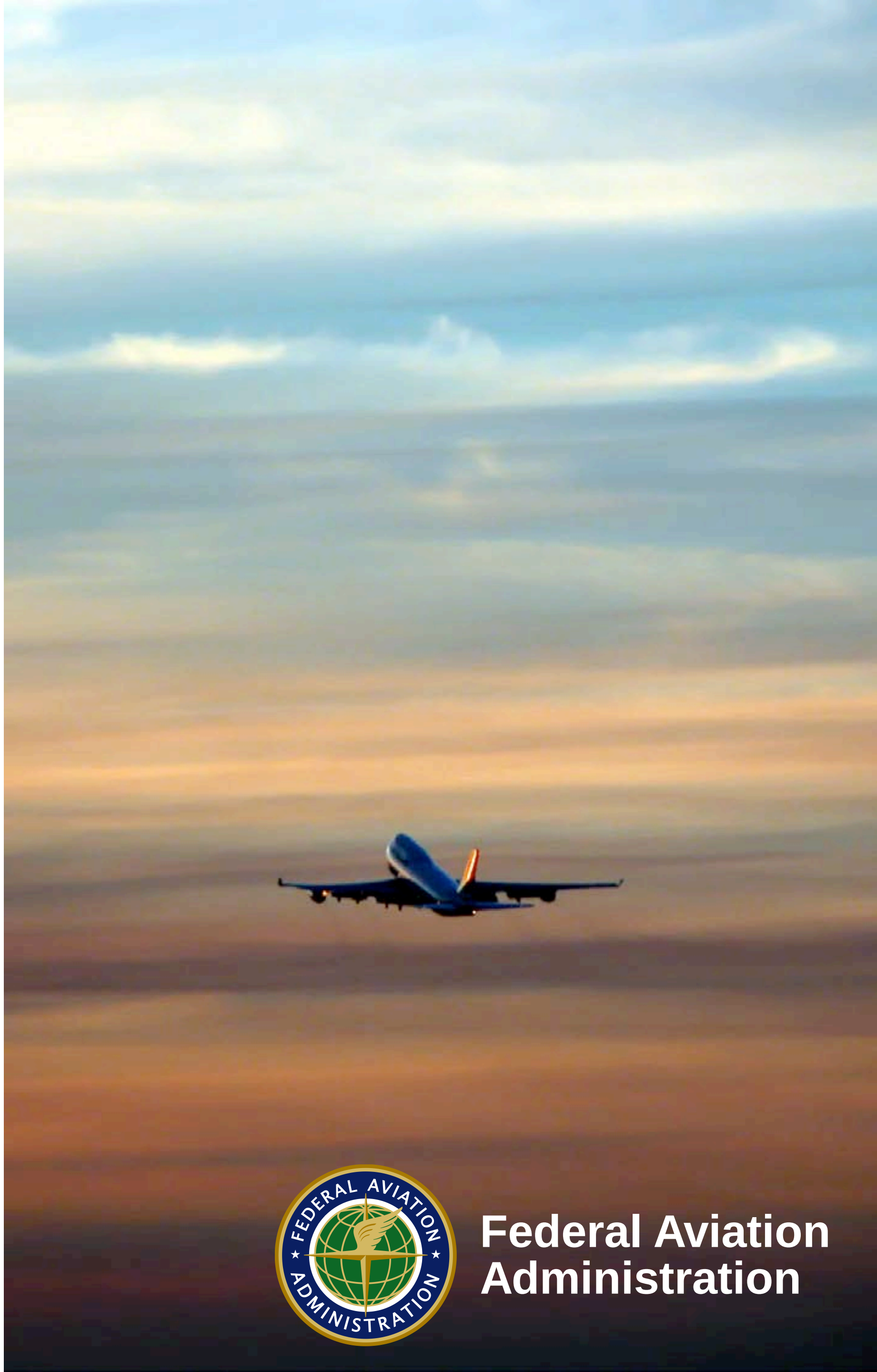
Office of Airports
Safety & Standards

Airports Engineering Division
AAS-100



Presented to: ICAO Global Runway Safety Summit

By: Khalil Elias Kodsi, P.E. PMP

Manager

Date: Nov. 22, 2017

AIRPORT ENGINEERING DIVISION (AAS-100)

We are a group of mainly engineers who continue to develop engineering design, and construction standards for civil airports, runway pavement and heliports. This includes standards for; airport lighting / LED, marking, signs, and other visual aids; operational safety during construction; surveying and GIS data; deicing, ARFF, Seaplane Bases and other facilities; bird radar and foreign object detection systems;

We initiate and manage airport related Research & Development projects via the William J. Hughes Technical Center to support Advisory Circular updates and Engineering Briefs and more.

https://www.faa.gov/airports/engineering/design_standards/

Few Advisory Circulars we are responsible for:

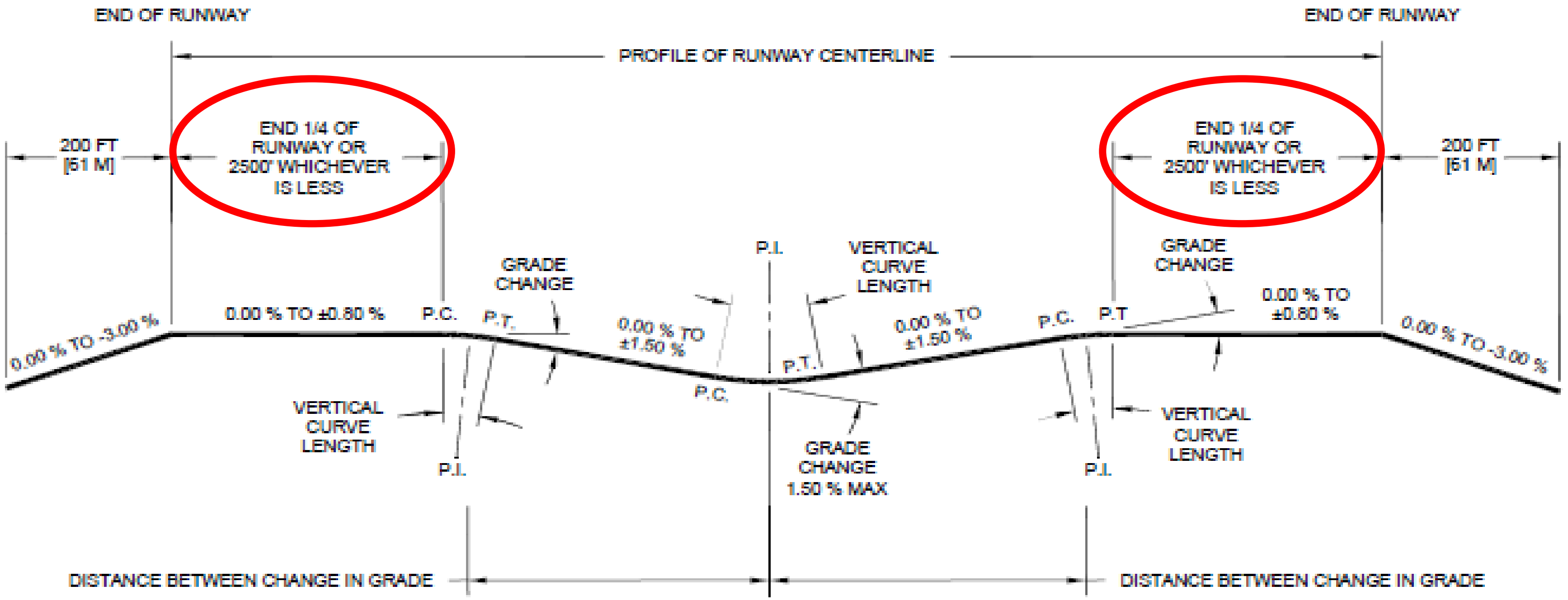
Airport Design	AC 150/5300-13
EMAS Arresting System	AC 150/5220-22
Airport Lighting	AC 150/5340-30
Pavement Design	AC 150/5320-6
Heliport Design	AC 150/5390-2
Airport Marking	AC 150/5340-1
Operational Safety during Construction	AC 150/5370-2
Airport Signage	AC 150/5340-18
Construction & Material Standards	AC 150/5370-10

Mitigation of Excursions

- ✓Runway Design Characteristics
- ✓Runway Safety Areas
- ✓Engineered Arresting System
- ✓Declared Distances
- ✓Distance Remaining Signs

Runway Longitudinal Grade

Follow Design Criteria



First and Last Runway

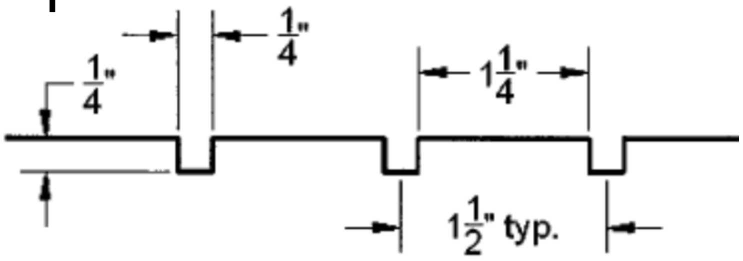
Quarter or 2500 feet – whichever is less

FAA Aircraft Approach Category C,D, E

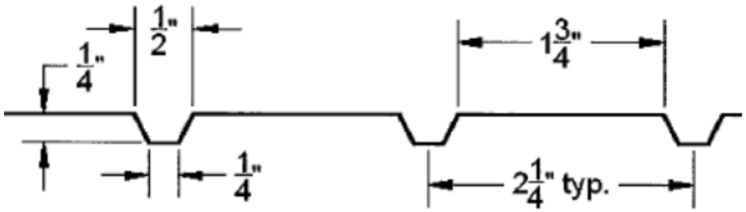
FAA Airport Design Advisory Circular AC 150/5300-13

Pavement Grooving - transverse

- Per FAA Specification:



- Now Testing Trapezoidal Grooves:



- Grooves provide channels for water to escape.

Runway Orientation

- Take your time analyzing wind speeds / direction
- Runway width - with or without shoulders
- Crosswind runways

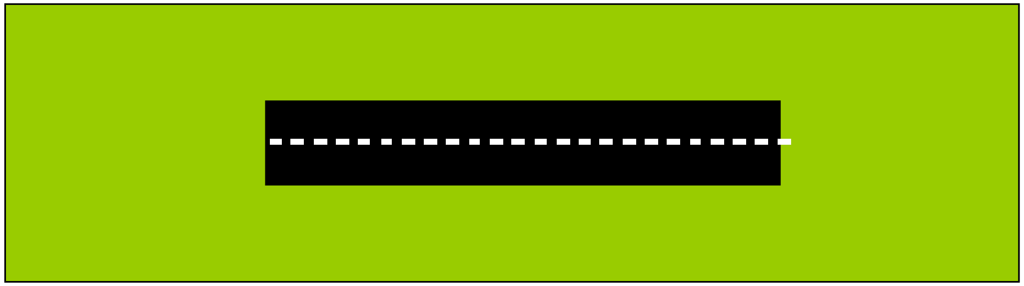
Table 3-1. Allowable crosswind component per Runway Design Code (RDC)

RDC	Allowable Crosswind Component
A-I and B-I *	10.5 knots
A-II and B-II	13 knots
A-III, B-III, C-I through D-III D-I through D-III	16 knots
A-IV and B-IV, C-IV through C-VI, D-IV through D-VI	20 knots
E-I through E-VI	20 knots

* Includes A-I and B-I small aircraft.

RUNWAY SAFETY AREA (RSA)
LAYOUT AND DIMENSIONS

RSA Length:
240’ to 1,000’ (approx. 75m – 300m)

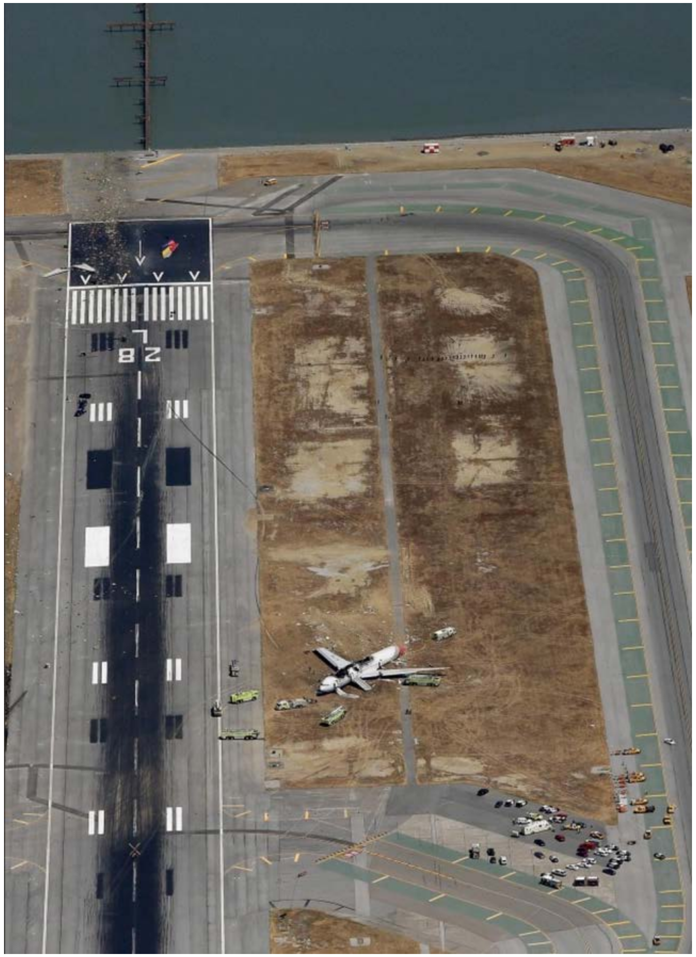


RSA Width:
120’ to 500’
(approx. 37m – 150m)

- **RSAs for runways that accommodate large aircraft are typically 1000’ x 500’ (75m – 300m)**
  - Must be clear of objects, structures, highways, bodies of water, drainage swales and navigational aides that are **not** fixed-by-function
  - Object Free Area Beyond the RSA (Lateral)

Runway Excursions - Asiana Airlines Flight 214 - July 6, 2013

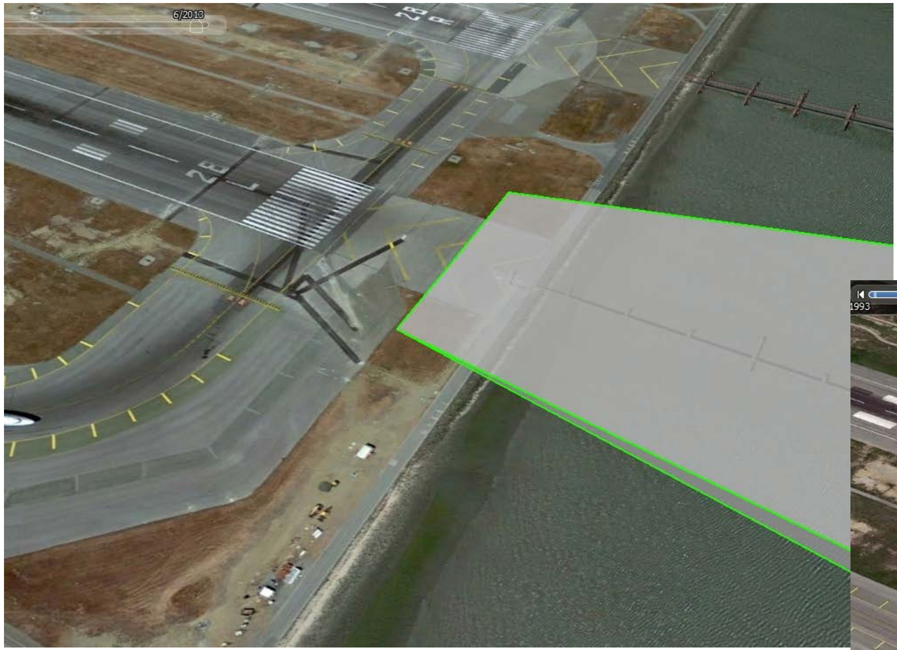
- The SFO runway 28L threshold and glide path lights were displaced on June 29, 2013 as part of RSA improvement project.
- The 300-ft relocation to the West provided for a 600-ft RSA between the seawall and the threshold.
- One week later Asiana 214, (Boeing 777), crashed while landing on runway 28L, killing three people and injuring many more.



•Ezra Shaw (Getty Images)

Runway Excursions – SFO RSA Improvement

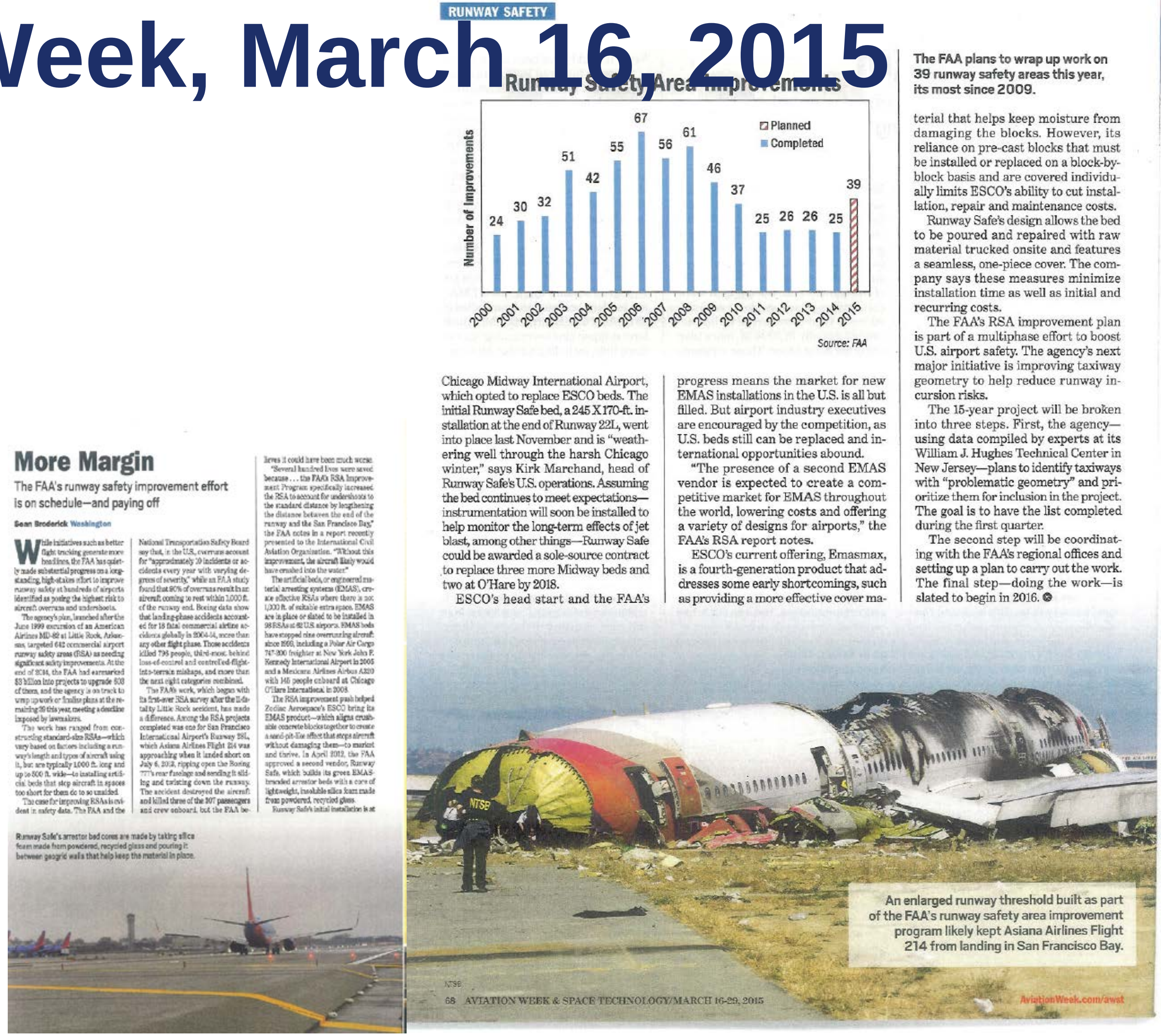
Before THLD relocation



After 300 ft. THLD relocation

Aviation Week, March 16, 2015

- **Aviation Week article credits the FAA's RSA program with likely prevented Asiana 214 from impacting the water.**



RUNWAY SAFETY

More Margin

The FAA's runway safety improvement effort is on schedule—and paying off

Sean Broderick Washington

While initiatives such as better flight tracking generate more headlines, the FAA has quietly made substantial progress on a long-standing, high-stakes effort to improve runway safety at hundreds of airports identified as posing the highest risk to aircraft overruns and undershoots.

The agency's plan, launched after the June 1999 excursion of an American Airlines MD-82 at Little Rock, Arkansas, targeted 642 commercial airport runway safety areas (RSA) as needing significant safety improvements. At the end of 2014, the FAA had earmarked $3 billion into projects to upgrade 603 of them, and the agency is on track to wrap up work or finalize plans at the remaining 39 this year, meeting a deadline imposed by lawmakers.

The work has ranged from constructing standard-size RSAs—which vary based on factors including a runway's length and types of aircraft using it, but are typically 1,000 ft. long and up to 500 ft. wide—to installing artificial beds that stop aircraft in spaces too short for them do to so unaided.

The case for improving RSAs is evident in safety data. The FAA and the National Transportation Safety Board say that, in the U.S., overruns account for "approximately 10 incidents or accidents every year with varying degrees of severity," while an FAA study found that 90% of overruns result in an aircraft coming to rest within 1,000 ft. of the runway end. Boeing data show that landing-phase accidents accounted for 18 fatal commercial airline accidents globally in 2004-14, more than any other flight phase. Those accidents killed 796 people, third-most behind loss-of-control and controlled-flight-into-terrain mishaps, and more than the next eight categories combined.

The FAA's work, which began with its first-ever RSA survey after the 11-fatality Little Rock accident, has made a difference. Among the RSA projects completed was one for San Francisco International Airport's Runway 28L, which Asiana Airlines Flight 214 was approaching when it landed short on July 6, 2013, ripping open the Boeing 777's rear fuselage and sending it sliding and twisting down the runway. The accident destroyed the aircraft and killed three of the 307 passengers and crew onboard, but the FAA believes it could have been much worse.

"Several hundred lives were saved because . . . the FAA's RSA Improvement Program specifically increased the RSA to account for undershoots to the standard distance by lengthening the distance between the end of the runway and the San Francisco Bay," the FAA notes in a report recently presented to the International Civil Aviation Organization. "Without this improvement, the aircraft likely would have crashed into the water."

The artificial beds, or engineered material arresting systems (EMAS), create effective RSAs where there is not 1,000 ft. of suitable extra space. EMAS are in place or slated to be installed in 98 RSAs at 62 U.S. airports. EMAS beds have stopped nine overrunning aircraft since 1999, including a Polar Air Cargo 747-200 freighter at New York John F. Kennedy International Airport in 2005 and a Mexicana Airlines Airbus A320 with 145 people onboard at Chicago O'Hare International in 2008.

The RSA improvement push helped Zodiac Aerospace's ESCO bring its EMAS product—which aligns crushable concrete blocks together to create a sand-pit-like effect that stops aircraft without damaging them—to market and thrive. In April 2012, the FAA approved a second vendor, Runway Safe, which builds its green EMAS-branded arrestor beds with a core of lightweight, insoluble silica foam made from powdered, recycled glass.

Runway Safe's initial installation is at Chicago Midway International Airport, which opted to replace ESCO beds. The initial Runway Safe bed, a 245 X 170-ft. installation at the end of Runway 22L, went into place last November and is "weathering well through the harsh Chicago winter," says Kirk Marchand, head of Runway Safe's U.S. operations. Assuming the bed continues to meet expectations—instrumentation will soon be installed to help monitor the long-term effects of jet blast, among other things—Runway Safe could be awarded a sole-source contract to replace three more Midway beds and two at O'Hare by 2018.

ESCO's head start and the FAA's progress means the market for new EMAS installations in the U.S. is all but filled. But airport industry executives are encouraged by the competition, as U.S. beds still can be replaced and international opportunities abound.

"The presence of a second EMAS vendor is expected to create a competitive market for EMAS throughout the world, lowering costs and offering a variety of designs for airports," the FAA's RSA report notes.

ESCO's current offering, Emasmax, is a fourth-generation product that addresses some early shortcomings, such as providing a more effective cover material that helps keep moisture from damaging the blocks. However, its reliance on pre-cast blocks that must be installed or replaced on a block-by-block basis and are covered individually limits ESCO's ability to cut installation, repair and maintenance costs.

Runway Safe's design allows the bed to be poured and repaired with raw material trucked onsite and features a seamless, one-piece cover. The company says these measures minimize installation time as well as initial and recurring costs.

The FAA's RSA improvement plan is part of a multiphase effort to boost U.S. airport safety. The agency's next major initiative is improving taxiway geometry to help reduce runway incursion risks.

The 15-year project will be broken into three steps. First, the agency—using data compiled by experts at its William J. Hughes Technical Center in New Jersey—plans to identify taxiways with "problematic geometry" and prioritize them for inclusion in the project. The goal is to have the list completed during the first quarter.

The second step will be coordinating with the FAA's regional offices and setting up a plan to carry out the work. The final step—doing the work—is slated to begin in 2016.

Runway Safety Area Improvements

Number of Improvements (Planned / Completed)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Improvements	24	30	32	51	42	55	67	56	61	46	37	25	26	26	25	39

Source: FAA

The FAA plans to wrap up work on 39 runway safety areas this year, its most since 2009.

Runway Safe's arrestor bed cores are made by taking silica foam made from powdered, recycled glass and pouring it between geogrid walls that help keep the material in place.

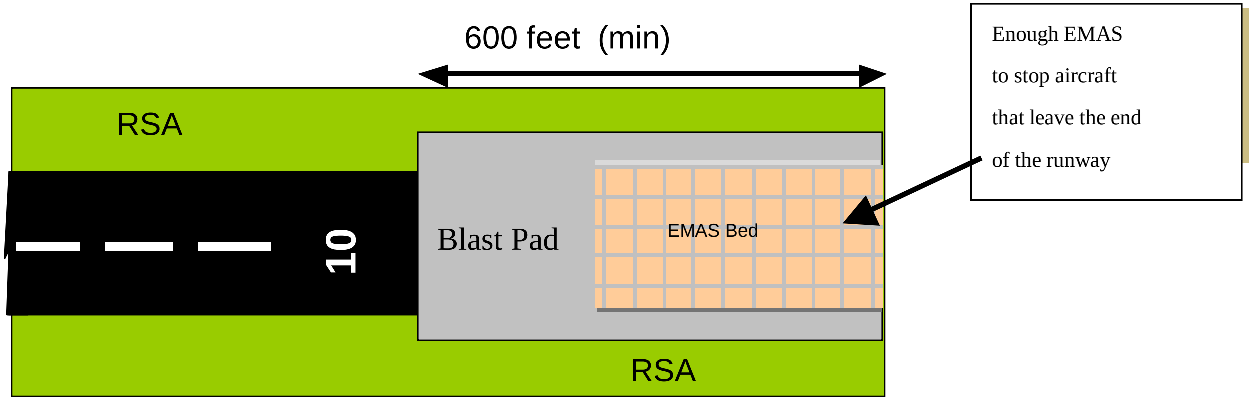
An enlarged runway threshold built as part of the FAA's runway safety area improvement program likely kept Asiana Airlines Flight 214 from landing in San Francisco Bay.

68 AVIATION WEEK & SPACE TECHNOLOGY/MARCH 16-29, 2015 AviationWeek.com/awst

ENGINEERED MATERIALS ARRESTING SYSTEM

- **DEFINITION –** A system consisting of a light bed of material placed at the end of runways that consists of "high energy absorbing materials of selected strength, which will reliably and predictably crush under the weight of an aircraft."
(AC No. 150/5220-22B)
- EMAS beds are intended to SAFELY and quickly stop aircraft that overrun runways with minimal or no damage to the aircraft
- Standard EMAS is designed to arrest with airplane entrance velocity of 70 knots

EMAS DIAGRAM



* Applies only to runway safety areas with vertical guidance for approaches from the opposite end

- There is typically a “setback” distance from the threshold to the EMAS bed to protect the bed from jet blast
- A proposed EMAS that does not have a sufficient amount of safety area may, if approved, be installed as a non-standard EMAS (must stop design aircraft traveling at a minimum of 40 knots)

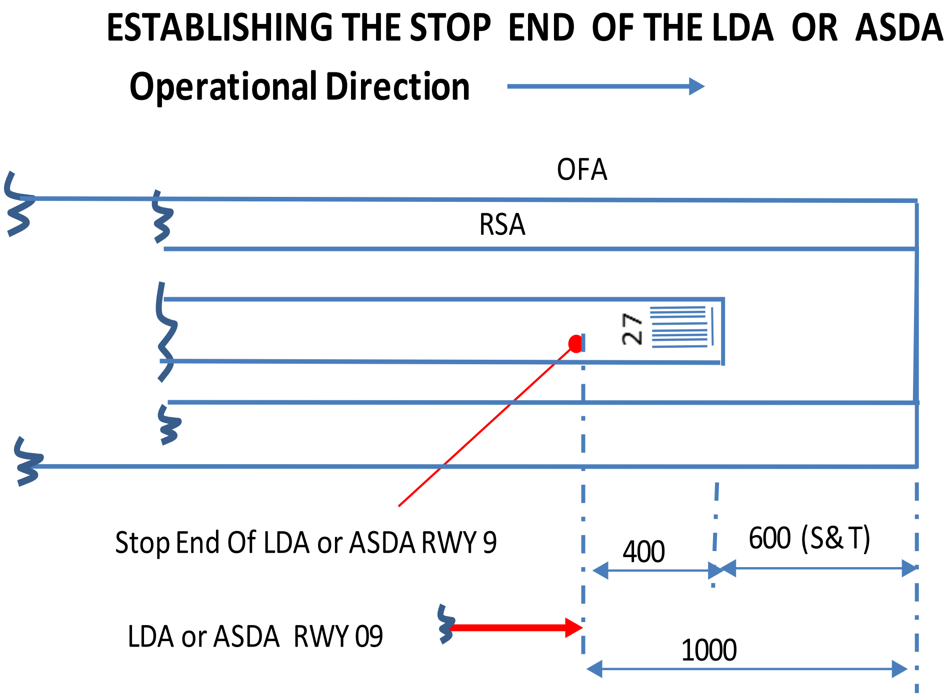
Solution: Successful Capture by Arrestor Bed Systems

EMAS BED
before the cliff

EMAS –

- **EMAS signs on airports**
  - FAA will get input from Pilots on a proposed new EMAS sign and it's location on a runway
  - **GOAL**: Provide a runway sign to inform pilots that an EMAS is at end of runway
- **EMAS standard markings**
  - **GOAL**: Update guidance information to standardize markings around EMAS to reduce accidental entry and damage

Declared Distances



S = Actual or proposed length of RSA beyond runway end

T= Actual or proposed length of ROFA beyond the runway end

P= Standard length of RSA/ROFA beyond departure end or landing stop end (1000 ft. in this example)

Fig 3-11 (b). Example where end of LDA & ASDA are located to meet RSA standards.

(LDA and ASDA reduced by 400 ft. to provide standard RSA beyond LDA & ASDA)

Distance Remaining Signs
(1000-Foot Increments)

Questions?

Presented by:

Khalil Elias Kodsi, P.E. PMP

Manager, Airport Engineering Division

AAS-100