Republic of the Philippines
CIVIL AVIATION AUTHORITY OF THE PHILIPPINES

MEMORANDUM CIRCULAR NO.: 017-18

TO : ALL CONCERNED

FROM : DIRECTOR GENERAL

SUBJECT : AMENDMENT TO PHILIPPINE CIVIL AVIATION REGULATIONS - AIR NAVIGATION SERVICES (CAR-ANS) PART 7 INCORPORATING AMENDMENT 90 TO ICAO ANNEX 10 VOLUME III Part I

REFERENCE:

1. Philippine Civil Aviation Regulations- Air Navigation Services Part 7, Issue 2 Amendment No. 2
2. ICAO Annex 10 Volume III Part I; Amendment 90
3. CAAP Regulations Amendment Procedures
4. Board Resolution No. 2012-054 dated 28 September 2012

Pursuant to the powers vested in me under the Republic Act 9497, otherwise known as the Civil Aviation Authority Act of 2008 and in accordance with the Board Resolution No.: 2012-054 dated 28 September 2012, I hereby approve the incorporation of ICAO Annex 10 Volume III Part I Amendment No. 90 to the Philippine Civil Aviation Regulations – Air Navigation Services (CAR-ANS) Part 7.

ORIGINAL REGULATION SUBJECT FOR REVIEW AND REVISION:

CAR-ANS Part 7

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7.7 ~~SUBNETWORK INTERCONNECTION~~ AERONAUTICAL MOBILE AIRPORT COMMUNICATIONS SYSTEM (AEROMACS)

~~*(to be developed)*~~

7.7.1 DEFINITIONS

Adaptive modulation. A system's ability to communicate with another system using multiple burst profiles and a system's ability to subsequently communicate with multiple systems using different burst profiles.

Aerodrome. A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

Aeronautical Mobile Airport Communications System (AeroMACS). A high capacity data link supporting mobile and fixed communications on the aerodrome surface.

AeroMACS downlink (DL). The transmission direction from the base station (BS) to the mobile station (MS).

AeroMACS uplink (UL). The transmission direction from the mobile station (MS) to the base station (BS).

AeroMACS handover. The process in which a mobile station (MS) migrates from the air-interface provided by one base station (BS) to the air-interface provided by another BS. A break-before-make AeroMACS handover is where service with the target BS starts after a disconnection of service with the previous serving BS.

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

Bit error rate (BER). The number of bit errors in a sample divided by the total number of bits in the sample, generally averaged over many such samples.

Burst profile. Set of parameters that describe the uplink or downlink transmission properties associated with an interval usage code. Each profile contains parameters such as modulation type, forward error correction (FEC) type, preamble length, guard times, etc.

Convolutional turbo codes (CTC). Type of forward error correction (FEC) code.

Data transit delay. In accordance with ISO 8348, the average value of the statistical distribution of data delays. This delay represents the subnetwork delay and does not include the connection establishment delay.

Domain. A set of end systems and intermediate systems that operate according to the same routing procedures and that is wholly contained within a single administrative domain.

Forward error correction. The process of adding redundant information to the transmitted signal in a manner which allows correction, at the receiver, of errors incurred in the transmission.

Frequency assignment. A logical assignment of centre frequency and channel bandwidth programmed to the 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).

Partial usage sub-channelization (PUSC). A technique in which the orthogonal frequency division multiplexing (OFDM) symbol subcarriers are divided and permuted among a subset of sub-channels for transmission, providing partial frequency diversity.

Residual error rate. The ratio of incorrect, lost and duplicate subnetwork service data units (SNSDUs) to the total number of SNSDUs that were sent.

Service data unit (SDU). A unit of data transferred between adjacent layer entities, which is encapsulated within a protocol data unit (PDU) for transfer to a peer layer.

Service flow. A unidirectional flow of media access control layer (MAC) service data units (SDUs) on a connection that is providing a particular quality of service (QoS).

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

Subnetwork entry time. The time from when the mobile station starts the scanning for BS transmission, until the network link establishes the connection, and the first network user "protocol data unit" can be sent.

Subnetwork service data unit (SNSDU). An amount of subnetwork user data, the identity of which is preserved from one end of a subnetwork connection to the other.

Time division duplex (TDD). A duplex scheme where uplink and downlink transmissions occur at different times but may share the same frequency.

7.7.2 INTRODUCTION

Note 1.— Aeronautical mobile airport communications system (AeroMACS) is a high capacity data link supporting mobile and fixed communications, related to the safety and regularity of flight, on the aerodrome surface.

Note 2.— AeroMACS is derived from the IEEE 802.16-2009 mobile standards. AeroMACS profile document (RTCA DO345 and EUROCAE ED 222) lists all features from these standards which are mandatory, not applicable or optional. AeroMACS profile differentiates between base station and mobile station functionality and contains, for each feature, a reference to the applicable standards.

7.7.3 GENERAL

7.7.3.1 AeroMACS shall conform to the requirements of this and the following chapters.

7.7.3.2 AeroMACS shall only transmit when on the surface of an aerodrome.

7.7.3.3 AeroMACS shall support aeronautical mobile (route) service (AM(R) S) communications.

7.7.3.4 AeroMACS shall process messages according to their associated priority.

7.7.3.5 AeroMACS shall support multiple levels of message priority.

7.7.3.6 AeroMACS shall support point to point communication.

7.7.3.7 AeroMACS shall support multicast and broadcast communication services.

7.7.3.8 AeroMACS shall support internet protocol (IP) packet data services.

7.7.3.9 AeroMACS shall provide mechanisms to transport ATN/IPS and ATN/OSI (over IP) based messaging.

7.7.3.10 AeroMACS shall support voice services.

Note.-Manual on the Aeronautical Telecommunication Network (ATN) using Internet Protocol Suite (IPS) Standards and Protocols *(Doc 9896) provides information on voice service over IP*.

7.7.3.11 AeroMACS shall support multiple service flows simultaneously.

7.7.3.12 AeroMACS shall support adaptive modulation and coding.

7.7.3.13 AeroMACS shall support handover between different AeroMACS BSs during aircraft movement or on degradation of connection with current BS.

7.7.3.14 AeroMACS shall keep total accumulated interference levels with limits defined by the International Telecommunication Union — Radiocommunication Sector (ITU-R) as required by national/international rules on frequency assignment planning and implementation.

7.7.3.15 AeroMACS shall support a flexible implementation architecture to permit link and network layer functions to be located in different or same physical entities.

7.7.4 RADIO FREQUENCY (RF) CHARACTERISTICS

7.7.4.1 General Radio Characteristics

7.7.4.1.1 AeroMACS shall operate in time division duplex (TDD) mode.

7.7.4.1.2 AeroMACS shall operate with a 5 MHz channel bandwidth.

7.7.4.1.3 AeroMACS MS antenna polarization shall be vertical.

7.7.4.1.4 AeroMACS BS antenna polarization shall have a vertical component.

7.7.4.1.5 AeroMACS shall operate without guard bands between adjacent AeroMACS channels.

7.7.4.1.6 AeroMACS shall operate according to the orthogonal frequency division multiple access method.

7.7.4.1.7 AeroMACS shall support both segmented partial usage sub-channelization (PUSC) and PUSC with all carriers as sub-carrier permutation methods.

7.7.4.2 Frequency bands

7.7.4.2.1 AeroMACS equipment shall operate in the band from 5 030 MHz to 5 150 MHz in channels of 5 MHz bandwidth.

Note 1.— Some States may, on the basis of national regulations, have additional allocations to support AeroMACS. Information on the technical characteristics and operational performance

of AeroMACS is contained in the AeroMACS Minimum Operational Performance Specification (MOPS) (*EUROCAE ED-223 / RTCA DO-346) and* AeroMACS Minimum Aviation System Performance Standard (MASPS) *(EUROCAE ED-227).*

Note 2.— The last centre frequency of 5 145 MHz is selected as the reference frequency for the numbering of AeroMACS channels. AeroMACS nominal centre frequencies are numbered downward from the reference frequency in 5 MHz steps.

7.7.4.2.2 The mobile equipment shall operate at centre frequencies offset from the preferred frequencies, with an offset of 250 kHz step size.

Note.— The nominal centre frequencies are the preferred centre frequencies for AeroMACS operations. However, the base stations should have the capability to deviate from the preferred centre frequencies to satisfy potential national spectrum authority implementation issues (i.e. to allow AeroMACS operations without receiving or causing interference to other systems operating in the band such as MLS and AMT).

7.7.4.3 Radiated power

7.7.4.3.1 The maximum mobile station equivalent isotropic radiated power (EIRP) shall not exceed 30 dBm.

7.7.4.3.2 The maximum base station EIRP in a sector shall not exceed 39.4 dBm.

7.7.4.3.3 In order to meet ITU requirements, the total base station EIRP in a sector shall be decreased from that peak, considering the antenna characteristics, at elevations above the horizon. Further information is provided in the guidance material.

Note 1.— EIRP defined as antenna gain in a specified elevation direction plus the average AeroMACS transmitter power. While the instantaneous peak power from a given transmitter may exceed that level when all of the subcarriers randomly align in phase, when the large number of transmitters assumed in the analysis is taken into account, average power is the appropriate metric.

Note 2.— If a sector contains multiple transmit antennas (e.g., multiple input multiple output (MIMO) antenna), the specified power limit is the sum of the powers from each antenna.

7.7.4.4 Minimum receiver sensitivity

7.7.4.4.1 AeroMACS receiver sensitivity shall comply with Table 7.7-1, AeroMACS receiver sensitivity values.

Note 1.— The computation of the sensitivity level for AeroMACS is described in the Aeronautical Mobile Airport Communications System (AeroMACS) Manual *(Doc 10044).*

Note 2.— AeroMACS receiver would be 2 dB more sensitive than indicated if Convolutional Turbo Codes (CTC) is used.

Note 3.— The sensitivity level is defined as the power level measured at the receiver input when the bit error rate (BER) is equal to 1 × 10-6 and all active sub-carriers are transmitted in the

channel. In general the requisite input power depends on the number of active sub-carriers of the transmission.

Note 4.— The values in Table 7.7-1 assume a receiver noise figure of 8 dB.

Note 5.— The sensitivity values in Table 7.7-1 assume absence of any source of interference except for thermal and receiver noise.

Table 7.7-1. AeroMACS receiver sensitivity values

Modulation scheme using convolutional codes (CC) encoding scheme	Rep. Factor	MS Sensitivity	BS Sensitivity
64 QAM 3/4	1	-74.3 dBm	-74.5 dBm
64 QAM 2/3	1	-76.3 dBm	-76.5 dBm
16 QAM 3/4	1	-80.3 dBm	-80.5 dBm
16 QAM 1/2	1	-83.8 dBm	-84.0 dBm
QPSK 3/4	1	-86.3 dBm	-86.5 dBm
QPSK 1/2	1	-89.3 dBm	-89.5 dBm
QPSK 1/2 with repetition 2	2	-92.3 dBm	-92.5 dBm

Note .— A 64 QAM transmission is optional for MS.

7.7.4.5 Spectral mask and emissions

7.7.4.5.1 The power spectral density of the emissions when all active sub-carriers are transmitted in the channel shall be attenuated below the maximum power spectral density as follows:

a) on any frequency removed from the assigned frequency between 50 and 55 per cent of the authorized bandwidth: 26 + 145 log (per cent of BW/50) dB;

b) on any frequency removed from the assigned frequency between 55 and 100 per cent of the authorized bandwidth: 32 + 31 log (per cent of (BW)/55) dB;

c) on any frequency removed from the assigned frequency between 100 and 150 per cent of the authorized bandwidth: 40 + 57 log (per cent of (BW)/100) dB; and

d) on any frequency removed from the assigned frequency beyond 150 per cent of the authorized bandwidth: 50 dB.

Note.— The power spectral density at a given frequency is the power within a bandwidth equal to 100 kHz centred at this frequency, divided by this measurement bandwidth. It is made clear that the measurement of the power spectral density should encompass the energy over at least one frame period.

7.7.4.5.2 AeroMACS shall implement power control.

7.7.4.5.3 AeroMACS minimum rejection for adjacent (+/–5MHz) channel, measured at BER=10-6 level for a victim signal power 3 dB higher than the receiver sensitivity, shall be 10 dB for 16 QAM 3/4.

7.7.4.5.4 AeroMACS minimum rejection for adjacent (+/–5MHz) channel, measured at BER=10-6 level for a victim signal power 3 dB higher than the receiver sensitivity, shall be 4 dB for 64 QAM 3/4.

7.7.4.5.5 AeroMACS minimum rejection for second adjacent (+/–10MHz) channel and beyond, measured at BER=10-6 level for a victim signal power 3 dB higher than the receiver sensitivity, shall be 29 dB for 16 QAM 3/4.

7.7.4.5.6 AeroMACS minimum rejection for second adjacent (+/–10MHz) channel and beyond, measured at BER=10-6 level for a victim signal power 3 dB higher than the receiver sensitivity, shall be 23 dB for 64 QAM 3/4.

Note.— For additional clarification to the requirements stated in 7.7.4.5.3, 7.7.4.5.4, 7.7.4.5.5 and 7.7.4.5.6, refer to IEEE 802.16-2009 section 8.4.14.2.

7.7.4.6 Frequency tolerance

7.7.4.6.1 AeroMACS BS transmitter frequency tolerance shall be better than +/- 2 × 10-6 of nominal channel frequency.

7.7.4.6.2 AeroMACS MS transmitter centre frequency shall be locked to that of the BS transmission centre frequency with a tolerance better than 2 per cent of the subcarrier spacing.

7.7.4.6.3 AeroMACS MS shall track the frequency of the BS and shall defer any transmission if synchronization is lost or exceeds the tolerances given above.

7.7.5 PERFORMANCE REQUIREMENTS

7.7.5.1 AeroMACS communications service provider

7.7.5.1.1 The maximum unplanned service outage duration on a per aerodrome basis shall be 6 minutes.

7.7.5.1.2 The maximum accumulated unplanned service outage time on a per aerodrome basis shall be 240 minutes/year.

7.7.5.1.3 The maximum number of unplanned service outages shall not exceed 40 per year per aerodrome.

Note.– The requirements given in 7.7.5.1.1 to 7.7.5.1.3 refer to the overall service provision by the AeroMACS communication service provider on the aerodrome surface. This may include other media which can provide alternate communication paths in the event of an AeroMACS failure.

7.7.5.1.4 Connection resilience. The probability that a transaction will be completed once started shall be at least 0.999 for AeroMACS over any one-hour interval.

Note.— Connection releases resulting from AeroMACS handover between base stations, log-off or circuit pre-emption are excluded from this specification.

7.7.5.2 Doppler shift

7.7.5.2.1 AeroMACS shall operate with a Doppler shift induced by the movement of the MS up to a radial speed of 92.6 km (50 NM) per hour, relative to the BS.

7.7.5.3 Delay

7.7.5.3.1 Subnetwork entry time shall be less than 90 seconds.

7.7.5.3.2 The from-MS data transit delay (95th percentile) for the highest priority data service, shall be less than or equal to 1.4 seconds over a window of 1 hour or 600 SDUs, whichever is longer.

7.7.5.3.3 The to-MS data transit delay (95th percentile) for the highest priority data service, shall be less than or equal to 1.4 seconds over a window of 1 hour or 600 SDUs, whichever is longer.

7.7.5.4 Integrity

7.7.5.4.1 AeroMACS BS and MS shall support mechanisms to detect and correct corrupt SNSDUs.

7.7.5.4.2 AeroMACS BS and MS shall only process SNSDUs addressed to themselves.

7.7.5.4.3 The residual error rate, to/from MS shall be less than or equal to 5 × 10-8 per SNSDU.

Note.— There are no integrity requirements for SNSDU residual rate to the BS and MS as the requirement is entirely satisfied by the end-to-end systems in the aircraft and air traffic service provider.

7.7.5.4.4 The maximum bit error rate shall not exceed 10-6 after CTC-FEC, if the received signal is equal to or greater than the minimum sensitivity level for the modulations scheme used, as given in Table 7.7-1.

7.7.5.5 Security

7.7.5.5.1 AeroMACS shall provide a capability to protect the integrity of messages in transit.

Note.— The capability includes cryptographic mechanisms to provide integrity of messages in transit.

7.7.5.5.2 AeroMACS shall provide a capability to protect the availability of the system.

Note.— The capability includes measures to ensure that the system and its capacity are available for authorized uses during unauthorized events.

7.7.5.5.3 AeroMACS shall provide a capability to protect the confidentiality of messages in transit.

Note.— The capability includes cryptographic mechanisms to provide encryption/decryption of messages.

7.7.5.5.4 AeroMACS shall provide an authentication capability.

Note.— The capability includes cryptographic mechanisms to provide peer entity authentication, mutual peer entity authentication, and data origin authentication.

7.7.5.5.5 AeroMACS shall provide a capability to ensure the authenticity of messages in transit.

Note.— The capability includes cryptographic mechanisms to provide authenticity of messages in transit.

7.7.5.5.6 AeroMACS shall provide a capability to authorize the permitted actions of users of the system.

Note.— The capability includes mechanisms to explicitly authorize the actions of authenticated users. Actions that are not explicitly authorized are denied.

7.7.5.5.7 If AeroMACS provide interfaces to multiple domains, AeroMACS shall provide capability to prevent intrusion from lower integrity domain to higher integrity domain.

7.7.6 SYSTEM INTERFACES

7.7.6.1 AeroMACS shall provide data service interface to the system users.

7.7.6.2 AeroMACS shall support notification of the status of communications.

Note.— This requirement could support notification of the loss of communications (such as join and leave events).

7.7.7 APPLICATION REQUIREMENTS

7.7.7.1 AeroMACS shall support multiple classes of services to provide appropriate service levels to applications.

7.7.7.2 If there is a resource contention, AeroMACS shall pre-empt services with a lower priority than those given in CAR-ANS Part 2, 2.8.1.8.

— END —

AMENDED REGULATION AFTER REVISION:

CAR-ANS PART 7:

7.7. AERONAUTICAL MOBILE AIRPORT COMMUNICATIONS SYSTEM (AEROMACS)

7.7.1 DEFINITIONS

Adaptive modulation. A system's ability to communicate with another system using multiple burst profiles and a system's ability to subsequently communicate with multiple systems using different burst profiles.

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

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Data transit delay. In accordance with ISO 8348, the average value of the statistical distribution of data delays. This delay represents the subnetwork delay and does not include the connection establishment delay.

Domain. A set of end systems and intermediate systems that operate according to the same routing procedures and that is wholly contained within a single administrative domain.

Forward error correction. The process of adding redundant information to the transmitted signal in a manner which allows correction, at the receiver, of errors incurred in the transmission.

Frequency assignment. A logical assignment of centre frequency and channel bandwidth programmed to the base station (BS).

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Residual error rate. The ratio of incorrect, lost and duplicate subnetwork service data units (SNSDUs) to the total number of SNSDUs that were sent.

Service data unit (SDU). A unit of data transferred between adjacent layer entities, which is encapsulated within a protocol data unit (PDU) for transfer to a peer layer.

Service flow. A unidirectional flow of media access control layer (MAC) service data units (SDUs) on a connection that is providing a particular quality of service (QoS).

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

Subnetwork entry time. The time from when the mobile station starts the scanning for BS transmission, until the network link establishes the connection, and the first network user "protocol data unit" can be sent.

Subnetwork service data unit (SNSDU). An amount of subnetwork user data, the identity of which is preserved from one end of a subnetwork connection to the other.

Time division duplex (TDD). A duplex scheme where uplink and downlink transmissions occur at different times but may share the same frequency.

7.7.2 INTRODUCTION

Note 1.— Aeronautical mobile airport communications system (AeroMACS) is a high capacity data link supporting mobile and fixed communications, related to the safety and regularity of flight, on the aerodrome surface.

Note 2.— AeroMACS is derived from the IEEE 802.16-2009 mobile standards. AeroMACS profile document (RTCA DO345 and EUROCAE ED 222) lists all features from these standards which are mandatory, not applicable or optional. AeroMACS profile differentiates between base station and mobile station functionality and contains, for each feature, a reference to the applicable standards.

7.7.3 GENERAL

7.7.3.1 AeroMACS shall conform to the requirements of this and the following chapters.

7.7.3.2 AeroMACS shall only transmit when on the surface of an aerodrome.

7.7.3.3 AeroMACS shall support aeronautical mobile (route) service (AM(R) S) communications.

7.7.3.4 AeroMACS shall process messages according to their associated priority.

7.7.3.5 AeroMACS shall support multiple levels of message priority.

7.7.3.6 AeroMACS shall support point to point communication.

7.7.3.7 AeroMACS shall support multicast and broadcast communication services.

7.7.3.8 AeroMACS shall support internet protocol (IP) packet data services.

7.7.3.9 AeroMACS shall provide mechanisms to transport ATN/IPS and ATN/OSI (over IP) based messaging.

7.7.3.10 AeroMACS should support voice services.

Note.-Manual on the Aeronautical Telecommunication Network (ATN) using Internet Protocol Suite (IPS) Standards and Protocols *(Doc 9896) provides information on voice service over IP.*

7.7.3.11AeroMACS shall support multiple service flows simultaneously.

7.7.3.12 AeroMACS shall support adaptive modulation and coding.

7.7.3.13 AeroMACS shall support handover between different AeroMACS BSs during aircraft movement or on degradation of connection with current BS.

7.7.3.14 AeroMACS shall keep total accumulated interference levels with limits defined by the International Telecommunication Union — Radiocommunication Sector (ITU-R) as required by national/international rules on frequency assignment planning and implementation.

7.7.3.15 AeroMACS shall support a flexible implementation architecture to permit link and network layer functions to be located in different or same physical entities.

7.7.4 RADIO FREQUENCY (RF) CHARACTERISTICS

7.7.4.1 General Radio Characteristics

7.7.4.1.1 AeroMACS shall operate in time division duplex (TDD) mode.

7.7.4.1.2 AeroMACS shall operate with a 5 MHz channel bandwidth.

7.7.4.1.3 AeroMACS MS antenna polarization shall be vertical.

7.7.4.1.4 AeroMACS BS antenna polarization shall have a vertical component.

7.7.4.1.5 AeroMACS shall operate without guard bands between adjacent AeroMACS channels.

7.7.4.1.6 AeroMACS shall operate according to the orthogonal frequency division multiple access method.

7.7.4.1.7 AeroMACS shall support both segmented partial usage sub-channelization (PUSC) and PUSC with all carriers as sub-carrier permutation methods.

7.7.4.2 Frequency bands

7.7.4.2.1 AeroMACS equipment shall operate in the band from 5 030 MHz to 5 150 MHz in channels of 5 MHz bandwidth.

Note 1.— Some States may, on the basis of national regulations, have additional allocations to support AeroMACS. Information on the technical characteristics and operational performance of AeroMACS is contained in the AeroMACS Minimum Operational Performance Specification (MOPS) (*EUROCAE ED-223 / RTCA DO-346) and* AeroMACS Minimum Aviation System Performance Standard (MASPS) *(EUROCAE ED-227).*

Note 2.— The last centre frequency of 5 145 MHz is selected as the reference frequency for the numbering of AeroMACS channels. AeroMACS nominal centre frequencies are numbered downward from the reference frequency in 5 MHz steps.

7.7.4.2.2 The mobile equipment shall operate at centre frequencies offset from the preferred frequencies, with an offset of 250 kHz step size.

Note.— The nominal centre frequencies are the preferred centre frequencies for AeroMACS operations. However, the base stations should have the capability to deviate from the preferred centre frequencies to satisfy potential national spectrum authority implementation issues (i.e. to allow AeroMACS operations without receiving or causing interference to other systems operating in the band such as MLS and AMT).

7.7.4.3 Radiated power

7.7.4.3.1 The maximum mobile station equivalent isotropic radiated power (EIRP) shall not exceed 30 dBm.

7.7.4.3.2 The maximum base station EIRP in a sector shall not exceed 39.4 dBm.

7.7.4.3.3 In order to meet ITU requirements, the total base station EIRP in a sector shall be decreased from that peak, considering the antenna characteristics, at elevations above the horizon. Further information is provided in the guidance material.

Note 1.— EIRP defined as antenna gain in a specified elevation direction plus the average AeroMACS transmitter power. While the instantaneous peak power from a given transmitter may exceed that level when all of the subcarriers randomly align in phase, when the large number of transmitters assumed in the analysis is taken into account, average power is the appropriate metric.

Note 2.— If a sector contains multiple transmit antennas (e.g., multiple input multiple output (MIMO) antenna), the specified power limit is the sum of the powers from each antenna.

7.7.4.4 Minimum receiver sensitivity

7.7.4.4.1 AeroMACS receiver sensitivity shall comply with Table 7.7-1, AeroMACS receiver sensitivity values.

Note 1.— The computation of the sensitivity level for AeroMACS is described in the Aeronautical Mobile Airport Communications System(AeroMACS) Manual *(Doc 10044).*

Note 2.— AeroMACS receiver would be 2 dB more sensitive than indicated if Convolutional Turbo Codes (CTC) is used.

Note 3.— The sensitivity level is defined as the power level measured at the receiver input when the bit error rate (BER) is equal to 1 × 10-6 and all active sub-carriers are transmitted in the channel. In general the requisite input power depends on the number of active sub-carriers of the transmission.

Note 4.— The values in Table 7.7-1 assume a receiver noise figure of 8 dB.

Note 5.— The sensitivity values in Table 7.7-1 assume absence of any source of interference except for thermal and receiver noise.

Table 7.7-1. AeroMACS receiver sensitivity values

Modulation scheme using convolutional codes (CC) encoding scheme	Rep. Factor	MS Sensitivity	BS Sensitivity
64 QAM 3/4	1	-74.3 dBm	-74.5 dBm
64 QAM 2/3	1	-76.3 dBm	-76.5 dBm
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16 QAM 1/2	1	-83.8 dBm	-84.0 dBm
QPSK 3/4	1	-86.3 dBm	-86.5 dBm
QPSK 1/2	1	-89.3 dBm	-89.5 dBm
QPSK 1/2 with repetition 2	2	-92.3 dBm	-92.5 dBm

Note .— A 64 QAM transmission is optional for MS.

7.7.4.5 Spectral mask and emissions

7.7.4.5.1 The power spectral density of the emissions when all active sub-carriers are transmitted in the channel shall be attenuated below the maximum power spectral density as follows:

a) on any frequency removed from the assigned frequency between 50 and 55 per cent of the authorized bandwidth: 26 + 145 log (per cent of BW/50) dB;

b) on any frequency removed from the assigned frequency between 55 and 100 per cent of the authorized bandwidth: 32 + 31 log (per cent of (BW)/55) dB;

c) on any frequency removed from the assigned frequency between 100 and 150 per cent of the authorized bandwidth: 40 + 57 log (per cent of (BW)/100) dB; and

d) on any frequency removed from the assigned frequency beyond 150 per cent of the authorized bandwidth: 50 dB.

Note.— The power spectral density at a given frequency is the power within a bandwidth equal to 100 kHz centred at this frequency, divided by this measurement bandwidth. It is made clear that the measurement of the power spectral density should encompass the energy over at least one frame period.

7.7.4.5.2 AeroMACS shall implement power control.

7.7.4.5.3 AeroMACS minimum rejection for adjacent (+/–5MHz) channel, measured at BER=10-6 level for a victim signal power 3 dB higher than the receiver sensitivity, shall be 10 dB for 16 QAM 3/4.

7.7.4.5.4 AeroMACS minimum rejection for adjacent (+/–5MHz) channel, measured at BER=10-6 level for a victim signal power 3 dB higher than the receiver sensitivity, shall be 4 dB for 64 QAM 3/4.

7.7.4.5.5 AeroMACS minimum rejection for second adjacent (+/–10MHz) channel and beyond, measured at BER=10-6 level for a victim signal power 3 dB higher than the receiver sensitivity, shall be 29 dB for 16 QAM 3/4.

7.7.4.5.6 AeroMACS minimum rejection for second adjacent (+/–10MHz) channel and beyond, measured at BER=10-6 level for a victim signal power 3 dB higher than the receiver sensitivity, shall be 23 dB for 64 QAM 3/4.

Note.— For additional clarification to the requirements stated in 7.7.4.5.3, 7.7.4.5.4, 7.7.4.5.5 and 7.7.4.5.6, refer to IEEE 802.16-2009 section 8.4.14.2.

7.7.4.6 Frequency tolerance

7.7.4.6.1 AeroMACS BS transmitter frequency tolerance shall be better than +/- 2 × 10-6 of nominal channel frequency.

7.7.4.6.2 AeroMACS MS transmitter centre frequency shall be locked to that of the BS transmission centre frequency with a tolerance better than 2 per cent of the subcarrier spacing.

7.7.4.6.3 AeroMACS MS shall track the frequency of the BS and shall defer any transmission if synchronization is lost or exceeds the tolerances given above.

7.7.5 PERFORMANCE REQUIREMENTS

7.7.5.1 AeroMACS communications service provider

7.7.5.1.1 The maximum unplanned service outage duration on a per aerodrome basis shall be 6 minutes.

7.7.5.1.2 The maximum accumulated unplanned service outage time on a per aerodrome basis shall be 240 minutes/year.

7.7.5.1.3 The maximum number of unplanned service outages shall not exceed 40 per year per aerodrome.

Note.– The requirements given in 7.7.5.1.1 to 7.7.5.1.3 refer to the overall service provision by the AeroMACS communication service provider on the aerodrome surface. This may include other media which can provide alternate communication paths in the event of an AeroMACS failure.

7.7.5.1.4 Connection resilience. The probability that a transaction will be completed once started shall be at least 0.999 for AeroMACS over any one-hour interval.

Note.— Connection releases resulting from AeroMACS handover between base stations, log-off or circuit pre-emption are excluded from this specification.

7.7.5.2 Doppler shift

7.7.5.2.1 AeroMACS shall operate with a Doppler shift induced by the movement of the MS up to a radial speed of 92.6 km (50 NM) per hour, relative to the BS.

7.7.5.3 Delay

7.7.5.3.1 Subnetwork entry time shall be less than 90 seconds.

7.7.5.3.2 The from-MS data transit delay (95th percentile) for the highest priority data service, shall be less than or equal to 1.4 seconds over a window of 1 hour or 600 SDUs, whichever is longer.

7.7.5.3.3 The to-MS data transit delay (95th percentile) for the highest priority data service, shall be less than or equal to 1.4 seconds over a window of 1 hour or 600 SDUs, whichever is longer.

7.7.5.4 Integrity

7.7.5.4.1 AeroMACS BS and MS shall support mechanisms to detect and correct corrupt SNSDUs.

7.7.5.4.2 AeroMACS BS and MS shall only process SNSDUs addressed to themselves.

7.7.5.4.3 The residual error rate, to/from MS shall be less than or equal to $5 \times 10\text{-}8$ per SNSDU.

Note.— There are no integrity requirements for SNSDU residual rate to the BS and MS as the requirement is entirely satisfied by the end-to-end systems in the aircraft and air traffic service provider.

7.7.5.4.4 The maximum bit error rate shall not exceed 10-6 after CTC-FEC, if the received signal is equal to or greater than the minimum sensitivity level for the modulations scheme used, as given in Table 7.7-1.

7.7.5.5 Security

7.7.5.5.1 AeroMACS shall provide a capability to protect the integrity of messages in transit.

Note.— The capability includes cryptographic mechanisms to provide integrity of messages in transit.

7.7.5.5.2 AeroMACS shall provide a capability to protect the availability of the system.

Note.— The capability includes measures to ensure that the system and its capacity are available for authorized uses during unauthorized events.

7.7.5.5.3 AeroMACS shall provide a capability to protect the confidentiality of messages in transit.

Note.— The capability includes cryptographic mechanisms to provide encryption/decryption of messages.

7.7.5.5.4 AeroMACS shall provide an authentication capability.

Note.— The capability includes cryptographic mechanisms to provide peer entity authentication, mutual peer entity authentication, and data origin authentication.

7.7.5.5.5 AeroMACS shall provide a capability to ensure the authenticity of messages in transit.

Note.— The capability includes cryptographic mechanisms to provide authenticity of messages in transit.

7.7.5.5.6 AeroMACS shall provide a capability to authorize the permitted actions of users of the system.

Note.— The capability includes mechanisms to explicitly authorize the actions of authenticated users. Actions that are not explicitly authorized are denied.

7.7.5.5.7 If AeroMACS provide interfaces to multiple domains, AeroMACS shall provide capability to prevent intrusion from lower integrity domain to higher integrity domain.

7.7.6 SYSTEM INTERFACES

7.7.6.1 AeroMACS shall provide data service interface to the system users.

7.7.6.2 AeroMACS shall support notification of the status of communications.

Note.— This requirement could support notification of the loss of communications (such as join and leave events).

7.7.7 APPLICATION REQUIREMENTS

7.7.7.1 AeroMACS shall support multiple classes of services to provide appropriate service levels to applications.

7.7.7.2 If there is a resource contention, AeroMACS shall pre-empt services with a lower priority than those given in CAR-ANS Part 2, 2.8.1.8.

— END—

i. ***Separability Clause.*** **-** If, for any reason, any provision of this Memorandum Circular is declared invalid or unconstitutional, the other part or parts thereof which are not affected thereby shall continue to be in full force and effect.

ii. ***Repealing Clause.*** **-** All orders, rules, regulations and issuances, or parts thereof which are inconsistent with this Memorandum Circular are hereby repealed, superseded or modified accordingly.

iii. ***Determination of changes.*** **–** To highlight the amendments and/or revisions in the Memorandum Circular, the deleted text shall be shown with strikethrough and the new inserted text shall be highlighted with grey shading, as illustrated below:

1. Text deleted: ~~Text to be deleted is shown with a line through it.~~
2. New text inserted: New text is highlighted with grey shading.
3. New text replacing existing text: ~~Text to be deleted is shown with a line through it~~ followed by the replacement text which is highlighted with grey shading.

iv. ***Effectivity Clause.*** **-** This Memorandum Circular shall take effect fifteen (15) days after publication in a requisite single newspaper of general circulation or the Official Gazette and a copy filed with the U.P. Law Center - Office of the National Administrative Register.

So Ordered. Signed this **17th** day of **MAY** 2018, at the Civil Aviation Authority of the Philippines, MIA Road, Pasay City, Metro Manila, 1301.

CAPTAIN JIM C. SYDIONGCO