Rockwell Collins

Washington Office

November 15, 2002

Ms. Dwana R. Terry
Chief
Public Safety and Private Wireless Division
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Request for a Waiver of Part 87 Rules to Allow Type Acceptance of Rockwell Collins' Aeronautical Satellite Communications System utilizing Inmarsat's Swift64 Service.

Dear Ms. Terry:

Rockwell Collins, Inc. ("Rockwell Collins") hereby requests a waiver of Sections 87.131, 87.133(a), 87.137(a), 87.139(i)(4), 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 Number HST-900.[1] Rockwell Collins wishes to market and sell this transceiver to support a new aeronautical data communications service offered by Inmarsat under the service mark, "Swift64."

Rockwell Collins requests the Commission certify the HST-900 satellite transceiver based upon technical data submitted demonstrating that the unit complies with the technical requirements established by Inmarsat for this service rather than the above referenced rules.[2]

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-900 satellite transceiver will meet the technical requirements of Part 87 related to power output,[3] spurious emissions,[4] intermodulation,[5] and priority and preemption.[6] This waiver request is submitted to allow use of the emissions types,

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[1] FCC ID: AJK8221772. Application originally electronically submitted October 4, 2002.
[2] Sections 87.131, 87.133(a), 87.137(a), 87.139(i), and 87.141(j), and 87.145(d).
[3] Section 87.131 note 8.
[4] Section 87.139(i)(1)
[5] Section 87.139(i)(2)
[6] Sections 87.187(q) and 87.189(e)

occupied bandwidths and frequency accuracy requirements associated with the Swift64 service.

Background

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.[7]

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.[8] 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 Quadature 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.[9] 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.[10] The HST-900 satellite transceiver expands 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.[11]

With this request for waiver and the associated applications for equipment authorization, Rockwell Collins seeks expedited approval to sell, on a commercial basis, satellite

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[7] See 47 C.F.R. Section 87.137, footnote 16.

[8] 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.

[9] Rockwell Collins is working with the FAA and Commission in changing Part 87, Subpart D 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).

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

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

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 operating outside the United States. The United States based service provider is Telenor, USA (formerly Comsat). Rockwell Collins hopes to provide the avionics equipment necessary to utilize this new service both within and outside the United States. 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.[12] As stated previously, transmissions can also 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.[13]

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.[14] 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

[12] See 47 CFR. Section 87.189(d).
[13] See 47 CFR. Section 87.189(e).
[14] See 47 CFR Part 25, Subpart C-Technical Standards, Part 80, Subpart C-General Technical Standards.

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,[15] 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 Swift 64 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[16] 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.[17]

A terminal operating in the Swift64 service is required by Inmarsat to maintain a frequency tolerance of +/- 1250 Hz.[18] A relaxed frequency tolerance is permitted for

[15] Inmarsat Mini-M System Definition Manual.
[16] Section 87.131 including footnote 8.
[17] Section 87.133 (a) footnote 11. This is a bench test.
[18] Inmarsat Mini-M System Definition Manual, Section B - Technical Requirements for Mini-M Mobile Earth Stations, Section 3.5.6.2.2

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-900 satellite transceiver operates with an 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-900 for transmit Doppler precompensation. The HST-900 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-900 accuracy (+/-320 Hz) or +/-480 Hz total.

When the HST-900 satellite transceiver operates with a SAT-906 system, the receiver Doppler is detected by the SAT-906 system, operating with an HSR accuracy equivalent to +/-160 Hz. The received Doppler is then communicated to the HST-900 for Doppler precompensation. The design of the HST-900 incorporates an HSR with guaranteed accuracy equivalent to +/-320 Hz. Therefore, the guaranteed accuracy of any Swift64 transmissions will be the result of the sum of the SAT-906 accuracy (+/-160 Hz) and the HST-900 accuracy (+/-320 Hz) or +/-480 Hz total.

The HST-900 utilizes 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.[19]

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:

[19] Section 87.133(e)

Class of Emission	Emission Designator	Authorized Bandwidth (kHz) (Above 50 MHz)
G1D[16*]	21K0G1D	25
G1E[16]	21K0G1E	25
G1W[16]	21K0G1W	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 Swift 64 service utilizes a 16-QAM modulation, which has a Class of Emission of D1D, D1E, or D1W depending on usage. 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 Swift 64 Emission designators and Authorized Bandwidths for use by Aircraft Earth Stations as filed with the ITU.

Class of Emission	Emission Designator	Authorized Bandwidth (kHz) (Above 50 MHz)
G1D	5K60G1D	25
D1D	40K0D1D	45
D1E	40K0D1E	45
D1W	40K0D1W	45

87.139 Emission Limitations:

Section 87.139(i) states: "In case of conflict with other provision of Section 87.139, the provision of this paragraph shall govern for aircraft earth stations. When using G1D, G1E, or G1W emissions in the 1646.5-1660.5 MHz frequency band, the emissions must be attenuated as shown below."

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)(4), even after adjusting for symbol rate. The mask for the 3000 bps BPSK , is defined by Inmarsat[20] 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)(4) to allow the use of a 3000 bps BPSK emission that meets the Inmarsat mask requirements stated above.

87.141 Modulation Requirements:

Current 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.[21] 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 AFC function and determine an overall frequency accuracy requirement of +/- 335 Hz (root sum square error). The equivalent Inmarsat frequency accuracy requirement of +/1250 Hz[22] stipulates that such closed loop frequency precompensation must be incorporated.

The HST-900 operating in cooperation with the SAT-906 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 "closed loop" frequency accuracy requirement stated within 87.145(d). As mentioned earlier, the High Stability Reference in the HST-900 is of a common design to other Inmarsat services.

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[20] Inmarsat Mini-M System Definition Manual, Module 2, Part 1, Section 3.5.8.2 and Figure 11.
[21] Section 87.141(j).
[22] Inmarsat Mini-M System Definition Manual, Section B - Technical Requirements for Mini-M Mobile Earth Stations, Section 3.5.6.2.2

When operating with the 0.1 ppm HSR in the SAT-906 system and the 0.2 ppm HSR in the HST-900, 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).

Conclusion

Based on information provided herein, Rockwell Collins requests that the Commission waive the regulations discussed above and certify the HST-900 aeronautical satellite transceiver 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. Joseph Cramer of this office at (703) 516-8213 if you have any questions.

Respectfully submitted,

Linda C. Sadler
Director, Federal Affairs