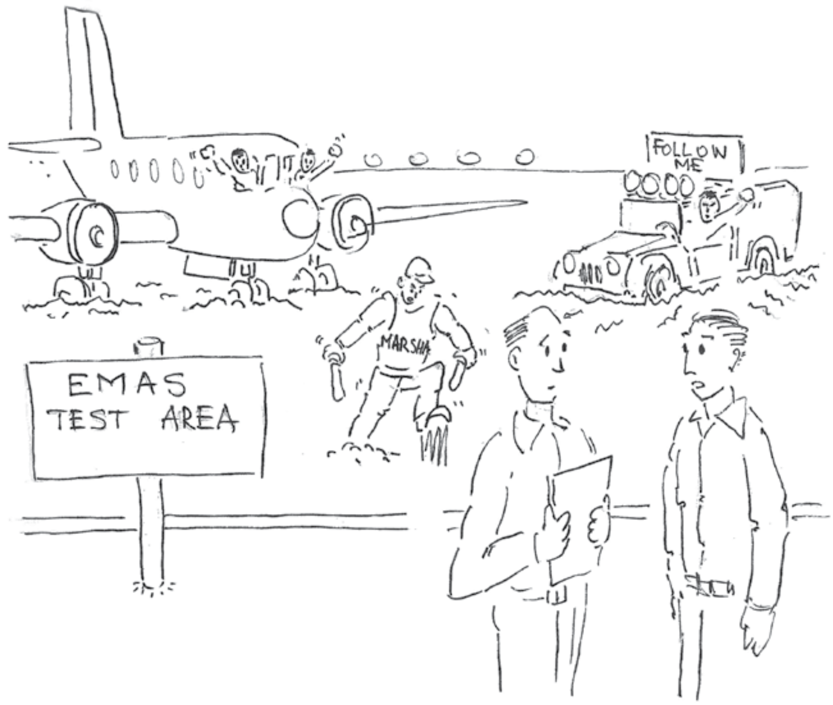
EMAS - A PASSIVE SAFETY NET FOR RUNWAY OVERRUNS

by Stan Koczkodaj

When addressing the area of ground-based or airborne safety nets, one subject that is often absent from discussions is that of an EMAS (Engineered Material Arresting System). Why is that so? After all, an EMAS certainly "prevents imminent or hazardous situations from developing into major incidents or accidents." The answer may stem from the fact that an EMAS is a passive system. Unlike most safety nets, an EMAS does not analyze and generate streams of data to a computer or relay that information to an air traffic controller, cockpit crew or other responsible party. There are no warnings, surveillance alerts, nor advisories.



I think that the retention material works a little bit too well...

The EMAS sits in a perpetual state of readiness, to be called upon to stop an aircraft on an airport runway when there is an overrun due to an aborted take-off or an anomaly in landing. It is a low-profile gray monument to the data and analysis gathered and processed months before the system was designed, manufactured, and installed. An EMAS directly addresses what is usually an unexpected and sudden emergency and delivers predictable performance and energy control that prevents a potentially catastrophic situation from occurring.

At one time, upon first hearing of an EMAS, the first question that may have been posed was: "What is an EMAS?" Thanks to evolving aviation policies, education, and word-of-mouth in the airport community, most aviation personnel know that an EMAS is an arrestor bed situated at the end of an airport runway and that it is designed to safely stop airplanes that overshoot runways. Over-simplification in descriptions by the media often compare/describe an EMAS to highway run-off gravel beds. The product is much more sophisticated.

The overall bed design and strength is based on an FAA-validated computer model that integrates the key elements of an airport's runway characteristics with the full range of their aircraft fleet mix. This model factors in over 100 data points, including airport fleet mix, available real estate, and a performance target of 70 knots as a standard or less when necessary. Because the main requirement upon calculation is to preserve the physical integrity of an aircraft, the design and performance takes into account all aircraft considered as critical, as one may have a weaker nose gear, a low engine clearance or specific gear configuration that would pose the greatest demand on the arresting system.

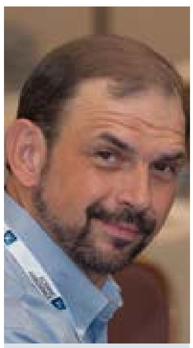
How does it work?

The EMAS predictably and reliably crushes under the weight of an aircraft, providing deceleration and a safe stop. It is FAA-accepted as an equivalent to a standard Runway End Safety Area (aka Runway Safety Area) and is an acceptable alternative for preventing overrun catastrophes at airports where RESAs/RSAs do not exist or are impractical due to environmental or other issues.

An EMAS bed is designed to stop an overrunning aircraft by exerting predictable deceleration forces on its landing gear as the EMAS material crushes without causing structural failure to the landing gear. The system operates independently of runway friction or braking action because the landing gear gradually sinks into the specially designed crushable material.

An EMAS may literally be the last line of defence against very dire consequences, which makes a very strong case for the system as a "safety net." The 243 passengers and crew that were on board the 9 aircraft, ranging from a Cessna Citation to a Boeing 747, that have been saved over the years by this technology would certainly provide a vote of confidence in agreement with that terminology. The 9 "saves" occurred in 9 attempts, with no failed arrestments, a perfect safety record: a safety net with flawless performance! After removal from the EMAS bed, every aircraft was able to return to service.

Air travel has never been safer than it is today. When justifying factors for not installing an EMAS, quite often statistics are cited to justify what could be perceived as a low percentage of runway excursions versus successful landings and take-offs. To put this in perspective:



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runway safety related accidents where excursions occurred accounted for 83% of all fatal runway accidents (according to Flight Safety Foundation analysis, 1995-2008.) All it takes is one disastrous overrun to result in significant loss of life and high value assets, as well as loss of revenue due to an inactive runway.

When "lightning struck twice" at the same location.

Speaking of statistics, unusual anomalies do occur. The odds of an aircraft overrun occurring on one end of an airport runway may be remote, but certainly in the realm of possibility. Even more unlikely is the concept that two of these incidents would occur on the opposite ends of the same runway, at the same airport. But the likelihood that two overruns would occur on the opposite ends of the same runway, at the same airport, during the same week, are highly improbable. Yet that is exactly what happened in Key West, Florida USA in October, 2011.

On Monday, Oct. 31 at 7:45 PM, a Gulfstream 150 business jet was landing on Runway 27 when the aircraft overran the runway. It passed through an unpaved 180 meter (600 ft). runway safety area and travelled an additional 70m (220 ft), stopping at the end of the airfield, 1m (3 ft) away from an airport perimeter fence. There was substantial damage to the wings, nose, landing gear and body. The left side and wing of the aircraft were partially submerged in a shallow salt pond, with some fuel leakage. One passenger was hospitalized with a broken clavicle and ribs, while another suffered minor cuts and bruises.

Four days later, on Thursday, Nov. 3 at 12:15 PM, a Cessna Citation 550 touched down for a landing on Runway 09 of the same 1,464m (4,800 ft) runway. Unable to stop, the aircraft passed over an 11m (35-ft) setback area then engaged an EMAS. The aircraft continued 45 m (148 ft) into the energy-absorbing arrestor bed and coasted to a safe, controlled stop. As the dust was still in the air, the pilot, co-pilot and three passengers quickly exited the aircraft with no injuries. The aircraft suffered only minimal damage to its belly and front landing gear, with no fuel leakage. By 2:00 PM, the aircraft had been towed to a hangar and the runway reopened at 2:06 PM.

Airport Director Peter Horton observed that the safety material worked perfectly: "Not even a bruise or a scratch." And further: ". . . I have never seen a more effective safety device than EMAS to minimize aircraft damage or passenger injury in the event of an over-run incident. And as recent events have proven, it works exactly as advertised." Key West installed a second EMAS at the end of Runway 27 in early 2015. Aircraft overruns seem to happen when you least expect it. Although the circumstances in these two were similar, the outcome in each situation was remarkably different.

The EMAS safety net and aborted take-off: "We made the investment and we saved lives."

January 19, 2010 at Yeager Airport, Charleston, West Virginia USA, at 4:20 PM, when US Airways Express Flight 2495, a Bombardier CRJ-200 regional jet carrying 34 passengers and crew onboard, rejected take off 4 seconds after V1 due to an incorrect flap setting and was safely stopped by an EMAS arrestor bed. This save was unique due to the circumstance of the aborted takeoff, as the five previous successful EMAS aircraft arrestments had all taken place during aircraft landings.

The aircraft had reached a speed of 143 knots before braking aggressively, leaving skid marks on the runway before entering a sub¬stantial distance into the length of the EMAS bed, safely and dramatically stopping short of a steep 136m (446 ft) drop at the end of the airport runway, which overlooks a valley near the Kanawha River and the city of Charleston. Thanks to the EMAS, the passengers and crew walked away unharmed. After a brief shutdown, the runway was reopened by 10:15 PM, less than six hours after the arrestment.

Yeager Airport officials and the FAA installed the EMAS system as part of an overall airport safety upgrade in April-May 2007. At a post-event press conference, Kanawha County Commission President Ken Carper commented: "If it hadn't been for the EMAS, I'm convinced a catastrophe would have occurred." Mr. Carper, to Charleston radio station WCHS: "This is what is important. The Board of Yeager Airport, Senator Byrd, Senator Rockefeller, Governor Manchin, and others felt that we had to do this. We made the investment, and we saved lives."

EMAS safety net: aviation community acceptance

In early 2014, EASA adopted a stance similar to that of ICAO's "Annex 14, Volume I, Aerodrome Design and Operations to the Convention on International Civil Aviation", which included the use of aircraft arresting systems, as an Alternative Means of Compliance to meet runway end safety area (RESA) requirements. Many airports have no space or only a very minimal area in which a RESA could be established. ICAO's allowance for an EMAS to be installed within the runway strip provides flexibility to improve safety for a runway with a severely constrained RESA/RSA. IFALPA, IATA, ACI and civil aviation authorities have also recommended the deployment of arresting systems such as an EMAS when it is impractical to build out to meet ICAO-required RESA lengths.

A Safety Net That can also Gain Runway Space

Runways with adequate RESA/RSA space can also benefit from the installation of an EMAS as a means of reducing the length of a safety area, based on the design specifications of the arrestor bed. This can potentially free up valuable RESA real estate for other airport planning purposes, such as runway extensions.

Such was the case at San Luis Obispo County Regional Airport, San Luis Obispo, California USA who implemented EMAS systems in a creative fashion that earned the airport the distinction of being the first to use the product to gain sizable runway extension within airport property.

The dilemma in San Luis Obispo: a primary runway needed an extension from 5,300 feet to 6,100 feet to meet airline requirements for regional jets. The airport did not have the necessary geographic flexibility to expand the runway and keep the required 1,000 feet of runway safety area on each end. The solution: By physically shifting their runway north and installing two approximately 100 metre (300 feet) long arrestor beds at both ends of runway 11-29, the airport gained 245 metres (800 feet) of runway length (112metres or 400 feet at each end), eliminating the need to purchase expensive real estate or deal with protected areas and environmental issues.

For Aircraft Operators: Engaging an EMAS

As the manufacturer of EMASMAX, Zodiac Arresting Systems (ZASA) cannot dictate procedures for aircraft operators. However, following the guidance below ensures that the aircraft engages the EMAS according to the design entry parameters.

During the takeoff or landing phase, if a pilot determines that the aircraft will exit the runway end and enter the EMAS, the following protocol should be adhered to:

1. Continue deceleration - Regardless of aircraft speed upon exiting the runway, continue to follow Rejected/Aborted Takeoff procedures, or if landing, Maximum Braking procedures outlined in the Flight Manual.
2. Maintain runway centreline - Not veering left or right of the bed and continuing straight ahead will maximize stopping capability of the EMAS bed. The quality of deceleration will be best within the confines of the bed.
3. Maintain deceleration efforts - The arrestor bed is a passive system, so this is the only action required by the pilot.
4. Once stopped, do not attempt to taxi or otherwise move the aircraft.

An arrestment by itself does not by default require an emergency ground egress, but it may be impractical to offload passengers and crew via an air stair truck, thus necessitating the use of slides or internal aircraft stairs. However, should an emergency egress be required, use published aircraft emergency ground egress procedures.

The certification process from the FAA extensively tested successful aircraft evacuation and fire fighting and rescue vehicle response. Where the surface of the bed has been breached, the loose material will crush under foot. There are continuous steps built into the back and sides of the bed to help provide easy access for responding fire fighting vehicles and to enable passengers to safely step off of the bed.

Safety net and more?

A safety net in a circus will not prevent an acrobat from falling, but it will save him from injuries, in case of a fall. Similarly, an EMAS is there when all other measures have failed to reduce the severity of an excursion and transform an accident into an incident. With the presentation of all of the information so far, I hope that I have shed some light on EMAS, the sometimes forgotten safety net, so that it can be included with the full array of safety nets in place at airports that ensure the safety and reliable transit of passengers, crew and ground support personnel throughout the world.

The next time you fly in or out of a particular airport, and you see a flat gray, stepped checkerboard bed with chevrons at the end of a runway, don't be alarmed – that is your safety net!