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Operational Landing Distances A new standard for in-flight landing distance assessment

1. Introduction

A third of major accidents of large commercial transport aircraft are runway excursions. Many involve difficulties by the crew to realistically assess the available landing distance margins at time of arrival.

This is to some extent explained by three contributing factors:

► The multitude of methods and formats for assessing and reporting the runway surface condition

► The lack of explicit regulation regarding the in-flight landing distance assessment

► The variety of landing performance data formats published by manufacturers or operators for in-flight use.

Following a runway overrun in winter conditions, the FAA launched a full review of American operators landing distance assessment policies. This review led the FAA to recommend guidelines and best practices to the airlines by the Safety Alert for Operators (SAFO) 06012, followed up by Advisory Circular (AC) 91-79. It then created the Takeoff and Landing Performance Assessment Aviation Rulemaking Committee (TALPA ARC). This group of representatives from the FAA and other regulators, airlines, airport operators, pilot associations and most manufacturers, including Airbus, finalized its proposal for new regulation of in-flight landing distance assessment in July 2009.

This article briefly describes the current regulations covering the landing distance assessment, restricted to the FAA and EASA for simplification purposes, and the options Airbus has chosen to follow. It will then outline the main concepts of the proposed TALPA ARC rules for landing.

2. Current situation

2.1. Runway condition assessment and reporting

There is currently not a unique standard for runway condition assessment and reporting:

► Most frequently the contaminant type and depth is reported, with variation in the measurement means and terminology

► When runway friction measurement vehicles are available, friction values may be reported, although there is no correlation available for a runway friction measured by a vehicle with aircraft performance on the same surface

► After landing, it is common practice for North American pilots used to winter conditions to report their assessment of braking action to the tower, and thus to following aircraft. The assessment is based on a scale ranging from GOOD to POOR.

2.2. In-flight assessment operational rules

Current FAA and EASA rules make a generic statement regarding the need to assess landing performance in flight: “The commander must satisfy himself/herself that, according to the information available to him/her, the weather at the aerodrome and the condition of the runway intended to be used should not prevent a safe approach and landing”. No guidance is given on the criteria and factors to be taken into account for the determination of a safe landing distance.

2.3. Landing performance computation and publication

2.3.1. Actual Landing Distances (ALD)

The data published in the Airbus operational documentation for in-flight reference are labeled as Actual Landing Distance (ALD). They are defined by regulations for publication in the Flight Manual for dry (FAA and EASA) and contaminated (EASA only) runways. There is no such a regulation for wet runways.

The ALD are the basis upon which margins are added for the regulatory dispatch requirements.

They are not a valid reference data for making in-flight performance assessments when used as published, with no additional margin (fig. 1 & 2).

The ALD are published for sea level, a reference temperature and no wind. Corrections for pressure altitude, longitudinal wind, reverse thrust use, planned approach speed, automatic landing and auto brake use are provided, but not for runway slope or temperature. A runway down slope or higher than reference temperature will thus make the achievable landing distance longer than the published one .

Airbus ALD computation method

Air distance:
- For dry and wet runways, it is derived from flight tests conditions.
- For contaminated runways, EASA has defined the air distance as 7 seconds at the equivalent ground speed of Vref, with a 7% speed decay between threshold and touchdown.

Ground roll wheel to ground frictions:
- For dry runways, it is derived from flight tests.
- For wet runways, Airbus uses the regulatory smooth runway friction approved for rejected take-off.
- For contaminated runways, they are defined by EASA regulations.

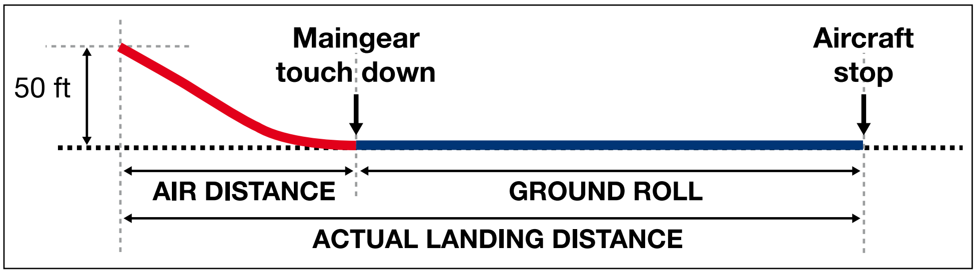

Figure 1
Regulations breakdown of ALD into air distance and ground roll

Runway condition	**Airbus ALD computation**		Regulatory basis
	Air distance	Ground roll wheel to ground frictions	
DRY	Flight tests	Flight tests	FAA and EASA
WET	Flight tests	FAA/EASA model with WET anti-skid efficiency from flight tests	FAA and EASA Rejected take-off
CONTAMINATED	7 sec with 7% speed decay	EASA CS25.1591	EASA only

Figure 2
Main characteristics of the ALD published by Airbus

2.3.2. Landing distance requirements for dispatch

The Required Landing Distances for dispatch are defined by regulations as factored ALD and are labeled as RLD (fig. 3). They must be shorter than the declared Landing Distance Available (LDA) of the intended runway, and vary with:

- Runway condition, and
- The approach type (for EASA only: dispatch requirement with AUTOLAND planned at arrival).

No RLD corrections are published for runway slopes or temperatures above the reference temperature:

- For dry runways, the effects of slope and temperature are covered by the large regulatory margin.
- For wet and contaminated runways the margins are comparatively small, particularly when taking into account that the recommended approach speed is Vref+5, which increases the landing distance significantly.

Figure 3
Main characteristics of the RLD

Runway condition	**RLD computation**	Regulatory basis	Reverse credit
DRY	1,67 x ALD DRY	FAA and EASA	No
WET	1,15 x RLD DRY = 1,92 x ALD DRY	FAA and EASA	The 15% margin implies use of max reverse thrust
CONTAMINATED	1,15 x ALD CONTAMINATED	EASA only	Allowed

3. FAA TALPA ARC proposals

The TALPA ARC proposals consist of three intensely related packages of:

► **Airports** standards for runway condition reporting (FAR139)

► **Aircraft** operational landing performance computation (FAR25/26)

► **Operators** operational rules (FAR121) and training.

3.1. Runway condition assessment and reporting

The centerpiece of the proposals is the runway condition "Matrix" hereafter, that associates:

► 7 runway condition codes, built on the existing ICAO runway friction codes, to

► 6 aircraft performance levels defined in § 3.2.1. No performance level is provided for the code 0 as operations in these conditions are prohibited.

► Provisions of specific landing and rejected take-off performance credit for wet grooved or PFC runways have been made. However no specific runway code was assigned to such runways.

The following reports are used as entry points:

► Contaminant type and depth

► Pilot braking action (PiREP)

► Runway friction measurement (Mu (µ)).

The latter two report types should be used exclusively to downgrade a runway assessed by means of contaminant type and depth (primary columns).

Fluid contaminants (snow, water, slush) generate an extra drag, function of their depth:

► TALPA ARC proposals limit this credit at landing (to half of the reported depth)

► Airbus has elected to take no credit for this fluid contaminant drag at landing, enabling one unique aircraft landing performance level associated with each code.

The "Matrix" has been already extensively tested in Alaska and other US airports in real conditions during the 2008-2009 and 2009-2010 winters. The runway condition classification made in the "Matrix" will also be the basis of the digital NOTAM system currently being developed in the US.

The information to be transmitted to the flight crew includes:

► The runway code for each third of the runway

► The type and depth of the contaminant and percentage of coverage in 25% increments

► The PiREPS when available.

Airport Estimated Runway Condition Assessment				Pilot Reports (PIREPs) Provided To ATC And Flight Dispatch
Runway Condition Assessment – Reported		Downgrade Assessment Criteria		
Code	Runway Contaminant	Mu (µ)	Deceleration And Directional Control Observation	PIREP
6	• Dry			Dry
5	• Wet (Smooth, Grooved or PFC) • Frost **1/8" or less of:** • Water, Slush, Dry or Wet Snow	40µ or higher	Braking deceleration is normal for the wheel braking effort applied. Directional control is normal.	Good
4	**At or below -13ºC:** • Compacted Snow	39-35µ	Brake deceleration and controllability is between Good and Medium.	Good to Medium
3	• Wet (Slippery) **At or below -3 C:** • Dry or Wet Snow greater than 1/8" **Above -13ºC and at or below -3ºC:** • Compacted Snow	34-30µ	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be slightly reduced.	Medium
2	**Greater than 1/8" of:** • Water or Slush **Above -3 C:** • Dry or Wet Snow greater than 1/8" • Compacted Snow	29-25µ	Brake deceleration and controllability is between Medium and Poor. Potential for hydroplaning exists.	Medium to Poor
1	**At or below -3°C:** • Ice	24-21µ	Braking deceleration is significantly reduced for the wheel braking effort applied. Directional control may be significantly reduced.	Poor
0	• Water on top of Compacted Snow • Wet Ice, Dry or Wet Snow over Ice **Above -3ºC:** • Ice	20µ or lower	Braking deceleration is minimal to non-existent for the wheel braking effort applied. Directional control may be uncertain.	Nil

Primary columns (Code, Runway Contaminant) — Downgrade columns (Mu, Deceleration, PIREP)

note

Code 2 - Water depth greater than 1/8" (3 mm) - may not be detected by airports, and may therefore not be reported.

TALPA ARC main rules associated to the "Matrix"

- Pilot reports (PIREPs) of braking action might provide insight that the friction level fell since the last airport evaluation. With existing technology, these reports reflect a purely subjective pilot evaluation, presently only in North America and from pilots used to such a difficult evaluation. They rarely apply to the full length of the runway. The airport should exercise prudent judgment, prompt a new evaluation, and if warranted, report a lower runway condition code than the "Matrix" would indicate for the contaminant type.
- Friction values from measurement vehicles in winter conditions will no longer be transmitted to pilots, but restricted for the airport authorities use in consolidating or downgrading a runway code. The "Matrix" area shown in blue above is therefore meant for airport use only.
- All ambiguous airport reporting terms will be eliminated (such as "patchy", "thin", etc).
- A damp runway must be considered wet.
- Wet runways failing maintenance friction survey as defined in AC 150-5320 (e.g., heavy rubber deposits) will be reported as "Slippery" until brought back into required friction standards.

3.2. Landing performance computation and publication

3.2.1. Operational Landing Distance (OLD)

The TALPA proposal defines the Operational Landing Distance (OLD) as the maximum landing performance realistically achievable by a line pilot adhering to standard techniques (fig. 4).

OLD computation method

Air distance:
The length of the air distance is the distance covered in 7 seconds at the ground speed corresponding to the approach speed (including temperature and conventional wind effect), with speed decay during the flare set at 4%.

Ground roll wheel to ground frictions:
Deceleration means are considered as per their prescribed use in the Standard Operating Procedures (SOP):
- For landing in manual braking, maximum pedal braking is assumed to be initiated, if allowed by SOP, at main gear touchdown with reversers deployed shortly after.
-For landing with auto brake, the automatic sequence is followed.

Runway condition code	Braking action	Main contaminant description	OLD computation		Regulatory basis	Reverse credit
			Air distance	Ground roll wheel to ground frictions		
6	/	DRY	7 sec, with 4% speed decay	Flight tests with abatement for rubber contamination	FAA	Allowed
5	GOOD	WET		Unchanged FAA/EASA model with wet anti-skid efficiency		
4	GOOD TO MEDIUM	Compact Snow		Consistent in essence with EASA CS25.1591 (*)		
3	MEDIUM	Loose Snow				
2	MEDIUM TO POOR	Standing Water, Slush				
1	POOR	ICE				

Figure 4
Main characteristics of the OLD

(*) The over-conservative ICE value built for dispatch requirements is changed to a more realistic friction coefficient.

3.2.2. Landing distance requirements for dispatch

TALPA ARC was not mandated to review current dispatch rules, therefore the existing rules continue to apply. However for the long term, the need to review dispatch landing distances for consistency with the time of arrival requirements, was acknowledged by TALPA ARC in its submission to the FAA.

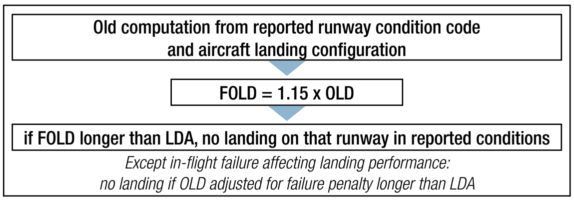

Figure 5
In-flight assessment prior to initiating an approach

3.3. In-flight assessment operational rules

The FAR 121 operational rules will mandate an in-flight landing distance assessment based on 115% of the Operational Landing Distance published for prevailing conditions (FOLD or Factored OLD) (fig. 5).

With the current dispatch requirements, it will be permitted to omit the in-flight assessment for landing on the runway planned at dispatch only if:

► Dispatch was performed for DRY and if, at the time of the approach preparation, a dry runway and no worse conditions than the standard ones considered for dispatch are reported

► Dispatch was performed for WET and if, at the time of the approach preparation, a wet runway and no worse conditions than those considered for the dispatch are reported and the runway is maintained to the standards defining grooved or PFC runways in AC 150-5320.

4. Conclusion

The FAA TALPA ARC proposal for regulatory changes is made up of three intensely related packages of:

► **Airport** runway condition reporting standards

► **Aircraft** performance computation and publication standards

► **Operators** operational rules and training.

The resulting FAA regulation will become applicable to all new aircraft, and be made retroactive for all existing aircraft.

Airbus supports the new methods for assessing Operational Landing Distances as part of the Industry efforts to help further reducing the runway overruns at landing.

Airbus will provide Operational Landing Distance data in the documentation by mid-2011, and has anticipated by issuing recommendations for interim measures since May 2009.

note

The Runway Overrun Prevention System (ROPS), described in Safety First Issue 8 dated July 2009, is consistent with the TALPA ARC proposals. The system was certified in October 2009 on the A380.
A future article will detail how the ROPS integrates the new in-flight landing distance assessment rules.

Safety First

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