Introduction to ROPS
Runway Overrun Prevention System

Presented by:
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Agenda

1. What is ROPS? Why is it needed

2. Overview of ROPS design

3. ROPS, a performance based solution

4. ROPS & industry

5. Conclusion
Right now, are there enough meters of runway to **safely stop the aircraft**?

**ROPS - the Alerting System to Prevent Runway Overruns**

- continuous real-time calculation of stopping distance vs remaining runway length
- clear, unambiguous visual and aural alerts with simple procedures
Why ROPS is Needed

#1 Air Transportation Safety Issue

Contributors to runway excursions at landing accidents and incidents

- 55% touched down in the recommended touchdown zone
- 74% respected FSF/IATA stable approach criteria
- 68% were on DRY or WET runways

Real-time continuous monitoring of aircraft energy allows to mitigate the runway excursion risk

source IATA Safety Report 2013
## Airbus-Willis Analysis on 1985-2010 Period: Claims Data

### Significant Cost to the Industry

<table>
<thead>
<tr>
<th>Flight Phase</th>
<th>No. of Incidents</th>
<th>Pax Fatalities</th>
<th>Crew Fatalities</th>
<th>Hull Loss (MUSD)</th>
<th>Liability (MUSD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>En Route (Cruise)</td>
<td>287</td>
<td>3,766</td>
<td>462</td>
<td>$1,576</td>
<td>$2,727</td>
</tr>
<tr>
<td>Ground (Taxi)</td>
<td>301</td>
<td>24</td>
<td>18</td>
<td>$474</td>
<td>$77</td>
</tr>
<tr>
<td>Landing - Approach</td>
<td>1,120</td>
<td>8,718</td>
<td>1,802</td>
<td>$2,937</td>
<td>$3,317</td>
</tr>
<tr>
<td>Landing - Go Around</td>
<td>107</td>
<td>1,324</td>
<td>209</td>
<td>$511</td>
<td>$499</td>
</tr>
<tr>
<td>Landing - Initial Descent</td>
<td>178</td>
<td>2,450</td>
<td>415</td>
<td>$442</td>
<td>$949</td>
</tr>
<tr>
<td><strong>Landing Roll - Excursions</strong></td>
<td><strong>1,020</strong></td>
<td><strong>970</strong></td>
<td><strong>112</strong></td>
<td><strong>$5,429</strong></td>
<td><strong>$1,133</strong></td>
</tr>
<tr>
<td>Landing – Landing Roll Others</td>
<td>1,567</td>
<td>291</td>
<td>90</td>
<td>$1,139</td>
<td>$186</td>
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<tr>
<td>Take Off - Climb to Cruise</td>
<td>298</td>
<td>5,250</td>
<td>722</td>
<td>$1,324</td>
<td>$6,976</td>
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<tr>
<td>Take Off - Initial Climb</td>
<td>541</td>
<td>3,936</td>
<td>854</td>
<td>$1,231</td>
<td>$1,860</td>
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<tr>
<td>Take Off Aborted</td>
<td>113</td>
<td>146</td>
<td>20</td>
<td>$352</td>
<td>$62</td>
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<tr>
<td>Take Off Run</td>
<td>407</td>
<td>725</td>
<td>106</td>
<td>$1,238</td>
<td>$990</td>
</tr>
</tbody>
</table>

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**Runway excursion is by far the most important cause of hull losses**
Airbus-Willis Analysis on 1985-2010 Period: Claims Data

Cost is increasing
Now 33% of all claims

Without a step change, the cost of runway excursion will continue to increase.
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ROPS automatically detects current landing runway using runway information from TAWS* terrain database.

*Terrain Awareness and Warning System
ROW : Runway End Overrun Warning, during Air Phase

During the Air-Phase, ROPS performs a real time in-flight landing distance assessment for dry & wet runways with respect to detected landing distance available.

→ If the estimated landing distance is longer than the runway length, ROPS triggers an alert to encourage the crew to go around

“RUNWAY TOO SHORT”
ROP : Runway Overrun Protection, during Ground Phase

During the Ground-Phase, ROPS performs a real time on-ground stopping distance assessment with respect to detected landing distance available.

→ If the remaining runway length is assessed too short, ROP triggers an alert to encourage the crew to apply AND keep all available deceleration means.
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ROPS advantages

• The strength of ROPS is the ability to continuously monitor aircraft position and energy with regards to the aircraft deceleration capabilities and the remaining runway length. This ensures a full consistency between the in air and ground computation.

• Consequences for ROW (in air alert)
  Any changes during the approach are immediately captured and the resulting distance to stop is updated:
  • Changing winds affect the ground speed and thus the predicted touchdown speed
  • Above glide-slope may affect the predicted threshold crossing point
  • Long flares affect the predicted touchdown point

• Consequences for ROP (on ground alert)
  The braking capabilities and the current deceleration are fully taken into account in the predictive stopping point.
ROPS, a performance based system

ROPS computes in real time a **performance distance**.

**This allows:**
- Real time assessment of the possibility to land or to stop before the runway end
- Clear and directive **alerts** on a challenging flight phase
- An unambiguous link with pilot’s operational landing distance computations.

**This avoids:**
- Any threshold effects: the performance based computation is continued
- Any undue Go Around
- Any tuning by the airline (no extra work for the airline: turnkey solution)

ROPS is certified by all major authorities and recognized by Insurance community
ROPS In-Service Experience
Example of events where ROPS prevented excursion

The following slides contains an analysis of two separate de-identified events which triggered ROPS alerts.

- Event 1 – As the tail-wind increased, the aircraft ground speed increased and ROW stop distance increased. At 10ft RAH the system triggered alerts as the safe stop distance was longer than the LDA.

- Event 2 – When the crew inadvertently selected FWD idle and the deceleration decreased, the ROP system detected the estimated stop distance was longer than the remaining runway length and triggered alerts.
In-Service Event 1: A380 ROW Event

Runway Characteristics
LDA ~ 2500m
Runway is DRY

Approach
Vapp ~ 145kt CAS
Strong wind gradient during the approach leading to progressive tailwind (10kt at 50ft HRA)

Event Description
• Approach Stable at 1000ft HRA
• 5kt tail-wind at 500ft HRA
• IF WET RWY TOO SHORT displayed on PFD below 500ft
• Tail-wind increased during final approach 7.5kt when crossing threshold
• Tail-wind continued to increase during the flare up to 13kt
• Aircraft was flaring longer than nominal 7 second air-phase
• RUNWAY TOO SHORT triggered at 12ft HRA
• Immediate pilot reaction to engage Go-Around
• Main landing gear briefly touched the runway, Go-Around safely conducted
In-Service Event 1: A380 ROW Event

Runway Characteristics

ROW monitors aircraft ground speed and long flare, alerts flight crew of overrun risk.

How to read the chart:
ROW prediction of stopping point as aircraft descends. e.g. at 300ft RA, ROW predicts A/C DRY and WET stopping point of 2200m and 2700m respectively.
## In-Service Event 2 : A380 ROP Event

### Runway Characteristics
- LDA ~ 3400m

### Approach
- \( V_{\text{app}} = 137 \text{kt} \)
- Autobrake 3 selected
- CONF Full

### Runway condition:
- **ATIS**: 60% bare and wet, 40% wet snow
- **PIREP**: POOR

Note: ROPS does not take into account contaminated runways

### Event Description
- Normal Flare and Touchdown at 558m
- Max Reverse immediately selected
- “70kt” called by PNF and PF inadvertently came back to Fwd Idle instead of Idle Rev (2000m from runway threshold)
- Zero deceleration
- ROP Alert “SET MAX REVERSE” (2169m from runway threshold). Braking already at max, therefore no BRAKE, MAX BRAKING alert
- PF selects max reverse
- Vacate at Runway End
In-Service Event 2: A380 ROP Event

How to read the chart:
ROP prediction of stopping point as aircraft advances down the runway. E.g. at 1200m from runway threshold, ROP predicts A/C stopping point at 2250m.

ROP monitors aircraft deceleration and alerts flight crew of runway overrun risk.
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ROPS In-Service Experience
It’s happening now

Certified by:
EASA, FAA, CAAC

1st Prototype
April 2004

Research

20+ airlines have selected or already operate ROPS:
AAL, AAR, AFR, ALK, AVA, BAW, CSN, DLH, ETD, KAC, KAL, LNI, MAS, PAL, QTR, TCX, THA, TSO, UAE, USA, VOI, VRE, 07P

277 aircraft in-service: 127 x A380, 2 x A350, 148 x A320

1,500+ commitments: 160 x A380, 750 x A350, 650 x A320

Figures as of April 2015
The Aviation Industry is Now Moving

3.5.3 On-board real time performance monitoring and alerting systems that will assist the flight crew with the land/go-around decision and warn when more deceleration force is needed should be made widely available.

European Action Plan for the Prevention of Runway Excursions
Edition 1.0

On Jan 2013

National Transportation Safety Board
Washington, D.C. 20594
Safety Recommendation

“Actively pursue with aircraft and avionics manufacturers the development of technology to reduce or prevent runway excursions and, once it becomes available, require that the technology be installed”. (NTSB recommendation to FAA A-11-28, March 2011)
EASA NPA 2013-09: Reduction of Runway Excursion

This NPA proposes to require through CS-25 and CS-26 the installation of systems which reduce the risk of runway excursions:

- CS-25 would affect newly certified aircraft
- CS-26 would affect newly produced aircraft

A ROAAS must be installed. The ROAAS must be a real-time crew alerting system that makes energy based assessments of predicted stopping distance versus landing distance available, and meets the following requirements:

(a) The system must provide the crew with timely in-flight predictive alert of runway overrun risk; and
(b) The system must provide the crew with:
   (1) on-ground predictive alert, or
   (2) automated means for runway overrun protection during landing

NPA = Notice Proposal for Amendment ( = FAA NPRM)
ROPS Global Deployment

Decision announced at the 2011 ICAO Global Runway Safety Symposium

Airbus offers runway overrun protection system to competitors

By David Colgan

Airbus has decided not to keep its patented runway overrun protection system (ROPS) as a "product differentiation", but will release it to competing aircraft builders.

The manufacturer says its decision has been spurred by the fact that runway excursion is by far the transport industry's most common serious accident category. The occurrence rate is also increasing faster than the world fleet is expanding.

Airbus's executive vice-president strategy and future programmes Christian Scherer said that it has received "a very positive reaction" from Bombardier, Embraer, Dassault - and from the aviation insurance industry - to the proposal to make ROPS commercially available to other manufacturers.

Scherer said that the idea was also well received at last month's International Civil Aviation Organisation (ICAO) Global Runway Safety Symposium, and that the International Federation of Aircraft Pilots Associations backs the manufacturer's move.

At present ROPS, which consists of a software upgrade to existing aircraft systems, will be fitted on all A320s that come off the line. It is installed on more than 50% of the in-service A330 fleet. It will be in all A350s, and then next year, it will be available on the other new Airbus types or for retrofit.

ROPS is integrated with the aircraft's flight management and navigation systems, and provides the pilot with a real-time constantly updated picture in the navigation display of where the aircraft will stop on the runway in wet or dry conditions.

If the approach profile varies, so does the stopping point, if it will not be possible to stop on the runway, the system provides the crew with a written and spoken "runway too short" warning.
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Conclusion

ROPS is a unique *performance based* solution alerting against runway overruns.

ROPS will be *available all in-production airbus aircraft* and is operated in Europe, US, Latin America, Asia and Middle-East.

ROPS technology is now proposed *to other aircraft manufacturers*.

Industry and regulators are now moving towards:
- **Standardization**
- **Installation mandate**
Thank You

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