

Presented by:
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Introduction to ROPS

Runway Overrun
Prevention System

ROPS
by Airbus

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

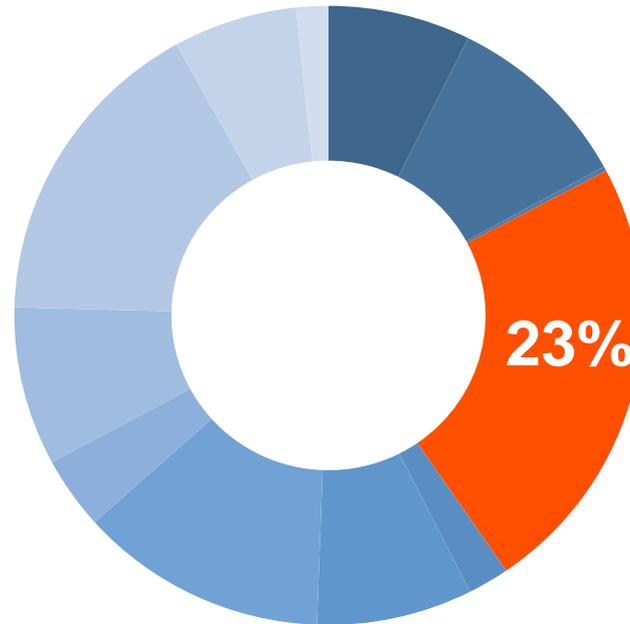
Why ROPS is Needed

#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

source IATA Safety Report 2013



- Controlled Flight into Terrain
- Loss of Control In-Flight
- Mid-Air Collision
- Runway/Taxiway Excursion
- Off Airport Landing / Ditching
- In-Flight Damage
- Ground Damage
- Undershoot
- Hard Landing
- Gear-up Landing / Gear Collapse
- Tailstrike
- Other End State

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

Airbus-Willis Analysis on 1985-2010 Period : Claims Data

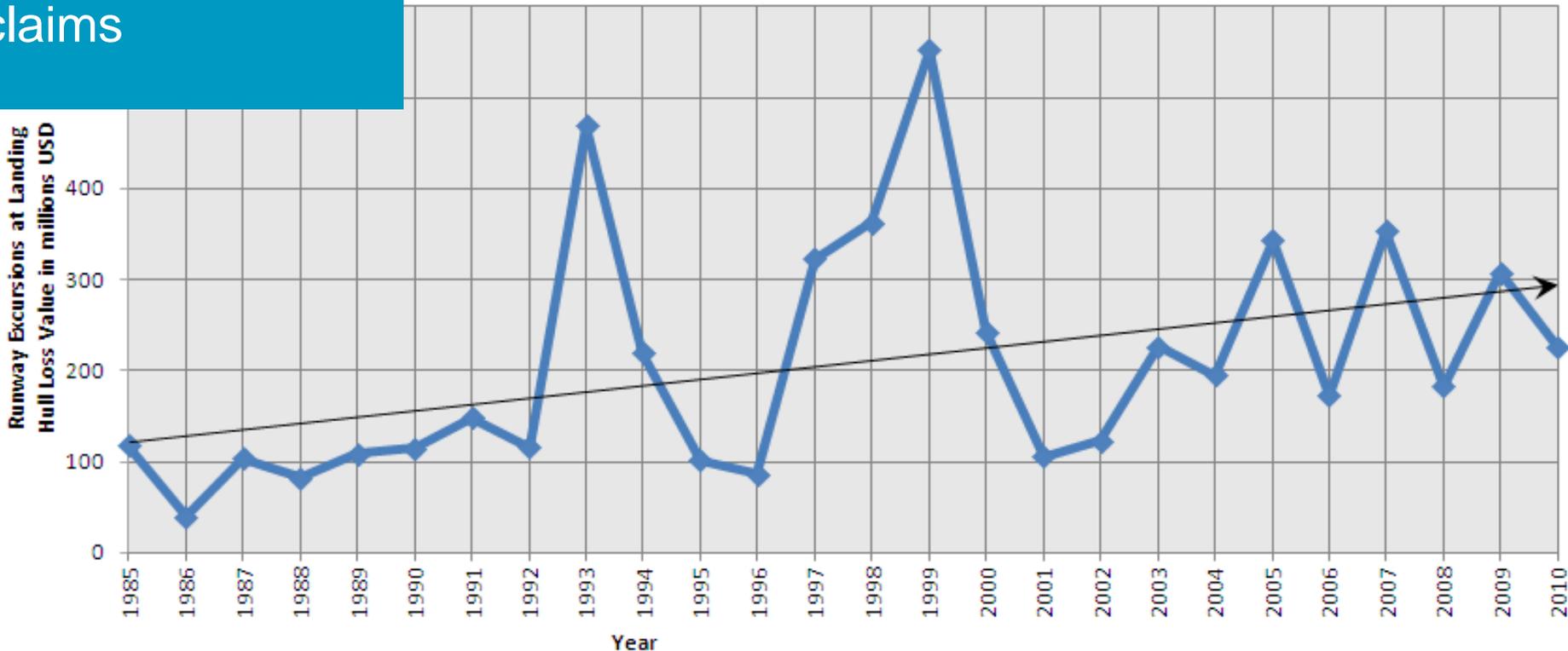
Significant Cost to the Industry

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

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

Agenda

1. What is ROPS? Why is it needed

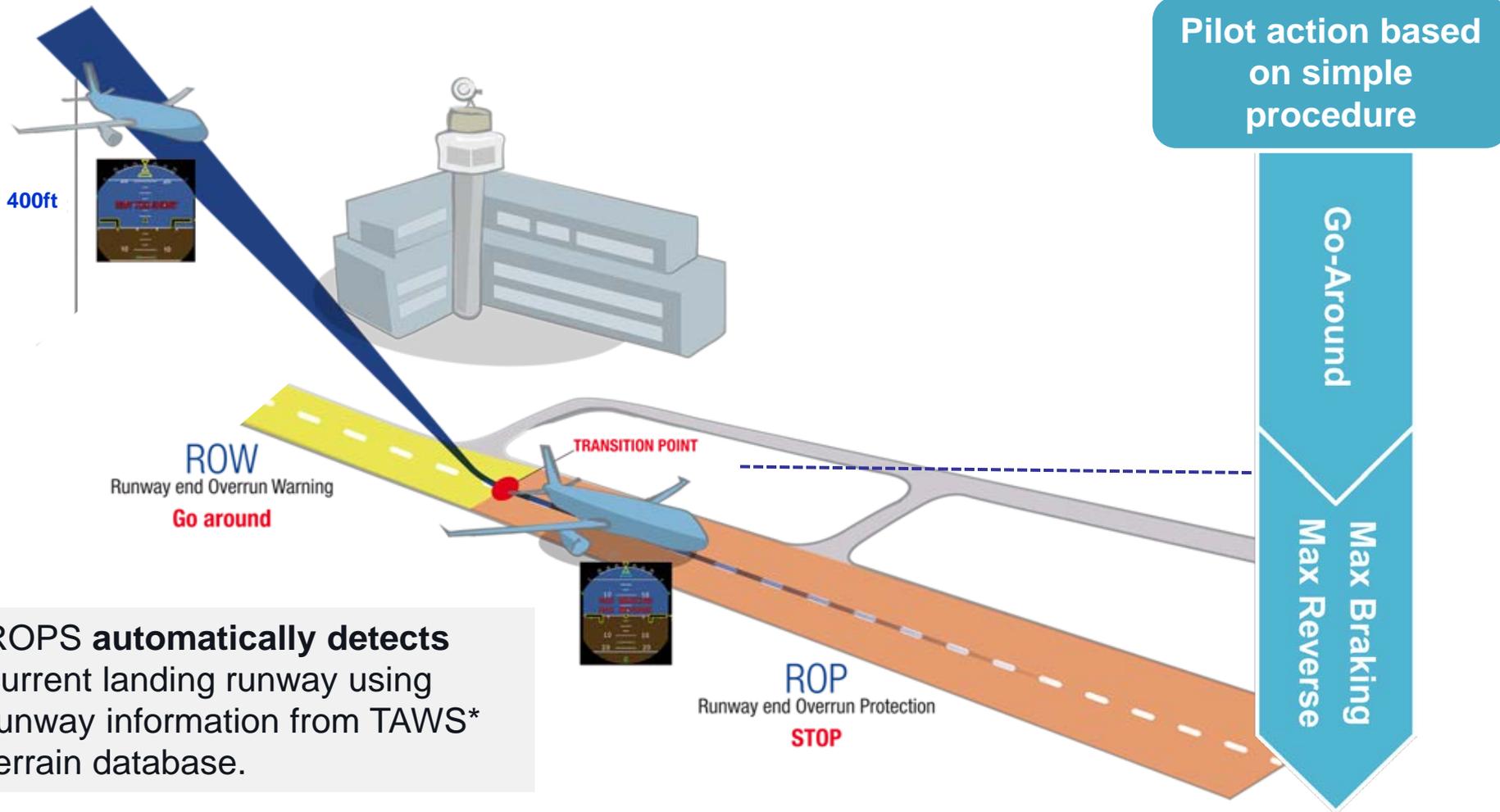
2. Overview of ROPS design

3. ROPS, a performance based solution

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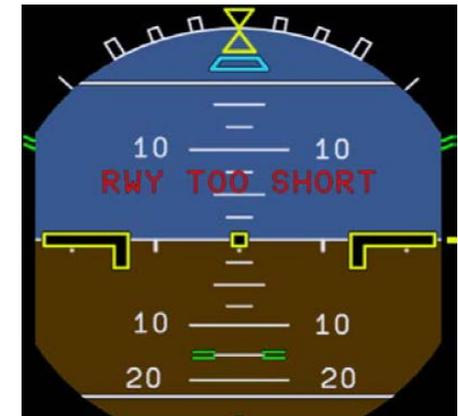
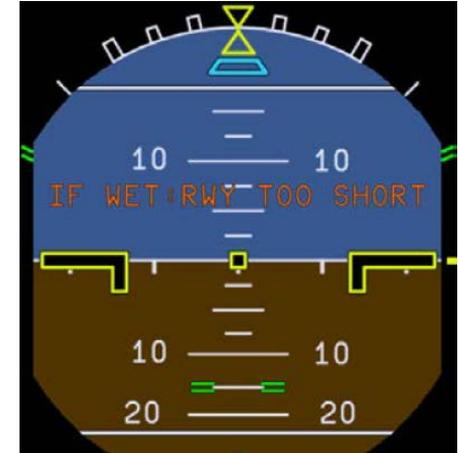
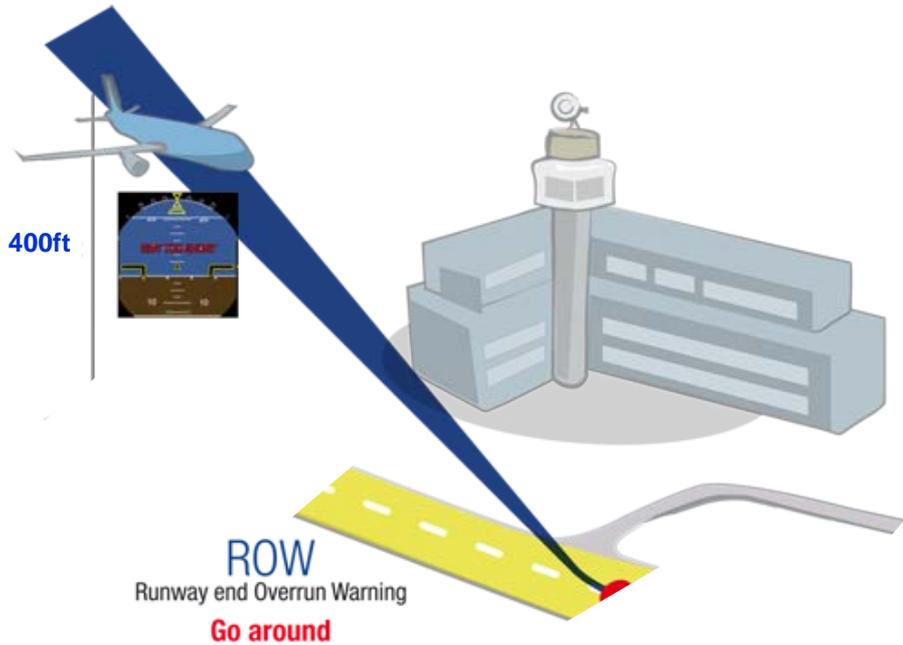
ROPS Combines Air and Ground Alerting



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

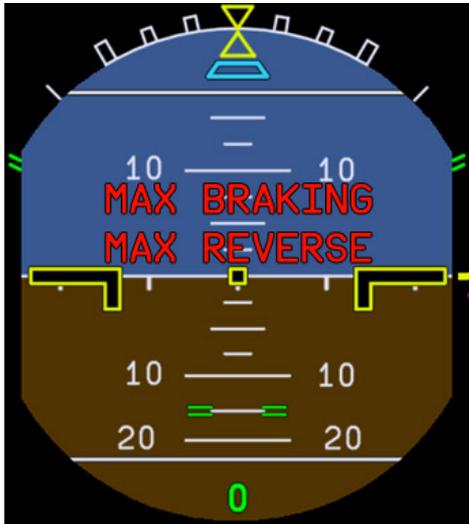


During the Air-Phase, ROPS performs a **real time in-flight landing distance assessment** for dry & wet runways with respect to detected landing distance available.

→ **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

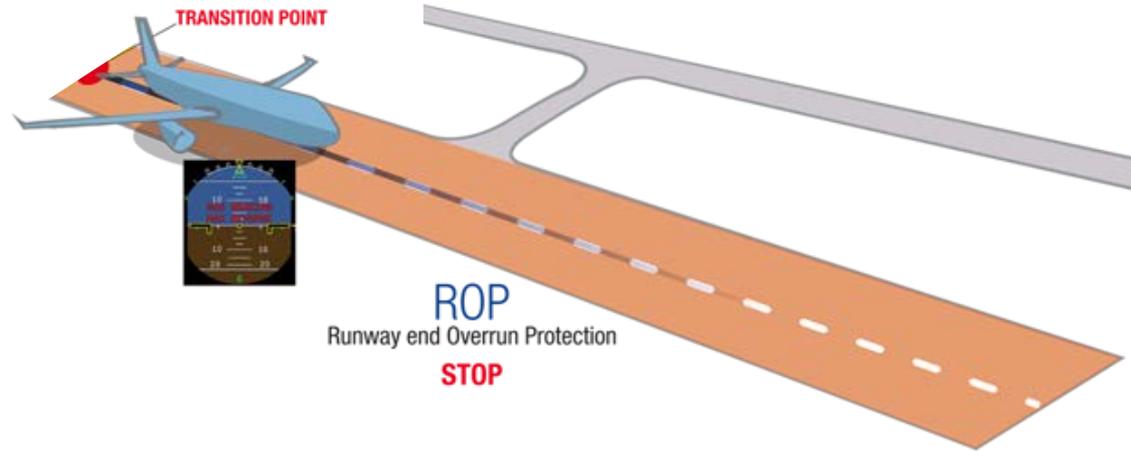
→ If the remaining runway length is assessed too short, ROP triggers an alert to encourage the crew to apply AND keep all available deceleration means



**BRAKE
MAX BRAKING
MAX BRAKING**



**SET MAX REVERSE
KEEP MAX REVERSE**



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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)

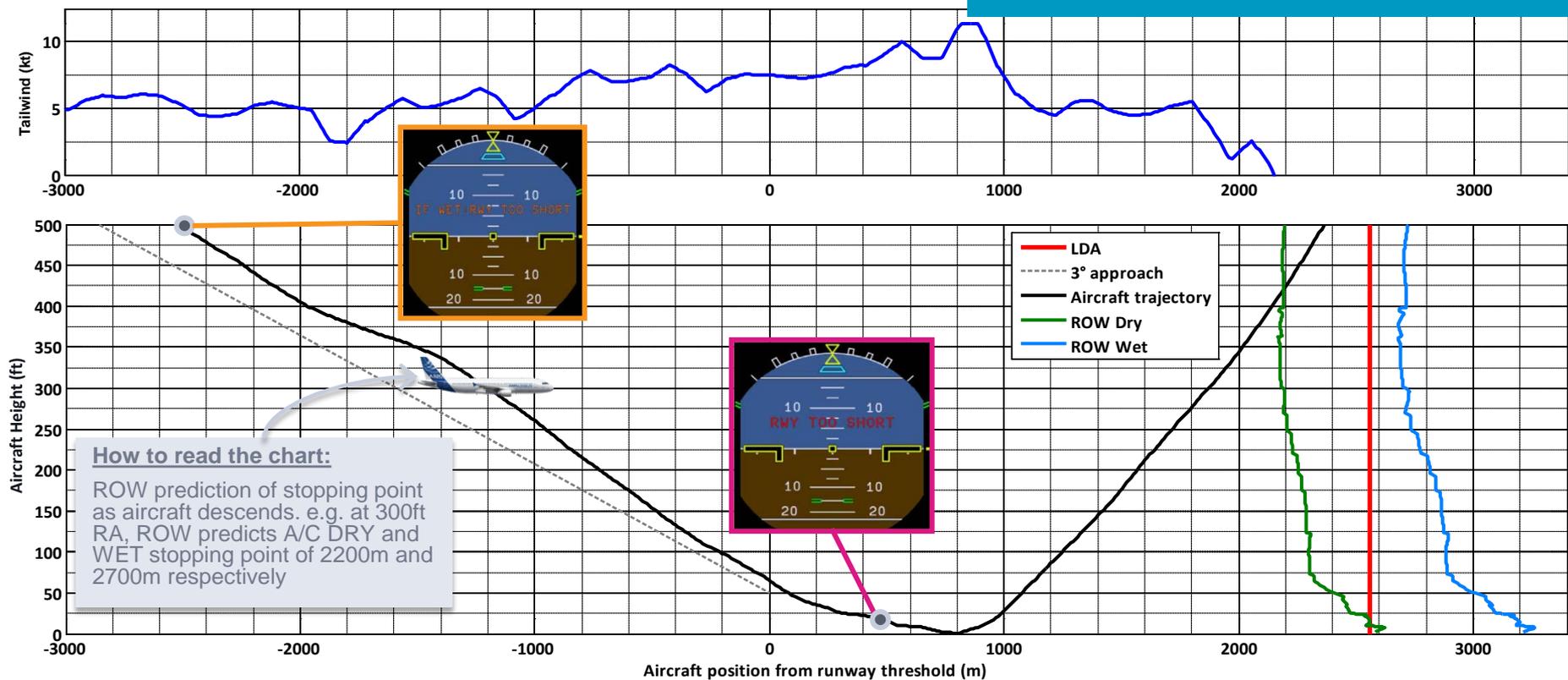
Event Description

- 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 Approach

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



In-Service Event 2 : A380 ROP Event

Runway Characteristics

LDA ~ 3400m

Runway condition:

ATIS: 60 % bare and wet, 40 % wet snow

PIREP: **POOR**

Note: ROPS does not take into account contaminated runways

Approach

Vapp = 137kt

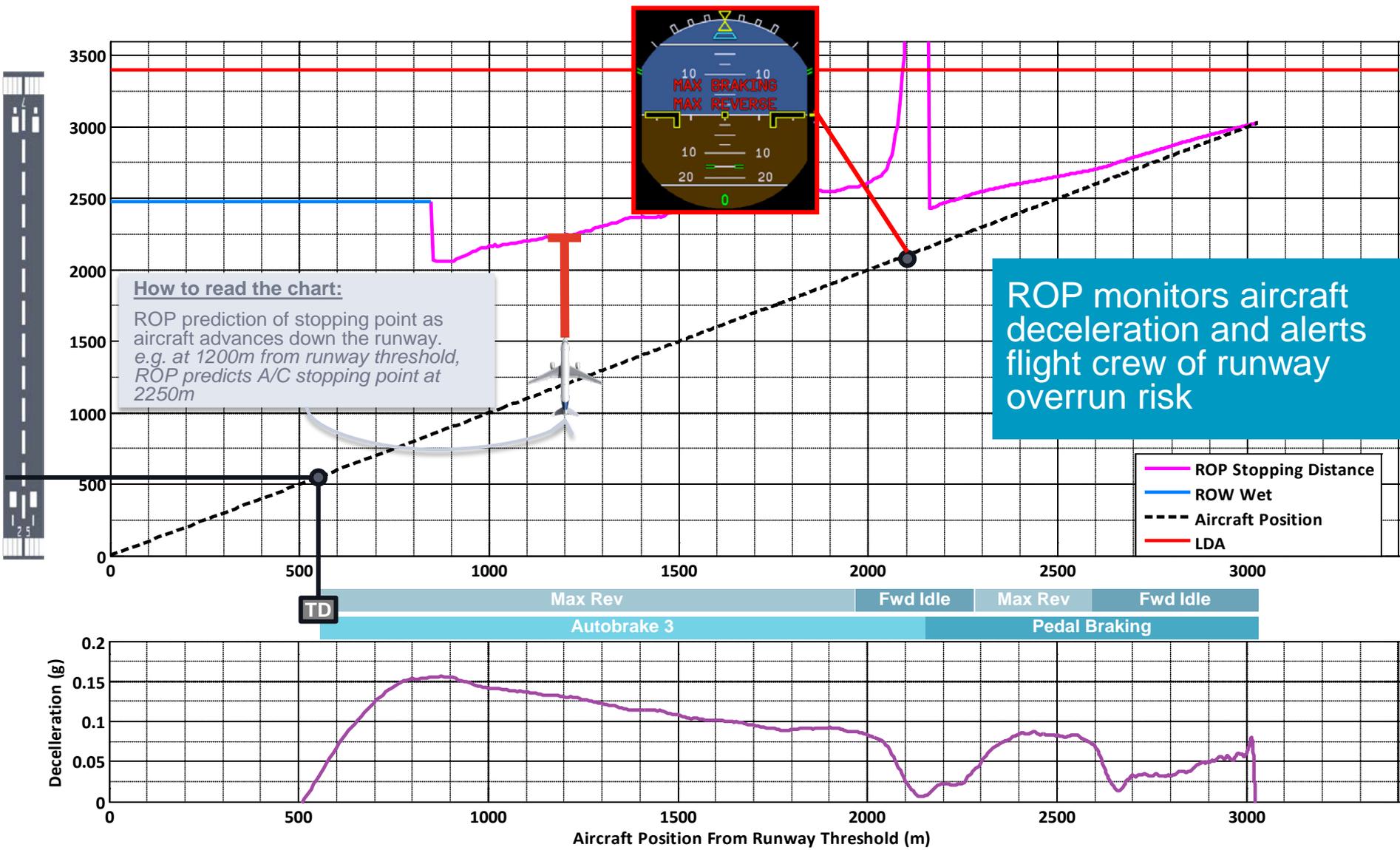
Autobrake 3 selected

CONF Full

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



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ROPS In-Service Experience

It's happening now

Certified by:
EASA, FAA, CAAC



1st Prototype
April 2004

Research
Oct. 1998 - Feb. 2002

A380 - 2009

A320 - 2013

A350 - 2014

A330 - 2015

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.

Aircraft Manufacturer

January 2014

APPENDIX F



European Action Plan for the Prevention of Runway Excursions

Edition 1.0



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)

(Jan 2013)

EASA NPA 2013-09: Reduction of Runway Excursion



European Aviation Safety Agency – Rulemaking Directorate
Notice of Proposed Amendment 2013-09

Reduction of Runway Excursions

RMT.0047 (25.027), RMT.0569 and RMT.0570 – 10/05/2013

EXECUTIVE SUMMARY

The scope of this rulemaking activity is outlined in the Terms of Reference (ToR) RMT.0047 (25.027), RMT.0569 and RMT.0570, Issue 1 of 9 October 2012.

For the last decades, runway excursions at landing (and in particular runway overruns) have been recognised as a major contributor to accidents worldwide and as an important risk to aviation safety.

Based on the analysis of these events, safety review reports, safety recommendations, and the recent development of on-board protective systems that can help to reduce the number of runway overruns at landing, this NPA proposes:

- a draft Decision for amending CS-25 (RMT.0047 (25.027)) for the certification standards of Runway Overrun Awareness and Avoidance Systems (ROAAS) for new designs; and
- a draft Opinion amending Part-26 (RMT.0569) and a draft Decision amending CS-26 (RMT.0570) for the mandatory installation of ROAAS into large aeroplanes produced after a certain date and operated by European commercial air transport operators.

Applicability	Process map
Affected regulations and decisions: CS-25, CS-26, Part-26	Concept Paper: No
Affected stakeholders: Large Aeroplane TC holders and applicants for TC/STC	Terms of Reference: 09/10/2012
Large aeroplane operators	Rulemaking group: No
Flight crew and Training Organisations	RIA type: Full
Driver/origin: Safety	Technical consultation during NPA drafting: Yes
Reference: See Pre-RIA	Duration of NPA consultation: 3 months
	Review group: TBD
	Focused consultation: TBD
	Publication date of the Opinion: 2013/Q4
	Publication date of the Decision: 2013/Q4: CS-25
	2014/Q1: CS-26

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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 ROASS 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



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DATE: 02/06/11

SOURCE: Flight International

Airbus offers runway overrun protection system to competitors

By David Lee

Airbus has decided not to keep its patented runway overrun prevention system (ROPS) as a "product differentiator", 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 air 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's Global Runway Safety Symposium, and that the International Federation of Airline 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 A380s that come off the line. It is installed on more than 60% of the in-service **A380** fleet. It will be in all A350s, and from next year, it will be available on the other new-build Airbus types or for retrofit.

ROPS is integrated with the aircraft's flight management and navigation systems, and provides the pilots 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.

Related Articles

NBAA: Airbus to extend runway overrun protection to corporate jets (20/10/10)

FARNBOROUGH: Smart safety avionics in the A350 (13/07/10)

Industry Resources

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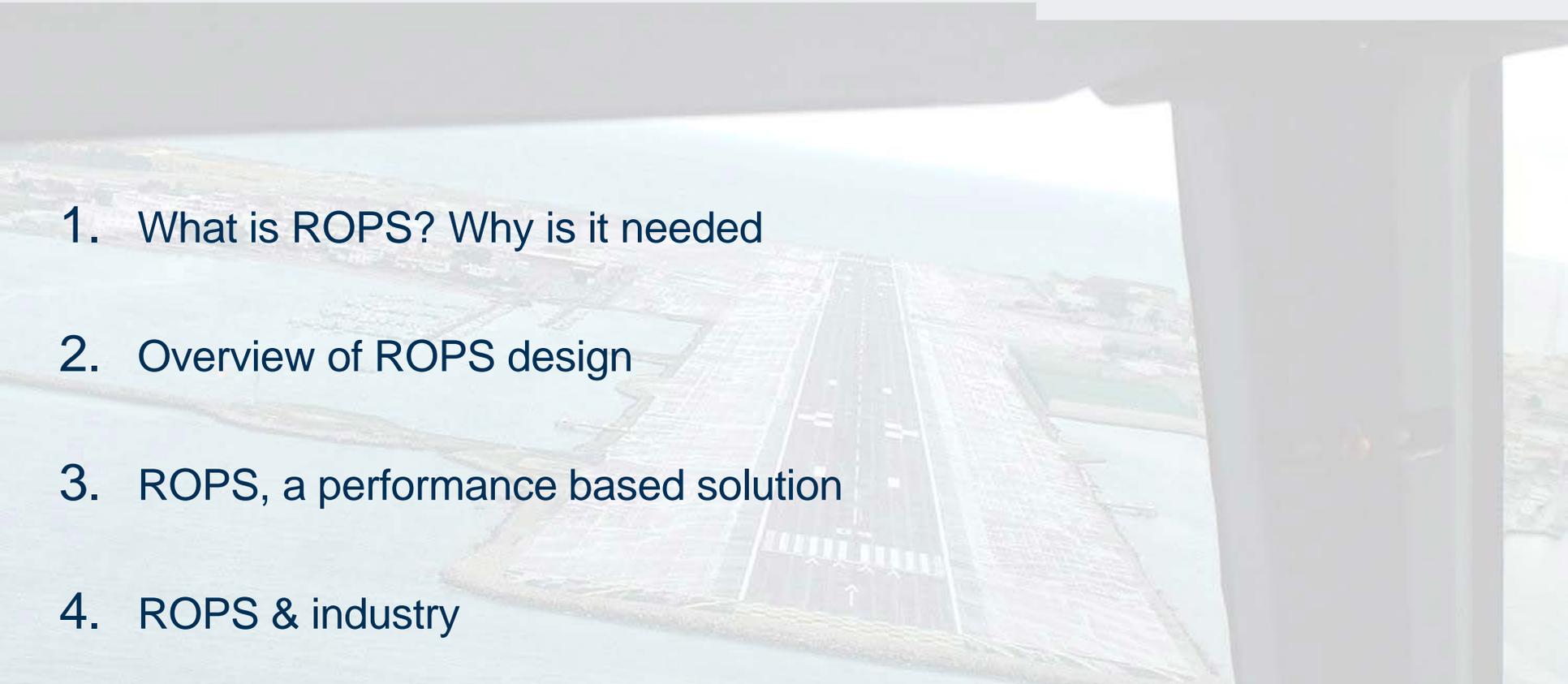
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- 
- An aerial photograph of an airport runway, viewed from an elevated perspective. A red wireframe grid is overlaid on the runway and surrounding taxiway areas, representing the ROPS (Runway Overlap Protection System) design. The runway is dark asphalt, and the surrounding areas are lighter, possibly grass or concrete. The background shows a hazy sky and some distant buildings.

5. Conclusion

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**

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Thank You

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