, whose proposal for a far greater increase in continuous uplink channels was approved subject only to post-license coordination.

First, other parties have misstated, and the *Bureau Order* mistakenly repeats, that Final Analysis has proposed an increase in uplink channels from 12 to 40. In fact, in its 1994

(Cont)

[27] *See Leo One USA Corp.*, Order and Authorization, DA 98-238 at ¶ 29 (Int'l Bur., rel. Feb 13, 1998) ("*Leo One Authorization Order*")

[28] *See E-SAT Authorization Order* at ¶ 26.

[29] Elsewhere, the Bureau has stated: "Historically, we have left inter-system coordination of satellite systems to the satellite licensees themselves, because they are in the best position to weigh the technical and economic trade-offs inherent in any coordination agreement." *Leo One Authorization Order* at ¶ 23

Application, Final Analysis proposed 14 uplink channels. In its 1996 amendment,[30] Final Analysis increased the number of proposed uplink channels from 14 to 28 in anticipation of the allocation in Region 2 of additional spectrum for Little LEO uplinks made available at WRC-95.

In its 1997 Amendment, Final Analysis proposed to build in a total of 40 uplink radio receivers to enhance the future reliability, flexibility and efficiency of its satellites, which are designed to have an in orbit life of 7 years. Unlike operational channels that can be accommodated in the assigned spectrum, not all proposed receivers will be activated now.[31]

In any event, the Commission previously has declined to place any *a priori* limit on the number of uplink receivers. Specifically, In the *First Round Little LEO Report and Order*, the FCC rejected just such an approach proposed by Leo One's predecessor-in-interest "dbX." Specifically, dbX proposed that "the pool of channels available to an individual FDMA/TDMA operator for mobile-to-satellite links be limited to 40."[32] The Commission declined to place an arbitrary limit on the number of uplink channels as requested by dbX because it was confident that ORBCOMM could effectively share uplink channels with other applicants using Dynamic Channel Activity Assignment System ("DCAAS") polling techniques.[33] In its 1997 Amendment, Final Analysis stated with regard to proposed service uplinks, "[it] will perform

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[30] In Final Analysis's amendment submitted in 1996, no specific number of uplink subscriber channels were identified by Final Analysis in the 148 MHz band, because under the Scanning Telemetry Activity Receiver System ("STARS"), "the STARS receiver on-board the satellite will scan this band in 2.5 kHz steps and identify unused channels [which] will be assigned as uplink frequencies for the RTs and MTs." *See* Final Analysis Amendment, dated February 23, 1996, File No. 79-SAT-AMEND-96, at III-5.

[31] *See* October 1997 Amendment at n 28.

[32] *First Round Little LEO Report and Order*, CC Docket No. 92-76, 8 FCC Rcd 8450, 8455 n 38 (1993)

[33] *See Id.*

STARS or DCAAS operation in [the band 148-149.81 MHz band] to find available channels."[34] Final Analysis's subscriber uplink channelization plan has always been based on the STARS/DCAAS random polling technique and, consistent with prior Commission views of such techniques, should not be subject to an artificial limit as to the designed-in number of receivers.

Similarly, the *Bureau Order's* rejection of Final Analysis's satellite uplink design is completely contrary to the Commission's determination elsewhere that no increase in interference will be created where downlinks remain limited. Under System 2, Final Analysis is limited to implementing only two, and at most three out of its originally proposed nine service downlinks until such time as additional spectrum may be allocated. In the *ORBCOMM Authorization Order*, the Bureau found that ORBCOMM's proposed increase in geographic coverage would not increase interference where ORBCOMM could not "increase the amount of data the system can transfer in a given time because it is limited by the downlink spectrum allocation." It is the same here. Final Analysis's ability to uplink subscriber data is inherently limited by the limited amount of channels available in the downlink spectrum assigned to it.

Finally, the *Bureau Order's* rejection of Final Analysis's proposal to increase the designed-in receivers starkly contrasts with the Bureau's approval of E-SAT's proposal to increase its operation of simultaneously operating uplink channels from 12 to 81. In the case of E-SAT, the Bureau stated that it would not interfere with the licensee's spacecraft design and would "not set an arbitrary limit on the number of simultaneous E-SAT uplink transmissions."[35]

As there is no possibility of increased potential interference from Final Analysis's proposed modification, there is no justification for denying Final Analysis the ability to build its

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[34] Final Analysis Amendment at 32 and at Fig. II-7 "System 2 Frequencies".

[35] *E-SAT Authorization Order* at ¶ 26 (emphasis added).

satellites to accommodate future conditions, especially in view of the fact that System 2 relies upon future allocations. Instead, this denial precludes efficient spectrum utilization.

4. Increased Uplink Subscriber Power

The *Bureau Order* erroneously deemed Final Analysis's proposal to increase subscriber uplink power a major amendment. First, as demonstrated in Appendix II, real world tests conducted through Final Analysis's experimental Little LEO program on the FAISAT-2v satellite launched in 1997 have determined that the actual noise level environment is much worse than originally anticipated when the original second round Little LEO applications were filed in 1994. Based upon this experience, Final Analysis has determined that a change in subscriber uplink power from 10W to 20W is essential to enable user terminals to communicate with the satellite. Without this change, a functional system is impossible.

The *Bureau Order* also mistakenly accepts Leo One's claim that its uplink signal would be overpowered in the event that a Leo One subscriber and a Final Analysis subscriber attempted simultaneous uplink transmissions. Final Analysis has demonstrated that it would require transmissions at 150W to 300W, not just 20W, for such overpowering to occur. Thus, there is no possibility of increased potential interference to Leo One from the proposed modest increase in increasing its uplink subscriber power [36]

Similarly, the *Bureau Order* erred in finding that "any increase in Final Analysis's user terminal transmit power will result in a corresponding increase in the inter-system noise level for all Little LEO systems..." *Bureau Order* at ¶ 64. This will not be the case in the event, as anticipated, that Little LEO operators successfully implement channel polling techniques such as ORBCOMM's DCAAS and Final Analysis's STARS systems.

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[36] The data concerning actual environmental and space conditions taken from FAISAT-2v experimental activities are described in attached Appendix II.

C. The Commission Must Clarify Other Aspects of the Bureau's Order that Appear to Deny Amendments for Which No Operational Authority was Requested

1. The Bureau's "Denial" of Final Analysis's Conforming Data Rates as "High" Data Rates Was Improper

The *Bureau Order* appears to deny Final Analysis's "high" data rates. However, as shown in the chart below, Final Analysis has proposed changes in data rates to suit its new frequency assignment. System 2 frequencies not only differ from those utilized by Final Analysis in its original Application, but they include channels of a wide variety of bandwidths. As illustrated below, "denial" of Final Analysis's Amendment data rates appears to create the absurd result of approving the higher data rates proposed in the 1994 Application. In any event,

Links	1994 Application	1997 Amendment	Different Frequency Assignment
Service Uplinks	19.2 & 9.6 kbps	9.6 kbsp	Yes
Service Downlinks	19.2 & 9.6 kbps	19.2 kbps	Yes
Feeder Uplinks	54 kbps	28 kbps	Yes
Feeder Downlinks	38.4 kbps	112 kbps	Yes

none of the proposed data rates may be considered "high" as each conforms with the specified emission designators, and is within the parameters of System 2.[37] The Commission should clarify that Final Analysis is approved to operate at the rates specified in its Amendment.

Final Analysis's Amendment also describes the range of its satellites' data rate capability in the service uplink as being between 1.2 to 307 kbps.[38] As clearly stated in its Amendment, this is an expression of the range of data capability to be built into Final Analysis's satellites, not

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[37] The implication from the Bureau's calling the data rates "high" is that they exceed what the spectrum assigned to System 2 can support. This is not the case. As clearly stated in Final Analysis's letter cited by the Bureau "the baud rates identified in the Amendment have been conformed to optimize bandwidth utilization in accordance with the corrected emission designators" specified by the FCC. *See* Letter from Counsel for Final Analysis to The Secretary, FCC, dated November 12, 1997.

[38] Final Analysis Amendment at Figure II-8.

a current request for authorization to operate at 307 kbps. This built-in flexibility to operate at a variety of data rates in the future is necessary to take advantage of the future spectrum of currently unknown bandwidth and emission characteristics. Denial of Final Analysis's ability to design such capabilities into its satellites completely vitiates the priority for future spectrum upon which the ultimate success of System 2 will rely.

2. Downlink Subscriber Links, Downlink Feeder Links and Uplink Feeder Links Have Not Increased

Final Analysis did not propose an increase in the number of downlink subscriber links, downlink feeder links or uplink feeder links, thus, there was nothing for the Bureau to "deny." The Commission should clarify that Final Analysis is authorized to operate within System 2.

In its Amendment, Final Analysis requested nine (9) service downlink channels, three (3) feeder downlinks, and one (1) feeder uplink. In its original Application, Final Analysis requested 9 service downlinks, 4 feeder downlinks (one more than in the Amendment), and 1 feeder uplink.[39] Therefore, Final Analysis's Amendment requests authorization for one less channel than in its original Application. Citing Leo One's Petition to Deny and Final Analysis's own Amendment, the *Bureau Order* misquotes the Amendment as stating that it "proposes to modify the design of its communications payload by increasing the number of downlink subscriber links (from 9 to 12), downlink feeder links (from 3 to 4), and uplink feeder links (from 1 to 4)."[40] The

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[39] *See* Application at Table II-6, p. II-9 and Fig. II-13, p. II-19.

[40] *See Bureau Order* at ¶ 55 n.94 (citing Final Analysis Amendment at 24-25). In fact, the *text* of the Amendment cited by the Bureau states that ". . . [f]ull implementation of [Final Analysis's] modified system *would optimally call for* twelve (12) service downlink channels, four (4) feeder downlinks and four (4) feeder uplinks operating at 307 kbps. However, we will begin implementing our constellation by using the limited spectrum assigned to System 2." Amendment at 24-5.

Bureau, citing Leo One's arguments, has misread Final Analysis's Amendment as proposing an increase when no such proposal has been made.[41]

D. Even as Major Amendments Final Analysis's Modifications Should be Permitted Under Applicable Exceptions

The *Bureau Order* erred in summarily rejecting Final Analysis's Amendment as not justified by the exceptions to the major amendment rule set forth in Section 25.116(c)(1) and (4) of the Commission's rules.[42] The *Bureau Order* appropriately concludes that the public benefits of the industry settlement justify a waiver under Section 25.116(c) to avoid deeming Final Analysis's application a major amendment that must be deferred to a new processing round.[43] But the Bureau inexplicably rejects individual amendments, despite the fact that they have been made only to implement the Joint Proposal.

Every proposed change in Final Analysis's Amendment is intended to help achieve a robustly competitive system, as contemplated by the industry settlement and the *Second Round Report and Order*. As such, all of Final Analysis's proposed changes are acceptable under Section 25.116(c)(1) as contributing to the resolution of frequency conflicts with other pending applicants. Similarly, all of the proposed changes are acceptable under Section 25.116(c)(4) as made to accommodate the new parameters of System 2 which were unknown and unforeseeable

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[41] As was acknowledged in the *Bureau Order* at ¶ 35, the *Second Round Report and* Order did not assign specific feeder link spectrum in the 137-138 MHz band. Final Analysis plans to utilize spectrum in the 137-138 MHz band primarily for feeder links, and to place subscriber links primarily in the 400 MHz band. Final Analysis has been granted in the *Bureau Order* at ¶¶ 32-36, the flexibility to determine whether and how many subscriber links can in fact be placed in the 137-138 MHz band. Thus, to conform to the particular characteristics of the spectrum included within System 2, the precise number of subscriber vs. feeder links may not be known until coordination with other users is completed.

[42] In particular, Section 25.116(c)(4) creates an exception for an amendment that "does not create new or increased frequency conflicts, and is demonstrably necessitated by events which the applicant could not have reasonably foreseen at the time of filing" the original application

at the time Final Analysis submitted its original proposal.[44] Particularly in the absence of any demonstrable increase in potential interference, the *Bureau Order's* flat rejection of Final Analysis's critical constellation modifications is unjustified and unreasonable.[45]

E. The *Bureau Order* Reflects Procedural Anomalies That Have Denied Final Analysis Due Process

The *Bureau Order* relied heavily upon communications from NTIA and NOAA in denying Final Analysis's proposed constellation reconfiguration as a major amendment. However, the "official" coordination input from NTIA concerning Final Analysis's license, dated March 26, 1998, did not address the issue of the number of satellites or proposed modifications to orbital planes and inclination.[46] Instead, the *Bureau Order* cited two informal communications, including emails from NOAA contractor Frank Eng (the "Eng Memoranda"), and a letter dated December 29, 1997 from Jim Vorhies of NTIA to Harry Ng of the International Bureau (the "Vorhies Letter") repeating the substance of the Eng Memoranda.

Neither the Eng Memoranda nor the Vorhies letter were ever served upon Final Analysis or placed in the public record prior to the release of the *Bureau Order*, and the Eng Memorada were done before the filing of Final Analysis's Opposition.. The substance of Mr. Eng's

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(Cont.)

[43] *Bureau Order* at ¶ 13

[44] *See Louisiana RSA No. 8 Limited Partnership*, 1997 WL 738104 (Wireless Tel. Bur. 1997) (approving proposed expansion of cellular licensee service area as exception to the major amendment restriction where, *inter alia*, a market settlement it entered into after filing its original application was an unforeseeable event).

[45] *See, e.g., Bureau Order* at ¶ 51. In rejecting an application for a license, the APA requires that the agency, at a minimum, explain why an alternative result was not reached. *See Achernar Broadcasting v. FCC*, 62 F.3d 1441 (D.C. Cir. 1995); *see also Citizens to Preserve Overton Park v. Volpe*, 401 U.S. 402 (1971).

[46] *See* Letter from William T. Hatch, Dep. Assoc. Administrator, Office of Spectrum Management, NTIA, to Regina Keeney, Chief, International Bureau, FCC dated March 26, 1998 (the "Hatch Letter"), *cited in Bureau Order* at ¶ 44 n.78.

message was relayed to Final Analysis on January 23, 1998 by letter from Mr. Vorhies of NTIA to Mr. Grimes of Final Analysis. Mr. Grimes responded in a letter dated February 26, 1998, demonstrating that Final Analysis's increased constellation would still produce less potential interference than NOAA committed to accept under the conditions established by the FCC in the *NPRM*. Neither Mr. Grimes' letter response nor any other information provided by Final Analysis on the record or directly to NTIA or NOAA on the issue of the constellation configuration was reflected in NTIA/NOAA communications to the FCC.

Not only do the Eng Memoranda and the Vorhies letter reflect incomplete analyses, but the reliance placed upon them in the *Bureau Order* is also misplaced.[47] Neither Mr. Eng nor Mr. Vorhies ever recommended that the proposal for increased satellites be denied. Thus, the informal and preliminary NTIA/NOAA material should not have formed the basis of a final determination in the *Bureau Order* that NOAA objected to the increased constellation.

Also, the *Bureau Order* at ¶ 39 imposes a new substantive rule on Final Analysis requiring its immediate shut-down upon detection of a time-sharing failure with NOAA. This is nowhere in the rules on time-sharing with NOAA adopted in the *Second Report and Order* and violates the prohibition on agency rulemaking without notice or opportunity for comment in

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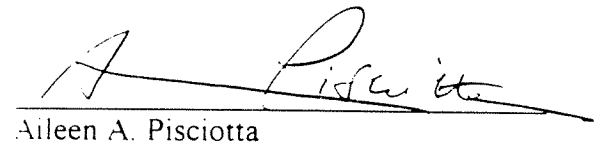
[47] The letter states that "review of the three amended applications to date point out the following . . . Change in number and inclination of satellites means more interference potential." *See* Hatch Letter. In support, the letter refers to the Leo One's Petition to Deny, filed December 4, 1997, and to attachments to the Vorhies letter consisting of internal emails from December 4 and 15, 1997 from Frank Eng, contractor to Dave McGinnis of NOAA. These emails reflect the same analysis as in the Leo One Petition to Deny that a larger Final Analysis constellation may increase satellite footprint overlaps, particularly at lower altitudes. Mr. Eng expressed the view in his December 4 email that it was the possibility of faulty operations, i.e., that Final Analysis would not operate as proposed, that created the risk of increased potential interference. In his December 15 email, Mr. Eng indicated that these concerns could be addressed through monitoring arrangements.

Section 553 of the APA, 5 U.S.C. § 553. Final Analysis should also be accorded the same opportunity given to others to address such issues in post-license coordination.

IV. CONCLUSION

For the reasons stated, Final Analysis respectfully requests that the Commission reverse those portions of the *Bureau Order* denying certain aspects of Final Analysis's proposed system as major amendments and approve Final Analysis's amended system altogether as required to conform to the *Second Round Report and Order* and otherwise acceptable under the Commission's rules. In the alternative, the Commission must declare the Joint Proposal to be null and void and require the International Bureau to reopen the second round NVNG MSS proceeding for the resolution of mutually exclusive applications.

FINAL ANALYSIS COMMUNICATION SERVICES, INC.

By 

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Dated May 1, 1998

APPENDIX I

The Effect on Potential Interference to NOAA Satellites from the Modification to the FAISAT Constellation Design

FINAL ANALYSIS

April 28, 1998

The Effect on Potential Interference to NOAA Satellites from the Modification to the FAISAT Constellation Design

Introduction

Final Analysis has been allocated downlink spectrum in the 137-138 MHz band on a time-shared, non-interference basis with NOAA. In order to conform with the Report and Order, the following goals were established:

1. Recover lost system availability due to time-sharing by increasing the number of on-orbit satellites.

2. Reduce any potential increase in interference with NOAA of the modified constellation design.

3. Do not exceed the potential increase in interference with NOAA caused by the Leo One constellation design of 48 satellites. (*This self imposed constraint is based on the fact that during the NPRM proceedings NOAA only stated they would time-share with no more than one Little-LEO system. NOAA did not specify a preferred system. Therefore, NOAA necessarily accepted a 48 satellite system inclined 50 degrees if the one system they would time-share frequency with was deemed to be Leo One.*)

Interference only occurs when a Final Analysis satellite (FAISAT) is transmitting in a frequency band actively being used by a NOAA satellite and its ground footprint is overlapping the ground footprint of the NOAA satellite. Both conditions must happen simultaneously for interference to occur. A FAISAT satellite transmitting at a NOAA frequency when it is not commanded to do so (the first condition for interference) is a failure scenario. The probability of this failure occurring is negligible and therefore the potential for interference is also negligible. The FAISAT constellation design affects the number of ground footprint overlaps (the second condition for interference). Although the number of footprint overlaps per se is not itself sufficient to draw conclusions about potential interference, Final Analysis completed a study which shows that a modified constellation design incorporating 32 operational satellites on orbit can be implemented without affecting the effective number of ground footprint overlaps over the globe.

Constellation Designs

This study compares the two proposed FAISAT constellation designs, which are described as follows:

> The original design included 26 operational satellites on orbit placed in four primary planes of six satellites each inclined at 66 degrees and two supplementary planes of one satellite each inclined at 83 degrees. The four primary planes were arranged asymmetrically at an altitude of 1000 km. Each satellite can transmit 100% of the time.
>
> The modified design includes 32 operational satellites on orbit placed in six primary planes of five satellites each inclined at 51 degrees and two supplementary planes of one satellite each inclined at 83 degrees. The six primary planes were arranged symmetrically. The altitude was left unchanged at 1000 km. Each satellite can only transmit 65% of the time on average due to the time-sharing requirements with NOAA.

Table 1 shows that the requirement to time-share NOAA frequencies on a non-interference secondary basis actually decreases the number of available satellites from 26 to 21. Also, the number of VHF downlink channels per satellite was decreased from three to one. Therefore, the net power flux density on the ground has actually been significantly reduced on a system level because the total active VHF downlink channels for the modified system is only 21 versus 78 for the original system.

Table 1: Comparison of Available Satellites

	Original Constellation	**Modified Constellation**
Operational Satellites on Orbit	26	32
Time-sharing Requirements	None	NOAA frequency available on a non-interference secondary basis
% of Time Satellites can Transmit	100 %	65 %
Available (or Transmitting) Satellites	**26** (= 26 x 1.0)	**21** (= 32 x 0.65)
Number of VHF Downlink Channels per Satellite	3	1
Total Active VHF Downlink Channels for the System	**78** (= 3 x 26)	**21** (= 1 x 21)

Methodology

The orbits of the NOAA-14 satellite and all the satellites of the two proposed FAISAT constellation designs were propagated for a 24 hour period (13+ revolutions about the earth). Ground footprint overlaps were calculated at zero degree elevation angles). The number of ground footprint overlaps were determined from the perspective of the NOAA satellite. This is the only method that protects against potential interference to all NOAA ground receivers within the NOAA satellite's ground footprint. Data was also generated for the 48 satellite Leo-One system.

Next, for each constellation design the mean and standard deviation, or sigma, of ground footprint overlaps were calculated. The mean plus three sigma statistics were compared. As shown in Table 1, the mean plus three sigma statistic provides the highest level of confidence and it is the statistic of choice in the aerospace industry.

Table 2: Comparison of Statistical Parameters

Statistic	% of Population Included in the Statistic	Confidence Level
mean	50 %	Low
mean + 1 sigma	84%	--
mean + 2 sigma	97.7%	--
mean + 3 sigma	**99.9%**	**High**

Finally, ground footprint overlap statistics were calculated as the sub-vehicle position of the NOAA satellite traversed the latitude range of 35 to 55 degrees. In order to calculate these statistics, the propagation period was increased to 96 hours since the NOAA satellite spends only a fraction of its time in this latitude range.

Results

The modifications to the FAISAT constellation design increased the mean number of satellites in overlap by only one (from 7 to 8) which is offset by the fact that the standard deviation decreased by one (from 2 to 1). As presented in the Final Analysis Conforming Amendment, a comparison of the mean + 1 sigma statistic for the two constellations shows that there is no increase to the effective number of ground footprint overlaps. For the highest level of confidence (mean + 3 sigma), the statistics show that the constellation design change does not increase the potential interference to a NOAA satellite.

Figure 1 and Table 2 summarizes the statistics of ground footprint overlaps for the two constellation designs. The modified constellation design results in a smaller standard deviation of ground footprint overlaps due to the symmetric arrangement of planes which results in a more uniform distribution of footprints over the globe. Also, NOAA satellites are placed in sun-synchronous orbits of high inclination and lowering the orbital inclination of the FAISAT constellation design from 66 to 51 degrees provides greater

separation and decreases the time that the satellites would be near each other. Therefore all the modifications made to the FAISAT constellation design (the symmetric arrangement of planes and lowered inclination) are required in combination to allow an increase in operational satellites (from 26 to 32) while decreasing footprint overlaps and therefore the potential interference to NOAA. Figure 1 also shows that the footprint overlaps for the 32 satellite constellation is much less than the overlaps for the 48 satellite constellation.

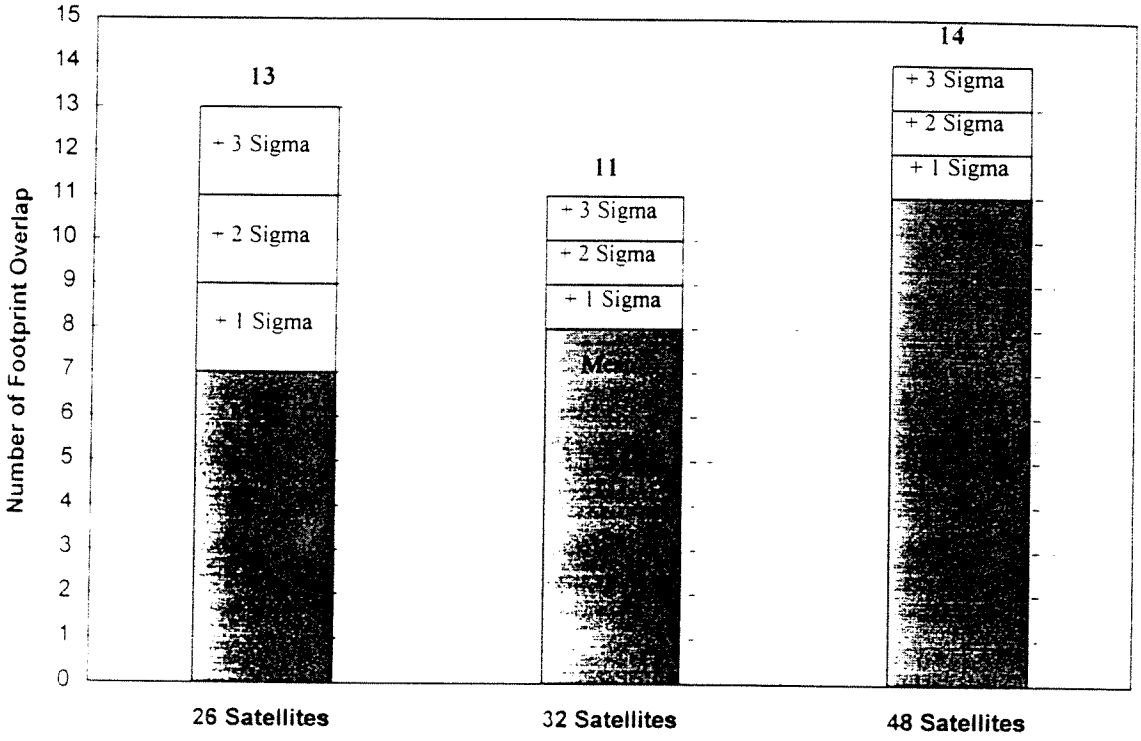

Figure 1: Comparison of Overlap Statistics

Table 3: Statistical Parameters versus Constellation Design (Global Coverage)

Statistic	26 Satellites	32 Satellites	Delta (32 - 26)	% Change
Mean	7	8	+ 1	+ 14%
Standard Deviation (Sigma)	2	1	- 1	- 50%
Mean + 1 Sigma	9	9	0	0%
Mean + 3 Sigma	13	11	- 2	- 15%

Table 3 presents the statistics for the number of satellite footprints overlaps as the NOAA satellite traverses the 35 to 55 degree latitude range. Although potential interference should be determined on a global basis since both the FAISAT and NOAA systems are global systems, this data has been included because it is of interest to NOAA. The statistics show that the constellation designs result in equivalent footprint overlaps and therefore the design change does not increase the potential interference to a NOAA satellite.

Table 4: Statistical Parameters versus Constellation Design (35 to 55 degrees Latitude)

Statistic	26 Satellites	32 Satellites	Delta (32 - 26)	% Change
Mean	7	7	0	0%
Standard Deviation (Sigma)	1	1	0	0%
Mean + 3 Sigma	10	10	0	0%

Comments on NOAA/CSC Analysis

On January 30, 1998 NOAA submitted to the FCC an analysis conducted by CSC which also attempted to determine the impact to ground footprint overlaps from the proposed modification to the FAISAT constellation. This analysis had two major flaws. An incorrect methodology was used and an incorrect metric was used to compare the constellations.

1) The NOAA/CSC methodology is incorrect.

The number of ground footprint overlaps must be determined from the perspective of a NOAA satellite. This is the only method that protects against potential interference to all NOAA ground receivers within the NOAA satellite's ground footprint. The Report and Order states that if a FAISAT satellite's ground footprint overlaps the ground footprint of a NOAA satellite then the FAISAT cannot use the downlink frequency of that NOAA satellite. The NOAA/CSC analysis incorrectly determined the number of footprint overlaps from the perspective of a single specific NOAA ground receiver. Their analysis underestimated the total number of overlaps. As illustrated in Figure 2, neither Faisat-1 nor Faisat-2 can use the frequency the NOAA satellite is transmitting at because the footprint of each satellite is overlapping the footprint of the NOAA satellite. However, the single specific NOAA ground receiver illustrated in the figure fails to determine that Faisat-1 must be restricted because it does not have a line-of-sight to Faisat-1 (the receiver is not within the footprint of Faisat-1). Therefore, counting ground footprint overlaps from the perspective of a NOAA satellite is more rigorous than counting overlaps from the perspective of a single specific NOAA ground receiver because all NOAA receivers that are within the NOAA satellite's ground footprint are protected.

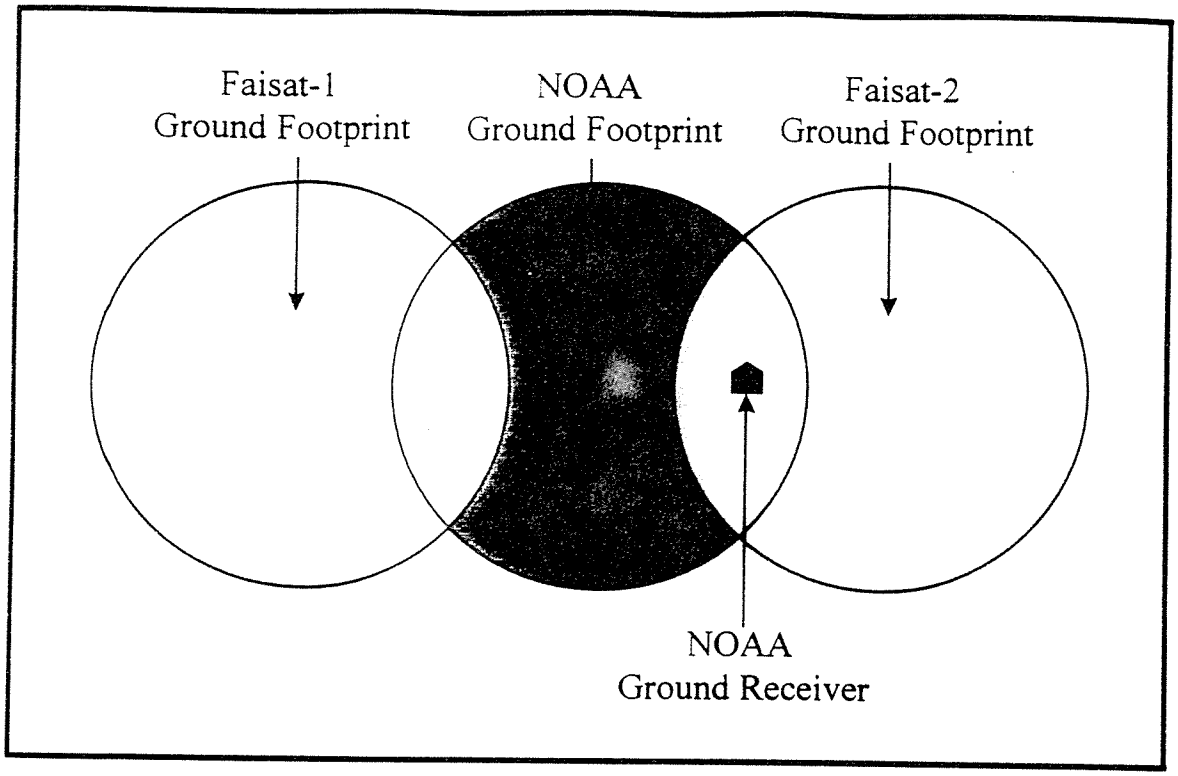

Figure 2: Determination of Ground Footprint Overlap

2) The NOAA/CSC comparison metric is incorrect.

The NOAA/CSC analysis calculated the percent of time that zero, one or more Final Analysis satellites were visible from an earth station provided that a NOAA satellite is also visible. They then normalized the data by dividing the Final Analysis satellite visibility by the NOAA satellite visibility. This is an attempt to calculate conditional probability. However, the number of FAISATs visible from any earth station is statistically independent of the number of NOAA satellites visible from the station. And by definition, a conditional probability does not exist between independent events. All the NOAA/CSC analysis effectively did was compare the coverage between the two constellation designs and note that the coverage differed, which is irrelevant to the issue of potential interference. No two satellite constellations of different design will provide the same coverage.

APPENDIX II

Measurement of Noise Levels From FAISAT-2v Spacecraft

Appendix II

Measurement of Noise Levels From FAISAT-2v Spacecraft

The subject of noise at altitude for near-earth satellite operations is one of uncertainty at best. In order to better determine noise levels affecting spacecraft communications, Final Analysis developed an experimental program involving the design, manufacture, and launch of two spacecraft. The second, FAISAT-2v, was launched in September 1997 and has performed scans of the noise environment. In analyzing this actual flight data, Final Analysis has worked over the past several months in partnership with Lockheed-Martin Management and Data Systems. Through this experimental program and the Lockheed-Martin collaboration, Final Analysis has been able to make measurements at altitude and has confirmed the substantial levels of noise and the variability of the noise environment. This conclusion is presented below using data collected on the FAISAT-2v experimental satellite.

The following paragraphs have been extracted from the Air Interface White Paper produced by Lockheed/Martin under contract to Final Analysis. We first give a description of the measurement technique employing an ~300 Hz digital filter and series of Fast Fourier Transform functions. This is the most appropriate measurement technique for determining the VHF-UHF noise received by low earth orbiting satellites. We show one FAISAT-2v scan for New Jersey, one FAISAT-2v scan for Thailand, and a summary chart for the eight scans presented.

The conclusion reached in reviewing the scan data is the following:

> **There is a significant increase in noise between the VHF and UHF channels of about 10 to 12 dB.**

Excerpt from Air Interface White Paper regarding man made interference. Prepared by Lockheed Martin Management and Data Systems, Valley Forge PA

Satellite Noise

The amount of noise presented to the satellite receivers can not be underestimated, particularly since the final Analysis system shares its VHF and UHF uplink bands with terrestrial based mobile radio. While it is assumed that land mobile radio will predominate the noise seen by the satellite, nothing is certain. To the extent the FCC proposed DCAAS (dynamic channel activity assignment system) will mitigate these uncertainties. The DCAAS approach will be discussed in a subsequent section on spectrum sharing.

An exhaustive literature search was performed to estimate the amount of noise presented at the satellite antenna receive terminals. The best source of information found comes from the data provided by the Final Analysis satellite currently in a 63 degree inclination by 1000 km circular orbit. A series of Fast-Fourier Transforms (FFT's) were performed at an intermediate frequency (IF) in the satellite receiver chain across the frequency bands of interest. A calibration was performed at the launch site to refer the

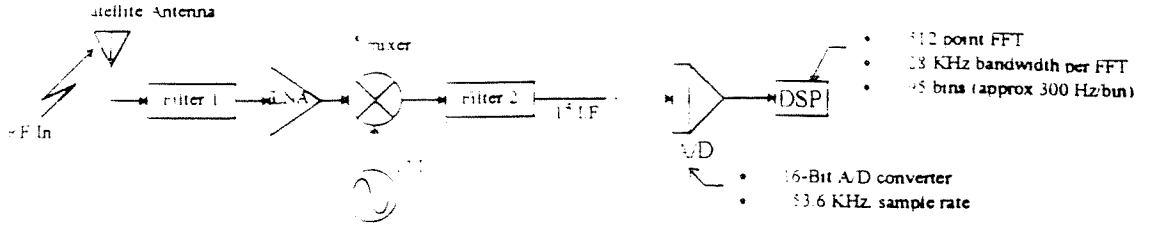

Figure 1 In-Orbit Noise Level Measurement

results of the FFT to the low noise amplifier (LNA) input terminals. Consecutive 28 kHz bandwidths are analyzed across the received frequency band of interest. The results obtained from Final Analysis are tables which give the LNA input power levels (in dBm) in a 300 Hz bandwidth as a function of frequency. A graph of two such tables is given in figures 2 and 4

The results are converted to F_A (dB) using the following relationship :

$$F_A = P_{LNA} - 10\log(300) + 174 \text{ (dB)}$$

where P_{LNA} is the total received power at the LNA input terminals in dBm. This is done for every point in the original table. Next, a set of descriptive statistics is generated for the entire table of F_A values. Also, a histogram showing the relative concentrations of values for F_A is made. Histograms for the New Jersey and Thailand data are given in figures 3 and 5

The graphs indicate the total number of measurements that fall within a 10 dB range for F_A (e.g. approximately 1600 measurements with F_A between 10 and 20 dB) The graphs also include a curve for the cumulative distribution of measurements For the New Jersey graph, approximately 80% of the measurements have F_A values below 20 dB The sweep over Thailand produced the worst case man-made noise values and this data is used in setting the noise limit for link calculations

The average values for F_A for a set of eight sweeps evaluated are given in the following table.

Frequency Band	Location	F_A Mean (dB)	standard deviation	Approximate Local Time
VHF	New Jersey	13.7	7.7	6:00 PM
VHF	N.E. Greenland	11.9	7.8	5:00 PM
VHF	Hudson Bay	5.4	3.6	3:00 AM
VHF	Brazil	11.1	8.2	4:30 PM
VHF	Barent's Sea	3.5	2.5	5:30 AM
VHF	Barent's Sea	15.5	7.5	5:30 AM
VHF	Argentina	13.3	7.4	4:30 AM
VHF	Thailand	7.6	3.8	7:30 PM

Table 1 Summary Statistics for FAI Satellite Determined F_A

The FAI measurements for Thailand are of the greatest interest since this is the most populated region used in the experiment and since the planned uplinks from the FAI user terminals fall in the VHF band. Note that the measurements for the Barents Sea are performed once for each RF band (VHF and UHF) at the same time of day but produce results which differ by 12 dB For the VHF uplink analysis to be presented later in this paper the Thailand data will be used The Thailand data minus 10 dB is used for the UHF service uplinks

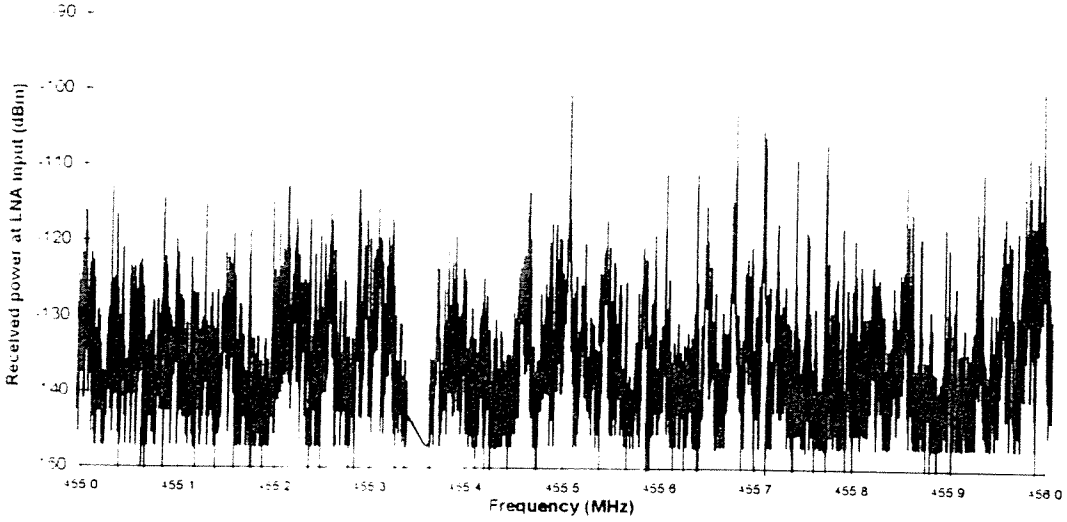

Figure 2 -FAISAT-2v Satellite Radio 1 Scan: New Jersey 10/1/97 6pm EST

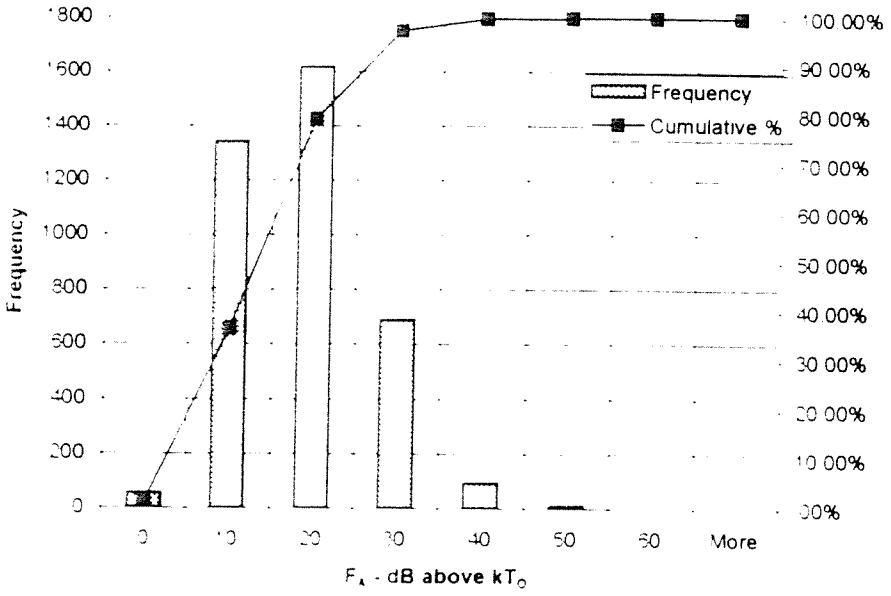

Figure 3 - F_A Histogram for Radio 1 New Jersey 10/1/97 6pm EST

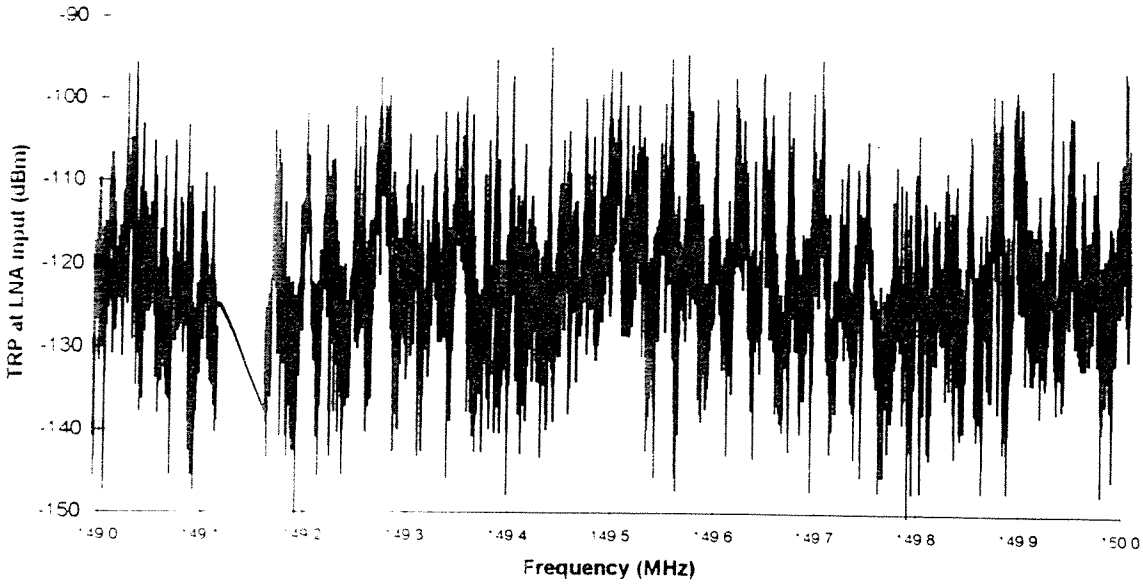

Figure 4 FAISAT-2v Satellite Radio 2 Scan: Thailand 1/23/98 09:30 GMT

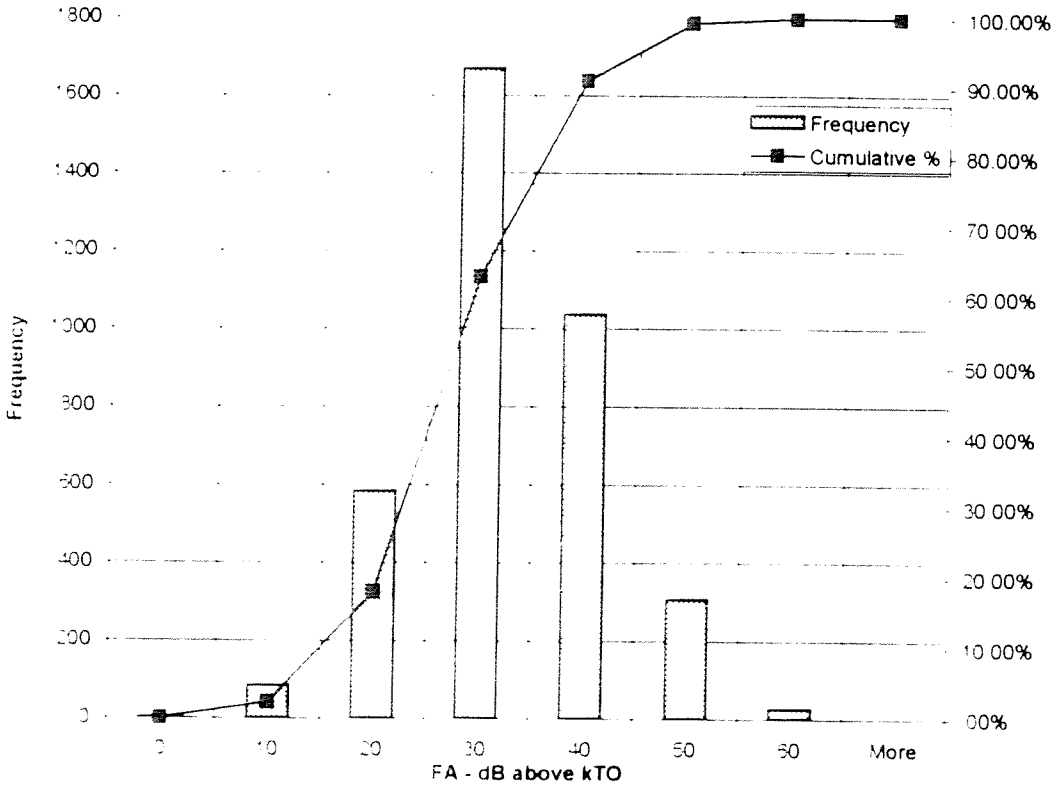

Figure 5 - F_A Histogram for Radio 2 Thailand 1/23/98 09:30 GMT

CERTIFICATE OF SERVICE

I, Beatriz Viera, hereby certify that a true and correct copy of the foregoing "**Application for Clarification and Review**" on behalf of Final Analysis Communication Services, Inc. was delivered via hand delivery or regular mail this 1st day of May 1998, to each of the following:

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