# Federal Aviation Administration

# Memorandum

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To: All Regional Airports Division Managers

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Subject: INFORMATION: Engineering Brief No. 97, Guidance for AeroMACS installation by the airport operator

This Engineering Brief (EB) provides installation guidance and technical information about the use of AeroMACS technology for communication and control purposes related to the safety and regularity of flight on the airport surface.

Attachment

**FAA**
**Airports**

# ENGINEERING BRIEF NO. 97
# Guidance for AeroMACS installation by the airport operator

## 1.0. Purpose.

This Engineering Brief provides installation guidance and technical information to airport operators, Airport District Offices (ADOs), and Architectural and Engineering (A&E) companies about the use of AeroMACS technology for communication and control purposes related to the safety and regularity of flight on the airport surface.

**Note:** This EB is applicable only for the non-federal AeroMACS field trial project. A revised EB, updated with the lessons learned from the field trials, will be issued in the future which will be applicable to the AeroMACS projects at other airports.

## 2.0. Background.

Current ground-to-ground communication at the airport surface uses the aeronautical frequencies (Very High Frequencies (VHF) in the 117.975-137MHz band). However, the aeronautical band is very congested. Moreover, the aeronautical band was designed for the analog voice communication and may not be suitable to introduce Federal Aviation Administration (FAA) NextGen technologies. The International Telecommunication Union (ITU) and International Civil Aviation Organization (ICAO) developed the AeroMACS system to address ground-to-ground communication congestion issues and to provide a platform to support the future introduction of NextGen technologies. The FAA, EUROCONTROL, ICAO, Radio Technical Commission for Aeronautics (RTCA) and European Organization for Civil Aviation Equipment (EUROCAE) are currently working to develop standards for AeroMACS.

AeroMACS is a broadband wireless service operating in a protected aeronautical frequency band for use on the airport surface. In the near future, the FAA, airlines, and airport authorities will be using AeroMACS for some ground-to-ground communication purposes. Broadband wireless communication systems like AeroMACS will also open up opportunities to introduce new technology services for both the airport and aircraft. This wireless communication link will enable the airports to improve their operational efficiency and is less costly to install/maintain than traditional infrastructure.

## 2.1. AeroMACS History.

**a.** The 2007 World Radiocommunications Conference (WRC-07) approved the allocation of the 5091-5150 MHz band to the Aeronautical Mobile (Route) Service [AM(R)S], enabling aeronautical safety communication on the airport surface.

**b.** Based on the WRC-07 decision, ICAO developed the standards and recommended practices (SARPS) for AeroMACS as a broadband wireless communication service operating in a protected aeronautical communications frequency band to allow ground operation safety and air traffic management (ATM)/regularity of flight on the airport surface functions. The protected broadband wireless service may be used by Air Navigation Service Providers, e.g. the Federal Aviation Administration (FAA), as well as airlines and airport operators.

**c.** The Federal use of AeroMACS and its associated frequencies is approved by the National Telecommunications and Information Administration (NTIA). Based on the approval, FAA/National Aeronautics and Space Administration (NASA) performed Federal AeroMACS field trials at the Cleveland-Hopkins International Airport (CLE). The FAA Airport Surface Surveillance Capability (ASSC) program office will be using AeroMACS at different airports through the US.

**d.** Currently, the Federal Communications Commission (FCC) is in the process of approving the non-federal use of AeroMACS by airport operators through the rulemaking process. See https://transition.fcc.gov/rules.html for detailed information about the rulemaking process at the FCC.

**e.** This EB addresses the non-Federal use of AeroMACS by airport operators.

**f.** The AeroMACS system will support easier and modular introduction of new airport technologies by providing an inexpensive, protected and reliable datalink that can be used across the airport surface.

## 2.2. AeroMACS Network Reference Model.

The AeroMACS Network Reference Model (NRM) represents the logical view of the AeroMACS network. It is composed of three logical entities: Mobile Station/Subscriber Station (MS/SS), Access Service Network (ASN) and Connectivity Service Network (CSN).

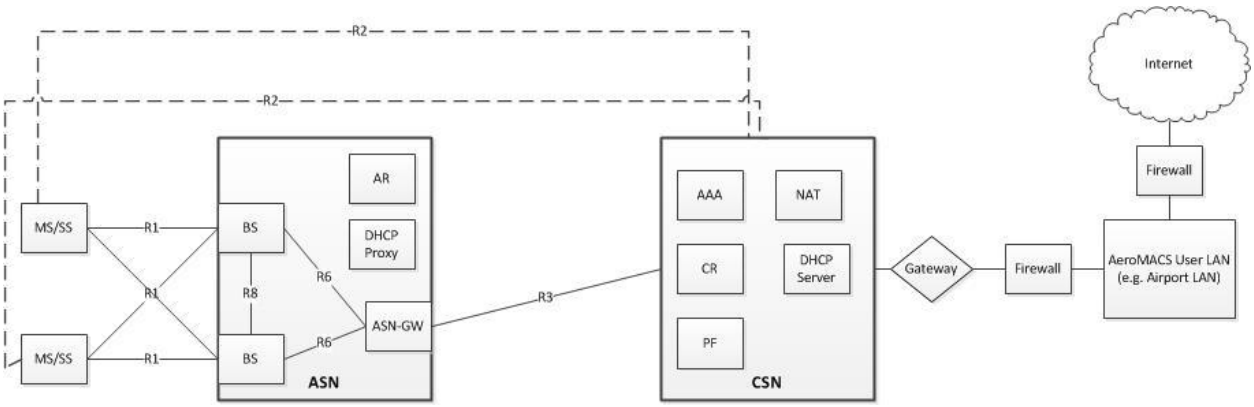


Figure 2.2.1 AeroMACS NRM

**a.** The MS/SS provides the wireless connectivity between the subscriber equipment and the Base Station (BS). The Subscriber Station (SS) is a variant of the Mobile Station (SS) which is stationary.

**b.** The ASN is composed of the Base Station (BS), Access Service Network-Gateway (ASN-GW) and all the network components to provide wireless network access services to the AeroMACS subscriber.

**c.** The BS provides connectivity, management and control of the MS/SS.

**d.** The ASN-GW supports the connectivity and mobility management of the MS/SS across AeroMACS cells.

**e.** The CSN entity is a logical set of network functions that provides IP connectivity services to the AeroMACS.

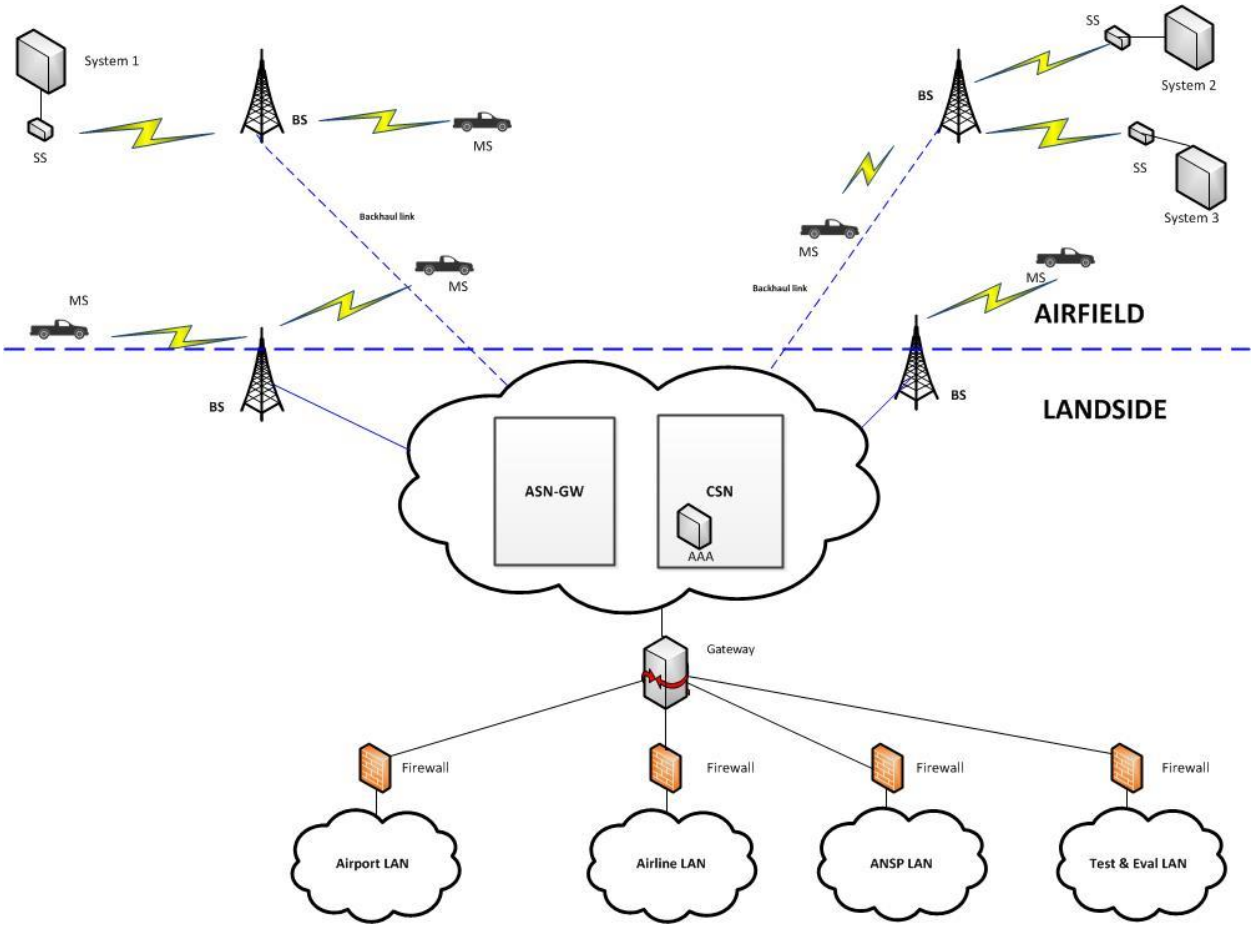


Figure 2.2.2: AeroMACS Physical Network

## 3.0. Application.

The Federal Aviation Administration recommends the design guidelines and standards in this Engineering Brief for the use of AeroMACS equipment in airport operator field applications.

## 4.0. Description.

This EB provides guidance to airport operators about AeroMACS operation and provides guidance for proper installation.

## 5.0. Effective Date.

This engineering brief will be effective after signature by the Manager of FAA Airport Engineering Division, AAS-100.

## 6.0 Applicable Documents.

**a. Federal Aviation Administration (FAA)**

| | |
|---|---|
| AC 150/5300-13A Change 1 | Airport Design |
| AC 150/5370-2F | Operational Safety on Airports During Construction |
| EB 79A | Determining RSA NAVAID Frangibility and Fixed-By-Function Requirements |

**b. WiMAX Forum**

WiMAX Forum Network Architecture, WMF-T32-003-R010v05

**c. Radio Technical Commission for Aeronautics (RTCA)**

DO 345 Aeronautical Mobile Airport Communications Systems (AeroMACS) Profile

DO 346 Minimum Operational Performance Standard (MOPS) for the Aeronautical Mobile Airport Communication System (AeroMACS)

**d. Institute of Electrical and Electronics Engineers (IEEE)**

| | |
|---|---|
| IEEE 802.16-2009 | Part 16: Air Interface for Broadband Wireless Access System |
| IEEE C62.41 | IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits |

**e. International Organization for Standardization**

ISO/IEC 17025 General Requirements for the competence of testing and calibration laboratories

## 7.0. AeroMACS Performance Requirements.

### 7.1. System Performance.

**a.** The AeroMACS Network Reference Model, per Fig 2.2.1, must be used to deploy the AeroMACS system at the airport.

**b.** The deployed AeroMACS network components must be logically and physically separated, per Fig 2.2.2, from the AeroMACS user network, i.e. the Airport LAN. This separation, implemented via a firewall, will ensure that any problem at the AeroMACS network components will not adversely impact the Airport LAN operation.

**c.** A centralized ASN-GW must be deployed with the AeroMACS systems at the airports as shown in figure 2.2.2.

**d.** The ASN-GW must support and implement either a RADIUS or DIAMETER client.

**e.** The AAA server must verify the credentials and check the policy database before authorizing a MS/SS connection.

**f.** The AAA server must allow the configuration of the quality of service (QoS) for a given MS/SS and must facilitate a Service Flow Authorization (SFA) through ASN Gateway as a response to a service flow initiation request from a MS/SS.

**g.** The AeroMACS system must support multiple user priorities for the same type of QoS service.

**h.** The Dynamic Host Configuration Protocol (DHCP) server must allocate private address to a MS/SS.

**i.** The Network Address Translation (NAT) must map the allocated private Internet Protocol (IP) network address to the user Local Area Network (LAN) address.

**j.** The deployed AeroMACS system must provide continuous system status and security incident information in an industry standard format, e.g. Simple Network Management Protocol (SNMP).

**k.** The BS/SS/MS must meet all the requirements in RTCA Minimum Operational Performance Standards (MOPS), DO-346.

**l.** The BS/SS/MS must meet all the requirements in the ICAO AeroMACS SARPS.

**m.** The BS/SS/MS must provide an Ethernet interface to connect to remote systems.

**7.2. Spectrum Use.**

**a.** The airport authority must apply for an experimental license from the FCC to operate the AeroMACS system during the field trial. The intended services for the AeroMACS system must be listed in the FCC application.

**b.** The airport authority must coordinate with the both FCC and FAA for the AeroMACS frequency assignments.

**c.** The AeroMACS operating frequencies must be per RTCA DO-346, MOPS, and must meet the conditions in the FCC experimental license.

**7.3 Spurious Responses.**

**a.** The AeroMACS spurious radiation must be per RTCA, DO-346 Minimum Operational Performance Standards (MOPS) and must meet the conditions in the FCC experimental license.

**b.** All the power transmission characteristics must follow ICAO SARPS, sections 7.4.3 and 7.4.5, and must meet the conditions in the FCC experimental license.

**7.4 Master Timing Signal.**

**a.** The BS must use a Global Positioning System (GPS) signal for the purpose of system synchronization.

**b.** The BS must provide alternative timing method when GPS becomes unavailable, for the purpose of system synchronization.

**c.** The BS must be shut down if transmissions occur outside its assigned channel due to a loss of synchronization.

**7.5 Interference.**

**a.** The installed AeroMACS system must not interfere with any communication, navigation and surveillance (CNS) systems at the airport.

**b.** The AeroMACS system must be installed separately from other operational systems at the airport.

**c.** The failure of the AeroMACS system must not cause the failure or the operational performance degradation of any other systems at the airport.

### 7.6 Interoperability.

The AeroMACS vendor must guarantee equipment inter-operability with the equipment from other AeroMACS vendors.

### 7.7. AeroMACS Security.

**a.** The operator of the AeroMACS network must ensure that all the recent software updates and patches are installed on time.

**b.** The operator of the AeroMACS network must install appropriate information security software.

**c.** The operator of the AeroMACS network must follow current industry standard information security procedures to prevent cyber security threats.

**d.** The AeroMACS network must be shut down if a cyber-security breach is detected. The network will resume operation until a corrective action is taken to prevent same breach in future.

**e.** The AeroMACS network must use encrypted X.509 Version 3 digital certificate for peer entity authentication and encryption of data flows.

**f.** The AeroMACS network must use the following protocol options:

**(1)** PKM V2 for Public Key Management

**(2)** EAP for Authentication using ECDSA with SHA 256 algorithm

**(3)** TLS method with EAP for exchanging Authentication parameter.

**(4)** OpenSSL version 1.0.1 or later using Elliptic Curve and PKCS #8 for private key encryption

### 7.8. Environmental Conditions.

The equipment must be designed to operate in the following environmental conditions:

**a. Temperature:** -40° to 131° Fahrenheit (F) (-40° to 55° Celsius (C))

**b. Relative humidity**: up to 95% non-condensing.

**c. Wind:** wind speeds up to 100 miles per hour (mph) (161 kilometers per hour).

**d. Rain:** exposure to wind driven rain, snow, or sleet.

**e. Solar radiation:** outdoor installations exposed to direct sunlight with associated heat gain.

**f. Salt:** exposure to salt laden air at coastal installations.

**g. Altitude:** exposure to altitudes up to 10,000 feet (ft.) (3,000 meters (m))

### 7.9. Power Supply.

**a.** The equipment must be designed to operate from 120 VAC, ±15%, 60 Hertz (Hz). Power for the encoder and decoders may be obtained from an associated transmitter or receiver.

**b.** An uninterruptible power supply (UPS) must be provided to prevent the loss of system operation during short term power outages (less than 15 minutes) and potential brownout conditions. The UPS equipment must output a pure sine wave.

**c.** Mobile Station (MS) - **TBD**.

### 7.10. Lightning Surge Arrestors.

**a.** Arresters of the proper rating to protect the equipment from lightning induced voltage and current surges must be installed at both the AC power input and antenna transmission line.

**b.** The lightning arresters must be rated for pulses per IEEE C62.41, Section 9, Table 4, Location Category C1.

**c.** The ground-side of the arresters must be connected to the cabinet grounding lug or other electrically equivalent ground location. If a bonding jumper wire is used, it must not be smaller than 14 American Wire Gauge (AWG).

### 7.11. Transient Voltage Protection.

Transient protection that does not degrade signal quality must be provided for all external signal, data, and control lines that enter the equipment enclosure.

## 8.0. AeroMACS Project Life Cycle.

AeroMACS installation project should be carried out in the following phases:

**a.** Planning Phase

**b.** Design Phase

**c.** Installation Phase

**d.** Testing Phase

### 8.1. Planning Phase.

During the planning phase, the airport sponsor must develop initial requirements for their AeroMACS project and perform a site survey.

### 8.1.1. Initial Requirements.

The initial requirements of the AeroMACS project must, at least, capture the following:

**a.** Identify data or voice services required.

**b.** Identify data throughput requirements

**c.** Identify the AeroMACS coverage area

**d.** Identify AeroMACS channels: maximum 4 channels.

**(1)** Advisable to select contiguous channels.

**(2)** Any coordination with the FCC and FAA for frequency use will be the responsibility of the airport authority.

**e.** Location where BS can be installed.

**(1)** It is advisable to use the existing infrastructure instead of separate antenna towers to install the BS antennas to assure the lowest cost installation.

**(2)** Additional cost to install BS at other locations is largely due to the installation of a power supply system and backhaul communication system from the BS to ASN.

### 8.1.2. Site Survey.

**a.** Perform a spectrum analysis of the AeroMACS band, i.e. 5091-5150 MHz, to determine that there are no potential EMI sources present which may cause RFI with the installed system.

**b.** Determine number of base stations and cells required to meet the required coverage, data throughput and availability of the network.

**c.** Perform the system performance testing with the BS installed at the existing infrastructure locations.

## 8.2. Design Phase.

During the design phase, the airport sponsor must develop an AeroMACS system design document and apply for an FCC license.

**8.2.1 System Design Document.**

The AeroMAC system design document must, at least, capture the following topics:

**a.** RF design.

**(1)** RF Operating Channels – coordination with FAA, FCC, and NTIA.

**(2)** Antenna types and relevant antenna gain over isotropic dipole.

**b.** Local Area Network **(**LAN) design.

**(1)** Equipment

**(2)** Private network – IP address

**(3)** Information System (IS) security

**c.** Backhaul designs that may include fiber optic cable runs or use existing fibers on airport.

**d.** Construction plan.

**(1)** Antenna towers and locations (Latitude/Longitude or physical location description)

**(2)** System AC Power

**(3)** Backhaul link

**e.** Safety plan.

All construction and installation associated with the infrastructure must be submitted in the form of a Construction Safety Phasing Plan (CSPP) to FAA for review and airspace determination. The CSPP should be prepared and completed during the design phase per AC 150/5370-2, Operational Safety on Airports during Construction (current edition), for review and approval by the airport sponsor, and submitted to the FAA for airspace determination. The sponsor may submit the CSPP to the FAA on line at oeaaa.faa.gov. The completed CSPP must include but not be limited to the following:

**(1)** Emergency/Fire/Medical response

**(2)** Airport areas and operations affected by the construction activity

**(3)** Personnel and vehicle access

**(4)** Foreign Object Debris (FOD) management

**(5)** Haul routes, roads and excavation material storage and management

**(6)** Notification of construction activities (Form 7460-1) per 14 CFR Part 77, "Safe, Efficient use and Preservation of Navigable Airspace".

**(7)** Site monitoring, inspection and enforcement responsibilities.

**(8)** AC 150/5370-2, Appendix 3. , Safety and Phasing Plan Checklist. (Consult this checklist to include the appropriate provision that is relevant to the location of all project components at the airport.)

**f.** Data traffic, classification QoS, and geographical distribution (offered traffic to network).

**g.** Base Station locations.

**h.** Radio Frequency (RF) propagation calibration.

**i.** RF coverage.

**j.** RF interference.

**k.** Network traffic capacity.

**8.2.2 FCC License.**

**a.** Identify the steps required to apply for an FCC license to operate the AeroMACS system.

**b.** To file for an experimental license, visit the FCC's ELS page at: https://apps.fcc.gov/oetcf/els/

47 CFR Part 5 of the FCC's rules govern the usage of the experimental radio service. Rules are available at: https://apps.fcc.gov/oetcf/els/

**8.3. Installation Phase.**

During the installation phase, the airport sponsor should develop the installation procedures and specific installation details. This document must, at least, capture the following topics:

**a.** Airport construction rules and regulation

**b.** Equipment (for example: antennas and associated towers) must not be located in the Runway Safety Area (RSA) per FAA EB 79A, Determining RSA NAVAID Frangibility and Fixed-By-Function Requirements.

**c.** The installation of the AeroMACS system must comply with all the FAA object clearing requirements per AC 150/5300-13A, CHG 1, Airport Design, Paragraph 306, Object clearing, current revision.

**d.** The installation of AeroMACS components also must meet all relevant federal, state and local construction rules and regulations.

**e.** The airport operator must file a Form 7460-1 to the Airport District Office (ADO). See the FAA OE/AAA website for additional information about obstructions and the submission of applicable forms at: https://oeaaa.faa.gov/oeaaa/external/portal.jsp. See also AC 70/7460-1L, Obstruction Marking and Lighting.

### 8.4. Testing Phase.

**a.** After the AeroMACS installation is completed, the installation vendor (or their designated testing activity) must perform system RF coverage, connectivity, and data throughput and security tests.

**b.** A written report that details the result of all testing must be submitted to the airport operator.

## 9.0. Training.

The manufacturer must provide AeroMACS instruction manuals and on-the-job training or formal classroom training to the airport operators about AeroMACS operation. At a minimum, system maintenance, troubleshooting and simplified theory of operation must be included.

## 10.0. Warranty.

The manufacturer must provide a 2 year warranty that covers equipment parts and labor.

## 11.0. AeroMACS Performance Data.

During AeroMACS field trial period, relevant performance data must be collected.

## 12.0. Materials and Workmanship.

Materials used and workmanship must be of the highest commercial quality and practices for equipment of this type.

## 13.0. Instruction Book.

An instruction book with following information must be furnished:

**a.** Installation instructions.

**b.** Parts list with manufacturer's part number.

**c.** Schematic and wiring diagrams showing all components cross-indexed to the parts list.

## 14.0. Certification.

The vendor must provide proof that their equipment meets all the requirements of this EB, preferably by using an IEC/ISO 17025 certified testing laboratory acceptable to the FAA.

## Glossary.

**AAA** (authentication, authorization and accounting) server processes SS or MS requests to access AeroMACS LAN and AeroMACS services.

**ASN-Gateway** supports connectivity and mobility management of a MS across AeroMACS cells. It also provides the connectivity between AeroMACS LAN and user LAN, e.g. Boston Airport LAN.

**Base station (BS).** A generalized equipment set providing connectivity, management, and control of the mobile station (MS).

**Subscriber station (SS).** A generalized equipment set providing connectivity between subscriber equipment and a base station (BS).

**Mobile station (MS).** A station in the mobile service intended to be used while in motion or during halts at unspecified points. An MS is always a subscriber station (SS).