Advisory Circular

Subject: SATELLITE VOICE EQUIPMENT AS A MEANS FOR AIR TRAFFIC SERVICES COMMUNICATIONS | **Date:** 2/10/06 | **Initiated by:** AIR-100 | **AC No:** 20-150 | **Change:**

1. PURPOSE.

a. This advisory circular (AC) provides guidance for designers, manufacturers, and installers of satellite voice equipment used for Air Traffic Services (ATS) communication. In this AC, the Federal Aviation Administration (FAA) recommends one way to gain airworthiness approval for your satellite voice equipment.

b. This AC is not mandatory and does not constitute a regulation. This AC describes an acceptable means, but not the only means, to gain airworthiness approval for your satellite voice equipment. However, if you use the means described in this AC, you must follow it in all-important respects.

2. BACKGROUND. Aircraft operators use high frequency (HF) and very high frequency (VHF) communications systems for aeronautical operational communication and ATS operations. Due to frequency congestion in oceanic and remote flight operations, aircraft operators have requested the use of satellite voice communication equipment as a supplement to existing HF and VHF voice systems.

3. DESIGN CONSIDERATIONS. Use the following guidance during the design stage. It applies to the design approval of satellite voice equipment, including:

∞ Performance standards,

∞ User and aircraft ergonomics.

∞ Qualification of the hardware and software,

∞ Safety assessment,

∞ Message priority assignment, and

a. Satellite Voice Transmission Medium. The satellite voice equipment should comply with RTCA, Inc.'s Document (RTCA/DO)-210D, Minimum Operational Performance Standards for Geosynchronous Orbit Aeronautical Mobile Satellite Services (AMSS), dated April 19, 2000.

b. Environmental Qualification. Qualify the components comprising the satellite voice equipment to the appropriate sections of RTCA/DO-160E, Environmental Conditions and Test Procedures for Airborne Equipment, dated December 9, 2004. The environmental qualifications must be compatible with the environment in which the equipment is installed.

c. Software Qualification. The equipment should comply with RTCA/DO-178B, Software Considerations in Airborne Systems and Equipment Certification, dated December 1, 1992.

d. Hardware Qualification. The equipment should comply with RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware, dated April 19, 2000. RTCA/DO-254 offers guidelines for meeting design assurance requirements when developing electronic hardware.

e. Cockpit Voice Recorder. Where the regulations require installing a cockpit voice recorder, record satellite voice equipment communication when monitoring the recorder's channels.

f. Flight Data Recorder. Where the regulations require installing a flight data recorder, record the radio transmitter keying CVR/DFDR synchronization in crash survivable memory.

g. Audio Management System. Interface with the existing audio management system by enabling the flight crew to promote crew awareness, coordination, and verbal error detection equivalent to the required VHF and HF communication systems.

4. SAFETY ASSESSMENT CONSIDERATIONS. Conduct a safety assessment, which considers the effects of satellite voice equipment failures on the aircraft. The safety assessment should determine, classify, and evaluate failure conditions that may result from malfunction, loss of function, or design errors. The safety assessment should also evaluate failures or design errors of the satellite voice equipment that could cause or contribute to failures of other systems. The following guidance applies to conducting safety assessments for satellite voice equipment:

a. Hazard Classification. Failure or malfunction of satellite voice equipment at the system function level used in the oceanic environment, and for a supplement to approved nonroutine ATS voice communication, results in a "minor" hazard classification.

b. Coexistence with HF Voice Radio. Sometimes the satellite voice equipment's ground network may use the public switched telephone network to send flight safety messages. This use has risks because of potential network congestion and audio level variability. You should resolve these issues. Their resolution must be appropriate for that aircraft's intended operating environment. Because we at the FAA will require HF radio services for the foreseeable future, HF radio will coexist with satellite voice.

c. Minimum Equipment List. If you use the satellite voice equipment to supplement the second HF transmitter and receiver [see Title 14 of the Code of Federal Regulations (14 CFR) § 91.511(d)], you must evaluate how the system works under a potential load-shed environment.

(1) Consider the power source of the satellite voice equipment. The integrity of the power source should be the same as the communications system it is intended to supplement.

(2) Satellite voice equipment often requires a high amount of power. Since the equipment supplements other communication systems, it should not be installed on the emergency bus where it could place a high electrical load on the emergency battery.

5. MESSAGE PRIORITY LEVELS. If you are a designer, prioritize satellite voice messages following figure 1. The satellite voice equipment's internal signaling procedures should allow the aircraft operator to start an AMSS voice call at four priority levels. Use the highest three priority levels only for safety communications. The lowest of the four levels is for nonsafety communications, such as aeronautical public correspondence and aeronautical administrative communications. Figure 1 shows the priority level and application category, following the requirements of International Civil Aviation Organization's Annex 10, Aeronautical Telecommunications. We list examples of messages in the third column.

FIGURE 1. MESSAGE PRIORITIES FOR SATELLITE VOICE MESSAGES

Priority Level	Application Category	Satellite Voice Message Examples
1 *Emergency* (highest) Safety of Flight	Distress and Urgency	Rapid Descent, Urgent Sidestep for Weather
2 *Operational High* (second highest) Safety of Flight	Flight Safety	Altitude Request
3 *Operational Low* (third highest) Safety of Flight	Regularity of Flight, Meteorological, Administrative	Air Traffic Information Service, Redispatch, Maintenance
4 *Nonoperational* (lowest) Nonsafety	Public Correspondence	Public Phone Calls

a. Message Preemption, Priority, and Precedence. The priority level column of figure 1 shows the order of precedence in setting up a satellite voice channel. We define preemption as the immediate and automatic seizure of resources allocated to a lower-priority call. The satellite voice equipment reallocates the resources to a higher-priority call. Trade-offs of flight safety requirements versus passenger satisfaction should not be a consideration. Treat preemption, priority, and precedence as follows:

(1) If a satellite voice channel for transmission and reception is in use and the aircraft earth station wants to send a higher-priority call, the satellite voice equipment should clear the

channel supporting the lower-priority call. If more than one lower-priority channel is in use, the equipment should preempt the channel supporting the lowest priority level.

(2) The satellite voice equipment should provide the flight crew the means to preempt any call at any time. The equipment may automatically preempt flight deck communications. However, it also must allow manual preemption.

(3) The satellite voice equipment may also allow flight crew members to place their call attempt at the top of a queue, that is, to camp-on while awaiting free resources. Flight crew procedures should include explicit instructions defining how the flight crew can use camp-on.

(4) The satellite voice equipment should allow the flight crew to designate the desired message priority level before starting a call attempt. Before starting a call, the crew should be able to confirm or select a voice call priority appropriate to the call's intended purpose, or at least be able to verify a known default priority. The flight crew should have the flexibility to override default levels, if necessary, for ATS communications.

b. Message Routing. The satellite voice equipment should route "ground-to-air" messages:

(1) To the flight deck, if they are satellite voice messages of priority level 1-3.

(2) To the passenger cabin, if they are satellite voice messages of priority level 4.

> **NOTE 1:** Due to identified security concerns, satellite voice equipment cannot route priority level 4 satellite voice messages to the flight deck. However, the flight deck crew can originate priority level 4 voice messages.
>
> **NOTE 2:** Under the message routing requirements in this AC, the equipment should route priority-based "ground-to-air" calls per figure 1. The equipment should also provide a migration path to address-based routing when the called terminal field in the call announcement signal unit is defined.

6. SATELLITE CHANNEL ALLOCATION. The satellite voice equipment should meet the following guidance:

a. In cases where *one* satellite voice equipment has two or more channels assigned to the cockpit, incoming calls should default to the specified position (for example, the captain's position) if it is not in current use. The flight crew should be able to select which channel to use when starting an outgoing call or, as a minimum, should be able to verify a default channel.

b. For an installation with *two* satellite voice equipment, the slave in the system should log-on once per flight cycle. This verifies that it will be available if it must assume the role as master if the master system fails.

7. FLIGHT DECK MESSAGE ANNUNCIATION. When installing airborne satellite voice equipment, you should integrate the system's annunciation into the aircraft's existing alerting scheme. The equipment should follow the guidance below:

a. The equipment should give an aural and visual alert for each "ground-to-air" ATS message, unless the safety assessment shows otherwise. The equipment may use visual alerts alone for annunciation of non-ATS communications.

b. The equipment should offer a means to alert the flight crew when it detects airborne system failures that would make it inoperative.

c. There should be a continuous visual annunciation to the crew showing a call is in progress. Each satellite voice channel in the flight deck audio panel should correspond to an individual call light. The light should illuminate once a call connects to the flight deck. It should remain illuminated while the associated channel is connected.

d. For air-to-ground calls, having the call light come on when the call starts (rather than when it connects) is acceptable. It informs the flight crew that the satellite voice equipment is responding to their input. For each air-to-ground call that cannot be completed as dialed, the satellite voice equipment should give an appropriate annunciation.

e. When the satellite voice equipment uses flight deck call camp-on [see paragraph 5a(3) of this AC], the equipment should visually indicate to the flight crew that it has designated the placed air-to-ground call as camp-on. The visual indicator should last until the crew ends the call or performs another action.

f. To avoid flight crew confusion, any destination address in the satellite voice display from a previous air-to-ground call should clear, or the flight crew should remove it, while a "ground-to-air" call is in progress.

g. After C-channel continuity ends, there should be an aural sidetone.

h. An aural or visual signal should alert the flight crew when there are abnormal call terminations and link failures, per the existing flight deck design philosophy of the aircraft. Examples of abnormal call terminations include satellite hand-over, selective release, link loss, and other breakdowns of communications.

i. The equipment should annunciate to the flight crew when AMSS resource limitations cause a higher-priority, ground-originated call to preempt a current flight deck call.

j. The equipment should give a continuous visual indication when any call is on hold.

8. CONTROL CAPABILITY. After initially powering up the satellite voice equipment, the flight crew should not have to "unlock" or reactivate the system during the flight by other means (for example, by inserting a credit card and reentering a security code). The system should have a means for allowing crew members to do the following:

a. Have adequate access to satellite voice controls.

b. Answer a call manually.

c. Reject an incoming call of any priority, and instead make an outgoing call.

d. Receive an alert when they input an invalid satellite voice number.

e. Use speed dialing, that is, the satellite voice address database, instead of having to dial the full international number, wherever possible. However, they should be able to dial the full international number (up to 17 digits) manually, if they choose.

f. Start, answer, place on hold, and end a call using only an audio control panel. The flight crew should be able to activate the call hold, using the audio control panel, not a control display unit (CDU). When the crew must place a satellite voice call on hold, the system should minimize the risk of accidentally clearing the call.

g. Place an individual satellite voice call on hold and use another radio channel, without ending the call. The flight crew should be able to activate the call hold using the audio control panel, not a CDU. When the crew must place a satellite voice call on hold, the system should minimize the risk of accidentally clearing the call.

h. Display the satellite voice equipment configuration, that is, operational software version and part number, database version and part number, as applicable.

9. GROUND AND FLIGHT TEST EVALUATION. Ground and flight tests should consider the following guidance:

a. Ground Test. Ground tests for certification should evaluate:

(1) The general arrangement and operation of controls, displays, circuit breakers, annunciators, alerts, and any placards of the satellite voice equipment. Be careful when using a multipurpose control and display unit (MCDU) or CDU for satellite voice equipment control. Your evaluation should verify that the equipment does not always force the flight crew to "back out" of multiple branches of the menu to start or answer a call. For example, if pilots are in the MCDU LEGS page of the flight management computer, they should not have to go back to the main menu page and select the SATCOM pages, to answer a satellite voice call.

(2) Any self-test features and failure mode displays and annunciators.

(3) The installation to ensure that the flight crew can identify, access, and see the satellite voice equipment during day and at night.

(4) Integration of the satellite voice equipment with other aircraft systems.

(5) The possibility of accidentally inputting errors and the effects of those errors.

(6) The satellite voice and other aircraft systems for mutual noninterference caused by radiofrequency emissions.

(7) The digital computer clock frequencies associated with the design of an aircraft earth station. If applicable, evaluate if the clocks interfere with existing navigation and communications receivers at these discrete frequencies and their associated harmonics.

b. Flight Tests. Flight tests for certification should:

(1) Evaluate how to integrate the satellite voice equipment with other systems. Evaluate other systems, such as the flight management system, as necessary, to determine if the satellite voice equipment interferes or interfaces with them. Pay attention to other "L" band equipment, particularly the global positioning system (GPS) equipment. Intermodulation effects are possible between multiple channel SATCOM installations and GPS. Though the GPS signal is typically below the value of the background noise, electrical noise near the GPS antenna can adversely affect system performance.

(2) Evaluate the system's general arrangement and how to operate the satellite voice equipment controls, annunciators, alerts, and displays in day, night, and dusk conditions. Insert (simulate) failure modes, as necessary, to evaluate aural and visual annunciation.

(3) Evaluate examples of functional operation of the satellite voice equipment and if the equipment can be used under the intended operating rules for a typical application.

(4) Show acceptable procedures for operating the satellite voice equipment. Determine that the equipment can execute the proposed procedures in acceptable workload, stress conditions, and with a minimal reliance on flight crew memory.

(5) Evaluate acceptable voice continuity in normal turns and pitch maneuvers, if the satellite voice equipment will probably use a beam-steered antenna.

10. AIRPLANE/ROTORCRAFT FLIGHT MANUAL (A/RFM) SUPPLEMENT. The airplane flight manual (AFM) or rotorcraft flight manual (RFM) supplement should provide a description of all normal modes, submodes, and abnormal modes (if applicable) of system operation. The description should include what corrective actions are expected by the flight crew for each case.

a. Operating Limitations. Use operating limitations to control the satellite voice equipment.

b. Operating Procedures. The normal operating procedures of the AFM or RFM supplement should identify the criteria used in the airworthiness assessment. For example, "The Federal Aviation Administration has approved the SATCOM voice equipment as a supplement only to the existing HF and VHF communications systems."

David W. Hempe
Manager, Aircraft Engineering Division
Aircraft Certification Service

APPENDIX 1. ACRONYMS

Acronym	Definition
14 CFR	Title 14 of the Code of Federal Regulations
AC	Advisory Circular
AFM	Airplane Flight Manual
AMS(R)S	Aeronautical Mobile Satellite (Route) Service
AMSS	Aeronautical Mobile Satellite Service
ARP	Aerospace Recommended Practice
ATS	Air Traffic Services
CDU	Control Display Unit
FAA	Federal Aviation Administration
GPS	Global Positioning System
HF	High Frequency
MCDU	Multipurpose Control and Display Unit
RFM	Rotorcraft Flight Manual
SATCOM	Satellite Communications
VHF	Very High Frequency

APPENDIX 2. DEFINITIONS

This appendix contains definitions of terms used throughout this AC.

Aeronautical Administrative Communications (AAC). AAC is nonsafety-related services, which include cabin services, seat assignments, passenger travel arrangements, and baggage tracing.

Aeronautical Operational Control (AOC). AOC is the communications required for exercise of authority over starting, continuing, diverting, or ending a flight for aircraft safety reasons and the regularity and efficiency of a flight.

Aeronautical Public Correspondence (APC). APC is nonsafety-related services, which include voice (for example, telephone) and data (for example, facsimile and computer) communication services that passengers and crew can use to connect with ground-based network subscribers worldwide.

Air Traffic Management (ATM). ATM applications include pilot/controller communications, which include the operational communications between pilots and controllers.

Air Traffic Services (ATS). We divide into three categories the ATS applications defined by the International Civil Aviation Organization's future area navigation system:

1. Alerting Service. Objective: Notify appropriate organizations about aircraft in need of search and rescue, and aid such organizations as required.

2. Flight Information Service. Objective: Provide advice and information useful for the safe and efficient conduct of flights.

3. Air Traffic Control. Objective: Consist of services to prevent collisions between multiple aircraft, and between aircraft and obstructions on the maneuvering area. It also includes services to speed up and maintain an orderly flow of air traffic (for example, Area Control Service, Air Traffic Advisory Service, Approach Control Service/Aerodrome Control Service).

C-Channel. We commonly refer to C-channel as voice channel, used in both forward and return directions for voice, voice/data, and data only channels. Use of the channel is controlled by assignment and release signaling at the start and end of each transaction.

Design Approval. Design approval describes the process that an applicant and the certification authority use to substantiate that the airborne satellite voice equipment complies with airworthiness requirements appropriate for the certification authority. For example, the equipment must comply with 14 CFR parts 21 through 29 when the certification authority is the FAA's Aircraft Certification Service.

APPENDIX 2. DEFINITIONS (CONTINUED)

Flight Information Services (FIS). FIS communications include real-time advisories and warnings that have a direct effect on flight safety; flight information planning services used in strategic flight planning; and aircraft observations that support wider dissemination of pilot and instrument observations of current atmospheric conditions.

Navigation Communications Services. These services include the delivery of information related to the observed and expected flight path (for example, route conformance monitoring). In certain cases, they may require use of protected navigation frequencies for delivery of this information.

Operational Authorization. Operational authorization describes the process that an operator and certification authority use to get the authorization to use the airborne satellite voice equipment, per the FAA's Flight Standards Service's operational requirements in 14 CFR parts 91 through 139.

Operational Environment. The operational environment consists of all factors relevant to system, crew, performance, environmental conditions, airspace, aircraft separation, and so on.

Safety Assessment. The safety assessment is a directed process for the orderly and timely evaluation of specific system behavior pertinent to a given operational state. The applicant conducts a safety assessment following the requirements of 14 CFR §§ 23.1309, 25.1309, 27.1309, and 29.1309. The safety assessment will examine the aircraft and system level functions, identify potential hazards, and classify related failure conditions considering the operational environment.

Satellite Voice Equipment. The satellite voice equipment consists of the airborne satellite voice equipment, aircraft earth station, the space segment (for example, INMARSAT satellite), and the ground earth station and associated subnetworks.

Surveillance. Surveillance communications include the delivery of position and intent data (for example, position waypoint passage and next waypoint). ATS and other aircraft operators use these data to monitor for safe and efficient separation. Surveillance communications include air-ground transmissions and air-air transmissions intended to supplement or eliminate the need for ground-based surveillance.

APPENDIX 3. REFERENCES AND HOW TO GET THEM

The following information may help you determine the airworthiness of your satellite equipment:

1. Title 14 of the Code of Federal Regulations (14 CFR). You can get copies of 14 CFR parts 21, 23, 25, 27, 29, 43, 91, 121, and 135 from the Superintendent of Documents, Government Printing Office, P.O. Box 37154, Pittsburgh, PA 15250-7954. Telephone (202) 512-1800, fax (202) 512-2250. You can also get copies from the Government Printing Office website at www.access.gpo.gov. Select "Access," then "Online Bookstore." Select "Aviation," then "Code of Federal Regulations."

2. FAA Advisory Circulars (AC). Although we do not refer to all the following ACs, they all relate to this AC. For example, AC 20-140 and AC 120-70 are guidance for data communication. You can get them from the FAA's Regulatory and Guidance Library (RGL) at www.airweb.faa.gov/rgl. On the RGL website, click on "Advisory Circulars." To request free ACs, contact: U.S. Department of Transportation, M-30, 3341 Q 75th Avenue, Landover, MD 20785. Telephone (301) 322-5377, fax (301) 386-5394. To add your name to FAA's mailing list for getting free ACs, contact U.S. Department of Transportation, Distribution Requirements Section, M-30, Washington, D.C. 20590.

a. AC 20-115B, RTCA, Inc., Document RTCA/DO-178B

b. AC 20-140, Guidelines for Design Approval of Aircraft Data Communications Systems

c. AC 21-160E, RTCA Document DO-160E

d. AC 23.1309-1C, Eqipment, Systems, and Installations in Part 23 Airplane

e. AC 23.1311-1B, Installation of Electronic Displays in Part 23 Airplanes

f. AC 25-10, Guidance for Installation of Miscellaneous Non-Required Electrical Equipment

g. AC 25-11, Transport Category Airplane Electronic Display Systems

h. AC 25.1309-1, System Design and Analysis

i. AC 27-1B, Certification of Normal Category Rotorcraft

j. AC 29-2C, Certification of Transport Category Rotorcraft

3. FAA Technical Standard Order (TSO). You can get copies of TSO-C132, Geosynchronous Orbit Aeronautical Mobile Satellite Services Aircraft Earth Station Equipment, and TSO-C113, Airborne Multipurpose Electronic Displays, from the RGL website

APPENDIX 3. REFERENCES AND HOW TO GET THEM (CONTINUED)

at www.airweb.faa.gov/rgl. On the website, select "Technical Standard Orders (TSO) and Index," then select "Current."

4. RTCA Documents. You can get copies of the following documents from RTCA, Inc., 1828 L Street, NW, Suite 805, Washington, D.C. 20036-4008. Telephone (202) 833-9339, fax (202) 833-9434, website www.rtca.org.

a. RTCA/DO-160E, Environmental Conditions and Test Procedures for Airborne Equipment, dated December 9, 2004.

b. RTCA/DO-178B, Software Considerations in Airborne Systems and Equipment Certification, dated December 1, 1992.

c. RTCA/DO-210D, (Change 1 and 2), Minimum Operational Performance Standards (MOPS) for Geosynchronous Orbit Aeronautical Mobile Satellite Services (AMSS) Avionics, dated April 19, 2000.

d. RTCA/DO-215A, Guidance on Aeronautical Mobile Satellite Service (AMSS) End-to-End System Performance, dated February 21, 1995.

e. RTCA/DO-222, Guidelines on AMS(R)S Near-Term Voice Implementation and Utilization, dated April 29, 1994.

f. RTCA/DO-231, Design Guidelines and Recommended Standards for the Implementation and Use of AMS(R)S Voice Services in a Data Link Environment, dated March 13, 1996.

5. Society of Automotive Engineers, Inc. (SAE) Documents. You can get copies of the following documents from SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001. Telephone (724) 776-4970, fax (724) 776-0790, website www.sae.org.

a. Aerospace Recommended Practice (ARP) 4754, Certification Considerations for Highly Integrated or Complex Aircraft Systems, dated November 1996.

b. ARP 4761 Guidelines and Methods for Conducting The Safety Assessment Process on Civil Airborne Systems and Equipment dated December 1996.

c. ARP 4101, Flight Deck Layout and Facilities, dated July 1988.

d. ARP 4102, Flight Deck Panels, Controls, and Displays, dated July 1988.

6. International Civil Aviation Organization (ICAO). You can get copies of Annex 10, Aeronautical Telecommunication, from ICAO External Relations and Public Information Office,

APPENDIX 3. REFERENCES AND HOW TO GET THEM (CONTINUED)

999 University Street, Montreal, Quebec H3C 5H7, Canada. Telephone (514) 954-8022, fax (514) 954-6769, website www.icao.int.