Rockwell Collins
Washington Office
1300 Wilson Boulevard
Suite 200
Arlington, VA 22209

GRANTED August 7, 2006
For the reasons indicated therein
/s/ Michael Wilhelm
10/17/06

Mr. Michael Wilhelm
Chief
Public Safety and Critical Infrastructure 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-2110[1] and HST-2120.[2] Rockwell Collins wishes to market and sell these transceivers to support a new aeronautical data communications service offered by Inmarsat under the service mark, "Swift64."

Rockwell Collins requests the Commission certify the HST-2110 and HST-2120 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

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 service rather than the above referenced rules.[5]

[1] FCC ID: AJK8222231. Application submitted electronically on August 7, 2006.
[2] FCC ID: AJK8222233. Application submitted electronically on August 7, 2006.
[3] RTCA DO-160D, Section 21, Category M.
[4] *See* 47 C.F.R. § 87.139(i)(1).
[5] *See* 47 C.F.R. §§ 87.131, 87.133(a), 87.137(a), 87.139(i)(3), 87.141(j), and 87.145(d).

The Commission has previously granted a waiver for the Rockwell Collins HST-900 satellite transceiver, which uses the same Swift64 service (a copy of the granted waiver is attached).[6] In addition, the HST-2110 and HST-2120 transceivers each support the same Inmarsat Swift64 emissions as the HST-900. The HST-2110 supports a single channel of Swift64 while the HST-2120 supports two channels. The internal RF and DSP hardware have been modified in the HST-2110 and HST-2120 to accommodate growth to future Inmarsat services, which therefore requires a new application for Equipment Authorization. However, the fundamental function of the HST-2110 and HST-2120 (i.e. Inmarsat Swift64 service) is the same as the HST-900. As a result, the waivers requested in this letter are very similar[7] to the waiver requested and approved for the HST-900, with the exception of an additional waiver request for the field strength of emissions from the equipment and interconnecting wiring. The additional waiver request is necessitated by a change to the section 87.139(i)(1) of the Commission's rules which occurred after the HST-900 was certified.[8]

Permitting the use of Swift64 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-2110 or HST-2120 satellite transceiver will meet the technical requirements of Part 87 related to power output,[9] spurious emissions at the antenna terminal,[10] and priority and preemption.[11] This waiver request is submitted to allow use of the emissions types, occupied bandwidths, and frequency accuracy requirements associated with the Swift64 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.[12]

Inmarsat is now offering a new aeronautical mobile satellite service under the service mark "Swift64." The Swift64 aeronautical service offers a significantly higher data rate than Inmarsat Aero-H, Aero-I, and Aero-L aeronautical satellite communications systems currently accommodated under Part 87.[13] The higher data rate of Swift64 is made possible by using 134,400 bps 16 Point Quadrature Amplitude Modulation ("16-QAM"). 16-QAM is a more spectrally efficient modulation waveform than the constant amplitude Bi-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

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[6] On November 15, 2002, Rockwell Collins submitted the waiver to the Commission which was granted on April 21, 2003, see DA 03-686.

[7] Some descriptive text has been updated to reflect minor changes to the FCC rules that occurred since the original HST-900 Waiver application.

[8] 69 FR 32661, June 14, 2004.

[9] *See* 47 C.F.R. § 87.131 note 8.

[10] *See* 47 C.F.R. § 87.139(i)(1).

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

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

[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.

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 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-2110 and HST-2120 satellite transceivers expand this requirement to include terminating Swift64 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 134,400 bits per second on aircraft flown within the United States.

Swift64 Service

The Inmarsat Swift64 aeronautical communication service is currently available world-wide. Telenor, USA (formerly COMSAT) provides this service in the United States. Rockwell Collins currently manufactures the avionics equipment which uses this new service 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.

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.

However, the Swift64 service is 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 service. Therefore, Swift64 employs 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

[14] Rockwell Collins submitted comments to the FCC to change Part 87, Subpart D to permit Swift64. However, the Commission has not changed its rules to permit Swift64. *See In Re* Review of Part 87 of the Commission's Rules Concerning the Aviation Radio Service, Notice of Proposed Rulemaking in WT Docket No. 01-289, FCC 01-303 (rel. Oct 16, 2001).

[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.

[17] *See* 47 C.F.R. § 87.189(d).

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 service is 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 Swift64 service operates 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 service is 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 service operates in the Aeronautical Mobile-Satellite Service, and is designed to share the same High Power Amplifier (HPA) and antenna system as the Aero-H service, the Swift64 service provides significantly higher data rates. The higher data rates are implemented 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. A 3000 bps BPSK modulation type is also utilized for system management.

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. The Swift64 service utilizes a 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, or D1W, depending on whether the transmission is being utilized for data, voice, or both.

Rockwell Collins requests a waiver to allow the use of D1D, D1E, and D1W emission types, with the expectation that these emissions would meet the same 60 Watt power limitation[21] as currently specified for Aircraft Earth Stations.

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[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] Inmarsat Mini-M System Definition Manual.
[21] *See* 47 C.F.R. § 87.131 including footnote 8.

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.[22]

A terminal operating in the Swift64 service is required by Inmarsat to maintain a frequency tolerance of +/- 1250 Hz.[23] 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-2110 and HST-2120 satellite transceivers are designed to operate with an SRT-2100 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 at. Therefore, the guaranteed accuracy of any Swift64 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.

The HST-2110 and HST-2120 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.

We request that the FCC accept a total guaranteed transmitter frequency accuracy of +/-480 Hz in lieu of +/-320 Hz to allow commonality of designs between the Aeronautical Swift64 transmitters, and those of the equivalent land-mobile and maritime services. We note that the FCC has the discretion to authorize tolerances other than those specified upon a satisfactory showing of need.[24]

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:

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

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. In addition, the necessary bandwidth for the 16-QAM has been registered with the ITU as 40 kHz. The higher necessary bandwidth is the direct result of the higher data rate of 33.6k symbols/sec (134.4k bits/sec) defined for Inmarsat's Swift64 service.

The Swift64 service also specifies 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 Emission designators and Authorized Bandwidths for use by Aircraft Earth Stations.

Class of Emission	Emission Designator	**Authorized Bandwidth (kHz) (Above 50 MHz)**
D1D	40K0D1D	45
D1E	40K0D1E	45
D1W	40K0D1W	45

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.[25] 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

[25] *See* 47 C.F.R. § 87.139.

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.[26] 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-2110 and HST-2120 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.

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

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

The 3000 bps Bi-Phase Shift Key (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 requirements as stated in Part 87.139(i)(3), even after adjusting for symbol rate. The mask for the 3000 bps BPSK , is defined by Inmarsat[27] 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.

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.[28] 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 134000 bps (33600 symbols/sec) channel. 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 134400 bps channel.

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[29] stipulates that such closed loop frequency precompensation must be incorporated.

The HST-2110 or HST-2120 are a part of the overall SRT-2100 communications system. The SRT-2100 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-2100 system and the 0.2 ppm HSR in the HST, the overall system will maintain

[27] Inmarsat Mini-M System Definition Manual, Module 2, Part 1, Section 3.5.8.2 and Figure 11.
[28] *See* 47 C.F.R. § 87.141(j).
[29] Inmarsat Mini-M System Definition Manual, Section B - Technical Requirements for Mini-M Mobile Earth Stations, Section 3.5.6.2.2.

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).

Conclusion

Based on information provided herein, Rockwell Collins requests that the Commission waive the regulations discussed above and certify the HST-2110 and HST-2120 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. 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,

Linda C. Sadler

Linda C. Sadler
Director, Federal Affairs