Runway Safe EMAS

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Aviation Safety

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Aviation Industry Record

- **International Air Travel Has Reached High Levels of Safety**

Aviation Safety

- **Result of Pro-Active Approach to Safety**
  - Extensive Review of Incidents
  - Focus on Mitigation of Risks
- **Continued Diligence Required**
  - New Methods for Maintaining and Improving Safety Are Necessary
  - Failure to do so Will Result in a Plateau in Safety

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Improving Aviation Safety

- **Identify the Issue**
  - Analysis of Data and Statistics
  - Input From Sectors of the
- **Implement Action**
  - Procedures
  - Training
  - Regulation
  - Technology

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Technology As A Solution

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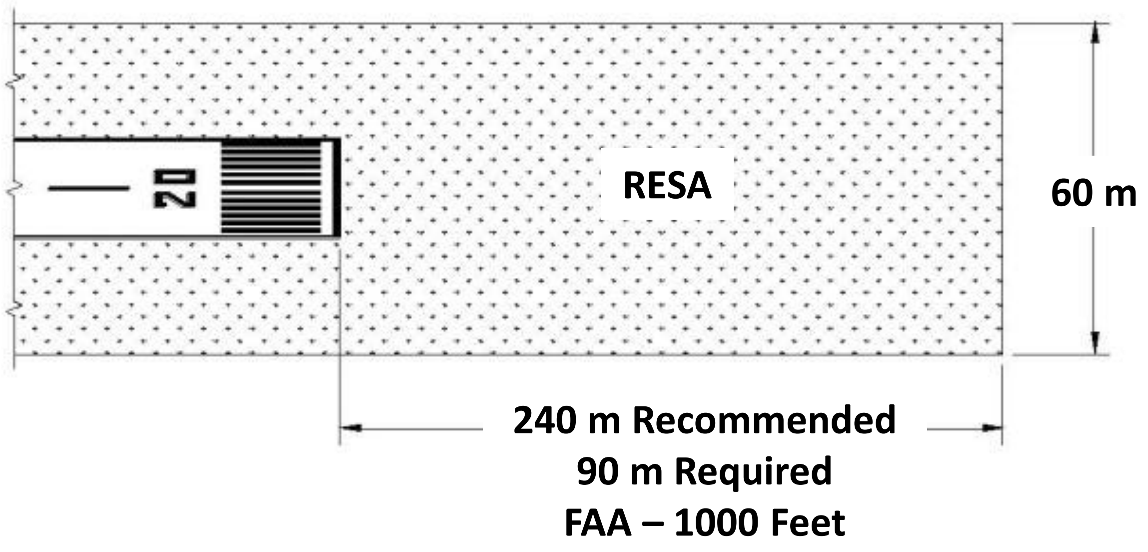
Runway End Safety Area

- US Federal Mandate to Bring All Commercial Runway Safety Areas Into Compliance
- Large Quantity of Deficiencies in Runway End Safety Area

Standard RESA



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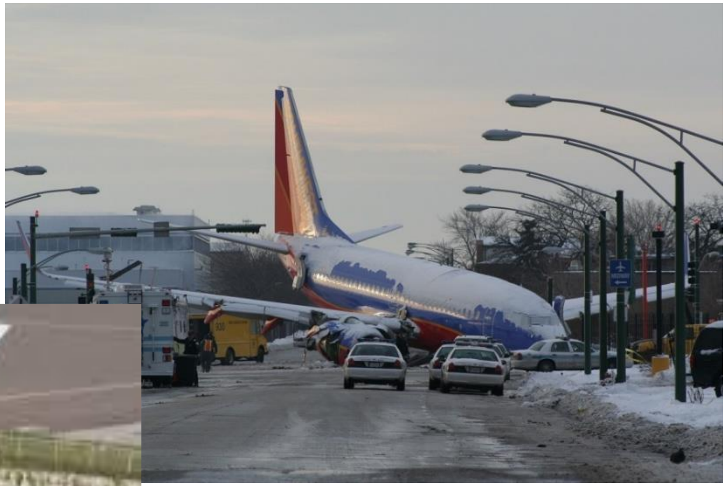
Runway Excursions

- **Most Common Type of Aviation Incident**
- **Average of Two Occurrences Per Month Globally**
- **Runway Overruns Account for More Than 50% of Runway Excursions**



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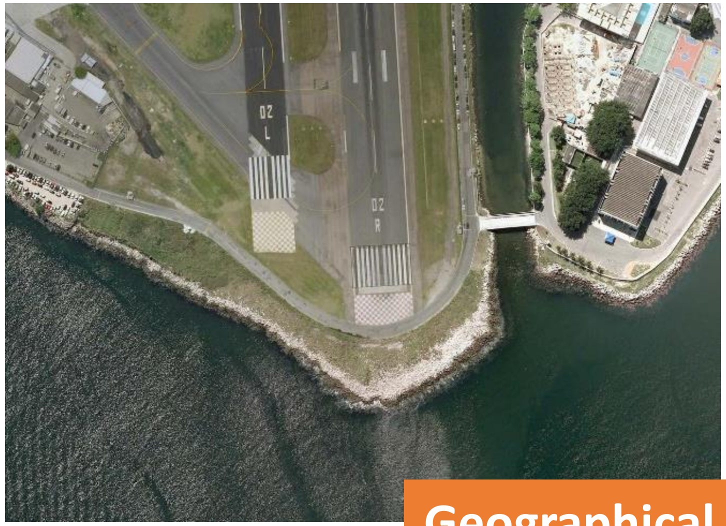
Factors Attributing to Deficiencies

Available Real Estate

Geometry



Geographical

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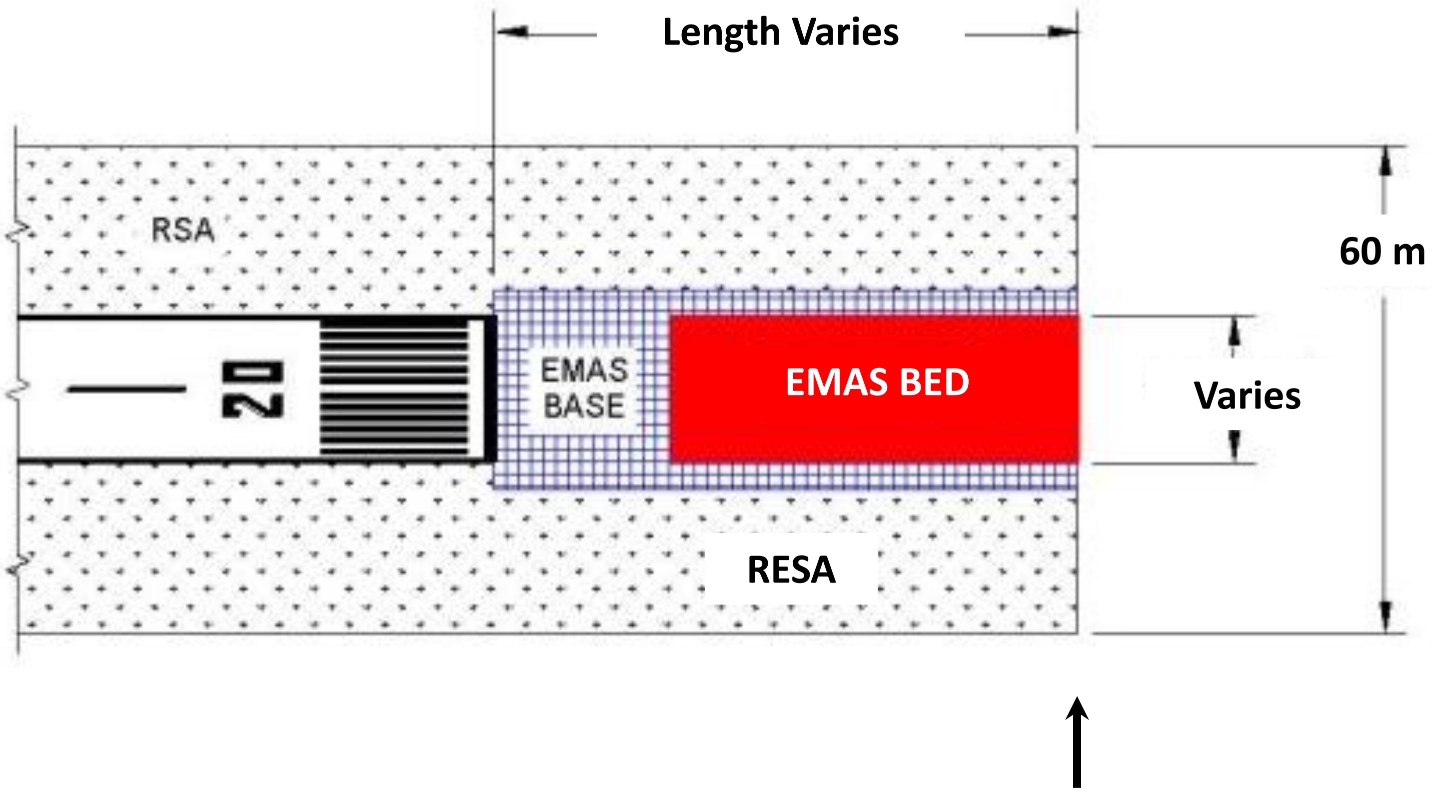
EMAS As A Solution

EMAS – ENGINEERED MATERIAL ARRESTING SYSTEM

Arrests Aircraft in the Event of a Runway Excursion

- No Major Damage to Aircraft
- No Injury to Passengers
- Option for Meeting ICAO RESA Requirements

Runway End Safety Area With EMAS



RESA Ends at Back of EMAS

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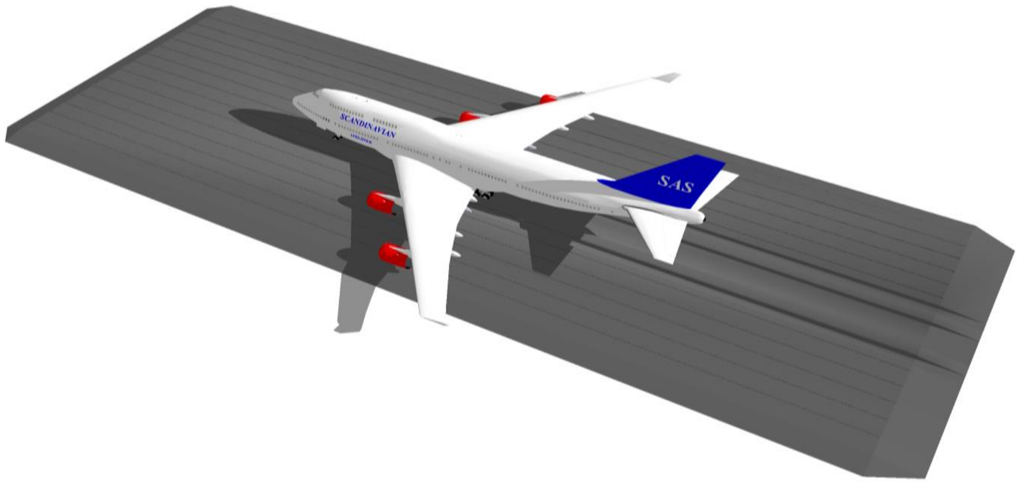
Runway Safe greenEMAS

RUNWAY
SAFE

The World's Only Green EMAS

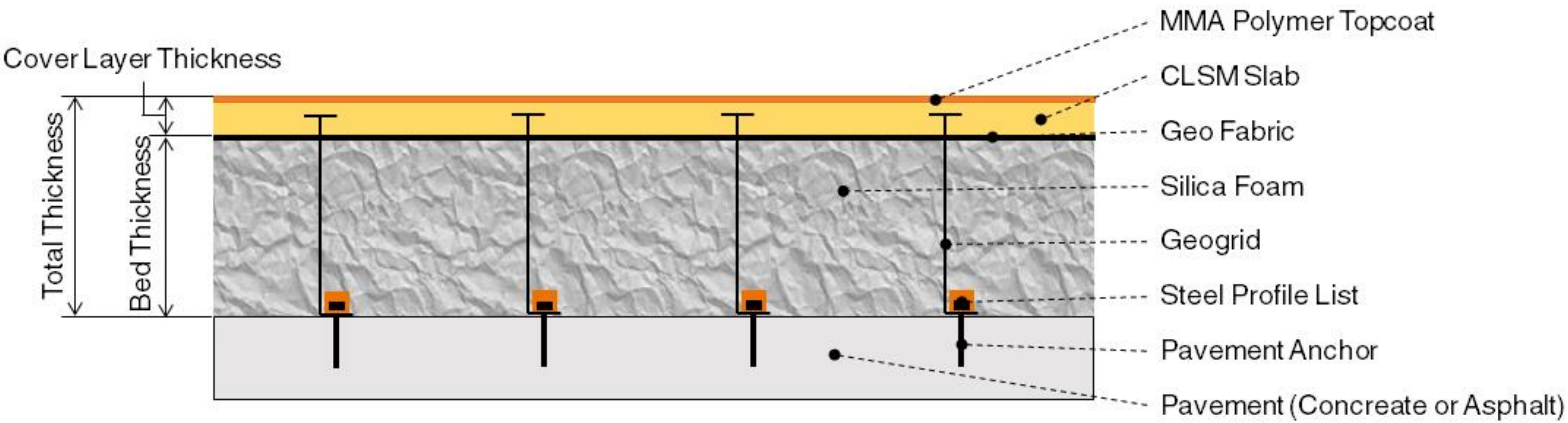
Key Aspects

- Made From Recycled Glass
- Ease of Installation
- Durability and Low Cost
- Complies with Advisory Circular 150/5220-22C



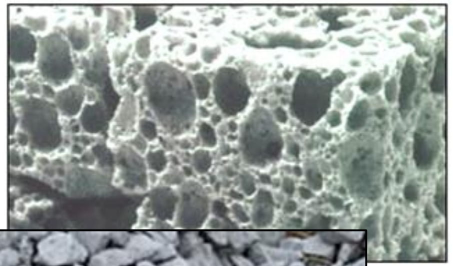
Runway Safe greenEMAS

- **Construction results in a system resistant to the harsh elements of a runway's environment**
  - Utilizes Normal Construction Means and Methods



Silica Foam Material

- Loose fill material
- Each piece is crushable foamed glass
- Recycled material (Green)
- Excellent environmental performance
- Typical uses: low density fill, roadbase material, insulation, athletic fields, etc.



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Development Process

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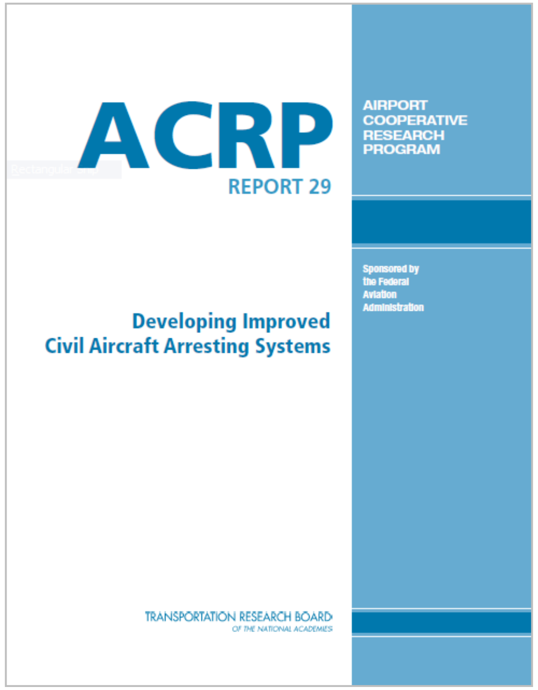
ACRP Background

- **Project executed through US National Academy of Science's Transportation Research Board (TRB) Airport Cooperative Research Program (ACRP)**
- **Effort ran from 2007 – 2009**
- **Principal investigator: Protection Engineering Consultants and Matthew Barsotti**
- **ACRP Report 29: "Developing Improved Civil Aircraft Arresting Systems"**
  - Designed to identify and vet alternatives to the current ESCO EMAS
- **NGG was a participant and had a "finalist" candidate design**



Development & Performance Prediction Correlation

1. Testing of Materials and System
2. Development of Computer Models to Replicate Tests
3. Run Suite of Simulations to Develop Data Libraries
4. Calculate EMAS Arresting Performance (APC-Full & -Express)

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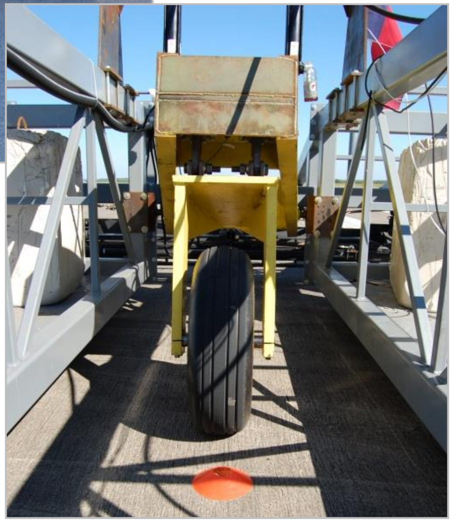
Test Bogie



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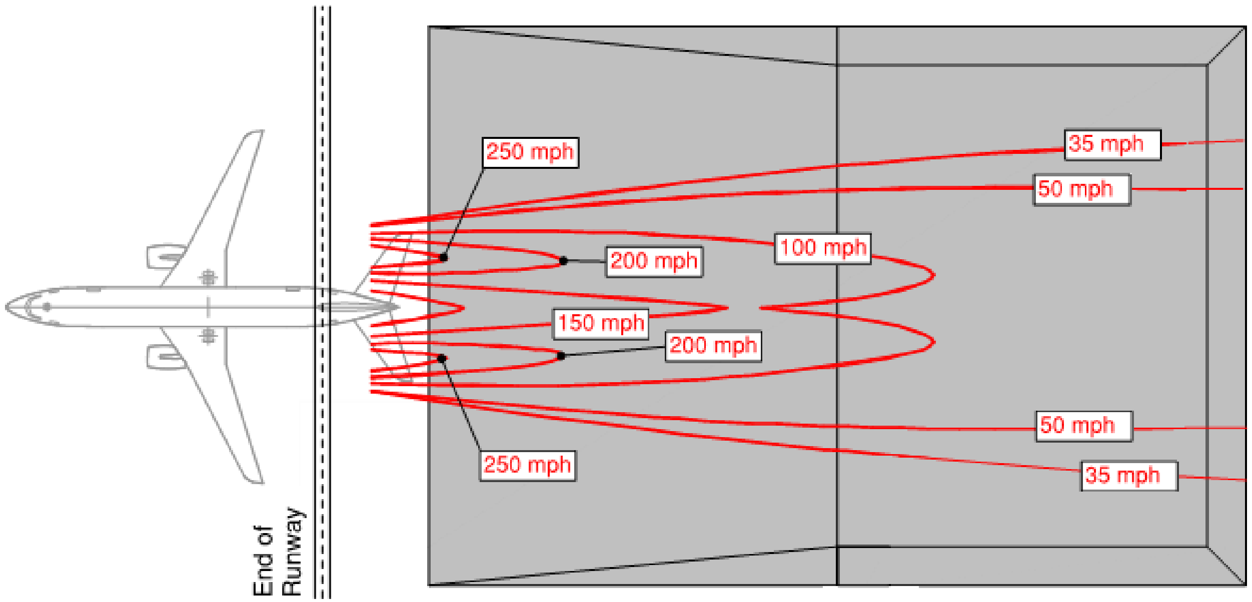
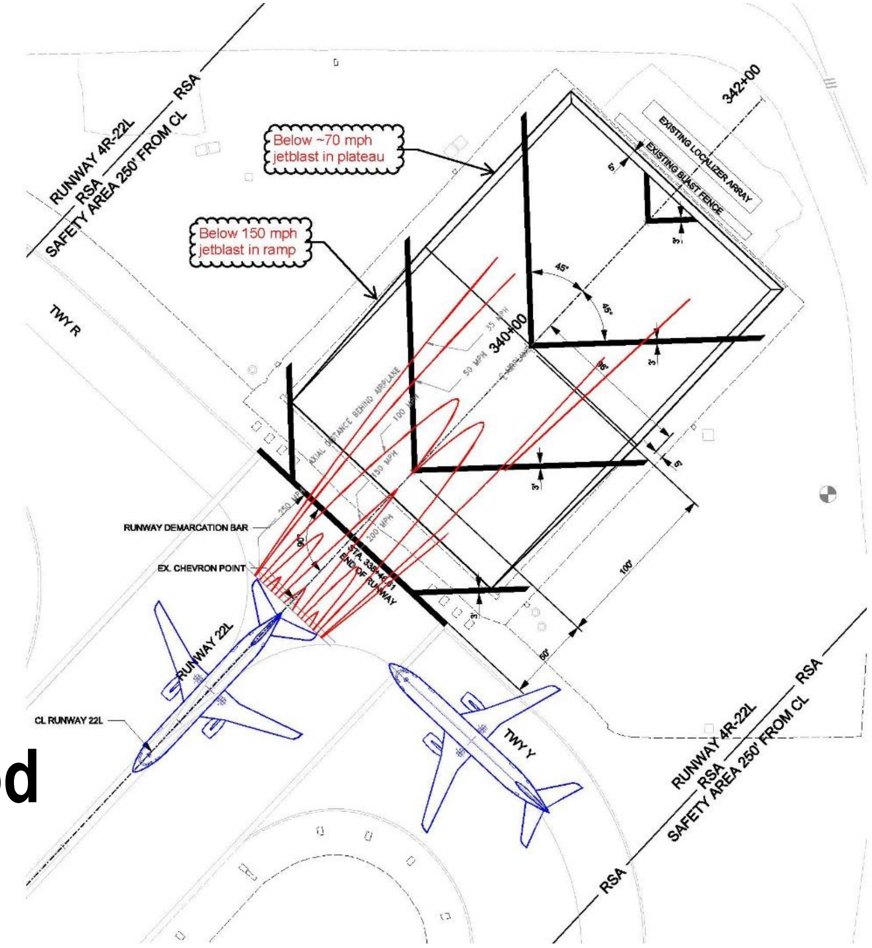
Jetblast Uplift Design





- **Worst case for design basis**
  - **Operational basis for construction period**

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Fire Testing and AARF Vehicle Tests

- **Burn pan and Abrasion tests at FAA William J. Hughes Technical Center**

- **AARF Testing at TTI**

FAA Acceptance

- **FAA reviewed major NGG submittal report for compliance with AC 150/5220-22a**
  - June 8, 2011
- **Robust set of requirements**
- **Additional clarifications requested**
- **Three further addendums to report submitted**
  - October and November 2011
- **Accepted by FAA on April 2, 2012**
- **Further Development Underway**

U.S. Department of Transportation
Federal Aviation Administration

Office of Airport Safety and Standards

800 Independence Ave., SW
Washington, DC 20591

APR 02 2012

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RE: Review of Glasopor EMAS Development: Design & Performance Report for FAA Review and Acceptance of Technical Sufficiency

Dear Mr. Helgesen:

We have reviewed the Norsk GlassGjenvinning (NGG) report titled "Glasopor EMAS Development: Design & Performance Report for FAA Review & Acceptance," dated June 8, 2011 and submitted by Matt Barsotti of Protection Engineering Consultants (PEC). We have also reviewed the three addendum reports submitted by PEC. These addenda are based on comments and questions we submitted regarding the engineered materials arresting system (EMAS) design and performance information stated in the report. These addenda are as follows:

Addendum Report 1 – October 3, 2011
Addendum Report 2 – October 17, 2011
Addendum Report 3 – November 3, 2011

The intent of this report, and its sequential addendums, was to seek the FAA's determination that your proposed EMAS product is in accordance with Advisory Circular (AC) 150/5220-22A, Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns.

The Airport Engineering Division (AAS-100), in consultation with the FAA's William J. Hughes Technical Center has determined, based on the information provided in this report, as updated by its supporting addenda that the design and performance of the NGG Glasopor EMAS complies with the required standards of AC 150/5220-22A under the following condition:

- The cover layer consists of cementitious controlled low strength material (CSLM) as opposed to polypropylene plastic. The FAA may accept plastic lids for technical sufficiency in the future if further testing proves that the design and performance complies with the AC under this configuration.

Performance Prediction

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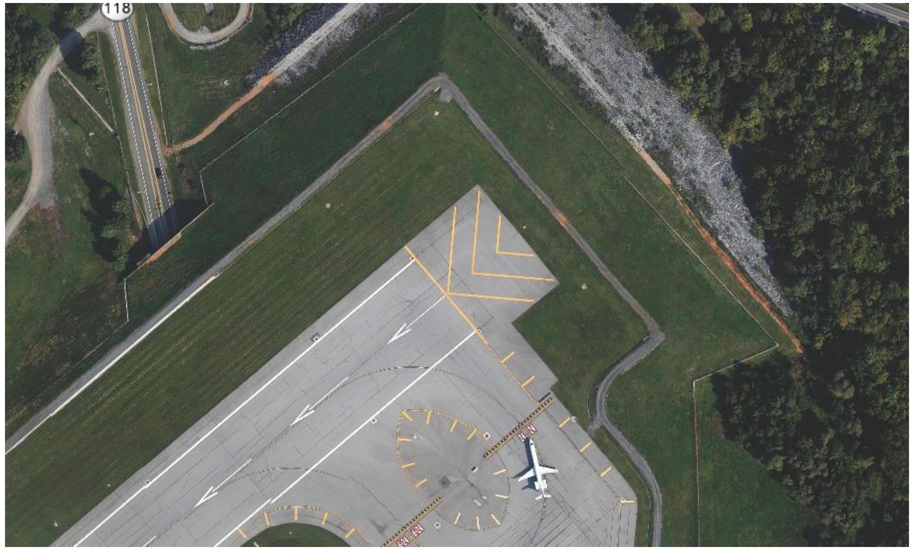
Performance Prediction Approach

1. Gather Airport Specific Information

- Fleet Mix
- Available RSA
- Site Specific Limitations



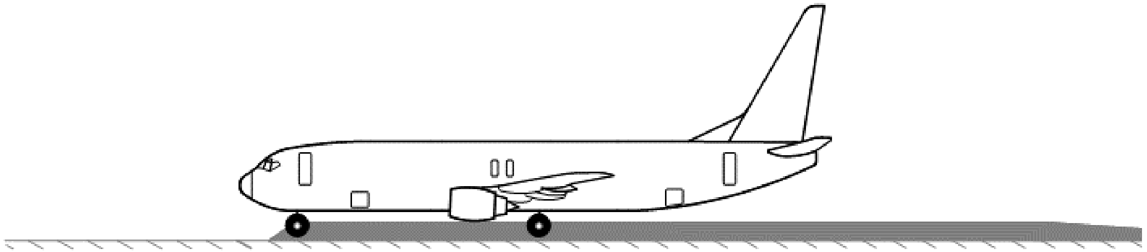
2. Develop Preliminary Performance Predictions

- Bed Geometry
- Predicted Performance

3. Refine EMAS Design

- Evaluate Airport Input From Preliminary Design
- Evaluate Alternate EMAS Options
- Provide Final Design Options

Performance Cases



Safe Stop

Overload Stop

Max Stop

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Example of Performance Predictions…LIH

- **Conceptual non-standard system at LIH in Hawaii (Kauai)**
  - EMAS on 21 Numbered End…minimal runway reconfiguration
  - EMAS on 3 Numbered End…runway reconfiguration
  - Predictions based on 767-300 (ER variant)
  - B763 only considered for preliminary predictions

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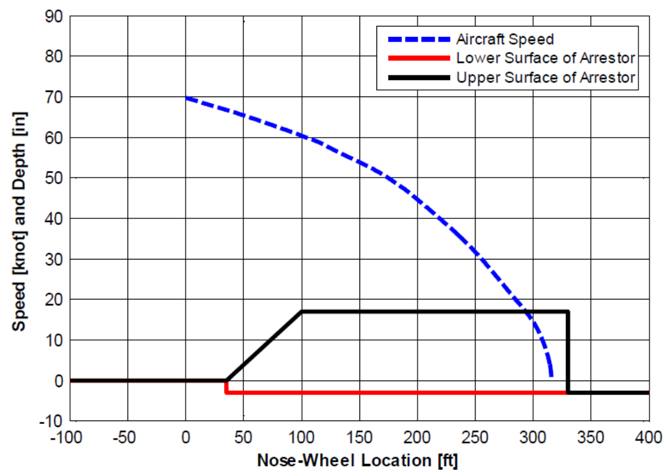
Performance Predictions – Example

- **Conceptual System at LIH in Hawaii**
  - EMAS considered as option for RWY 21 Numbered End
  - B763 only considered for preliminary predictions



Site Location:	Lihue Airport
Runway End ID:	Runway 21 Departure End (3 Numbered End)
RSA Length	330-ft
Provided Setback:	35-ft
Bed Length:	295-ft
Max Depth:	20-in
Entry Ramp Length:	65-ft

EMAS PERFORMANCE SUMMARY - MTOW

Aircraft Model	MTOW [lbs]	Performance Results		Notes
		Design Case [knots]	Typical Case [knots]	
B763 (Boeing 767-300) [ER Variant]	412,000	55 [58*]	58 [69*]	

EMAS PERFORMANCE SUMMARY – 80%MLW

Aircraft Model	80% MLW [lbs]	Performance Results		Notes
		Design Case [knots]	Typical Case [knots]	
B763 (Boeing 767-300) [ER Variant]	256,000	56	70	

Design Case: using 0.25 braking coefficient and no reverse thrust (μ = 0.25; No T/R)
Typical Case: using 0.35 braking coefficient and full reverse thrust (μ = 0.35; Full T/R)
[…*]: Overload stop: alternate exit speed with predicted nose gear overload

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Thank You

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