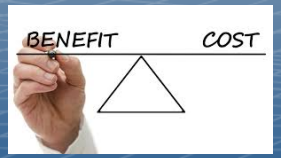
Cost-benefit

Analysis of runway occurrences

Rob van Eekeren
Safe-Runway GmbH



The Issue

www.Safe-Runway.com

- Hull Losses: 0.48 hull losses per 1 million sectors
- Fatal Accidents: 0.11 accidents per 1 million sector.

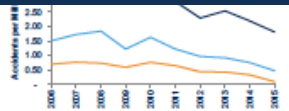
An interesting trend is the performance of jet accidents compared to turboprop accidents, particularly over the last four years.

While the accident rate for jets has been consistently lower than the rate for turboprops, it has seen no substantial improvement over this period. In fact, the jet category is showing a slight upward trend in the overall accident rate.

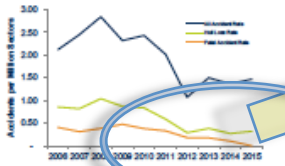
The exception are the jet fatal and hull loss rates, which have been consistently decreasing over the past eight years. This upward trend in the overall jet accident rate could be mainly attributed to an increase in the occurrences of 'Hard Landing', 'In-Flight Damage' and 'Undershoot' categories.

On the other hand, the turboprop overall accident rate has seen a substantial decrease in the past four years, dropping by approximately 50% since 2012. This downward trend, is also seen in the turboprop hull loss and fatal accident rates.

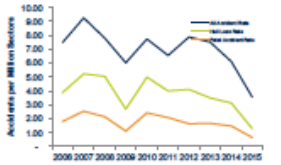
'Hard Landing' and 'In-Flight Damage' rates are also on the rise for turboprops, but significant improvement is observed in almost all other accident categories.



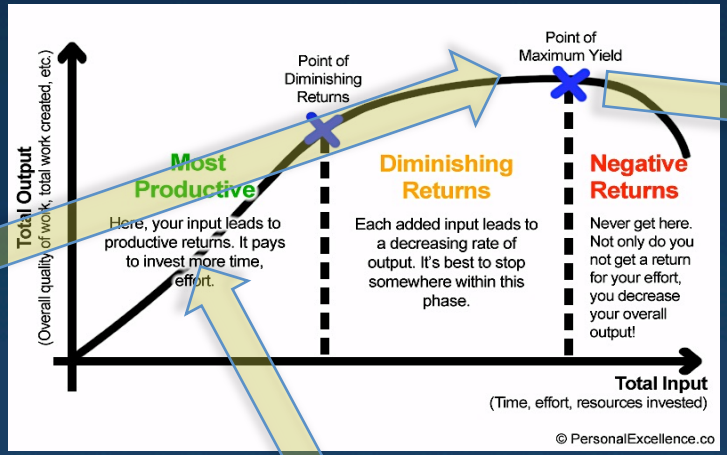
Jet - All accidents



Turboprop - All accidents



Prevention successful



Runway issues: 3 other events

www.Safe-Runway.com

Riyadh: A Royal Jordanian plane veered off the runway early this morning as it was landing at Sulaimaniyah International Airport in Iraqi Kurdistan. The Embraer 175 jet was heading from Amman, Jordan to Iraqi Kurdistan with 30 passengers and crew members aboard, reported Jazirah.
In a statement, the Royal Jordanian Company said no casualties were reported.
SOURCE: GDN Gulf Digital News, 04-03. 2017

RIGA, Feb 17 (LETA) –" A Vim Airlines charter flight from the Russian city of Ufa got into
Riga International Airport today when the aircraft started skidding on the runway
There were 43 passengers and seven crewmembers on board the plane, but
as injured in the accident.
The plane has been taxied to the apron. The runway has been close
examined for technical issues. According to information on the airport's we
e been no arrivals at Riga airport since 11.54 a.m., while the last departure to
2 a.m."
SOURCE: LETA, Latvian information agency, 17.02.20

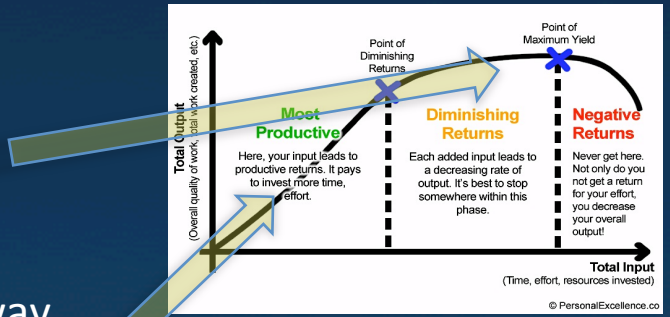
KALININGRAD, Jan 17 –"Aeroflot flight
ed a runway excursion and nose landing gear collapse after landing at Kalinin
Airport (KGD) in Russia.
The aircraft, an Airbus A321
scow's Sheremetyevo Airport at 19:18 UTC on a domestic service to Kaliningrad
ed on runway 24, a 2400 m long runway, but was not able to stop on the runw
y 15-20 meters, coming to rest in the snow with a collapsed nose landing gear."
*SOURCE: TASS, R
n News agency 03-01-2017*

DESPITE ALL PREVENTION MEASURES, RUNWAY EXURSIONS OCCUR

The challenge

www.Safe-Runway.com

- Runway Safety has priority
- The ROI of additional prevention measures might become negative
- CHALLENGE: Find cost effective solutions for runway safety risks

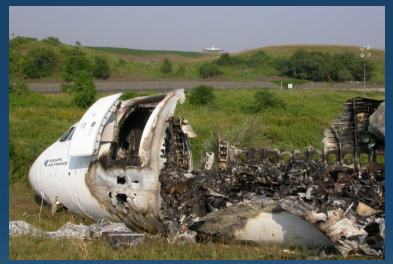


INSPIRATION: Two runway excursions

www.Safe-Runway.com

NO grooving and, NO standard RESA·····WHY NOT?

- AF 358; 2 aug 2005, A 340, CYYZ, runway excursion into Etobicoke creek , 12 injuries, fully destroyed.



- TAM3054; 17 July 2007, A 320, SBSP, runway excursion into road fuel station, 199 fatalities (187 SOB + 12 others)

Runway End Safety Area (RESA)

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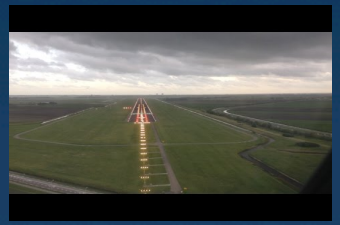
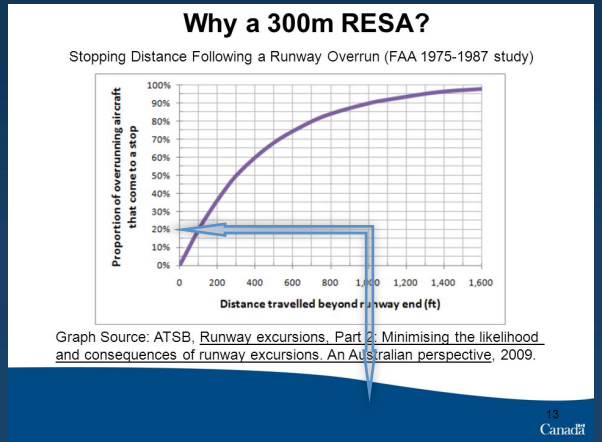
ICAO standard RESA← Inadequate RESA → Risks

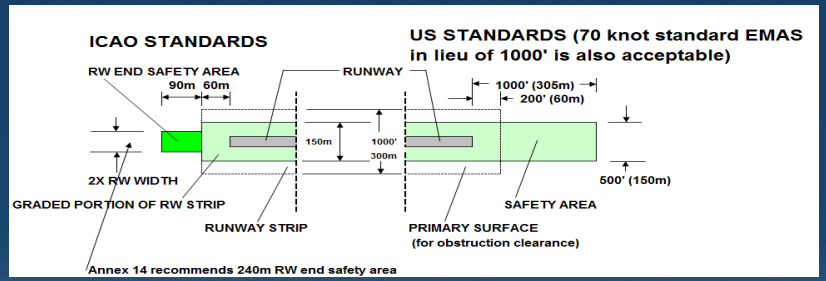
RESA

RESA inadequate





Graph Source: ATSB, Runway excursions, Part 2: Minimising the likelihood and consequences of runway excursions. An Australian perspective, 2009.



ALARP EASA NPA 2015-18(B)

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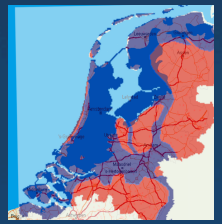
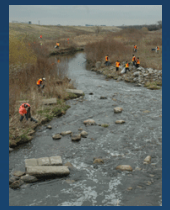
- EASA Safety Risk Management defines ALARP:
- *" Showing that the safety risk is ALARP means that any further risk reduction is either impracticable or grossly outweighed by the cost".*

CYYZ





- Impracticable ?
  - NO
- Grossly outweighed by the costs ?

Let's find out. → Model

Model Principle

www.Safe-Runway.com

Costs of runway overruns

Accident data

Open Source and Accident reports

Assumptions

- Human costs
- Direct Safety Costs
- Indirect Safety Costs

Calculation

Accident costs

Source: Safe-Runway GmbH

Who Pays?

www.Safe-Runway.com

Accident data

Open Source and Accident reports

Accident costs

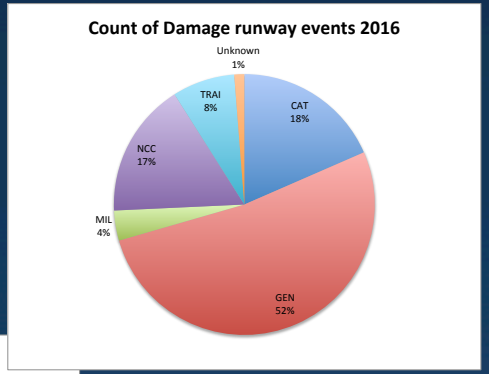
- Aerodrome operator
  - Opportunity costs
  - Damage (too limited data)
- Aircraft Operator
  - Aircraft damage costs
  - Delay and Diversion costs
  - Passengers compensation
- Human
  - Injury and casualty costs
- ISC

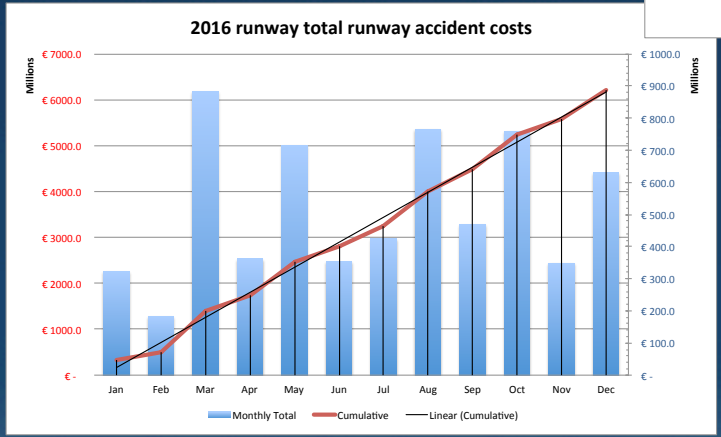
Source: Safe-Runway GmbH

Major results 2016

www.Safe-Runway.com

- 643 Identified runway accidents
  - 52% General Aviation
  - 18% CAT
- $ 6.5 Billion total costs
  - averaging $ 0.5B per month.

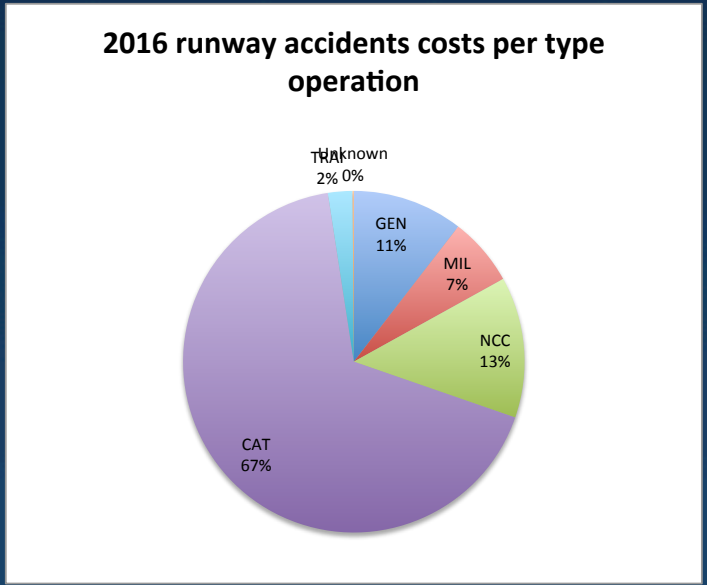




Major results 2016

www.Safe-Runway.com

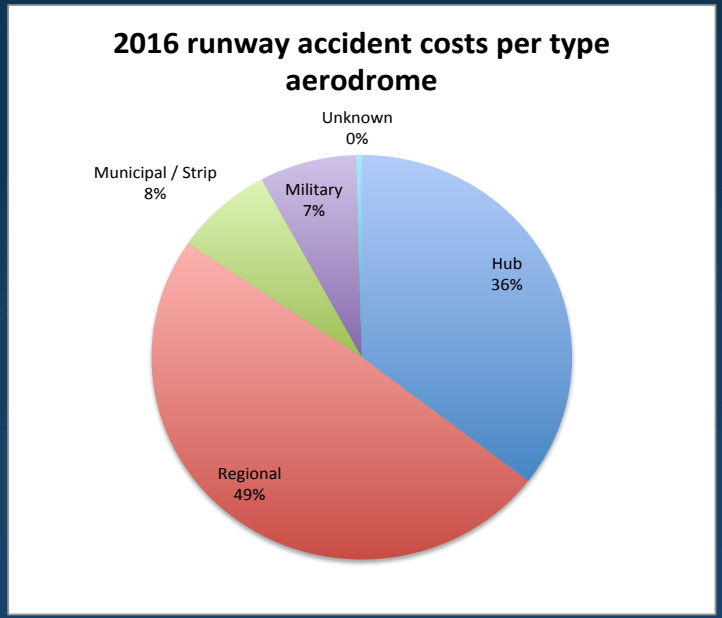
- 643 Identified runway accidents.
- Cost distribution per Type of operation:
  - CAT (67%)
  - GEN (11%)
  - NCC (13%)
  - MIL (7%)



Major results 2016

www.Safe-Runway.com

- 643 Identified runway accidents.
- Cost distribution Type of aerodrome.
  - Hubs: (36%)
  - Regional aerodromes (49%)
  - Military and Municipal airports each (8%).

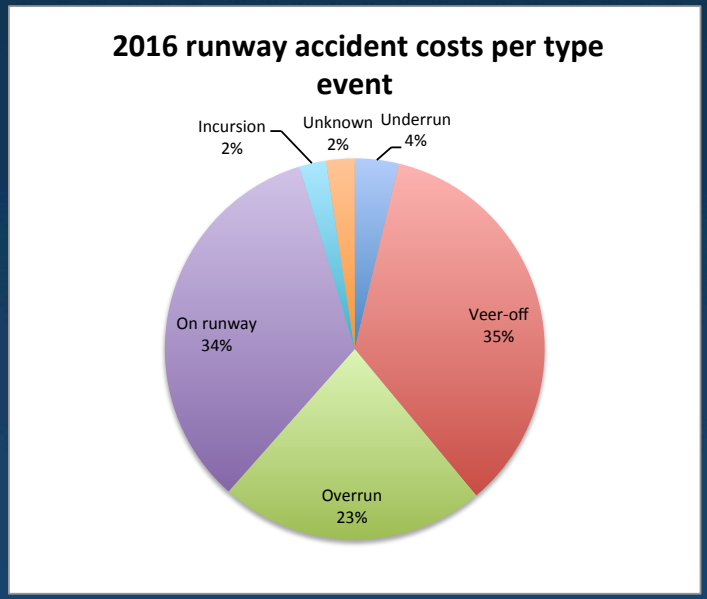


Major results 2016

www.Safe-Runway.com

- 643 Identified runway accidents.
- Cost distribution Type of accident.
  - On runway accidents (34%)
  - Veer-offs (35%)
  - Overruns (23%)
  - Incursions (<2%)
  - Underruns (4%)

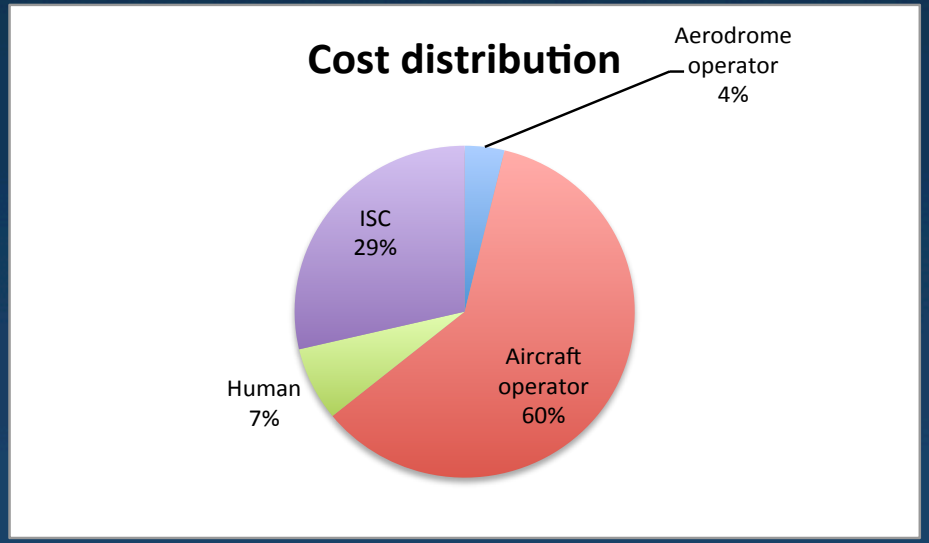
Example on runway accident



Major results 2016

www.Safe-Runway.com

- 643 Identified runway accidents.
- Cost distribution per type of operator.
  - Aerodrome operators (4%)
  - Aircraft operators (60%).
  - Fatalities in injuries (7%.)
  - ISC (30%)



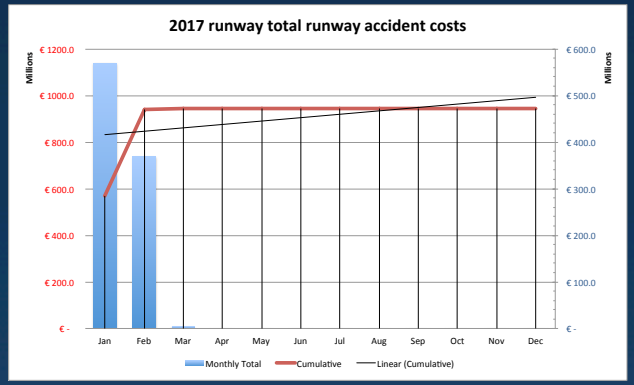
Results 2016

www.Safe-Runway.com

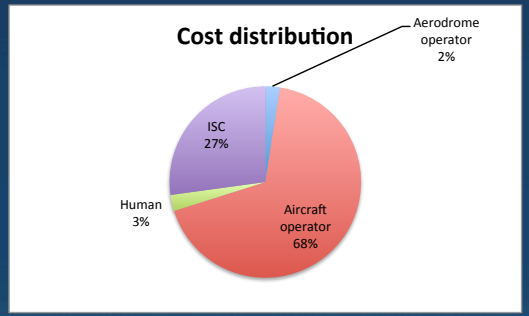
- 52% of Number of occurrences with GENeral aviation
- 65% of Costs by CAT & MCTOM >5700kg & MCPSC>20.
- 49% of Costs occur at Regional Aerodromes.
- 62% of Costs are due to Runway excursions
- 56% of Runway excursion costs are due to veer-offs.
- Costs for Aircraft operators 15 x higher than for aerodrome operators
- Number of injuries and fatalities in General aviation supersede those in CAT

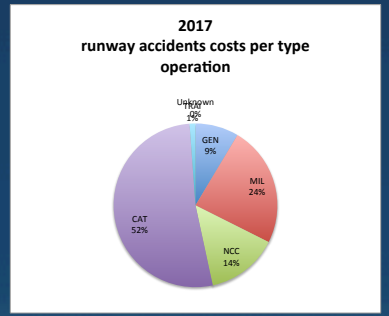
Results Jan-Feb 2017 (provisional)

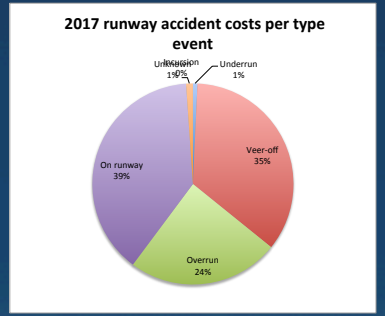
www.Safe-Runway.com



Conclusion:
No Significant differences

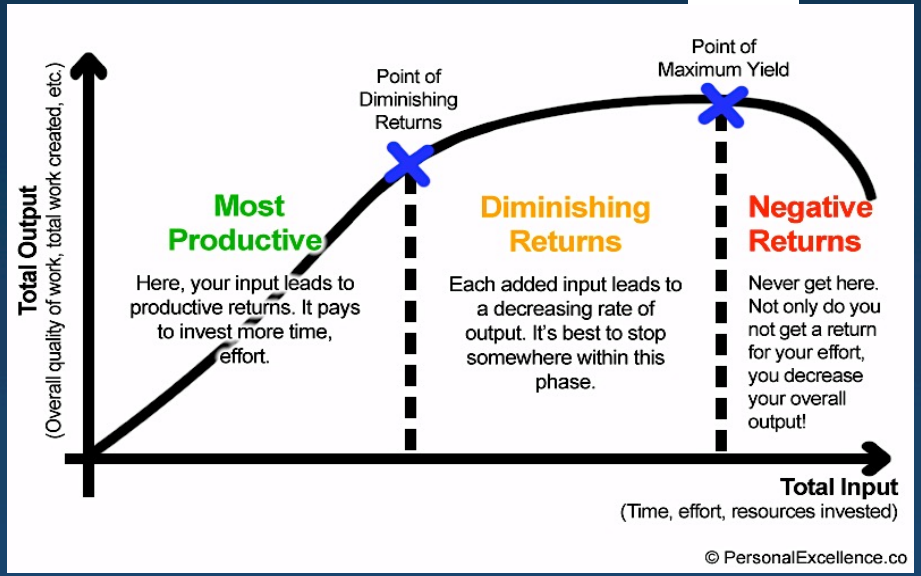






Opportunities

www.Safe-Runway.com



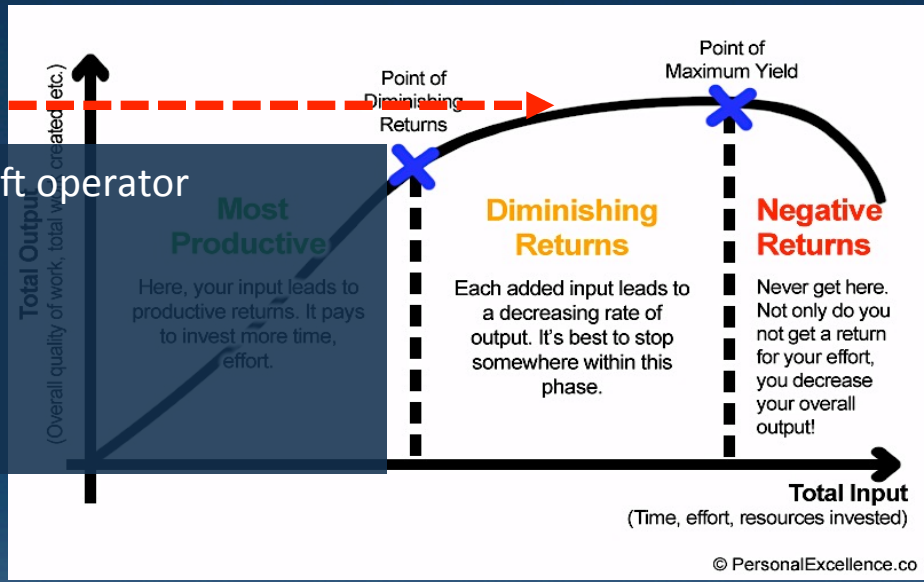
Reducing runway events RISK

www.Safe-Runway.com

Risk=f [Probability, Severity]

Probability	Negligible (1)	Marginal (2)	Moderate (3)	Critical (4)	Catastrophic (5)
	Severity				
Almost certain (5)	Medium (5)	High (10)	High (15)	High	High
Likely (4)	Low (4)	Medium (8)	High (12)	High	High (20)
Possible (3)	Low (3)	Medium (6)	Medium (9)	Medium	(15)
Unlikely (2)	Low (2)	Low (4)	Medium (6)	Medium	High
Rare (1)	Low (1)	Low (2)	Low (3)	Low (4)	Medium (5)

Probability → Aircraft operator
- Crew
- SOP's
- Equipment
- SMS
- Oversight



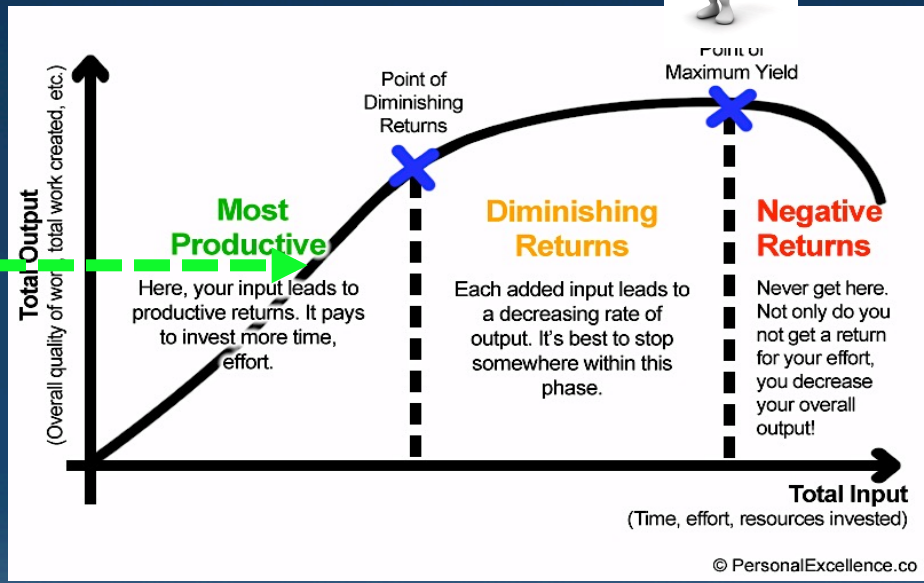
Reducing runway events RISK

www.Safe-Runway.com

Risk=f [Probability, Severity]

Probability	Negligible (1)	Marginal (2)	Moderate (3)	Critical (4)	Catastrophic (5)
Almost certain (5)	Medium (5)	High (10)	High (15)	High (20)	High (25)
Likely (4)	Low (4)	Medium (8)	Medium (12)	High (16)	High (20)
Possible (3)	Low (3)	Medium (6)	Medium (9)	High (12)	High (15)
Unlikely (2)	Low (2)	Low (4)	Medium (6)	Medium (8)	High (10)
Rare (1)	Low (1)	Low (2)	Low (3)	Low (4)	Medium (5)

Severity → Hardware
Aircraft & Interior
Aerodrome
RESA
Strip
Oversight



Severity reduction costs effective?

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Analysis study (2016 Safe-Runway GmbH):

- Was it Cost effective to bring a non-ICAO standard RESA to an equivalent level of safety by EMAS?
  - Total Installation costs
  - Total costs of overruns in EMAS
  - Total hypothetical accident costs without EMAS

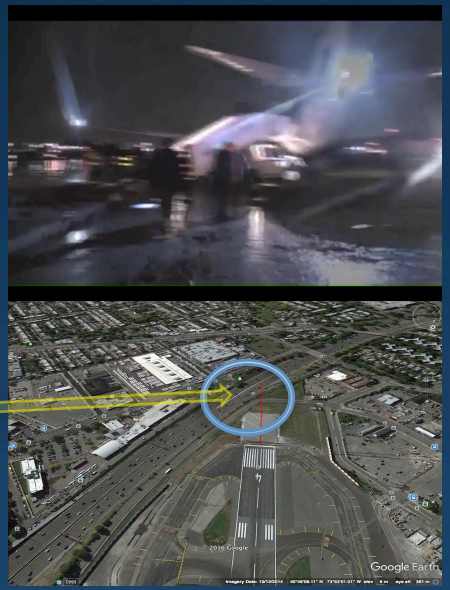
METHOD

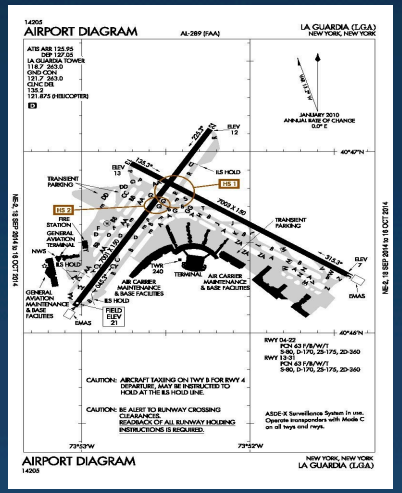
- 117 world wide installations
- 12 actual overruns into an EMAS
- Each overrun analyzed and associated overrun costs estimated
- Two scenario's estimated:
  - Actual overrun costs (AOC)
  - Hypothetical overrun costs if EMAS would not have been installed (HOC)
- Difference between hypothetical accident cost estimate and actual arrestments costs estimate
- ALL world wide installations costs (WIC)
- NET COSTS SAVED= HOC-AOC-WIC= one billion $

Example: New York, 26-10-2016 KLGA, Boeing 737-700

www.Safe-Runway.com

On 26 October 2016 at 19:40 eastern daylight time, a Boeing 737 N278EA, carrying 37 passengers and 11 crew, including the republican vice presidential candidate Pence experienced a runway overrun upon landing at LaGuardia Airport in New York City. Sources state that "it was a rough landing, the pilot jammed the brakes and that the aircraft was suddenly stopped."





- Estimated position NO EMAS
- Central parkway rush hour traffic: 300 vehicles per minute
- Estimate a certain nr of Human Injuries distribution
- Estimate level of damage, associated costs (Aircraft and third party) and ISC
- Estimate installation costs, bed repair costs

The key issue: Right Priority?

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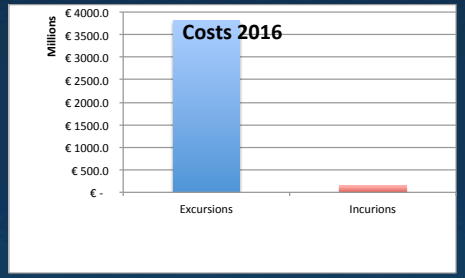
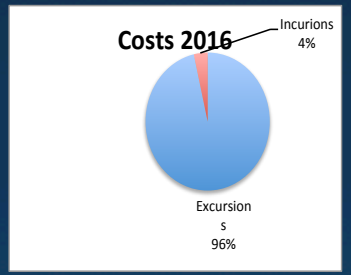
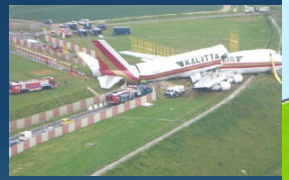
- Total world-wide runway accidents costs of 6.5 Billion $
- Costs of runway excursions 25 x Higher than runway incursions
- Investment in adequate / improved RESA's and runway strips could possibly be a cost efficient method to reduce the runway excursion costs







Conclusion & Problem

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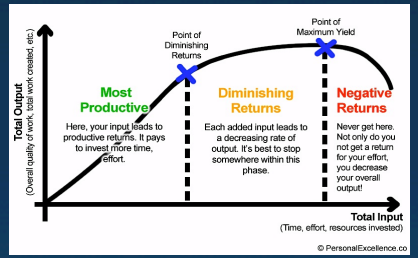
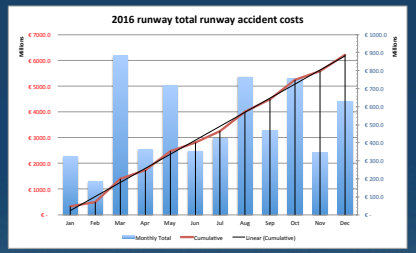
- Conclusion
  - Further likelihood reduction faces future limits due to law of diminishing returns
  - As an alternative could the excursion costs be reduced by addressing the severity of excursions
  - Adequate / Improved RESA and runway strip reduce these cost effecively
- Problem
  - Aerodromes are not all to ICAO RESA or Strip standard,
  - Situation is accepted by a number of CAA's.
  - Aircraft operators operate in these aerodromes
  - resulting is an increased runway excursion risk and thus costs.





Conclusion Runway accidents

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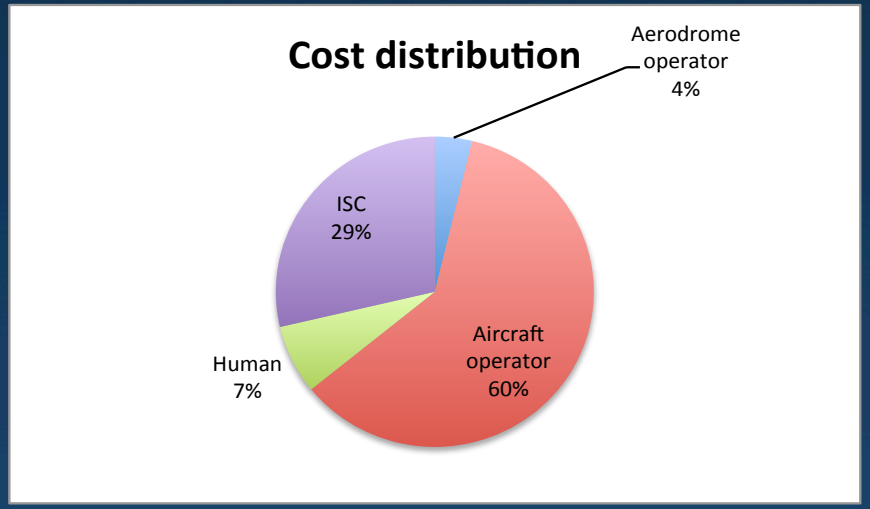
- Policy on Runway Risk reduction for CAT is justified.
- **Risk** reduction of runway excursions through reducing the severity of an runway excursion could likely cost-effectively be realized.
- Financial incentive for aerodromes to reduce the overall runway risk costs is lacking.



Disproportional costs distribution blocks cost-effective solutions, potentially saving up to 1 Billion $ on runway excursion costs.

Recommendations

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① Prioritize i.a.w. Follow the Money concept

② Special attention to:

a) Regional aerodromes (also outside Basic regulation)

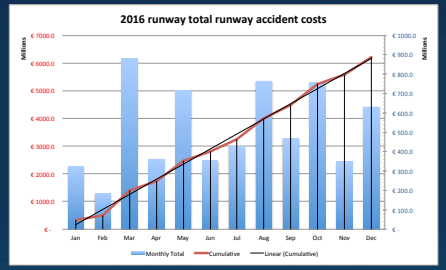
b) Reduction # Injuries General aviation.

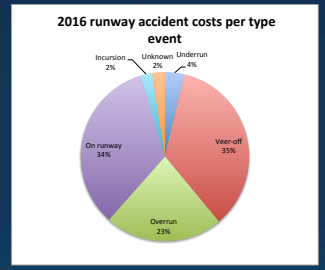
c) Veer-Offs

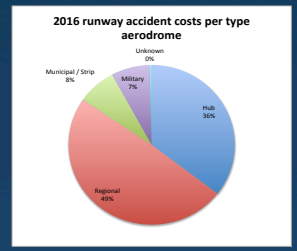
③ Include Severity reduction in runway risk reduction policies

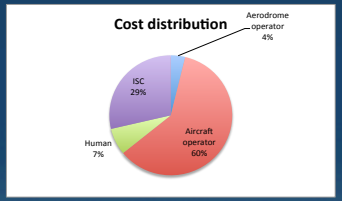
a) Solve disproportional problem

b) Align CAA's









Questions / Discussion

www.Safe-Runway.com
A safe runway is THE core business

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0031 6 125 90997