U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Satellite Voice Equipment as a Means for Air Traffic Services Communications | **Date:** | **AC No:** 20-SV
Initiated by: AIR-100 | **Change:**

1. PURPOSE.

a. This advisory circular (AC) provides guidance for the eventual migration of satellite voice systems for direct pilot/controller communications as a supplement to High Frequency/ Very High Frequency (HF/VHF) voice communication systems. This AC is for designers, manufacturers, and installers of satellite voice equipment used for Air Traffic Services (ATS). In it, we (the Federal Aviation Administration, or FAA) recommend how you get design approval and airworthiness approval for your equipment.

b. Aircraft installation requirements and a system-level view of design approval are provided. It also includes guidance on how to use airborne satellite voice equipment for ATS and Aeronautical Operational Control (AOC) communications that affect flight safety. Refer to AC 25-10, Guidance for Installation of Miscellaneous Non-Required Electrical Equipment, for non-safety related Aeronautical Administrative Communications (AAC) and Aeronautical Public Correspondence (APC).

c. Like all advisory material, this AC is not mandatory, and does not constitute a regulation. Because the means of compliance in this AC are not mandatory, the terms “should” and “must” apply only if you choose to follow this AC.

2. BACKGROUND. Aircraft operators have traditionally used High Frequency (HF)/Very High Frequency (VHF) communications systems for AOC and ATS operations. Due to frequency congestion in oceanic and remote flight operations, aircraft operators have requested the use of satellite voice communication systems as a supplement to existing HF and VHF voice systems. Therefore the objective of this AC is to provide guidance to allow for the airworthiness certification and evolutionary development of satellite voice during flight operations without compromising safety.

3. SAFETY ASSESSMENT CONSIDERATIONS. Conduct a safety assessment, which considers the effects of failures on the aircraft. The safety assessment should determine, classify, and evaluate failure conditions which result from malfunction, loss of function, or design errors. The safety assessment should also evaluate failures or design errors of the satellite voice system, which could cause or contribute to failure conditions of other systems. Deviation from the requirements set forth in this AC or modification to the operational environment, that is, use of

satellite voice as a sole means of routine ATS communications may change the assessment of the hazard classification. The following criteria apply to conducting safety assessments for satellite voice systems:

a. Current Hazard Classification. Certification programs used in the oceanic environment as a supplement to approved HF communications systems and for non-routine ATS voice communications only, result in a "minor" hazard classification for an equipment failure or malfunction condition.

b. Co-Existence with High Frequency Voice Radio. Sometimes the satellite voice system's ground network may use the public switched telephone network (PSTN) to send flight safety messages. This has risks because of potential network congestion and audio level variability. Until you address these issues, you cannot use the satellite voice system without another approved means of communication. Those means must be appropriate for the aircraft's intended operating environment. Because we at the FAA will require HF radio services for the foreseeable future, satellite voice will coexist with HF radio for the near future.

c. Minimum Equipment List Relief and Derived Safety Requirements. If you use the satellite voice system for MEL relief for one of the two existing HF radios, you must evaluate how the system works under a potential load-shed environment.

(1) Consider the power source of the satellite voice system used for MEL relief. The satellite voice system must use the same amount of electrical power and amplifier cooling source integrity as the communications system it is intended to relieve.

(2) Many current installations of HF radios have a battery that backs up the left (Captain's) positions only. Single satellite voice system installations may consume up to about 700 watts, which is a major load for most aircraft batteries. If your safety assessment supports using satellite electrical power, the battery power bus (emergency or back-up power bus) should not need to provide that power. However, this may limit MEL relief for example, MEL credit for right HF only, MEL dispatch which is limited by time, and so on, as determined by the cognizant Flight Standards inspector.

d. User Modifiable, Option Selectable Functions. If the system allows the user to select or modify it without re-evaluating for airworthiness, then you must define how to ensure system safety throughout the system's service life for example, processes, design features, environment, tools, certification data. Also, define how to manage these safety configurations.

4. DESIGN CONSIDERATIONS. The following criteria apply to design approval of satellite voice systems, including qualification of the system and software for the intended environment, performance standards, message priority assignment, and user/aircraft ergonomics:

a. Satellite Voice Transmission Medium. The satellite voice equipment should comply with RTCA/DO-210D, (change 1&2) Minimum Operational Performance Standards for Geosynchronous Orbit Aeronautical Mobile Satellite Services (AMSS).

b. Environmental Qualification. The components comprising the satellite voice system should be qualified to the appropriate sections of RTCA/DO-160D (change 3), Environmental Conditions and Test Procedures for Airborne Equipment. The environmental qualifications must be compatible with the environment in which the equipment is installed.

c. Software Qualification. The system should comply with RTCA DO 178B Software Considerations in Airborne Systems and Equipment Certification.

d. Cockpit Voice Recorder (CVR). Where operating rules require a CVR, record the satellite voice communications between flight crew and ATS in crash survivable memory.

e. Flight Data Recorder (FDR). Where operating rules require a FDR, record the time at which messages are either transmitted to or received from ATC in crash survivable memory.

f. Audio Management System. Interface with the existing audio management system by affording the flight crew the ability to promote crew awareness, coordination, and verbal error detection on a par with current VHF and HF communication systems.

5. MESSAGE PRIORITY LEVELS Proritize satellite voice messages in accordance with Figure 1. The satellite voice system's internal signaling procedures should provide for the operator to initiate an AMSS voice call of four priority levels. The highest three priority levels in this scheme are used only for safety communications. The lowest of the four levels is for non-Safety communications such as Aeronautical Public Correspondence (APC) and Aeronautical Administrative Communications (AAC). Figure 1 shows the Priority Level and Application Category in accordance with the requirements of International Civil Aviation Organization (ICAO) Annex 10. Some examples are listed in the Satellite Voice Message Examples 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 Side-step 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, Re-dispatch, Maintenance
4 *Non-Operational* (lowest) Non-Safety	Public Correspondence	Public Phone-calls

a. Message Preemption, Priority, and Precedence. The order of precedence of setting up a satellite voice channel should be as shown in the priority level column in Figure 1. Preemption is defined as the immediate and automatic seizure of resources allocated to a lower-priority call in order to reallocate the resources to a higher-priority call. Trade-offs of flight safety requirements versus passenger satisfaction should not be a consideration. The treatment of preemption, priority, and precedence should meet the following criteria:

(1) If a satellite voice channel for transmission and reception is unavailable to the Aircraft Earth Station to serve a higher priority call and a channel is in use for a lower priority call, the channel supporting the lower priority call should be cleared and made available for the higher priority call. If more than one lower-priority channel is in use, a channel of the lowest priority level should be so preempted.

(2) The satellite voice system should provide the flight crew the means to preempt any call at any time. Auto-preemption may be provided for flight deck communications; however, a manual preemption option must also be provided.

(3) The satellite voice system 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, if their call attempt would otherwise preempt an existing passenger call. Flight crew procedures should include explicit instructions defining when the crew can use camp-on.

(4) The satellite voice system should allow the crew to designate the desired message priority level upon initiation of a call attempt. Before a call is initiated, the crew should be capable of confirming or selecting a voice call priority appropriate to the call's intended purpose;

or at least capable of verifying a known default priority. The crew should have the flexibility to override default priority levels, if necessary, for ATS communications.

b. Message Routing. The satellite voice system should route "ground-to-air" messages according to the following criteria:

(1) Only satellite voice messages of priority Level 1-3 may be routed to the flight deck.

(2) Only satellite voice messages of priority Level 4 may be routed to the passenger cabin.

> NOTE 1: Due to identified security concerns, Level 4 satellite voice messages may not be routed to the flight deck. However, Level 4 voice messages may be originated by the flight deck crew.
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> NOTE 2: The message routing requirements in this AC provide priority based "ground-to-air" call routing to be performed with today's system definition, while providing a migration path to address-based routing if and when the called terminal field in the call announcement signal unit is defined.

c. Satellite Channel Allocation. The satellite voice system should satisfy the following criteria:

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

(2) If certification credit is being sought for a dual satcom installation, the slave in a dual satcom system should log-on once per flight cycle to verify that it will indeed be available if it must assume the role as master in the case of a failure in the master system.

d. Flight Deck Message Annunciation. When installing the airborne satellite voice system, you should integrate the system's annunciation into the aircraft's existing alerting scheme. The system should comply with the following:

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

(2) It should offer a means to alert the flight crew when it detects airborne system failures that would make it inoperative.

(3) 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 is connected to the flight deck. It should remain illuminated, while the associated channel is connected.

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

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

(6) To avoid flight crew confusion, any destination address in the satellite voice display for example, multi-purpose control and display unit (MCDU)) 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.

(7) After C-channel continuity ends, there should be an aural sidetone.

(8) 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 in question. Examples of abnormal call terminations include satellite hand-over, selective release, link loss, and other genuine breakdowns of communications.

(9) The system should annunciate to the flight crew when AMSS resource limitations cause a higher priority, ground originated call to preempt a current flight deck call.

(10) The system should give a continuous visual indication when any call is on hold.

e. Control Capability. After initially powering up the satellite voice system, the flight crew should not have to "unlock," or re-activate the system during the flight by other means for example, insert a credit card, re-enter a security code. The system should have a means for allowing crew members to do the following:

(1) Have adequate access to satellite voice controls, unless a particular crewmember will not use the system.

(2) Answer a call manually.

(3) Reject an incoming call of any priority, and instead make an outgoing call.

(4) Receive an alert when they input an invalid satellite voice number.

(5) Use speed dialing, that is, 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.

(6) Start, answer, place on hold, and end a call using only the audio control panel. The flight crew should not be able to use a control and display unit (CDU) alone to answer and end a satellite voice call, unless the CDU is dedicated to the satellite voice function. To start a call from the audio control panel, the outgoing call address would be to a pre-selected number stored in a discrete call register.

(7) 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.

(8) Display the satellite voice system configuration that is, operational software version and part number, database version and part number, as applicable.

f. Antenna Installation. This AC does not address all ways the antenna installation affects the airframe. Although installing SATCOM equipment in the vertical fin tip is convenient and popular, it can adversely affect the safety margins required for the aeroelastic stability of the airplane. For transport category airplanes, the system must maintain the aeroelastic stability margins (flutter margins) for the normal and failure configurations and adverse conditions, such as a completely free rudder or ice mass on the vertical fin tip (Title 14 of the Code of Federal Regulations (CFR) § 25.629). If you are the installer, make sure a fin tip antenna installation does not compromise the minimum required flutter margins of the vertical fin or rudder.

6. GROUND AND FLIGHT TEST EVALUATION. Ground and flight tests should consider the following criteria.

a. Ground Test. The 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 system. Be careful when using a MCDU or CDU for satellite voice system control. Your evaluation should verify that the system 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 system during the day and at night.

(4) How to integrate the satellite voice system 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 non-interference caused by radio frequency emissions.

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

b. Flight Tests. The flight tests for certification should:

(1) Evaluate how to integrate the satellite voice system with other systems. Evaluate other systems, such as the flight management system, as necessary, to determine if the satellite voice system 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 system's 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 system and if the system can be used under the intended operating rules for a typical application.

(4) Show acceptable procedures for operating the satellite voice system. Determine that the system 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 system will probably use a beam-steered antenna.

7. AIRPLANE/ROTORCRAFT FLIGHT MANUAL (A/RFM) SUPPLEMENT. The Airplane Flight Manual (AFM) or Rotocraft Flight Manual (RFM) Supplement should provide a description of all normal modes, submodes, and abnormal (if applicable) modes of system operation, including what corrective actions are expected by the flight crew for each case.

a. Operating Limitations. Operating limitations should be used to control the use of the satellite voice system intended for evaluation purposes only in operational service or if an operating limitation would provide an alternative to satisfying the criteria contained in this AC.

b. Operating Procedures. The normal operating procedures of the (AFM) or (RFM) Supplement should identify the criteria utilized in the airworthiness assessment. For example, "The SATCOM voice system has been approved as a supplement only to the existing HF and VHF communications systems."

David W. Hempe
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APPENDIX 1. ACRONYMS

Acronym	Definition
14 CFR	Title 14 of the Code of Federal Regulations
AAC	Aeronautical Administrative Communications
AC	Advisory Circular
AES	Aeronautical Earth Station
AFM	Airplane Flight Manual
AMS(R)S	Aeronautical Mobile Satellite (Route) Service
AMSS	Aeronautical Mobile Satellite Service
AOC	Aeronautical Operational Control
APC	Aeronautical Public Correspondence
ARP	Aerospace Recommended Practice
ATC	Air Traffic Control
ATM	Air Traffic Management
ATIS	Air Traffic Information Service
ATS	Air Traffic Services
CDU	Control Display Unit
CVR	Cockpit Voice Recorder
FAA	Federal Aviation Administration
FDR	Flight Data Recorder
GES	Ground Earth Station
GPS	Global Positioning System
HF	High Frequency
ICAO	International Civil Aviation Organization

APPENDIX 1. ACRONYMS (CONTINUED)

Acronym	Definition
IRS	Inertial Reference System
ISO	International Organization for Standards
MCDU	Multi-Purpose Control and Display Unit
MEL	Minimum Equipment List
PSTN	Public Switched Telephone Network
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 communications are non-safety related services, which include cabin services, seat assignments, passenger travel arrangements, and baggage tracing.

Aeronautical Operational Control (AOC). Communications required for exercise of authority over the initiation, continuation, diversion or termination of a flight in the interest of the safety of the aircraft and the regularity and efficiency of a flight.

Aeronautical Public Correspondence (APC). APC communications are non-safety related services that 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, advanced ATM which includes air/ground digital data transfers supporting more efficient operations, and traffic flow management (TFM).

Air Traffic Services (ATS). ATS applications as defined by ICAO Future Area Navigation System are divided into three categories:

1. Alerting Service (AL). Objective: Notify appropriate organizations regarding aircraft in need of search and rescue; aid and assist such organizations as required.

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

3. Air Traffic Control (ATC). Objective: Prevent collisions between aircraft and between aircraft and obstructions on the maneuvering area and to expedite and maintain an orderly flow of air traffic.

a. Area Control Service.

b. Air Traffic Advisory Service.

c. Approach Control Service/Aerodrome Control Service.

Design Approval. Design approval describes the process that an applicant and the certification authority use to substantiate that the airborne satellite voice system comply with airworthiness requirements appropriate for the certification authority (for example, 14 CFR parts 21 through 29 when the certification authority is the Aircraft Certification Service within the FAA).

APPENDIX 2. DEFINITIONS (CONTINUED)

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

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

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

Operational Environment. The operational environment consists of all relevant factors to include 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 in accordance with the requirements of 14 CFR §§ 23.1309, 25.1309, 27.1309, and 29.1309. The safety assessment will examine the aircraft level functions, identify potential hazards, and classify related failure conditions considering the operational environment.

Satellite Voice System. The satellite voice system comprises 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) to permit ATS and other aircraft to monitor for safe and efficient separation. Surveillance communications include air-ground transmissions and air-air transmissions intended for 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 system:

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, Washington, D.C. 20402-9325. Telephone 202-512-1800, fax 202-512-2250. You can also get copies from the Government Printing Office (GPO), electronic CFR Internet website at: www.access.gpo.gov/ecfr/.

2. FAA Advisory Circulars (AC). You can get copies of the following ACs from the U.S. Department of Transportation, Subsequent Distribution Office, M-30, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20795. Telephone (301) 322-5377, fax (301) 386-5394. You can also get copies from our Regulatory and Guidance library (RGL) at: www.airweb.faa.gov/rgl. On the RGL website, select "Advisory Circulars," then select "By Number."

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

b. AC 21-16, RTCA Document DO-160D

c. AC 23.1309-1, Equipment, Systems, and Installations in Part 23 Airplanes

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

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

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

g. AC 25.1309-1, System Design and Analysis

h. AC 27-1, Certification of Normal Category Rotorcraft

i. AC 29-2, Certification of Transport Category Rotorcraft

3. FAA Technical Standard Order (TSO). You can get copies of TSO-C113, Airborne Multipurpose Electronic Displays, from the RGL website at: www.airweb.faa.gov/rgl. On the website, select "Technical Standard Orders (TSO) and Index," then select "Current."

4. RTCA, Inc., Documents. You can get a 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.

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

a. RTCA/DO-160D, Environmental Conditions and Test Procedures for Airborne Equipment, dated July 29, 1997.

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

c. RTCA/DO-210D, 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) 926B, Fault/Failure Analysis Procedure, dated June 1997.

b. ARP 1834A, Fault/Failure Analysis for Digital Systems and Equipment, dated June 1997.

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 Organization for Standardization (ISO)/International Electrotechnical Commission (IEC) Standards. You can get copies of ISO/IEC 7498 – Basic Reference Model, 2nd edition, dated June 21, 2000, from ISO, 1 rue de Varembé, CH-1211 Geneva 20, Switzerland. Telephone +41 22 749 01 11, Fax +41 22 749 09 47, website: www.iso.org.