Advisory Circular

AC AGA–EMAS–01–2024

ENGINEERED MATERIALS ARRESTING SYSTEM (EMAS)

FOR AIRCRAFT OVERRUNS

(First Issue)

Aerodrome & Air Navigation Safety Oversight Office (AANSOO)
Office of the Director General
Civil Aviation Authority of the Philippines
Old MIA Road, Pasay City, 1300

JANUARY 2024

Advisory Circulars (AC) are intended to provide recommendations and guidance, illustrate a means-but not necessarily the only means of complying with regulatory requirements, or to explain certain regulatory requirements by providing interpretative and explanatory materials.

CAAP will generally accept that when the provisions of an Advisory Circular have been met, compliance with the relevant regulatory obligations has been satisfied.

Where an AC is referred to in a "Note" within regulatory documentation, the AC remains as a guidance material.

ACs should always be read in conjunction with the referenced regulations.

Engineered Materials Arresting System (EMAS) for Aircraft Overruns

I. PURPOSE

This Advisory Circular (AC AGA-EMAS-01-2024) is issued to provide guidance for the design and installation of Engineered Materials Arresting System (EMAS) as an alternative or an acceptable means of compliance to a runway end safety area (RESA).

II. APPLICATION

AC AGA-EMAS-01-2024 is applicable to all airport operators in the Philippines. CAAP recognizes the difficulties associated with achieving a standard RESA at all airports, thus, it is recommended that EMAS may be installed, as applicable, to any aerodromes as an alternative to RESA.

III. RELATED RULES

This AC relates specifically to the requirements of MOS-Aerodromes under Section 6.4 (Runway End Safety Area).

IV. ACKNOWLEDGEMENT

AANSOO of the Civil Aviation Authority of the Philippines acknowledges the valuable information provided by ICAO through its published Documents and other related guidance materials and best practices developed by international organizations.

V. CHANGE NOTICE

Not applicable

VI. COPIES OF THIS AC

AC AGA-EMAS-01-2024 is available and can be downloaded at the official website of CAAP at www.caap.gov.ph. A printed copy of this AC can be requested from the Regulatory Safety Standards Division (RSSD) of the Aerodrome and Air Navigation Safety Oversight Office (AANSOO), Civil Aviation

Authority of the Philippines, located at MIA Road corner, Ninoy Aquino Avenue, Pasay City, Metro Manila, 1300 with Tel. No.: (02) 8246 4988.

CAPTAIN MANUEL ANTONIO L. TAMAYO
Director General
Civil Aviation Authority of the Philippines

Table of Contents

FOREWORD

Annex 14 Volume I (Aerodrome Design and Operations) requires a runway end safety area (RESA) to be provided at each end of a runway strip. ICAO Aircraft Accident/Incident Data Reports (ADREP) have indicated that aircraft undershooting or overrunning the runway during landings or take-offs suffer significant damage. To minimize such damage, it is considered necessary to provide an additional area beyond the ends of the runway strip.

A Runway End Safety Area (RESA) serves as a protective measure in cases where an aircraft veers off the runway during takeoff or landing, referred to as an "overrun," or when the aircraft touches down before the runway threshold, known as an "undershoot." It is a crucial civil engineering facility designed to ensure airport functionality and enhance safety for human life while minimizing damage to aircraft.

CAAP recommends a globally accepted alternative to comply with this ICAO requirement. The Engineered Materials Arresting System or EMAS, may be installed at the Philippines licensed aerodromes as an alternative to RESA. Where provision of a runway end safety area will be particularly prohibitive to implement, consideration will have to be given to reducing some of the declared distances of the runway for the provision of a runway end safety area and installation of an arresting system.

An aircraft arresting system is a system designed to decelerate an aeroplane overrunning the runway. In accordance with the Manual of Standards for Aerodromes, if an arresting system is installed, the length of the standard or recommended RESA may be reduced, based on the design specification of the system, subject to acceptance by CAAP.

CAAP recognizes the difficulties associated with achieving a standard RESA at all airports. Hence, AANSOO hereby developed a guidance material on the requirements and evaluation process once the aerodrome operator fully decided for the installation of an EMAS. This AC is not mandatory and does not constitute a regulation. It is issued for guidance purposes and to outline a method of compliance. However, use of these guidelines is mandatory for an airport operator installing an EMAS. Mandatory terms such a "must" used herein apply only to those who seek to demonstrate compliance by use of the specific method described by this AC.

INTENTIONALLY LEFT BLANK

DEFINITIONS

Aircraft Arresting System - A system designed to decelerate an aeroplane overruning the runway.

Critical aircraft - That aircraft regularly using the associated runway that imposes the greatest demand on the EMAS.

Design aircraft list - refers to the combination of the aircraft types which are/will be operating regularly on the runway.

Exit speed - The speed of the nose gear of the aeroplane as it passes the physical end of the runway or stopway, if provided.

Setback - The distance between the runway end or stopway and the beginning of the EMAS.

ACRONYMS AND ABBREVIATIONS

AANSOO	Aerodrome and Air Navigation Safety Oversight Office
AAS	Aircraft Arresting System
AC	Advisory Circular
ADREP	Aircraft Accident/Incident Data Report
AIS	Aeronautical Information Services
ARFF	Aircraft Rescue and Fire Fighting
CAAP	Civil Aviation Authority of the Philippines
EMAS	Engineered Materials Arresting System
ICAO	International Civil Aviation Organization
MC	Memorandum Circular
MOS	Manual of Standards for Aerodromes
RESA	Runway End Safety Area
RSSD	Regulatory Safety Standards Division

1. INTRODUCTION

1.1 Runway End Safety Area (RESA)

There are many runways, particularly those constructed prior to the adoption of the runway end safety area standards, where natural obstacles, local development, and/or environmental constraints, make the construction of a standard safety area impracticable. There have been accidents at some airports where the ability to stop an overrunning aircraft within the runway safety area would gave prevented major damage to aircraft and/or injuries to passengers.

Runway safety standards remain in effect regardless of the presence of natural or man-made objects or surface conditions that might create hazard to aircraft that overrun the end of a runway. Runway safety area standards cannot be modified nor waived.

To minimize the hazards of overruns, CAAP incorporated the concept of runway end safety area (RESA) under Section 6.4 of the Manual of Standards for Aerodromes. RESA should be capable of adequately supporting any aircraft which overruns or undershoots the runway and should be clear of all equipment and installations which are not frangible.

Where a runway end safety area is provided in accordance with MOS for Aerodromes, consideration should be given to providing an area long enough to contain overruns and undershoots resulting from a reasonably probable combination of adverse operational factors. On a precision approach runway, the ILS localizer is normally the first upstanding obstacle, and the runway end safety area should extend up to this facility. In other circumstances, the first upstanding obstacle may be a road, a railroad or other constructed or natural feature. The provision of a runway end safety area should take such obstacles into consideration.

Where provision of a runway end safety area would be particularly prohibitive to implement, consideration would have to be given to reducing some of the declared distances of the runway for the provision of a runway end safety area and installation of an arresting system.

1.2 Arresting System

Research programmes, as well as evaluation of actual aircraft overruns into arresting systems, have demonstrated that the performance of some arresting systems can be predictable and effective in arresting aircraft overruns.

Demonstrated performance of an arresting system can be achieved by a validated design method, which can predict the performance of the system. The design and performance should be based on the type of aircraft anticipated to use the associated runway that imposes the greatest demand upon the arresting system.

The design of an arresting system must consider multiple aircraft parameters, including but not limited to, allowable aircraft gear loads, gear configuration, tire contact pressure, aircraft centre of gravity and aircraft speed. Accommodating undershoots must also be addressed. Additionally, the design must allow the safe operation of fully loaded rescue and fire fighting vehicles, including their ingress and egress.

If an arresting system is installed, MOS for Aerodromes under 6.4.1.3 states that the stipulated length may be reduced, based on the design specification of the system, subject to acceptance by CAAP.

2. Engineered Materials Arresting System (EMAS)

Engineered Materials Arresting System (EMAS) is an aircraft arresting system (AAS) designed to decelerate an aeroplane overruning the runway. It consists of high energy absorbing materials of specific strength, which will reliably and predictably crush under the weight of an aircraft. The materials are tailored to specific mechanical properties and are referred to as Engineered Materials. The Engineered Materials will be crushed under the landing gears of the aeroplane when it engages the EMAS. The crushing is an irreversible or partly irreversible process and the arresting performance of the system is proportional to the amount of energy that is dissipated.

2.1 Pre-installation of EMAS

When EMAS is the selected option to comply with RESA , it is considered that it also meets the other safety area requirements specified under Section 6.4 of MOS for Aerodromes.

Prior to the installation of EMAS or to other similar subtypes of arresting systems, suggested procedures should be followed as an additional guidance to meet national requirements regarding industry, environment or emergency plans.

2.1.1 Manufacturers need an EMAS type acceptance/approval from CAAP, demonstrating compliance to general requirements; and

2.1.2 Once the EMAS type is accepted, aerodrome operators can make a proposal by providing details of the EMAS to be installed.

Note: CAAP may include a review of testing conducted previously, a detailed programme of evaluations and tests, or the acceptance of certificates of compliance by the oversight carried out by other States for EMAS type acceptance/approval.

2.2 System Design Requirements

The following system design requirements must prevail for all EMAS installations:

2.2.1 ***Concept***

An EMAS is designed to stop an overrunning aircraft by exerting predictable deceleration forces on its landing gear as the EMAS material deforms. It must be designed to minimize the potential for structural damage to aircraft, since such damage could result in injuries to passengers and/or affect the predictability of deceleration forces.

2.2.2 ***Lifespan***

An EMAS must be designed for a 20-year service life.

2.2.3 ***Location***

A. An EMAS is located beyond the end of the runway and centered on the extended runway centerline. It will usually begin at some setback distance from the end of the runway to avoid damage due to jet blast and undershoots. This distance will vary depending on the available area and the EMAS materials. (*See ANNEX B for typical EMAS layout*)

B. Where the area available is longer than required for installation of a standard EMAS designed to stop the design aircraft at an exit speed of 40 knots (minimum) or 70 knots (recommended), the EMAS should be placed as far from the runway end as practicable.

2.2.4 ***Design***

A. An EMAS design must be supported by a validated design method that can predict the performance of the system. The design (or critical) aircraft is defined as that aircraft using the associated runway that imposes the greatest demand upon the EMAS.

B. The design method must be derived from field or laboratory tests or actual aircraft overruns. Testing may be based either on passage of an actual aircraft or an equivalent single wheel load through a test bed. The design must consider multiple aircraft parameters, including but not limited to allowable aircraft gear loads, gear configuration, tire contact pressure, aircraft center of gravity, and aircraft speed. The model must calculate imposed aircraft gear loads, g-forces on aircraft occupants, deceleration rates, and stopping distances within the arresting system. Any rebound of the crushed material that may lessen its effectiveness must also be considered.

2.2.5 ***Operation***

The EMAS must be a passive system which requires no external means to initiate/trigger the operation of the EMAS to arrest an aircraft.

2.2.6 ***Width***

The EMAS functional width must be the width of the runway (plus any sloped area as necessary) and should be based on the standard runway width for the applicable airplane design group. (*See ANNEX B*)

2.2.7 ***Length***

The EMAS functional length must be designed based on the operating conditions of the associated runway with its center line coincidental with the extended center line of the runway. (*See ANNEX B*)

2.2.8 ***EMAS Base***

The EMAS must be constructed on a paved base with the strength of the runway threshold which is capable of supporting the occasional passage of the critical design aircraft using the runway and fully loaded Aircraft Rescue and Fire Fighting (ARFF) vehicles without deformation of the base surface or structural damage to the aircraft or vehicles. It must be designed to provide sufficient support to facilitate removal of the aircraft from the EMAS.

2.2.9 ***Entrance Speed***

A. The EMAS must be designed to decelerate the design aircraft expected to use the runway at exit speeds of 40 knots (minimum) or 70 knots (recommended) without imposing loads that exceed the aircraft's design limits, causing major structural damage to the aircraft or imposing excessive forces on its occupants.

B. For design purposes, assume the aircraft has all of its landing gear in full contact with the runway and is travelling within the confines of the runway and parallel to the runway center line upon overrunning the runway end. The aerodrome operator, EMAS manufacturer, and the Civil Aviation Authority of the Philippines must consult regarding the selection of the appropriate design entrance speed for the EMAS installation.

2.2.10 ***Aircraft Evacuation***

The EMAS must be designed to enable safe ingress and egress as well as movement of ARFF equipment (not necessarily without damage to the EMAS) operating during an emergency. Provision for access from the back of the EMAS may be provided if desirable. Maximum slopes must be based on the EMAS material and performance characteristics of the aerodrome's ARFF equipment.

2.2.11 ***Maintenance Access***

The EMAS must be capable of supporting regular pedestrian traffic for the purposes of maintenance of the arresting material and co-located navigation aids without damage to the surface of the EMAS bed. An EMAS is not intended to support vehicular traffic for maintenance purposes.

2.2.12 ***Undershoots***

The runway safety area should provide adequate protection for aircraft that touch down prior to the runway threshold (undershoot).

The EMAS must not cause control problems for aircraft undershoots which touch down in the EMAS bed.

2.2.13 ***Navigational Aids***

The EMAS must be constructed to accommodate approach lighting structures and other approved facilities within its boundaries and must not cause visual or electronic interference with any air navigational aids. All navigational aids within the EMAS must be frangible as required by the latest version of ICAO on frangibility requirements.

2.2.14 ***Drainage***

The EMAS must be designed to prevent water from accumulating on the surface of the EMAS bed, the runway or the runway safety area. The removal and disposal of water, which may hinder any activity necessary for the safe and efficient operation of the airport, must be in accordance with the latest version of the CAAP Manual of Standards for Aerodromes, MOS-Aerodromes-2nd-Edition-Amendment-No.-8-incorporating-MC-23-2021.

2.2.15 ***Jet Blast***

The EMAS must be designed and constructed with adequate set back so that it will not be damaged by expected jet blast.

2.2.16 ***Repair***

The EMAS must be designed for repair to a usable condition (in which the bed is completely repaired) within an acceptable period of an overrun by the design aircraft at the design entrance speed.

2.3 Material Qualification

The material comprising the EMAS must have the following requirements and characteristics:

2.3.1 *Material Strength and Deformation Requirements*

Materials must meet a force vs. deformation profile within limits having been shown to assure uniform characteristics, and therefore, predictable response to an aircraft entering the arresting system.

2.3.2 *Material Characteristics*

The materials comprising the EMAS must:

1. Be water-resistant to the extent that the presence of water does not affect system performance.
2. Not attract, or be physically vulnerable to vermin, birds, wildlife or other creatures to the greatest extent possible.
3. Be non-sparking.
4. Be non-flammable.
5. Not promote combustion.
6. Not emit toxic or malodorous fumes in a fire environment after installation.
7. Not support unintended plant growth with proper application of herbicides.
8. Exhibit constant strength and density characteristics during all climatic conditions within a temperature range appropriate for the locale.
9. Be resistant to deterioration due to:
    a. Salt.
    b. Aircraft Fuels, hydraulic fluids, and lubricating oils.
    c. UV radiation.
    d. Water.
    e. Paint.
    f. Herbicides.

2.4 Material Conformance Requirements

An EMAS manufacturer must establish a material sampling and testing program including testing frequency to verify that all materials are in conformance with the initial approved material force versus deformation profile established. Materials failing to meet these requirements must not be used.

2.5 Submission of Design Proposal

The EMAS design must be prepared by the design engineer and the EMAS manufacturer for the aerodrome operator.

The aerodrome operator must submit the EMAS design to CAAP, for review and approval. The EMAS design must be certified as meeting all the requirements of this AC and the submission must include all design assumptions and data utilized in its development as well as proposed construction procedures and techniques.

2.6 Quality Assurance Program

The construction contractor and the EMAS manufacturer must prepare the construction quality assurance program to be implemented to ensure that installation/construction is in accordance with the approved EMAS design. The aerodrome operator must submit the construction QA program to CAAP for approval 14 days prior to the project notice to proceed.

2.7 Marking

An EMAS must be marked with yellow chevrons as an area unusable for landing, takeoff, and taxiing.

2.8 Inspection and Maintenance

The EMAS manufacturer must prepare an inspection and maintenance program for the airport operator for each EMAS installation, prior to completion of the final design.The aerodrome operator must submit this inspection and maintenance program to CAAP for approval prior to final project acceptance. The inspection and maintenance program must be incorporated into the aerodrome operator's manual. (*See Annex A for the minimum maintenance plan.*)

The aerodrome operator must implement the approved inspection and maintenance program. The program must include necessary procedures for inspection, preventive maintenance and unscheduled repairs, particularly to weatherproofing layers. It should also include testing and evaluation procedures and criteria for determining when an installed EMAS has reached the end of its service life.Procedures must be sufficiently detailed to allow maintenance/repair of the EMAS bed with the aerodrome operator's staff.

The aerodrome operator may elect to have the EMAS manufacturer maintain the EMAS bed. The program must include appropriate records to verify that all required inspections and maintenance have been performed by the aerodrome operator and/or EMAS manufacturer. These records must be made available to CAAP upon request.

2.9 Aircraft Rescue and Fire Fighting Vehicles (ARFF)

The EMAS is designed to allow the movement of typical ARFF equipment operating during an emergency.

3.0 Notification

Upon installation of an EMAS, its length, width, and location must be depicted by the aerodrome operator in the airport diagram and must forward the required information to CAAP AIS as soon as possible, for the publication on the desired effective date.

When an EMAS is damaged due to an overrun or determined to be less than fully serviceable, a NOTAM must be issued to alert airport users of the reduced performance of the EMAS.

ANNEX A

Inspection and Maintenance Program

The aerodrome operator must implement the approved inspection and maintenance program. At a minimum, the maintenance plan must address the following areas:

A. General information on the EMAS bed including:

- ✓ A description of the EMAS bed
- ✓ Material description
- ✓ Contact information for the EMAS manufacturer

B. Inspection requirements including:

- ✓ Type and frequency of required inspections
- ✓ Training of personnel
- ✓ Checklist(s) and instructions on how to conduct each inspection
- ✓ List of typical problems and possible solutions
- ✓ Testing and evaluation procedures, and criteria for determining when an installed EMAS has reached the end of its useful service life
- ✓ Required documentation for inspections
- ✓ Inspection forms

C. Maintenance and repair procedures including:

- ✓ List of approved materials and tools
- ✓ Description of repair procedures for typical damage to an EMAS bed such as repairing depressions/holes, abrasion damage, replacing a damaged block, repairing coatings, caulking/joint repair, etc.

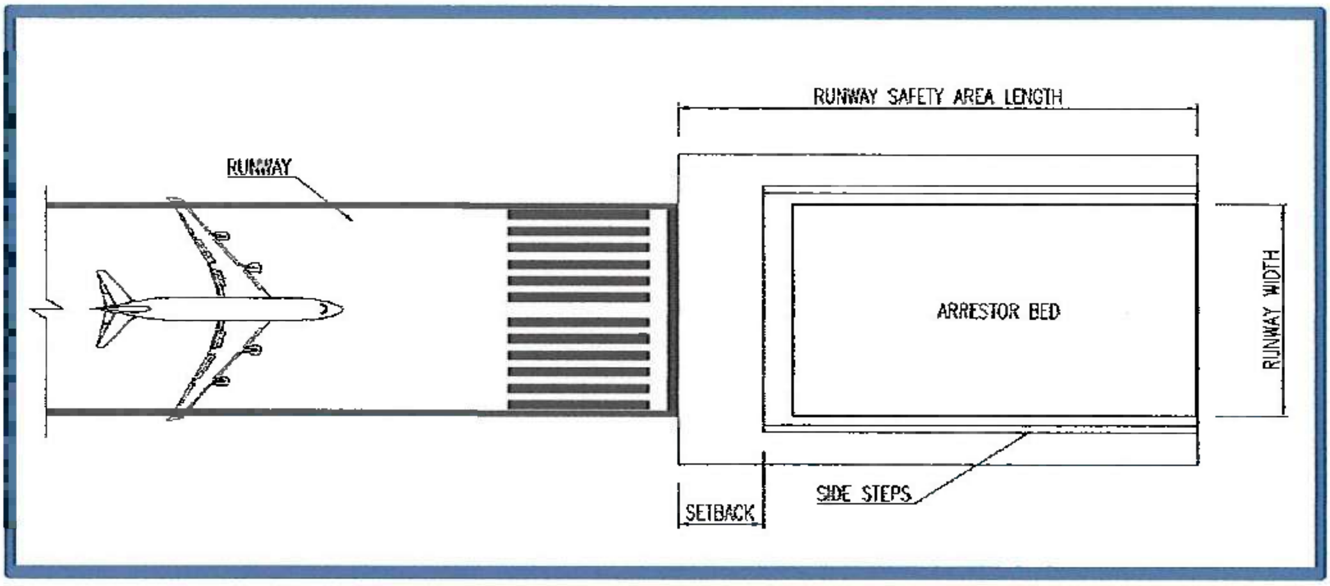
D. Any unique requirements due to location (both geographically and within the aerodrome), in order to protect the operation of the airfield and its facilities.

E. Warranty information.

INTENTIONALLY LEFT BLANK

ANNEX B

Typical EMAS Layout



INTENTIONALLY LEFT BLANK