RECEIVED
MAY 16 1996
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

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

In the Matter of	)	
	)	
Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Mobile-Satellite Service in the 1610 - 1626.5/2483.5 - 2500 MHz Frequency Band	)	CC Docket No. 92-166

DOCKET FILE COPY ORIGINAL

OPPOSITION TO PETITION FOR RECONSIDERATION

William F. Adler
Vice President &
Division Counsel
GLOBALSTAR
3200 Zanker Road
San Jose, CA 95134

Leslie A. Taylor
Guy T. Christiansen
Leslie Taylor Associates, Inc.
6800 Carlynn Court
Bethesda, MD 20817
(301) 229-9341

William D. Wallace
CROWELL & MORING
1001 Pennsylvania Avenue, N.W.
Washington, DC 20004
(202) 624-2500

Its Attorneys

Date: May 16, 1996

No. of Copies rec'd 0+9
List ABCDE

TABLE OF CONTENTS

Executive Summary iii

I. The Commission's Determination That an Interim Band Plan to Protect GLONASS Is Unnecessary Is Supported By the Record. 2

II. The Commission Should Reaffirm Its Policy Determination That No Interim Protection of GLONASS Is Necessary In the United States 5

III. GLONASS Should Be Protected Only In Its Final Frequency Configuration 6

1. Any operational integration of GLONASS into the GNSS will not occur before the planned migration of GLONASS 6

2. Protecting the interim GLONASS frequencies will not aid the development of the GNSS 10

3. Protection of GLONASS Is Not Required by the ITU Radio Regulations 11

IV. The Commission Cannot At This Time Choose the Appropriate Means of Protecting GLONASS Operations Below 1605 MHz From Out-of-Band Emissions 12

V Conclusion 13

Technical Appendix

EXECUTIVE SUMMARY

L/Q Licensee, Inc. (LQL), licensee of the Globalstar™, MSS above 1 GHz non-geostationary system, opposes the Petition for Reconsideration of ARINC to the Commission's reconsideration of its Big LEO Report & Order. LQL opposes ARINC's request that the Commission adopt an interim frequency plan which would prohibit operation of MSS systems in portions of the 1610-1626.5 MHz band until the GLONASS system has completed its transition to its final frequency configuration in 2005.

ARINC's Petition should be denied for the following reasons:

(1) ARINC has provided no new information to support a reversal of the Commission's decision;

(2) the record clearly demonstrates that an interim band plan to protect the interim GLONASS frequency configuration is unnecessary;

(3) the "acceptance" of GLONASS by the ICAO into the GNSS is the start of a lengthy process which is unlikely to be concluded prior to transition of GLONASS into its final frequency configuration;

(4) integration of GLONASS into the GNSS for use in precision approach will involve lengthy and detailed technical evaluation and processes that are unlikely to be concluded before the planned migration of GLONASS to its final frequency configurations;

(5) because of the short period of use of the interim GLONASS frequencies, it is extremely unlikely that GLONASS/GPS equipment will be standardized, manufactured and installed in civil aircraft when such equipment would have to be modified in 2005.

ARINC's proposal must be rejected because it would result in reduced spectrum for MSS systems without any demonstrated benefit for aviation navigation. Moreover, the Commission should consider the appropriate means of protecting GLONASS operations below 1605 MHz from out-of-band emissions when it receives the report of RTCA, Inc. ARINC's petition should be denied.

RECEIVED
MAY 1 6 1996
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

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

In the Matter of	)	
	)	
Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Mobile-Satellite Service in the 1610 - 1626.5/2483.5 - 2500 MHz Frequency Band	)	CC Docket No. 92-166

OPPOSITION TO PETITION FOR RECONSIDERATION

L/Q Licensee, Inc. (LQL) hereby submits its Opposition to the Petition for Reconsideration filed by Aeronautical Radio, Inc. (ARINC) in the above captioned proceeding. LQL, a wholly-owned subsidiary of Loral/QUALCOMM Partnership, L.P., and licensee of the Globalstar™ low-earth orbit satellite telecommunications system,[1] opposes ARINC's request that the Commission adopt an interim frequency plan which would unnecessarily prohibit operation of MSS systems in portions of the 1610 - 1626.5 MHz band from now until the GLONASS system has completed its transition to its final frequency configuration in 2005.

In its Petition, ARINC seeks reconsideration of the Commission's decision not to adopt an interim frequency plan to protect the Global Navigation Satellite System (GLONASS) in the United States.[2] ARINC urges the Commission to impose substantial restrictions on the operation of MSS Above 1 GHz systems, commonly known as Big LEOs, to "protect" GLONASS as an integral component of

---

[1] See Order and Authorization, 10 FCC Rcd 2333 (Int'l Bur. 1995).

[2] Memorandum Opinion & Order, FCC 96-54 (released February 15, 1996) (Reconsideration Order) at ¶ 14.

the GNSS for use at precision approach altitudes.[3]

ARINC provides no technical or public interest justification for its proposal to restrict Big LEO operations. GLONASS is not currently an integral part of the GNSS and, due to technical and practical considerations, may never become an integral part of the GNSS. In any case, it is extremely unlikely that GLONASS will be integrated into GNSS prior to January 1, 2005 when GLONASS has committed to move to its final frequency configuration. Thus, the only frequency plan relevant to this proceeding is the final GLONASS frequency plan which does not require implementation of an interim plan for MSS. Accordingly, LQL urges the Commission to reaffirm its determination contained in the Report and Order "that no interim protection of GLONASS is necessary in the United States."[4]

I. The Commission's Determination That an Interim Band Plan to Protect GLONASS Is Unnecessary Is Supported By the Record.

As the Commission and ARINC recognize, the Russian GLONASS Administration has indicated that it plans to move GLONASS operations to below 1605 MHz by 2005, with its highest effective channel located well below the 1604.25 MHz center frequency.[5] The Commission recognized in the Big LEO Report & Order that this revised GLONASS frequency plan would eliminate the need for the protection requirements for MSS systems operating above 1610 MHz.

---

[3] LQL notes that TRW, Inc. has also raised concerns about the Commission's decision not to adopt an interim plan. TRW agrees with LQP, however, that GLONASS need not be protected in the 1610 - 1626.5 MHz band. See Petition of TRW, Inc. for Further Reconsideration, filed April 11, 1996 at 6 n.13.

[4] Memorandum Opinion & Order at ¶ 14.

[5] See Big LEO Report & Order, ¶ 51 n.60; see also LQP Comments, Tech. App., at 12; Motorola Comments, at 44-46. The upper two GLONASS channels are intended to be technical channels which are only operated by the Russian Federation when the satellites are within view of Russia.

These intended modifications to GLONASS would eliminate any need for an "interim" plan, and along with this, any requirement that U.S. MSS systems protect receivers designated for some "transitional" use.

LQP pointed out in its comments in this proceeding that the expressed plans to use a GNSS for aeronautical navigation may or may not be adopted. See LQP Comments, Tech. App., at 12. The United States has developed its own 24-satellite Global Positioning System (GPS) to be used within GNSS, which may not utilize GLONASS. Only five satellites of the GNSS system are needed for position location including integrity checking. LQP has presented a study which demonstrates, for various combinations of GPS plus GLONASS, that at least six, seven or more satellites would be available. See LQP Comments, Tech. App., at Attach. 1. Under these circumstances, even if GLONASS were incorporated into the GNSS at some date in the future, its signals are not required to achieve navigational objectives.[6] See LQP Comments, Tech. App., Attach. 1. Multiple measurements from satellites in the GPS and GLONASS constellations would be available, and the ability to navigate with the system would not be impaired.

LQP also pointed out that the change in the GLONASS frequency plan is a major system modification which will greatly impact the design of avionics hardware compatible with GNSS. Potential GLONASS receiver manufacturers will be impacted by this frequency change and must implement appropriate interference mitigation techniques in the design of GLONASS receivers. Filters designed for GLONASS receivers up to 1616 MHz would not protect GLONASS signals below 1610 MHz from MSS operations in the band once GLONASS operations move entirely below 1606 MHz. Additional filters have to be added to

---

[6] LQP has demonstrated previously that protection of GLONASS receivers above 1606 MHz is not required to utilize GLONASS-M in the GNSS. The Sat-Tech Study contained in LQP's Comments in this proceeding support the conclusion that virtually all aviation objectives can be achieved through use of GPS and as few as six GLONASS satellites operating below 1606 MHz. See Comments of LQP, pp. 66-73 and Tech. App., Sections 2.2.3, 2.2.4 and 2.2.5, filed May 5, 1994.

those receivers for them to operate effectively at the new GLONASS frequencies below 1606 MHz.

As MSS systems seek to coordinate globally, they should be able to claim the benefit of the new GLONASS frequency plan. If the United States provides for an "interim" plan for the transitional GLONASS band plan, which implies that MSS systems can operate in less spectrum than 1610-1626.5 MHz, then revisions to the GLONASS plan would likely become less imperative. Efforts of the United States and MSS industry to encourage the revision to the GLONASS frequency plan might be viewed as optional rather than essential to the development of MSS services, hampering the global development of MSS with the attendant loss of U.S. jobs and increased foreign competition. Thus, as LQP explained, adopting an "interim" plan could seriously jeopardize the future of MSS operations in the 1610-1626.5 MHz band.

In the MO&O, the Commission properly decided that it was unnecessary for it to adopt an "interim" band plan to protect GLONASS receivers in the United States. The Commission's action was taken with the knowledge that GLONASS may at some point be incorporated into the GNSS.[7] ARINC has requested reconsideration of this issue but has offered no new facts or arguments to justify such a rule, other than the alleged "acceptance" by ICAO of GLONASS into the GNSS. Accordingly, ARINC's Petition on this issue should be denied because "reconsideration will not be granted to debate matters upon which [the Commission] has already deliberated and spoken."[8]

---

[7] See MO&O at ¶ 14.

[8] See Miami Latino Broadcasting Corp., 68 RR 2d 1088, 1089 (1990); see also American Int'l Development, Inc., 50 RR 2d 370, 371 (1981); Presidents and Directors of Georgetown College, 50 RR 2d 366, 367 (1981).

II. The Commission Should Reaffirm Its Policy Determination That No Interim Protection of GLONASS Is Necessary In the United States.

The Commission, based on the record in this proceeding, has determined "that no interim protection of GLONASS is necessary in the United States." This decision was based, at least in part, on the Commission's finding that there is "substantial uncertainty as to whether protection of GLONASS will ever be necessary in any configuration other than its final configuration at frequencies below 1606 MHz."[9]

This determination is supported by the record in this docket,[10] the current state of development of the GNSS, the timetable for integrating use of GLONASS in the GNSS and by commercial practices in the development and implementation of aircraft navigation systems. In contrast, ARINC's Petition is based solely on the alleged official "acceptance" of GLONASS as part of the GNSS by ICAO. Even if "accepted", GLONASS is not -- and ARINC never claims that it is -- being used as a navigation aid in the United States. Thus, in and of itself, this "acceptance" imputes no practical or technical obligations upon Big LEO licensees and so provides no basis for reversal of the Commission's decision. Providing protection for a system which is not in use for radionavigation purposes, as ARINC urges would curtail the availability of MSS without any concomitant benefit to aeronautical navigation or the public.

As LQP has demonstrated in prior pleadings, and as further outlined in the Opposition and the attached Technical Appendix, such protection for GLONASS receivers in the United States would have the following detrimental effects:

(1) capacity of Big LEO systems would be reduced;

---

[9] Id.

[10] See Petition for Clarification, CC Docket No. 92-166, filed by LQL, April 11, 1996. See also, LQP's Petition for Clarification and Partial Reconsideration, at 12-17 (filed Nov. 21, 1994) and LQL's Reply Comments, at 11-18 (filed June 20, 1994).

(2) development of standards for GNSS systems using GLONASS would proceed with uncertainty as to which frequency plan should be utilized;

(3) equipment using the GLONASS interim frequencies might be manufactured and installed in aircraft, with retrofitting of such equipment required within a few years due to the GLONASS frequency migration, imposing costs on aviation and consumers; and

(4) the Russian administration might perceive protection of the interim frequency plan as an opportunity to delay or to avoid implementation of the final frequency configuration.

In sum, there is no sound technical or policy reason for providing interim protection to GLONASS operations in the 1605 - 1616 MHz band. Contrary to the assertions of ARINC, there is currently no master plan for the GNSS which requires or would even permit the immediate integration and use of GLONASS. Further, there are no existing standards or requirements for the GNSS that would use the GLONASS signals in the 1605 - 1616 MHz band. Thus, no public interests would be served by the Commission requiring an interim plan that would restrict Big LEO systems from operating in the 1610 - 1616 MHz band.

III. GLONASS Should Be Protected Only In Its Final Frequency Configuration.

The Commission should provide for the protection of GLONASS only in accordance with the final frequency plan. The approach adopted in the MO&O provides sufficient MSS capacity, certainty for developers of any GNSS standards which might include GLONASS, protection for the users of aeronautical radionavigation equipment and proper incentives for the Russian Federation to complete the frequency migration to which it has committed.

1. Any operational integration of GLONASS into the GNSS will not occur before the planned migration of GLONASS.

GLONASS currently operates in the 1610 - 1616 MHz band but, as ARINC concedes, the Russian Federation has agreed to migrate GLONASS operations to frequencies below 1605 MHz. Under this transition plan, GLONASS will cease operations above 1609 MHz by 1998 and complete migration to frequencies below 1605 MHz by the year 2005.

Even with this transition plan, the proposed interim frequency plan has no relevance to United States ARNS needs. There is a lengthy process for adopting standards for aircraft navigation equipment as well as developing, manufacturing and installing certified equipment. Moreover, even if such equipment is available, the United States must still make a decision to develop a public ARNS system that incorporates GLONASS. As a result, GLONASS will no longer be operating in the 1605 - 1616 MHz band when such standards and equipment become available. Thus, only the final GLONASS frequency plan should be considered for any possible use of GLONASS as an aeronautical navigation aid.

As described more fully in the attached technical appendix, the contemplated use of GPS/GNSS for precision approach is a recent development Although the use of GPS/GNSS for en route navigation was seen as feasible in the early 1990s, it was unclear if precision approach could be supported *even with GPS* because of the extremely stringent performance requirements and accuracy needed for such use.[11] Use of the GNSS for precision approach requires accuracy and performance levels that approach the theoretical limits of the GNSS. The margin for error and the need for accuracy in precision approach are so great that

---

[11] See 1994 Federal Radionavigation Plan (published by Department of Defense and Department of Transportation) at 4-17. The Report states that "[t]he use of GPS as a primary means of navigation depends on the successful development, deployment, and operation of the WAAS, as well as the development of appropriate standards, operating procedures and avionics." Id. at 4-5.

to this day numerous issues must be resolved to permit the use of the GNSS for precision approach.[12]

Currently, GPS is used only as a supplement to existing navigational equipment in en route navigation.[13] The first public system that will allow precision approach is the Wide Area Augmentation System (WAAS). WAAS is designed to provide precision approach capabilities in the United States and does not involve the use of GLONASS at all. In its current form, WAAS is not scheduled for completion until the year 2002 at the earliest.[14] Although RTCA is currently developing minimum operational performance standards (MOPS) for WAAS, these MOPS do not include GLONASS.[15] Integration of GLONASS into WAAS would require the development of new specifications for WAAS which would have to pass FAA review. Given the investment of the United States in developing WAAS as the next generation precision landing aid, and the fact that the integration of GLONASS into WAAS would not significantly improve the capabilities of WAAS, it is unlikely that GLONASS will become part of the GNSS/precision approach framework.

With the long timetable for implementation of WAAS, it is virtually inconceivable that any GNSS precision approach system using GLONASS could come into use before the year 2005. A more realistic estimate is some time after 2005 - after the migration of GLONASS below 1605 MHz is completed.

Full integration of GLONASS into the GNSS is unlikely to occur before, or even concurrent, with GPS/WAAS. First of all, the GLONASS system possesses

---

[12] As ARINC recognizes, minimum operational performance standards (MOPS) have not yet been finalized for *non*-precision approach altitudes. MOPS for precision approach are not even under formal consideration yet. ARINC Petition at 7.

[13] Federal Radionavigation Report at 4-5.

[14] Technical Appendix at 5.

[15] Technical Appendix at 4.

several unique characteristics, resulting in significant differences in accuracy and integrity of the GLONASS signal as compared with GPS, that must be addressed before GLONASS can be used for precision approach.[16] Although RTCA, Inc. has a working group tasked with developing MOPS for combined GPS/GLONASS GNSS operations, this group has not yet begun its work. Full integration of GLONASS into the GNSS cannot be considered accomplished until this work is complete and accepted by the FAA and the aviation community.

Under the migration plan, GLONASS will cease using frequencies above 1605 MHz by the year 2005. Even if RTCA adopts standards for the 1605 - 1616 MHz band and the entire manufacturing, certification and implementation process is concluded at some time before that date the equipment and standards adopted for frequencies above 1605 MHz would be useful only until 2005. It is unlikely that any manufacturer will build -- or that any airline would purchase, install and rely on -- equipment that will be useful only until 2005. In reality, due to the short time these frequencies will be available for use, it is unlikely that any GNSS equipment using them would be available.

Moreover, any receiver that is designed to receive and rely on frequencies above 1605 MHz would have to be retrofitted after 2005 to filter out these frequencies. The limited possible utility of incorporating these frequencies for use for such a short period of time could not possibly justify the cost of the retrofitting these receivers after 2005.

ARINC has provided no demonstration of how U.S. protection of GLONASS signals in the 1605 - 1616 MHz band could possibly enhance aircraft navigation, or how such protection would facilitate integration of GLONASS into the GNSS. Given the many years that it will take both to adopt standards and procedures and then to produce and install compliant equipment, it would be illogical to adopt a frequency plan that protects frequencies that GLONASS will use for only a short period of time. Similarly the short period of utility of this band is likely to

---

[16] See Technical Appendix at 2-3.

prompt RTCA to exclude the 1605 - 1616 MHz band from any standards it adopts.

2. Protecting the interim GLONASS frequencies will not aid the development of the GNSS.

Although ARINC claims that the development of en route standards and procedures may be adopted in the next few years, standards for precision approach will take longer.[17] Until those standards are approved, it will remain unknown exactly what role GLONASS will play in the GNSS - whether it will be used as a primary navigation aid, a verification tool, or simply as a back-up system.[18]

Moreover, ARINC fails to note that a GNSS system utilizing GLONASS could be based on the final frequency configuration regardless of whether the Russian Federation moves to that configuration. Such a system could utilize the additional signals made available by GLONASS without reducing capacity of MSS systems or requiring retrofitting of aircraft navigation equipment. If this approach were utilized, as the Russian Federation implements the migration plan, such equipment will become more useful because the number of satellites using the final frequency plan will increase.[19] By contrast, equipment using interim frequencies would become less useful as the final GLONASS frequency plan was implemented since there would be fewer satellites available that used the interim frequencies. Thus, the utility of using GLONASS frequencies above 1605 MHz is very limited and is certainly not required for achieving the goals for GNSS as outlined by ARINC.

---

[17] ARINC Petition at 7. LQL notes that RR S5.364 already provides adequate protection for en route radionavigation.

[18] See Federal Radionavigation Report at 4-17 (stating that "Local-area DGPS systems, ILS, GLONASS and other navigation sources and sensors *may* play roles *of varying significance* in the far-term precision approach architecture.") (emphasis provided).

[19] See Technical Appendix at 6.

A plain illustration of the hollowness of ARINC's claim is the fact that *there is currently no commercially available GPS/GLONASS equipment suitable for aviation use.*[20] This stark reality is at odds with ARINC's statement that GLONASS is already an integral part of the GNSS.

Full integration of GLONASS is still many years off and integration of the frequencies affected by the interim plan is unlikely to be part of the integration. The simple acceptance by ICAO of the Russian offer to make GLONASS available for use as part of the GNSS is the beginning of a very long process, not its conclusion.

3. Protection of GLONASS Is Not Required by the ITU Radio Regulations.

ARINC states in its Petition that from the time of the initial MSS allocation, Big LEOs knew that the need to protect ARNS would "severely limit the operation of mobile earth terminals at frequencies below 1616 MHz."[21] In support of this claim ARINC cites ITU RR 731E which stated that "stations of the mobile-satellite service shall not cause harmful interference to, or claim protection from, stations of the aeronautical radio and navigation service."[22] ARINC's use of this regulation is misleading, however, because it implies that this obligation is still in effect.

While RR 731E did contain a "no harmful interference" provision in its original form, this regulation was modified at WRC-95, with the agreement of the Russian Federation, to replace this clause with the lesser requirement that MSS

---

[20] Technical Appendix at 4. A recent article noted that even in the Russian Federation - the country that developed GLONASS and the only country that manufactures GLONASS receivers - GPS receivers outnumber GLONASS receivers one thousand to one. "GLONASS Emerges" GPS World, May 1996 at 12.

[21] ARINC Petition at 3.

[22] Id.

systems take "all practicable efforts to ensure protection."[23] It is inappropriate for ARINC to omit this significant modification to the Radio Regulations. As LQL has demonstrated, the Commission's decision fully complies with the "all practicable efforts" requirement placed on MSS operations by the *current* ITU Radio Regulations.

IV. The Commission Cannot At This Time Choose the Appropriate Means of Protecting GLONASS Operations Below 1605 MHz From Out-of-Band Emissions.

The Commission stated in the Reconsideration Order that it will be considering the proposals of RTCA, Inc. concerning protection of GLONASS receivers operating in the United States. However, as LQL stated recently in its Petition for Clarification, before a determination is made regarding the most appropriate means of protecting receivers using GLONASS frequencies, the Commission must first determine if it is necessary for Big LEO licensees to protect GLONASS receivers in the United States.[24] And, if such protection is deemed warranted, a subsequent determination must be made as to the means of achieving the out-of-band protection levels. The possible means include a frequency guardband, modification of equipment, or other means. The determination as to the protection required and the means to achieve it cannot be made until the RTCA forwards its proposal regarding protection criteria for GPS and GLONASS receivers in the United States, to the Commission. Even if these criteria are adopted in the next few years, it is highly unlikely that the interim GLONASS bands will be included in the RTCA proposal.

---

[23] See ITU RR S5.364.

[24] LQL Petition for Clarification, at p. 2.

V. Conclusion

ARINC has failed to provide any basis for reversing prior Commission decisions and adopting its request that Big LEO systems be prohibited from operating in frequencies used by GLONASS in its interim configuration. ARINC has not explained how such frequency avoidance in the United States will enhance the integration of GLONASS into the GNSS or improve aircraft navigation. As LQL has shown in previous filings, and reiterated in this Opposition, protection of the interim GLONASS frequencies is not in the public interest, but rather would impose a detriment to Big LEO systems and their users with no concomitant benefit to aviation.

For the foregoing reasons, LQL requests that the Commission deny ARINC's Petition for Reconsideration.

Respectfully submitted,
L/Q LICENSEE, INC.

By: _____

Leslie A. Taylor
Guy T. Christiansen
Leslie Taylor Associates, Inc.
6800 Carlynn Court
Bethesda, MD 20817
(301) 229-9341

William D. Wallace
CROWELL & MORING
1001 Pennsylvania Avenue, N.W.
Washington, DC 20004
(202) 624-2500

Its Attorneys

Of Counsel:

William F. Adler
Vice President &
Division Counsel
GLOBALSTAR
3200 Zanker Road
San Jose, CA 95134

Date: May 16, 1996

TECHNICAL APPENDIX
INTEGRATION OF GLONASS INTO THE GNSS: TECHNICAL CONSIDERATIONS AND TIMETABLE
by SatTech Systems, Inc.

SUMMARY. This technical appendix addresses a number of statements contained in the ARINC Petition and provides a technical explanation of why ARINC's statements no not provide a basis for the relief it seeks. A summary of these statements by ARINC, and the opposing position of GLOBALSTAR, is provided in Exhibit A-1 below. This appendix also provides additional technical data in support of the Commission's decision in its MO&O regarding protection of GLONASS in the frequency band 1605-1610 MHz. ARINC has not demonstrated any quantifiable benefit to the aviation community, associated with ARINC's request for the Commission to reinstate the interim frequency plan and protect aviation use of GLONASS (up to 1608.25 MHz) at precision approach altitudes through 2005. The integration of GLONASS into an as yet undefined GNSS must address the specific characteristics of GLONASS and will take several years. Given the transition timeline for GLONASS, which will be completed by 2005, a U.S. policy to protect only GLONASS operations below 1605 MHz (while allowing operations on an unprotected basis above 1605 MHz) minimizes regulatory confusion, satisfies all aviation requirements without penalty, and minimizes costs and uncertainty to the MSS community.

Exhibit A-1: Summary of ARINC's Position and Technical Response

ARINC position	Technical response
ITU RR731E unconditionally protects GLONASS from harmful interference	ITU RR731E was modified at WRC-95; new language mandates "all practicable efforts to ensure protection".
GLONASS can be used at approach altitudes by itself (sole means) or as an element of GNSS	Key technical differences exist between GPS and GLONASS. GLONASS is functionally inferior to GPS and may not be suitable for precision approach (more study is needed).
Substantial investments have been made in GNSS (composed of GPS and GLONASS)	There has been no substantial investment in GLONASS outside the Russian Federation. There has been some investment in hybrid GPS/GLONASS equipment and systems, but this investment is limited to a small number of research units. Hybrid systems are not available for civil aviation.
Recent developments ensure that GLONASS will become part of the international and domestic aeronautical radionavigation system	The issue is ***when***, and for ***what applications?*** Protection of the GLONASS interim transition plan is not required. Hybrid use can evolve based on the GLONASS far-term transition plan, and regulatory protection of signals below 1605 MHz.
U.S. is obligated by treaty to protect GLONASS as a sole means of navigation (cites Chapter 2 of the Convention of International Civil Aviation (Chicago Convention))	All civil aviation operations which may eventually be supported with a hybrid GNSS can be protected in the context of the GLONASS far-term transition plan. Furthermore, ***the indicated citation does not obligate the U.S. to protect GLONASS. To the contrary, it indicates that foreign aircraft are obligated to conform to U.S. regulations***.
Urges the Commission to reinstate the interim frequency plan for MSS and protect GLONASS at approach altitudes through 2005.	A clear policy statement, protecting the GLONASS ***far-term plan*** at precision approach altitudes, will avoid regulatory confusion, reduce costs and risks to the civil aviation community, satisfy all reasonable operational scenarios for use of GLONASS, and avoid harm to MSS.

I. Use of GNSS for Aeronautical Navigation and Precision Approach

The serious consideration of GPS and GNSS for precision approach (PA) is a recent development. Neither GPS nor GLONASS were originally designed for PA. In the early 1990's, it was unclear if PA could be supported with ***any*** form of satellite navigation. Studies and field trials in the late 1980's had indicated the potential for at least near-Category I operations, but GLONASS was considered highly unreliable within the United States, and significant issues remained even for GPS. For example, in 1991, the FAA commissioned a study[1] of systems engineering and operational issues associated with the use of GNSS for PA. This study identified 20 issues with varying degrees of criticality (five considered highly critical), with projected resolution times of 2 to 8 years. These projected resolution times related to the ***technical/conceptual solution to an identified problem***, and did not include the time required to develop equipment standards for associated avionics, design and build prototypes, perform testing, complete the certification process, and field the associated equipment. At the time of WARC-92, therefore, it was entirely reasonable to limit consideration of GPS and GLONASS to en route operations.

II. GLONASS Is Not Functionally Equivalent to GPS, and May Not be Suitable for Precision Approach (More Study is Needed)

At the heart of the debate regarding protection strategies for GLONASS is its potential to support navigation in various phases of flight. Representatives of the aviation community frequently state that GLONASS is functionally equivalent to GPS. This is misleading in regard to precision approach operations. GLONASS has certain inherent differences relative to GPS, which may be substantially ignored for en route use but are significant at the accuracy and integrity levels demanded for precision approach. These include:

1. Lower PRN code rate. The GLONASS PRN code rate (511 kcps) is half that of GPS. This adversely affects ranging accuracy at a given signal-to-noise ratio and correlator spacing.
2. Non-conformal coordinate system. This requires the receiver to perform a coordinate transformation to convert GLONASS satellite ephemerides into the WGS-84 coordinate system that is native for GPS (a time translation is also required, with the time offset provided by some external source such as WAAS). These transformations are not conceptually difficult; however, an internationally-agreed transformation that minimizes error ***at the GLONASS orbit as well as near the Earth's surface*** has not been selected. One issue is to identify a transformation that satisfies the integrity requirements of precision approach. Methods to handle this transformation in both locally-augmented and wide-area augmented systems have not been selected.

[1] Study performed by System Resources Corporation and Stanford Telecommunications, Inc., under contract to the Volpe National Transportation Systems Center, with collaboration by Ohio University Avionics Engineering Center. Final report completed in February 1992. Results presented at the Institute of Navigation 48th Annual Meeting in Washington, D.C., 29 June 1992.

3. Signals separated in frequency rather than code. This is a serious problem that may affect accuracy in precision approach applications. GPS signals are separated in code, but are transmitted on a common frequency. At the receiver, GPS signals differ in frequency only due to Doppler. In contrast, GLONASS signals are transmitted on different carrier frequencies with separations that are thousands of times larger than those due to Doppler. Low noise amplifiers in a GNSS receiver front-end may introduce a group delay that is frequency-dependent, with different delays across the GLONASS band and between GLONASS and GPS, possibly changing with age, temperature, atmospheric pressure and other parameters. Each nanosecond of unknown differential delay between GLONASS channels, or between GLONASS and GPS, translates into a foot of pseudorange error on the affected signal(s). This error source is internal to the receiver, and cannot be removed with differential techniques. Resulting errors may be sufficiently large to prevent GLONASS use for precision approach. Research efforts to overcome this problem are currently underway; results are not yet available.
4. Longer word length for the navigation messages. This affects the utility of word-by-word parity checks for integrity determination purposes, and may affect continuity calculations as well. To ensure navigation integrity, certain procedures envisioned for GPS/WAAS receivers depend on the periodic and frequent arrival of parity checks on the GPS signals under track. These procedures may be adversely affected by the longer word length of GLONASS, which provides parity checking at less than one third the rate of GPS (i.e., every 2 seconds for GLONASS versus every 0.6 seconds for GPS).
5. More frequent short-term outages. During April 1996, based on information disseminated by the Russian Federation's Intergovernment Navigation and Information Center (2, B. Vusovsky Lane, Moscow), there were over 20 unscheduled short-term interruptions of GLONASS operational service (i.e., individual satellite signals) with durations ranging from 2 minutes to in excess of 10 days. This operational failure rate is much worse than that experienced with GPS, and must be considered when developing system architectures intended to support safety-critical phases of flight such as precision approach.

III. Use of GLONASS as Part of a GNSS Needs Careful Definition and is Still Several Years Away.

The problems noted above highlight the fact that significant technical obstacles must still be overcome in terms of hybrid GNSS receivers (i.e., GNSS receivers which incorporate GPS and GLONASS) applied to precision approach. Even if these problems can be overcome, a suitable architecture for hybrid receivers supporting precision approach applications has not yet been identified. Also, the very real certification issues of these receivers have not been addressed (and typically take years to resolve). Hybrid receivers will therefore lag GPS-only receivers in terms of their dates of introduction into service.

IV. Very Little Study of the Appropriate Technical Standards Has Been Made for GLONASS Outside the Russian Federation

ARINC, in referring to GNSS composed of both GPS and GLONASS, states that "[S]ubstantial investments have been made by the United States, the Russian Federation, and other nations in pursuit of civil use of this system."[2] This is misleading since only the Russian Federation has made a "substantial" investment in GLONASS. Within the U.S., substantial study and investments have been made in GPS and GPS-based systems including local area augmentations (LAAS) and wide area augmentations (WAAS) to support PA. However, little effort has been expended on GLONASS. For example,

1. The RTCA has developed Minimum Operational Performance Standards (MOPS) for DGNSS Instrument Approach Systems: Special Category I (DIAS:SCAT-I); ***these MOPS do not consider GLONASS***.

2. The FAA has a major procurement effort underway today, to provide public-use wide-area augmentation to GNSS for en route, terminal area and non-precision approach, ultimately evolving to PA early in the next century. This is based on RTCA's published MOPS for GPS/WAAS, which does not address PA (operational performance standards for PA will be added at a later date). While the "address space" in the WAAS message set is sufficient to incorporate GLONASS, ***the current MOPS does not define or incorporate the full range of technical issues required to support GLONASS***.

3. Until recently, RTCA/SC-159 had a working group tasked with developing an Appendix to the GPS/WAAS MOPS to accommodate GPS/GLONASS operations (SC-159/WG1). This WG was recently disbanded, and its functions taken over by SC-159 plenary, because of ***insufficient interest by industry (at this time) to support an effective working group***. A draft Appendix has been circulated in the last two months only through the personal efforts of Mr. Larry Chesto, an employee of ARINC.

4. ***The FAA's system specification for the WAAS, which is the basis of its procurement, does not accommodate GLONASS***. Inclusion of GLONASS in the WAAS would require unspecified technical modifications to the procurement specification, a change to the procurement, increased costs and a schedule delay.

5. In contrast to the wide availability of GPS avionics, hybrid GPS/GLONASS equipment suitable for aeronautical use is simply not available (the only such equipment manufactured today is for the Russian Federation military services, and this equipment is not commercially available). Some hybrid GNSS equipment is available for non-aviation use, but this equipment would require unspecified technical changes for use by civil aviation. These changes take time, and cannot be initiated prior to a clear statement of technical performance requirements for the hybrid equipment.

---

[2] ARINC, op. cit., p. 3.

V. Current ITU Radio Regulations And U.S. Policy

RR731E (now S5.364) was modified at WRC-95 with the agreement of the Russian Federation. It specifies a peak e.i.r.p. density of -15 dBW/4kHz in the part of the band used by [GLONASS], unless otherwise agreed by the affected Administrations. In the part of the band where [GLONASS] is not operating, the average e.i.r.p. density of a mobile earth station shall not exceed -3 dBW/4kHz. It is also stated that Administrations responsible for the coordination of mobile-satellite networks shall make all practicable efforts to ensure protection of [GLONASS].

The potential for interference, and the nature of practicable solution(s) that might overcome it, depend on the architecture of the GNSS receivers, the signals they employ, and the operations for which they are used (e.g., en route versus precision approach). These in turn depend on the timeline for GLONASS transition, the timeline for development of appropriate GNSS avionics, and of course technological advances (if required) to support the intended operation. These factors are addressed below.

VI. Timeline Considerations For The Protection Of GLONASS

The timeline for development of aeronautical radionavigation systems, and their introduction into operational use, is measured in years and often decades. The Microwave Landing System was conceived in the early 1970's, and required 20 years to reach the point of operational deployment for civil aviation. In 1992, the RTCA initiated a crash effort to develop MOPS for Special-use Category I operations (SCAT-I) using GPS and local-area differential augmentation. This was intended to support operational use in late 1994, relying on private rather than public procurement as a means to speed development. This simple system, providing an ILS look-alike straight-in approach, and requiring certification on a case-by-case basis, took about one year to develop in RTCA (a record), but is not yet operationally available. Following its initial development in RTCA, an approximate 1 year delay was incurred to modify the VHF data link, and the messaging protocols were revised and made more stringent in early 1996. It is not clear if SCAT-I systems will ever achieve widespread deployment. The WAAS program was conceived in 1993 and 1994, went to procurement in 1995, recently underwent a change in contractors, and will deliver en route capability in 1998 (assuming the schedule is maintained). Category I PA capability with GPS/WAAS will be achieved around 2001 or 2002, for a total development timeline (assuming the schedule is maintained) on the order of 8-9 years. The WAAS is one of the highest-priority programs in the FAA today, yet it is generally acknowledged that the program will require exceptionally effective management and technical expertise to maintain its aggressive schedule.

GLONASS stands in sharp contrast to the WAAS. As was noted above, RTCA was unable to muster and maintain sufficient interest on the part of the aviation industry to maintain its working group charged with developing a GPS/GLONASS appendix for the WAAS MOPS. Given the technical issues associated with GLONASS, and the time required to develop standards, ***it is highly likely that the far-term GLONASS transition***

plan will be in effect before precision operations with GLONASS are certified for use in the United States.

There is a chance that hybrid GNSS receivers for en route operations (i.e., receivers which use GPS and GLONASS signals together) may emerge prior to 2005. The frequency band of operation of these receivers is subject to question, however, due to the GLONASS transition plan and the existence of MSS operations in an adjacent band. This affects the return on investment associated with alternative receiver designs (see paragraph VII below). It is also reasonable to expect a decline in the number of satellites operating above 1605 MHz; actual satellite counts over time will fluctuate, but are constrained by the need to reach zero (and complete the GLONASS transition) by 2 January 2005.

VII. It is Economical for the Aviation Community to Use GLONASS Receivers Compatible with the Far-Term GLONASS Transition plan

The aviation community is very sensitive to the cost of avionics, the benefits accrued by purchase and installation of specific avionics, projected periods of operational use and economic payback times. This is significant because of the technical accommodations that would be required to use the GLONASS interim transition plan. Ultimately, in 2005, hybrid GNSS receivers will require a narrowband front-end that rejects RF signals above 1605 MHz. This front-end design is inconsistent with use of the GLONASS interim transition plan; thus, a hypothetical hybrid GNSS receiver designed to use the interim plan would require retro-fit in 2005. This is a potentially significant expense.

Furthermore, the benefits associated with the GLONASS interim transition plan are short-lived and difficult to quantify. Within the U.S., GPS/WAAS will provide primary-means en route navigation (the required navigation performance includes specification of accuracy, availability, continuity and integrity). The addition of GLONASS would possibly enhance the mathematically-calculated availability to some degree, ***but such enhancement offers no change in fundamental operational capability***. The use of GLONASS channels -7 to +4 reduces total unavailability time for en route operations to a few seconds per year; thus, the total availability benefit of channels +5 to +12 is upper bounded by a few seconds per year (declining as the year 2005 approaches, and easily handled by the coasting capability already mandated for GNSS equipment). Potential manufacturers of GPS/GLONASS equipment must question the merit of relying on GLONASS signals above 1605 MHz given: (1) the steadily declining numbers of such signals over time; (2) the lack of defined operational benefits associated with using such signals; (3) the short planning horizon over which such signals will be available; (4) the cost of developing such a receiver; and (5) the additional costs to themselves, as well as their customers, of transitioning to the far-term plan in 2005 (versus an alternative strategy that relies solely on the far-term plan from the outset). ***In summary, use of the GLONASS interim plan leads to increased cost and complexity of associated hybrid GNSS receivers, requires relatively near-term equipment modification in or around the***

year 2005, offers neither quantifiable operational benefit nor quantifiable economic benefit, and is therefore unlikely to materialize in practice.

VIII. Summary And Conclusions

En route usage of GLONASS, on channels -7 to +4, may occur before the year 2005. However, deployment of hybrid GNSS equipment for en route operations, consistent with the GLONASS interim transition plan, is unlikely because of the lack of defined operational benefits of such a receiver, its higher cost relative to GPS-only as well as hybrid GNSS equipment designed to operate with GLONASS channels -7 to +4, and the short period of usage such a receiver would offer prior to mandatory retro-fit.

Precision approach usage of GLONASS will certainly be delayed until after 2005.

The adoption of restrictive GLONASS protection requirements, which would force the MSS community to operate under the interim MSS frequency plan that the FCC abandoned in its recent MO&O, would hurt the LEO/MSS community and offer no quantifiable benefit to the aviation community.

Hybrid GNSS operations using GPS and GLONASS channels consistent with the far-term GLONASS transition plan should be protected. There is no need to specifically protect the GLONASS interim transition plan. Hybrid GNSS equipment could satisfy all operational performance requirements without reliance on GLONASS channels above +4. Such a receiver could rely on GLONASS channels -7 to +4, GPS at 1575.42 MHz, and WAAS (when available), and satisfy all defined navigation performance requirements for en route operations. GLONASS signals on channels 5 through 12 could be used on a supplemental basis when available, until they are phased-out and the receivers are redesigned or otherwise modified to provide greater selectivity.

Engineering Certification

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this Technical Appendix, that I am familiar with Part 25 of the Commission's Rules, that I have either prepared or reviewed the engineering information submitted in this Technical Appendix and that it is complete and accurate to the best of my knowledge.

John McDonald
SatTech Systems, Inc.

CERTIFICATE OF SERVICE

I, Andrew F. Taylor, hereby certify that I have on this 16th day of May 1996, caused copies of the foregoing "Opposition" to be delivered by U.S. mail, postage prepaid, to the following:

Scott Blake Harris
Chief, International Bureau
Federal Communications Commission
Suite 800
2000 M Street, N.W.
Washington, D.C. 20554

Thomas Tycz
Chief, Satellite & Radio
Communications Division
Federal Communications Commission
Suite 800
2000 M Street, N.W.
Washington, D.C. 20554

Cecily C. Holiday
Deputy Chief, Satellite & Radio
Communications Division
Federal Communications Commission
Suite 800
2000 M Street, N.W.
Washington, D.C. 20554

Karl A. Kensinger
International Bureau
Satellite Radio Branch
Federal Communications Commission
Suite 800
2000 M Street, N.W.
Washington, D.C. 20554

Kathleen Campbell
International Bureau
Satellite Policy Branch
Federal Communications Commission
Suite 800
2000 M Street, N.W.
Washington, D.C. 20554

Fern J. Jarmulnek
Chief, Satellite Policy Branch
Federal Communications Commission
Room 518
2000 M Street, N.W.
Washington, D.C. 20554

Harry Ng
Satellite Engineering Branch
Federal Communications Commission
Room 512
2000 M Street, N.W.
Washington, D.C. 20554

Jill Abeshouse Stern
Shaw, Pittman, Potts & Trowbridge
2300 N Street, N.W.
Washington, D.C. 20036

Robert A. Mazer
Albert Shuldiner
Vinson & Elkins L.L.P.
1455 Pennsylvania Ave. N.W.
Suite 700
Washington, D.C. 20004

Lon C. Levin
American Mobile Satellite Corp.
10802 Parkridge Boulevard
Reston, VA 22091