Airbus China Safety Conference
Chengdu, 15-16 July 2015

ROPS

Runway Overrun Prevention System

Presented by Eric JEANPIERRE

Content

- Overview of ROPS
- ROW function
- ROP function
- ROPS In service experience

Overview of ROPS

Runway excursion is #1 Air Transportation Safety Issue

22% of aircraft accidents over 2010-2014.

Contributors to runway excursions at landing accidents and incidents:

- 50% undesired states at touch down (Long flare, bounce,…)
- 16% unstable approach
- 43% weather was a factor

source IATA Safety Report 2014

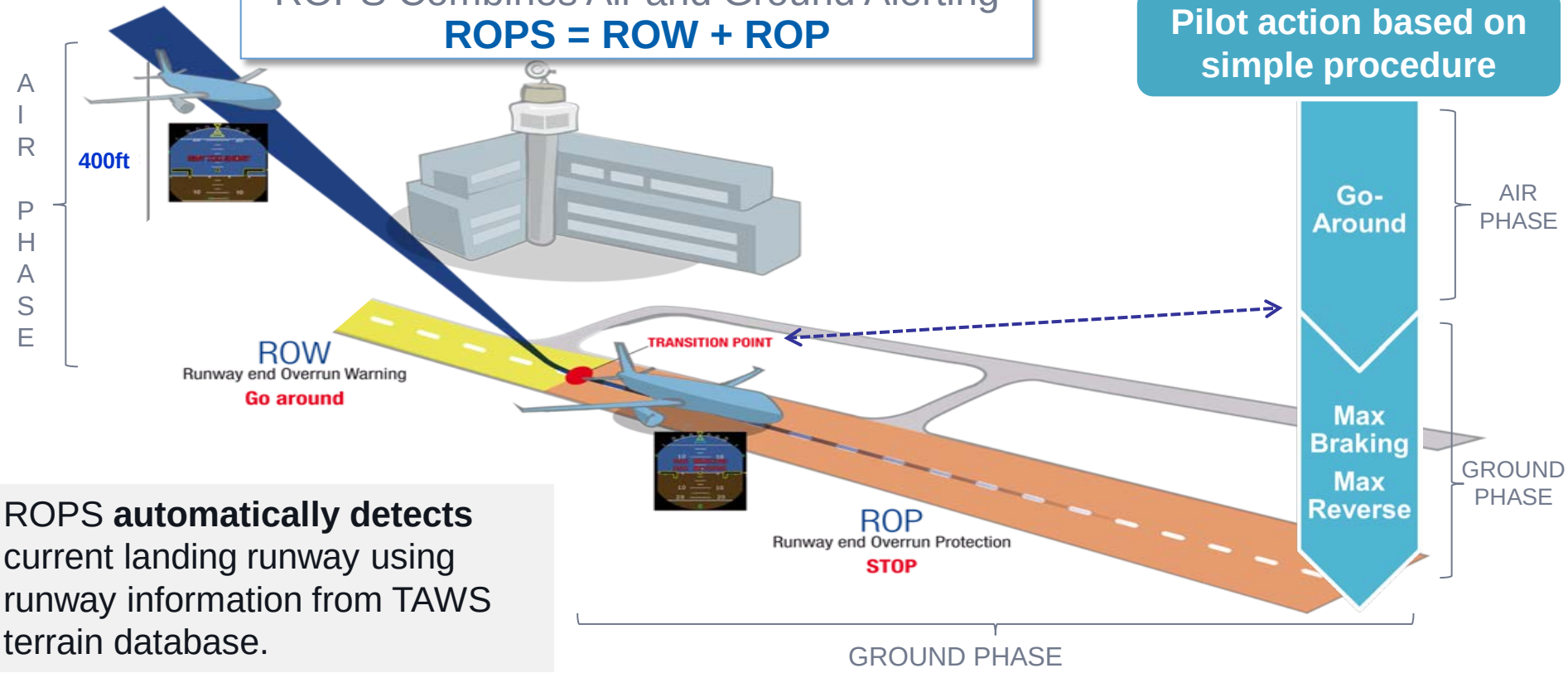
ROPS - the Alerting System to Prevent Runway Overruns

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

Overview of ROPS

ROPS Combines Air and Ground Alerting
ROPS = ROW + ROP

Pilot action based on simple procedure



ROPS **automatically detects** current landing runway using runway information from TAWS terrain database.

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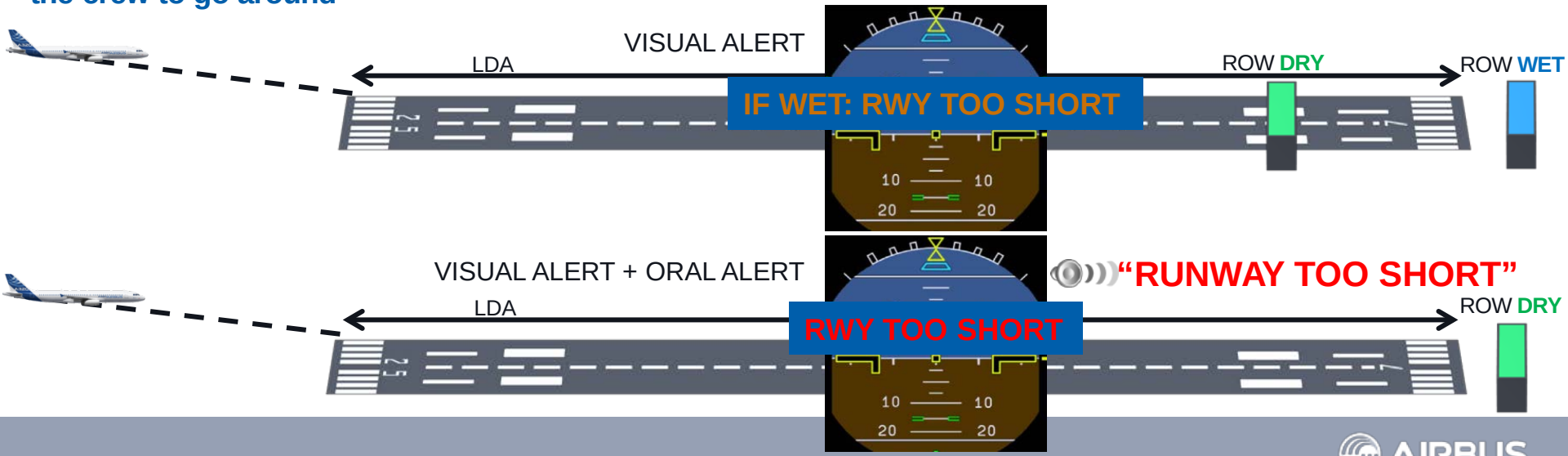
ROW : Runway End Overrun Warning, during Air Phase

Below 400 feet, ROW estimates the distance necessary to safely stop the airplane for **DRY** and **WET** runways

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



ROW : Runway End Overrun Warning, during Air Phase

- ROW Landing Distance uses the same principles as the factored In-Flight Landing Distance (FLD)

- ROW continuously monitors aircraft position and energy with regards to remaining runway length.

- Any changes during approach (changing winds, long flare, above glide slope) are immediately captured and the resulting distance to stop is updated.

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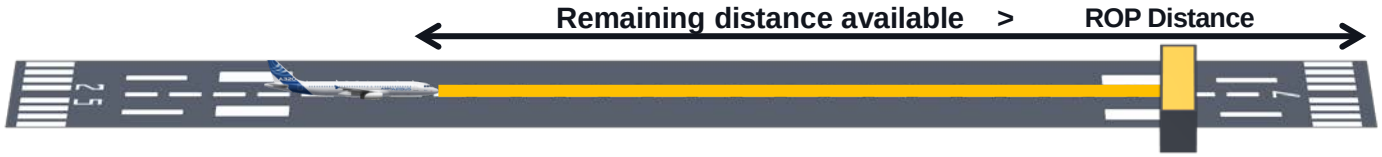
ROP : Runway Overrun Protection, during Ground Phase

ROPS performs a real time on-ground stopping distance assessment with respect to remaining landing distance available:

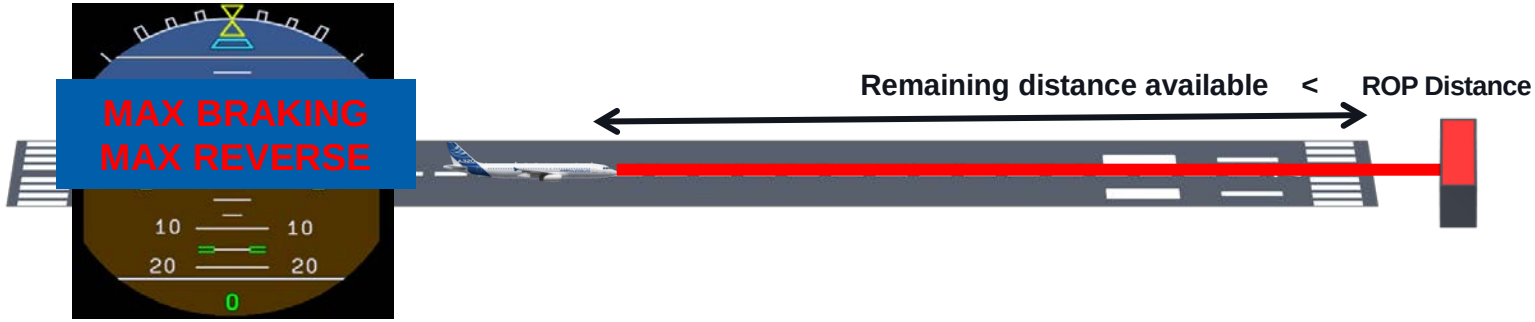
- ROP monitoring starts on ground and continues until aircraft reaches 30kt
- ROP estimates the distance necessary to stop based on current aircraft speed and deceleration



ROP : Runway Overrun Protection, during Ground Phase

If the remaining runway length is assessed too short, ROP triggers alerts to encourage the crew to apply AND keep all available deceleration means

VISUAL ALERT



ORAL ALERTS

If brake pedals not deflected to maximum:

BRAKE, MAX BRAKING

If max reverse not set:

SET MAX REVERSE

At reverse cut-off speed:

KEEP MAX REVERSE

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ROPS In-Service Experience

Certified by:
EASA, FAA, CAAC

A380 - 2009

A320 - 2013

A350 - 2014

A330 - 2015

1st Prototype
April 2004

Research
Oct. 1998 - Feb. 2002

More than 20 airlines have selected or already operate ROPS.

This represents almost 300 aircraft in service.

Figures as of April 2015

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ROPS demonstration with CAAC and Sichuan Airlines

Airbus will equip two Airbus A319s from Sichuan Airlines to demonstrate ROPS technology for the Civil Aviation Administration of China (CAAC).

These aircraft regularly fly to high-altitude airports, allowing demonstration of ROPS efficiency throughout entire flight domain.

Demonstration planned to start last quarter of 2015.

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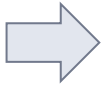
Retrofit for ROPS solution
A320 family and A330

Systems supporting the ROPS function (Software upgrade)	
A320 Family	**A330**
FMGC 2G or 3G	FMGEC Genepi
FAC B or FAC C	
EIS1 or EIS2	
HUD	
FWC / SDAC	
TAWS (EGPWS or T3CAS)	
ADIRU	
MMR	

ROPS In-Service Experience

In the 6 years since the entry into-service of ROPS, the system's effectiveness has already been proven.



Next slides present a ROW event on A380 that led to Go-Around

In-Service Event: A380 ROW Event

Runway Characteristics

LDA ~ 2500m

Runway is **DRY**

Approach

Vapp ~ 145kt CAS

CONF Full

Strong wind gradient during the approach leading to progressive tailwind (10kt at 50ft RA)

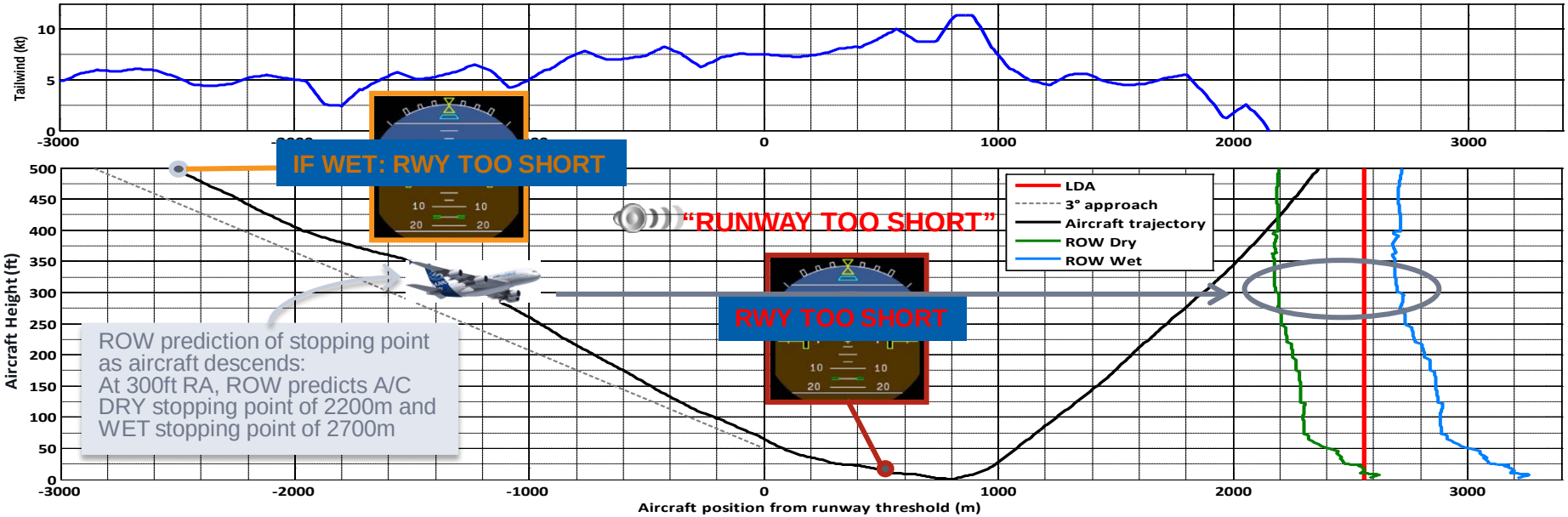
Event Description

- Approach Stable at 1000ft RA
- 5kt tailwind at 500ft RA
- **IF WET RWY TOO SHORT** displayed on PFD below 500ft
- Tailwind increased during final approach: 7.5kt when crossing threshold
- Tailwind continued to increase during the flare up to 13kt
- Long flare detected
- **RUNWAY TOO SHORT** triggered at 12ft RA
- Immediate pilot reaction to engage Go-Around
- Main landing gear briefly touched the runway, Go-Around safely conducted

In-Service Event: A380 ROW Event

As the tailwind increased, the aircraft ground speed increased and ROW stop distance increased. ROW monitors aircraft ground speed and long flare in real time.

At 10ft RA the system triggered ROW alerts as the safe stop distance was longer than the LDA.



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ROPS Replay

Next slide contains an analysis to show ROPS behavior in an actual overrun.

The ROPS function was not fitted on this aircraft ➔ ROPS behavior is simulated

Runway Characteristics

LDA ~ 2750m

Heavy rain and active storm cell around the airport

Approach

Vapp ~ 140kt CAS

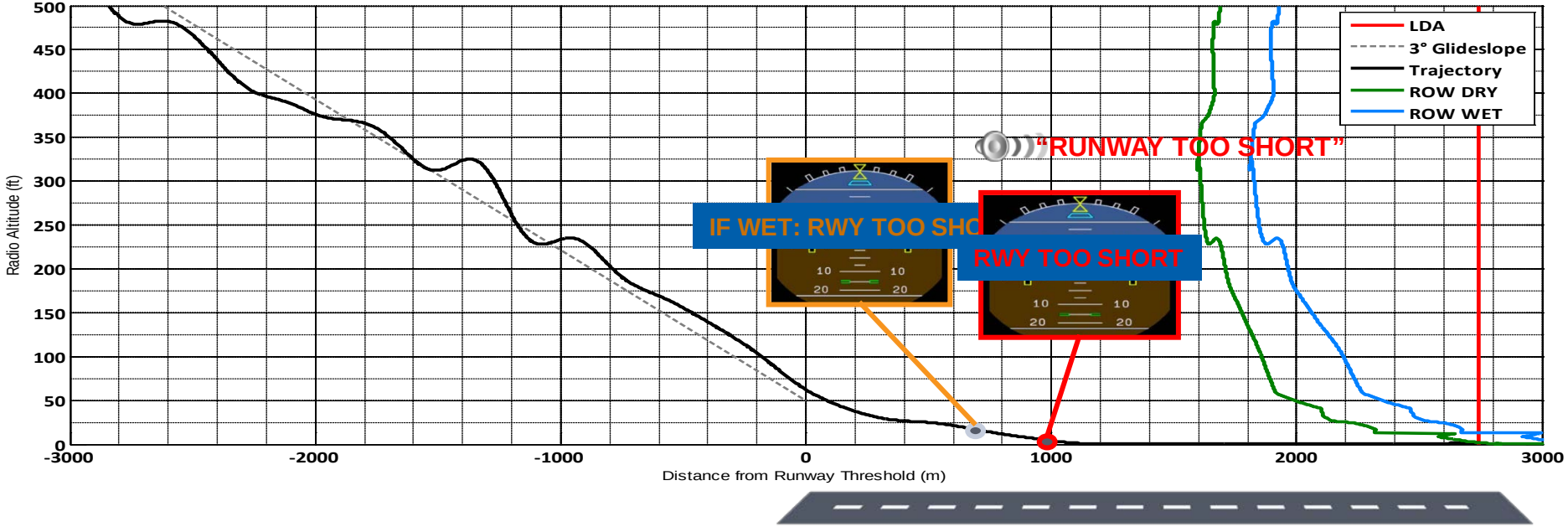
Strong variable winds during the approach leading to tailwind in short final (up to 10kt)

Actual Event Description

- At 300ft, wind shifted from headwind to tailwind up to 10kt
- Aircraft crossed the threshold about 40ft high
- Due to excess speed, aircraft touched down long
- Aircraft could not stop and overrun the end of the runway

ROPS Replay – Runway Overrun Accident

- ROW « IF WET: TOO SHORT» message on PFD would have triggered around 5s before touchdown. Aircraft ground speed was around 153kts and aircraft was around 770m after runway threshold.
- ROW « RUNWAY TOO SHORT» message on PFD and associated audio would have triggered around 1.4s before touchdown, at 1070m after runway threshold.



Summary

ROPS

- Continuously monitors aircraft position and energy with regards to the remaining runway length
- Provides clear, unambiguous visual and aural alerts with simple procedures
- Is available today on A380, A350, A320 Family and soon on A330
- Has already proven its effectiveness in service

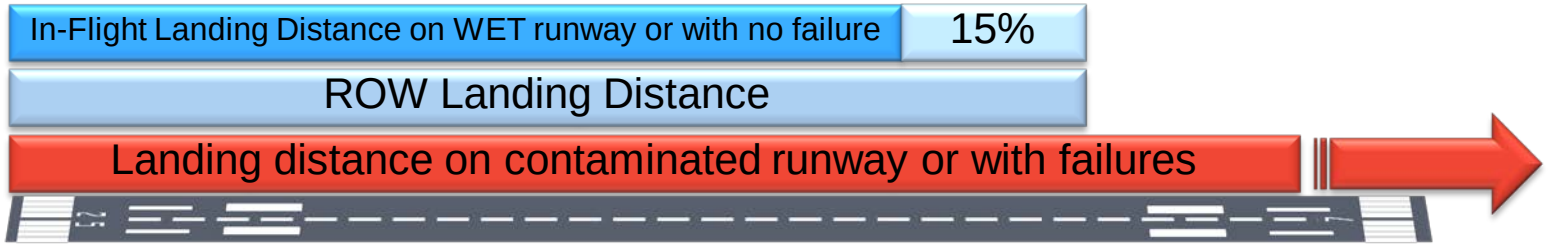
Contaminated Runways / Failure Cases Affecting Aircraft Performance

ROPS has been certified for **DRY** and **WET** runways and with no aircraft system failure.

For contaminated runways and/or in cases of failures affecting aircraft performance,

- ROPS remains active
- ROPS does not know the runway is contaminated and/or that aircraft have failures degrading its stopping performance
- Any ROPS alert predicts an overrun risk on a DRY or WET runway and for a nominal aircraft

All ROW and ROP alerts must be followed as they represent a high-risk of runway overrun



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ROP : Runway Overrun Protection, runway state selection

On A380, SA and LR aircraft, there is no explicit selection of the runway condition. Therefore the system makes an implicit selection **at touchdown:**

- If alert **IF WET RWY TOO SHORT** is displayed at touchdown, the runway should be DRY as the pilot has continued the landing

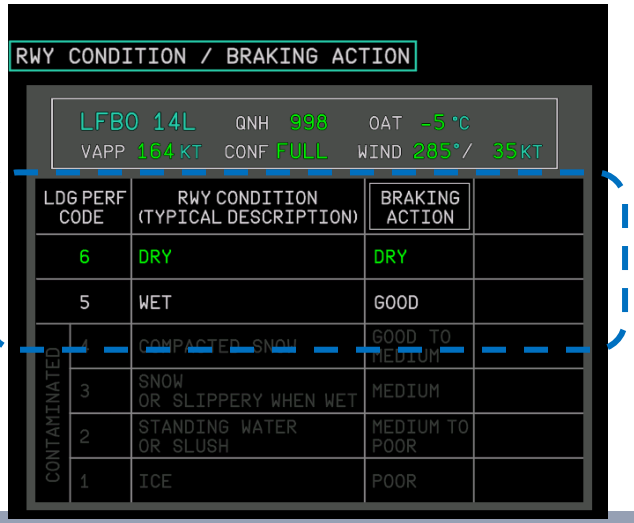
  → Therefore ROP protection is based on a **DRY** runway

- If there is no ROW alert at touchdown, the runway could be WET or DRY

  → Therefore ROP protection is based on a **WET** runway

ROPS on the A350

- With the introduction of the Airbus A350, ROPS include a dedicated runway state selection by the pilot.
- Currently available for DRY and WET runways, ROPS protection will be expanded to cover contaminated runways.



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