Rockwell Collins

Washington Office
1300 Wilson
Boulevard
Suite 200
Arlington, VA 22209

May 19, 2008

Mr. Roger Noel
Chief
Mobility Division
Wireless Telecommunications Bureau
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: WAIVER – EXPEDITED ACTION REQUESTED- Request for a Waiver of Part 87 Rules
to Allow Certification of Rockwell Collins' Aeronautical Satellite Communications Systems

Dear Mr. Wilhelm:

Rockwell Collins, Inc. ("Rockwell Collins") hereby requests a waiver of Sections 87.131,
87.133(a), 87.137(a), 87.139(i)(1), 87.139(i)(3), 87.141(j), and 87.145(d) of the Federal
Communications Commission's ("Commission's" or "FCC's") rules to permit certification of its
aeronautical satellite communications transceiver, Type Numbers HST-2110B[1] and HST-
2120B.[2] The Commission has previously granted Rockwell Collins' request for waiver to permit
the certification of the HST-2110 and HST-2120, which both use the Swift64 service. Rockwell
Collins wishes to market and sell these transceivers to support a new aeronautical data
communications service offered by Inmarsat under the service mark, "SwiftBroadband."

In this letter and the attachments, Rockwell Collins requests the Commission certify the HST-
2110B and HST-2120B satellite transceivers based upon technical data submitted demonstrating
that the unit complies with:

> a) the field strength of emissions from the equipment and interconnecting wiring
> (excluding emissions from the antenna) based on standard FAA requirements for all
> aeronautical electronic equipment mounted internal to an aircraft fuselage[3], rather than
> the emissions limits as specified in the rules for the antenna terminal[4]; and

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[1] FCC ID: AJK8222232. Application will be submitted electronically in May 2008.
[2] FCC ID: AJK8222234. Application will be submitted electronically in May 2008.
[3] RTCA DO-160D, Section 21, Category M.
[4] *See* 47 C.F.R. § 87.139(i)(1).

b) the technical requirements relating to authorized emissions, frequency tolerance emission types, spectrum mask, modulation type, and Doppler compensation that have been established by Inmarsat for the Swift64 and SwiftBroadband service.

The Commission has previously granted waivers for the Rockwell Collins aeronautical satellite transceivers which use the Swift64 service- most recently the HST-2110 and HST-2120.[6] The HST-2110B supports a single channel of Swift64 or SwiftBroadband service while the HST-2120B supports two channels. The internal hardware of the HST-2110B and HST-2120B are the same as the HST-2110 and HST-2120. In addition, the fundamental function of the HST-2110B and HST-2120B (i.e. Inmarsat Swift64 service) are the same as the HST-2110 and HST-2120, but the primary difference is a software change has been implemented in the HST-2110B and HST-2120B to enable them to transmit a new RF waveform to support the SwiftBroadband service. As a result, the waiver requested in this letter is very similar to the waiver requested and approved by the FCC for the HST-2110 and HST-2120 (a copy of the granted waiver is attached).[7] In addition, a copy of the Test Reports for the HST-2110B and HST-2120B, which provides supporting information for the Technical Discussion section, are attached.

Permitting the use of Swift64 and SwiftBroadband services for aeronautical satellite communications use will not cause harmful interference to safety-of-life satellite users, radio astronomy, or other aeronautical mobile satellite users. A satellite communications ("SATCOM") system with an installed HST-2110B or HST-2120B satellite transceiver will meet the technical requirements of Part 87 related to power output,[8] spurious emissions at the antenna terminal,[9] and priority and preemption.[10] This waiver request is submitted to allow use of the emissions types, occupied bandwidths, and frequency accuracy requirements associated with the Swift64 or SwiftBroadband service.

Background

The current Part 87 aeronautical mobile satellite regulations were written specifically for the Inmarsat "Aero-H" and "Aero-L" services. Subsequently, Inmarsat launched the Aero-I service which did not require any modifications to Part 87, as lower values of necessary and authorized bandwidths were permitted.[11]

Inmarsat now offers aeronautical mobile satellite service under the service marks "Swift64" and "SwiftBroadband."[12] Both services offer significantly higher data rates than Inmarsat Aero-H, Aero-I, and Aero-L aeronautical satellite communications systems currently accommodated

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[6] The Commission has granted waivers for the HST-900 (FCC ID: AJK8221772- waiver granted on 4/21/03), HST-2110 (FCC ID: AJK8222231- waiver granted on 10/16/06), and HST-2120 (FCC ID: AJK8222233 – waiver granted 10/16/06).

[7] On August 6, 2006, Rockwell Collins submitted the waiver to the Commission for HST-2110 and HST-2120. The Commission granted the waiver was granted on October 16, 2006.

[8] See 47 C.F.R. § 87.131 note 8.

[9] See 47 C.F.R. § 87.139(i)(1).

[10] See 47 C.F.R. § 87.187(q) and 87.189(e).

[11] See 47 C.F.R. § 87.137, footnote 16.

[12] Inmarsat introduced the SwiftBroadband service in October 2007. See <http://www.inmarsat.com/About/Newsroom/00023369.aspx?language=EN&textonly=False >.

under Part 87.[13] The higher data rate of Swift64 is made possible by using 134.4 kbps 16 Point Quadrature Amplitude Modulation ("16-QAM"), whereas the higher data rate of SwiftBroadband is made possible by using 432 kbps 16-QAM. 16-QAM is a more spectrally efficient modulation waveform than the constant amplitude Binary Phase Shift Key ("BPSK") or Quadrature Phase Shift Key ("QPSK") emissions currently utilized in the Inmarsat Aero services. However, using 16-QAM modulation introduces an emission type and occupied bandwidth not presently accommodated in Part 87.[14] The wider bandwidth nature of the signal also makes the tight frequency tolerance required in Part 87 unnecessary for these emissions.

As noted above, Inmarsat has designed the Swift64 and SwiftBroadband service specifically for aeronautical use. Part 87 requires that public correspondence be suspended when such operation will delay or interfere with messages pertaining to safety of life and property, regularity of flight, or when ordered by the captain of the aircraft.[15] The HST-2110B and HST-2120B satellite transceivers expand this requirement to include terminating Swift64 and SwiftBroadband operation if system resources are needed for higher priority Aero-H/H+ or Aero-I safety traffic. This operation is consistent with ICAO AMSS SARPS requirements.[16]

With this request for waiver and the associated applications for equipment authorization, Rockwell Collins seeks expedited approval to sell, on a commercial basis, satellite communications equipment capable of transmitting data at rates as high as 432 kbps on aircraft flown within the United States.

Swift64 and SwiftBroadband Service

The Inmarsat currently offers Swift64 and SwiftBroadband aeronautical communication service world-wide. Vizada is one of the providers of these services in the United States. Rockwell Collins currently manufactures the avionics equipment which use these services in both domestic and international locations. Swift64 service provides secure, reliable data communications at user data rates up to 64 kbps to military, air transport, and business aircraft operators while SwiftBroadband provide data rates to 432 kbps.

The Swift64 service can be used for many purposes unrelated to safety of life services, including:

1. Aircraft security (real-time video);
2. Access to public and corporate E-mail;
3. Internet Access;
4. Transfer of large files (audio, still and video images);
5. Flight and cabin crew access to ground based information systems; and
6. Ground-based authorities access to video images aboard an aircraft.

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[13] Swift64 is designed to take advantage of the existing Inmarsat Aero H installations by sharing the same antennas and High Power Amplifiers as the current Aero-H avionics.

[14] Rockwell Collins twice submitted comments to the FCC to change Part 87, Subpart D to permit Swift64 and SwiftBroadband. However, the Commission has not changed its rules to permit Swift64 or SwiftBroadband. *See In Re Review of Part 87 of the Commission's Rules Concerning the Aviation Radio Service*, Second Report and Order and Second Further Notice of Proposed Rulemaking in WT Docket No. 01-289, FCC 06-148 (rel. Oct 10, 2006).

[15] *See* 47 C.F.R. §§ 87.187(q) and 87.189(e).

[16] International Civil Aviation Organization – International Standards and Recommended Practices and Procedures for Air Navigation, Aeronautical Telecommunications, Annex 10, Volume III Communications Systems.

The SwiftBroadband service, which also can be used for the same purposes as mentioned above, offers the new capability of video conferencing. However, both the Swift64 and SwiftBroadband services are not certified for safety-related applications, such as air traffic control communications. In addition, the ICAO SARPS for aeronautical satellite communications do not define a safety function for the Swift64 or SwiftBroadband service. Therefore, both services employ technology to provide priority and real-time preemptive access for the Aeronautical Mobile Service and the Aeronautical Mobile-Satellite (R) Service messages.[17] As previously mentioned, transmissions can be suspended when such operation will delay or interfere with messages pertaining to safety-of-life and property or regularity of flight, or when ordered by the captain of the aircraft.[18]

Use in Maritime and Land Mobile

The Inmarsat Swift64 aeronautical services are an extension of the existing Inmarsat M4 land mobile service and Inmarsat Fleet F77 maritime service. M4 and Fleet F77 operations are currently authorized under Part 25 and Part 80 regulations, respectively.[19] The SwiftBroadband service uses the same telecommunications network as the BGAN and FleetBroadband services. The Swift64 and SwiftBroadband services operate using the same emission types as the land mobile and maritime equivalents. Nearly identical protocols allow the use of a common ground station infrastructure for all three services. The only notable difference in the Swift64 and SwiftBroadband services are the use of data interleaving to accommodate the aeronautical fading environment, and operation of the terminals in the Aeronautical Mobile Satellite (R) Service band.

To illustrate the similarity, Inmarsat has chosen to document the requirements for the Swift64 service as minor modifications to the documents that contain the M4 and Fleet F77 requirements,[20] rather than to document them as part of the existing requirements documents for the Aero-H/H+ and Aero-I services.

Technical Discussion

As noted above, current Aeronautical Mobile-Satellite Part 87 regulations are based on the existing Aero-H and Aero-L Inmarsat services. Although the Swift64 and SwiftBroadband services operate in the Aeronautical Mobile-Satellite Service, and are designed to share the same High Power Amplifier (HPA) and antenna system as the Aero-H service, both services provide significantly higher data rates. Swift64 is able to obtain a higher date rate by using a 16-QAM waveform at a 33.6 kHz symbol rate over the 1545-1559 MHz (receive) and 1646.5 – 1660.5 MHz (transmit) frequencies. SwiftBroadband obtains the higher data rate by using a 16-QAM waveform at a 151.2 kHz symbol rate over the 1525-1559 MHz (receive) and 1626.5 – 1660.5 MHz (transmit) frequencies.

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[17] *See* 47 C.F.R. § 87.189(d).
[18] *See* 47 CFR. Section 87.189(e).
[19] *See* 47 CFR Part 25, Subpart C-Technical Standards and Part 80, Subpart C-General Technical Standards.
[20] *See* Inmarsat Mini-M System Definition Manual.

87.131 Power and Emissions:

The current authorized emissions presently specified in Section 87.131 for an "Aircraft Earth" class of station is G1D, G1E, or G1W. Both the Swift64 and SwiftBroadband service utilize 16-QAM modulation, which uses simultaneous angle and amplitude modulation. This type of modulation is defined by Part 2.201 as an emission type of D1D, D1E, D1W, D7D, D7E, D7W, G7D, G7E, or G7W, depending on whether the transmission is being utilized for data, voice, or both.

The Commission has previously granted Rockwell Collins waivers for the D1D, D1E, and D1W emission types for the HST-2110 and HST-2120.[21] Rockwell Collins requests a similar waiver to allow the use of D1D, D1E, D1W, D7D, D7E, D7W, G7D, G7E, or G7W emission types, with the expectation that these emissions would meet the same 60 Watt power limitation[22] as currently specified for Aircraft Earth Stations.

87.133 Frequency Stability:

The current frequency tolerance for an Aircraft Earth Station ("AES") operating in the 470-2450 MHz band is specified in Section 87.133(a) as +/-320 Hz. For purposes of certification, a tolerance of +/-160 Hz applies to the reference oscillator of the AES transmitter.[23]

A terminal operating in the Swift64 or SwiftBroadband service is required by Inmarsat to maintain a frequency tolerance of +/- 1250 Hz.[24] A relaxed frequency tolerance is permitted for Swift64 terminals as channel spacing has been designed to accommodate this accuracy without causing adjacent channel interference.

The intent of the current FCC requirement is to guarantee that the aeronautical mobile transmitter is within +/- 320 Hz, excluding the effects of any Doppler precompensation. The Commission recognized in footnote 11 of Part 87.133 that the Doppler precompensation requires a High Stability Reference (HSR) oscillator frequency accuracy equivalent to +/-160 Hz, because the Doppler precompensation mechanism has the effect of doubling any HSR inaccuracy at the transmitter output.

The HST-2110B and HST-2120B satellite transceivers are designed to operate with an SRT-2100B Aero-H/H+ system to determine the correct Doppler precompensation. An estimate of the aircraft induced Doppler is provided by the Aero-H/H+ receiver. The Aero-H/H+ HSR oscillator has an accuracy equivalent to +/-160 Hz. The received Doppler estimate is then communicated to the HST for transmit Doppler precompensation. The HSTs contains an independent HSR oscillator with a guaranteed accuracy equivalent to +/-320 Hz. Therefore, the guaranteed accuracy of any Swift64 or SwiftBroadband transmissions will be the result of the sum of the Aero-H receiver accuracy (+/-160 Hz) and the HST accuracy (+/-320 Hz) or +/-480 Hz total.

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[21] *See* Waiver, page 4.
[22] *See* 47 C.F.R. § 87.131 including footnote 8.
[23] *See* 47 C.F.R. § 87.133 (a) footnote 11. This is a bench test.
[24] Inmarsat Mini-M System Definition Manual, Section B - Technical Requirements for Mini-M Mobile Earth Stations, Section 3.5.6.2.2.

The HST-2110B and HST-2120B utilize a channel modem and HSR design that is identical to that used for the Inmarsat land mobile and maritime equivalents of Swift64, and exceeds the Inmarsat requirements for Swift64.

The Commission has previously granted Rockwell Collins a waiver for transmission accuracy to be +/- 480 Hz for the HST-2110 and HST-2120.[25] We now request that the same waiver from the FCC for the HST-2110B and HST-2120B to accept a total guaranteed transmitter frequency accuracy of +/-480 Hz in lieu of +/-320 Hz to allow commonality of designs between the Aeronautical Swift64 and SwiftBroadband transmitters, and those of the equivalent land-mobile and maritime services.

87.137 Types of Emission:

The current Class of Emission, Emission Designator and Authorized Bandwidths permitted for Aircraft Earth Stations in the table of 87.137 (a) are as follows:

Class of Emission	Emission Designator	Authorized Bandwidth (kHz) (Above 50 MHz)
G1D[16*]	21K0G1D	25

* Refers to Footnote 16 which states: "Authorized for use by aircraft earth stations. Lower values of necessary and authorized bandwidth are permitted.

As explained in the comments relating to 87.131, the Swift64 service utilizes a 16-QAM modulation, which has a Class of Emission of D1D, DIE, and DIW and the SwiftBroadband service uses a 16-QAM modulation, which has a Class of Emission of D7D, D7E, D7W, G7D, G7E, and G7W. In addition, the necessary bandwidth for the Swift64 service has been registered with the ITU as 40 kHz while the SwiftBroadband has been registered as 225 kHz.

The higher necessary bandwidth is the direct result of the higher data rate of 33.6k symbols/sec (134.4k bits/sec channel rate) defined for Inmarsat's Swift64 service and 151.2k symbols/sec (604.8 k bits/sec channel rate) for the SwiftBroadband service. Both the Swift64 and SwiftBroadband services also specify the use of a signaling channel common to the Inmarsat Mini-M, M4 and Fleet F77 services. This signaling channel requires the use of an "unfiltered" BPSK modulation at 3000 bits/sec. The use of unfiltered BPSK requires a larger Authorized Bandwidth than if the BSPK signal employed a raised co-sine filtering similar to that specified for the current Aero-H and Aero-I systems. Therefore, the signaling channel BPSK emission defined by Inmarsat will not, by design, meet the authorized bandwidth limits of 25 kHz as presently defined in 87.137(a) for G1D emissions.

Rockwell Collins requests a waiver of the rules to permit the use of the following Swift64 and SwiftBroadband Emission designators and Authorized Bandwidths for use by Aircraft Earth Stations.

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[25] *See* Waiver, page 5-6.
[27] *See* 47 C.F.R. § 87.139.

Class of Emission	Emission Designator	Authorized Bandwidth (kHz) (Above 50 MHz)
DID	40K0D1D	45
D1E	40K0D1E	45
DIW	40K0D1W	45
D7D	200KD7D	225
D7E	200KD7E	225
D7W	200KD7W	225
G7D	200KG7D	225
G7E	200KG7E	225
G7W	200KG7W	225

87.139 Emission Limitations: as tested by 2.1053 "Measurements Required: Field Strength of Spurious Radiation"

The FCC's rules for emissions limitations are listed in section 87.139(i). Section 87.139(i) governs when a conflict exists with other parts of section 87.139.[27] When using G1D, G1E, or G1W emissions in the 1646.5-1660.5 MHz frequency band, the emissions must be attenuated as shown below.

Section 87.139(i)(1) as amended states (in part):

At rated output power, while transmitting a modulated single carrier, the composite spurious and noise output shall be attenuated by at least:

Frequency (MHz)	Attenuation (dB)
0.01 – 1559	-135 dB/4 KHz
1525 – 1559	-203 dB/4 KHz
1559 – 1585	-155 dB/MHz
1585 – 1605	-143 dB/MHz
1605 – 1610	-117 dB/MHz
1610 – 1610.6	-95 dB/MHz
1610.6 – 1613.8	-80 dBW/MHz
1613.8 – 1614	-95 dB/MHz
1614 – 1626.5	-70 dB/4 KHz
1626.5 – 1660	-70 dB/4 KHz
1660 – 1670	-49.5dBW/20 KHz
1670 – 1735	-60 dB/4 KHz
1735 – 12000	-105 dB/4 KHz
12000 – 18000	-70 dB/4 KHz

The FCC test procedures for emissions radiated from the equipment case and interconnecting cables is specified in Section 2.1053 "Measurements Required: Field Strength of Spurious Radiation." These procedures require demonstration of compliance with the same emissions limits specified in 87.139(i)(1). In June 2004, the FCC modified section 87.139(i)(1) to align with the requirements of RTCA DO-210D "Minimum Operational Performance Standards for Geosynchronous Orbit Aeronautical Mobile Satellite Services (AMSS) Avionics" (MOPS). This resulted in a change from the previous FCC attenuation limits of 83 dB (below 1559 MHz)

and 55 dB (above 1559 MHz) to attenuations now as high as 203 dB in the receive band (1525-1559 MHz). These new requirements are appropriate at the SATCOM antenna terminals because SATCOM is a full duplex system and shares a single antenna. Most of the receiver/transmitter isolation to achieve this attenuation is provided by the LNA/Diplexer.[28] Other attenuation requirements in the MOPS were established to protect any GPS receiver antenna mounted nearby on the aircraft and to protect radio astronomy. These limits assumed the SATCOM antenna could exhibit in excess of 12 dB gain at these frequencies.

The limits specified in DO-210D were not intended to also apply to emissions radiated directly from the equipment or interconnecting cables. The equipment and cables for the HST-2110B and HST-2120B are located inside the fuselage of the aircraft. The aircraft fuselage provides attenuation of any emissions that might be received by other aircraft antenna or Radio Astronomy receivers. In addition, the field strength of any spurious emission originating from the equipment or interconnecting cables is not amplified by the gain of the antenna. None of the other electronic equipment that is installed in the aircraft is required to be tested to the levels of Section 87.139(i)(1).

As a result, Rockwell Collins requests a waiver of Section 87.139(i)(1) as applied to the field strength measurements of equipment and interconnecting cables specified in Section 2.1053 because the purpose of the rule would not be served if applied in this instance. Instead, Rockwell Collins requests that the FCC accept compliance with the standard radiated field strength procedures and limits for equipment and interconnecting cables for equipment installed internal to aircraft fuselage as specified in RTCA DO-160D, Section 21, Category M as sufficient compliance with the intent of the rules. Rockwell Collins requested and the Commission granted the same waiver for Section 87.139(i)(1) for the HST-2110 and HST-2120.[29]

87.139(i)(3) Emission Limitations – Emission Mask

The 3000 bps BPSK signaling channel used for Swift64 does not employ the same filtering as used by other modulation types. The BPSK signal will (by design) not meet the mask requirement as stated in Section 87.139(i)(3), even after adjusting for symbol rate. The mask for the 3000 bps BPSK, is defined by Inmarsat[30] as:

Offset from Assigned Carrier Frequency (kHz)	Relative Level (dB) Minimum	Maximum
0 to 1	-1.7	+1
1 to 10	Not specified	+1
10 to 20	Not specified	-16-(9/10)(F-10)
20 to 40	Not specified	-25-(6/20)(F-20)
40 to 80	Not specified	-31-(6/40)(F-40)
80 to 100	Not specified	-37-(23/20)(F-80)

Rockwell Collins requests a waiver of 87.139(i)(3) to allow the use of a 3000 bps BPSK emission that meets the Inmarsat mask requirements stated above. A waiver is not needed for

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[28] The LNA/Diplexer is not manufactured by Rockwell Collins, but the attenuation requirements have been standardized in ARINC 741.

[29] See Waiver, page 6-7.

[30] See Inmarsat Mini-M System Definition Manual, Module 2, Part 1, Section 3.5.8.2 and Figure 11.

the SwiftBroadband service because Inmarsat employs a more strict requirements than specified in Section 87.139(i)(3) of the Commission's regulation.[31]

87.141 Modulation Requirements:

Current FCC regulations require transmitters used as Aircraft Earth Stations to employ BPSK for transmission rates up to and including 2400 bits per second, and QPSK for higher rates.[32] The current regulations were appropriate for the existing Inmarsat Aero-H and Aero-I services. However, the Swift64 system utilizes BPSK for the transmission rates of 3000 bits per second, and 16-QAM for the 134 kbps (33.6 k symbols/sec) channel. The SwiftBroadband uses QPSK for the transmission rates of 252.8 kbps (151.2k symbols/sec) and 16-QAM for the 432 kbps (151.2k symbols/sec) bps. These modulations are already in use by the Inmarsat Mini-M and Fleet 77 services.

Rockwell Collins requests a waiver of 87.141(j) to permit the use of BPSK for the Swift64 3000 bps channel, and 16-QAM for the Swift64 134.4 kbps channel. In addition, we request the same waiver to permit the use of QPSK and 16-QAM for the SwiftBroadband service.

87.145 Acceptability of Transmitters for Licensing:

Section 87.145 requires the transmitter to pre-compensate its transmission frequency to account for Doppler shifts that will occur between the aircraft transmitter and the satellite. Section 87.145(d) also incorporates an allowance for possible error in the Automatic Frequency Control function and determine an overall frequency accuracy requirement of +/- 335 Hz (root sum square error). The equivalent Inmarsat frequency accuracy requirement of +/1250 Hz[33] stipulates that such closed loop frequency precompensation must be incorporated.

The HST-2110B or HST-2120B are a part of the overall SRT-2100B communications system. The SRT-2100B system complies with the requirement that the transmit frequency be pre-compensated for Doppler effect relative to the satellite. However, Rockwell Collins requests a waiver of the frequency accuracy requirement stated within 87.145(d). As mentioned earlier, the HSR in the HST is of a common design with other Inmarsat services. When operating with the 0.1 ppm HSR in the SRT-2100B system and the 0.2 ppm HSR in the HST, the overall system will maintain a root sum square error frequency error of less than +/- 490 Hz for Swift64 emissions only. (All Aero-H and Aero-I emissions will continue to meet the existing +/-335Hz requirement).

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[31] *See* Inmarsat Mini-M System Definition Manual, Module 2, Part 1, Section 3.5.8.2.
[32] *See* 47 C.F.R. § 87.141(j).
[33] *See* Inmarsat Mini-M System Definition Manual, Section B - Technical Requirements for Mini-M Mobile Earth Stations, Section 3.5.6.2.2.

Conclusion

Based on information provided herein, Rockwell Collins requests that the Commission waive the regulations discussed above and certify the HST-2110B and HST-2120B aeronautical satellite transceivers for use in the United States.

Granting certification will allow aircraft passengers to connect to the internet at approximately the same speed as dial-up modems. In addition, the HST-210B and HST-2120B will enable the flight and cabin crew to access ground-based information systems at faster data rates. This connectivity is significantly faster than current aeronautical mobile satellite communications without causing harmful interference to other services, and is therefore in the public interest.

Rockwell Collins respectfully requests expedited review of this request. Please contact Mr. John Gifft of this office at (703) 516-8213 if you have any questions.

Respectfully submitted,

John F. Provenzano
Senior Director, Federal Affairs
May 19, 2008

Attachments (2)
- Attachment 1 – Granted Waiver Request for HST-2110 and HST-2120
- Attachment 2- Test Reports for HST-2110B and HST-2120B