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Airbus New Operational Landing Distances

1. Introduction

The Operational Landing Distances (OLD) were described in an article titled "Operational Landing Distances - A New Standard for In-Flight Landing Distance Assessment" published in the tenth issue of Safety First, dated August 2010. This new standard is the outcome of the FAA Takeoff and Landing Performance Assessment Aviation Rulemaking Group (TALPA ARC), and considered a strong industry consensus. The article concluded that Airbus supported the OLD concept and would anticipate FAA rulemaking by providing operational documentation and computation tools to customers in the course of this year.

This paper describes the way the OLDs will be published from the end of the year by Airbus. Airlines should start planning the integration into their operations, especially concerning publication of the information and training of the concerned personnel.

2. Major Conceptual Changes

The TALPA ARC rulemaking recommendations to the FAA are a tightly integrated package of three sets of regulation proposals:

► To AIRPORTS, on the runway condition assessment and reporting mechanisms,

► To AIRCRAFT MANUFACTURERS, on the publication of in-flight landing performance assessment data,

► To OPERATORS, on the time of arrival assessment.

Airbus is tackling the adaptation of its ground and on-board performance computation tools, and of the operational documentation to comply with the principles set down in the proposals. They will as well recommend best practices to their customers on how to use this information and take most advantage of the concept.

However, the regulatory framework for the OLD concept is not in place yet, even under FAA rule. The major consequence is that the use of the OLDs has to fit into an environment where runway condition reporting practices will not necessarily comply with the recommendations.

Another aspect is that the new in-flight performance assessment may, under some conditions, be more constraining than currently applicable dispatch requirements. This is especially true under JAR/EASA rule. As a result, a runway that is dispatched to according to the current factored Available Landing Distances (ALDs) requirement may, as soon as the aircraft leaves the ground, become inappropriate according to the OLDs.

Airlines will have to put into place policies and training to enable crews to compensate for these shortcomings, until the rulemaking processes that have been initiated by FAA, ICAO and EASA come to fruition.

3. The Matrix

The Runway Condition Assessment Table is the cornerstone of the OLD concept. It provides a mechanism for mitigation of a number of real-life risks associated with performance computations based on contaminant type and depth only. These risks include:

► Disregard or wrong interpretation by the flight crew of reports of runway contaminants not covered in the performance computation options, like frost/rime or slippery when wet .

► Disregard or wrong interpretation by the flight crew of reported estimated friction or braking action (Pilot Report).

► Contaminant phase change around freezing point.

► Layered contaminants.

► Rapid change in conditions under active precipitation.

The TALPA ARC runway condition reporting process intends to cover a maximum of possible conditions, and to make a safe report to flight crew by considering all information that may be available. This does not mean that credit of accuracy is given to the subjective assessment made by a preceding pilot or to a continuous friction measurement, for which the lack of correlation with aircraft performance has been extensively discussed over the years. However, the indicators given by such information, when available, should be used to downgrade a primary assessment made on the basis of the contaminant type and depth.

Code	Runway Condition Description	Deceleration and Directional Control Observation	Reported Braking Action
6	Dry		Dry
5	Wet • Water up to 1/8" (3mm) • Damp ***1/8" (3mm) or less of*** • Slush • Dry Snow • Wet Snow	Braking deceleration is normal for the wheel braking effort applied. Directional control is normal.	Good
4	Frost Compacted Snow ***(OAT at or below -15ºC)***	Brake deceleration and controllability is between Good and Medium.	Good to Medium
3	Slippery when wet ***More than 1/8"(3mm)*** • Dry Snow – max 5" (130mm) • Wet Snow – max 1 1/8" (30mm) Compacted Snow ***(OAT above -15ºC)***	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be noticeably reduced.	Medium
2	***More than 1/8" (3mm)*** • Water – max 1/2" (12.7mm) • Slush – max 1/2" (12.7mm)	Brake deceleration and controllability is between Medium and Poor. Potential for hydroplaning exists.	Medium To Poor
1	Ice ***(cold & dry)***	Braking deceleration is significantly reduced for the wheel braking effort applied. Directional control may be significantly reduced.	Poor
0	• Wet Ice • Water on top of Compacted Snow • Dry Snow or Wet Snow over Ice	Braking deceleration is minimal to non-existent for the wheel braking effort applied. Directional control may be uncertain.	Nil

Figure 1
TALPA ARC runway condition matrix

In fact, as long as international standards do not exist for the airports to fulfill their role in the TALPA ARC system, the flight crew will have to do their best, from their imperfect vantage point in the cockpit, to make a full runway condition assessment with all the information they have at their disposal without being able to inspect the runway themselves. This is a compulsory first step in performing the time-of-arrival performance computation, more so since Airbus has decided to present landing distances against the 6 operable levels of Reported Braking Action (RBA) that make up the matrix.

4. Implementation

4.1. Certified Airplane Flight Manual (AFM)

The Operational Landing Distances are purely advisory and do not have an impact on aircraft certification. However, since the OLDs are a new reference for in-flight landing performance assessment, Airbus has decided to use this reference under all circumstances, including when a system failure has occurred during the flight, which affects approach speed and/or landing distance. This information is subject to approval by the authorities, and the OLD concept will thus find its way into the AFM in this area. We have taken this opportunity to move it into the digital AFM, thus permitting optimized computations for failure situations, including in case of multiple failures.

4.2. Documentation

Airbus currently publishes the certified Actual Landing Distances (ALDs) in the Quick Reference Handbook (QRH) and the Flight Crew Operating Manual (FCOM). The ALDs serve as a basis for in-flight landing distance assessments both without and with in-flight system failures. The shortcomings of this policy were described in depth

in the previously mentioned article published in Safety First n°10.

The switch to the OLDs for the assessment at time-of-arrival involves a number of changes to the Airbus operational documentation: FCOM, QRH and also FCTM (Flight Crew Training Manual) for background explanation and examples.

Perhaps unexpectedly, these changes also concern the dispatch information, which must be derived by the user from the ALD by applying the appropriate factors. To allow complete removal of the ALD tables, it is thus necessary to switch to a publication of Required Landing Distances (RLD) that are already factored.

A major change in publication practices is the replacement of corrections for variations from reference conditions as increments in meters rather than in percent. This allows a more straightforward computation by the flight crew.

Notably, the RLDs are shown against the usual runway description terms of contaminant type, since this data is certified and must follow existing JAR/EASA regulation. Conversely, the OLDs will be shown against the Reported Braking Action (RBA) terms of Dry, Good, Good to Medium, Medium, Medium to Poor and Poor to allow the full benefit of the matrix used in reporting runway condition.

For each of the RBA, two consecutive tables for both certified landing configurations will show all required information for:

- Manual and automatic landing
- Manual and automatic braking
- Normal and overweight landing.

On top of the usual parameters, the new OLD will include accountability for outside temperature and runway slope, in full compliance with the recommendations formulated by the TALPA ARC.

The use of these tables will be associated to a new and simplified flow chart for approach speed determination. This will take into account the appropriate requirements

Required Landing Distances (m)					
Runway state / Weight (1000 kg)	Dry	Wet	Compacted snow	Slush	Water
46	1170	1340	1370	1360	1410
50	1220	1400	1450	1450	1500
54	1270	1460	1540	1540	1590
58	1330	1530	1620	1630	1690
62	1390	1600	1700	1730	1820
66	1510	1730	1780	1820	1950

Figure 2
Required Landing Distances (RLDs) table

Corrections on landing distances (m)						
Runway state		Dry	Wet	Compacted snow	Slush	Water
Altitude	Per 1000ft above SL	+ 60	+ 60	+ 80	+ 110	+ 40
VAPP	Per 5 kt	+ 90	+ 110	+ 90	+ 100	+ 110
Wind	Per 5 kt TW	+ 280	+ 320	+ 280	+ 380	+ 440
REV	all reversers operative	-	-	-140	-140	-160

Figure 3
RLDs correction table

Figure 4
Operational Landing Distances (OLDs) table

GOOD									
CONF FULL									
		WEIGHT corr*		SPD corr	ALT corr	WIND corr	TEMP corr	SLOPE corr	REV corr
Corrections on landing distance (m) / Braking mode	REF DIST (m) for 66T	Per 1T below 66T	Per 1T above 66T	Per 5kt	Per 1000ft above SL	Per 5kt TW	Per 10°C above ISA	Per 1% down slope	Per thrust reverser operative
Manual	1420	- 20	+ 30	+ 90	+ 80	+ 150	+ 40	+ 30	- 50
Autobrake MED	1470	- 20	+ 30	+ 90	+ 80	+ 160	+ 40	+ 30	- 40
Autobrake LOW	1970	- 20	+ 40	+ 120	+ 90	+ 180	+ 60	+ 30	- 10
Autoland corr (m)	+ 340	** In case of an overweight landing, add 100m.*							

CONF 3									
		WEIGHT corr*		SPD corr	ALT corr	WIND corr	TEMP corr	SLOPE corr	REV corr
Corrections on landing distance (m) / Braking mode	REF DIST (m) for 66T	Per 1T below 66T	Per 1T above 66T	Per 5kt	Per 1000ft above SL	Per 5kt TW	Per 10°C above ISA	Per 1% down slope	Per thrust reverser operative
Manual	1570	- 20	+ 20	+ 100	+ 90	+ 170	+ 50	+ 40	- 60
Autobrake MED	1620	- 20	+ 20	+ 100	+ 90	+ 180	+ 60	+ 40	- 40
Autobrake LOW	2130	- 20	+ 30	+ 130	+ 100	+ 180	+ 60	+ 20	- 10
Autoland corr (m)	+ 340	** In case of an overweight landing, add 150m.*							

for autothrust use, ice accretion and wind, including their effect on the landing distance.

The same format will be used for landing distance determination with in-flight failures, thus directly providing a distance for the relevant aircraft condition instead of a correction factor to be applied to the appropriately determined reference distance without failure. This presentation no longer requires pilots to refer to two different sections of the QRH to make this computation, everything is available in one place.

5. FlySmart with Airbus

For all users of the Airbus Electronic Flight Bag solutions, collectively known as FlySmart with Airbus (FSA), the Landing module is being fully redesigned to implement the OLDs for the in-flight computations, while dispatch remains largely unchanged.

The on-board platform with full optimization capability allows an enhanced implementation when compared with the charts of the QRH. For example, the approach speed can be determined in full compliance with those computed by the Flight Management System (FMS) and displayed on the Primary Flight Display (PFD) to the pilots.

HYDRAULIC SYSTEM											
* In case of an overweight landing, add 120m.				WEIGHT corr*		SPD corr	ALT corr	WIND corr	TEMP corr	SLOPE corr	REV corr
FAILURE	FLAPS LEVER for LDG	D VREF APPR SPD INCR	REF DIST (m) for 66T	Per 1T below 66T	Per 1T above 66T	Per 5kt	Per 1000ft above SL	Per 5kt TW	Per 10° above ISA	Per 1% down slope	Per thrust reserver operative
DRY											
GREEN	FULL	-	1280	- 10	+ 20	+ 90	+ 50	+ 100	+ 40	+ 20	- 40
	3	6	1350	- 10	+ 20	+ 90	+ 60	+ 120	+ 50	+ 30	- 40
BLUE	FULL	-	1150	- 10	+ 30	+ 80	+ 50	+ 110	+ 40	+ 20	- 20
	3	6	1240	- 10	+ 30	+ 90	+ 50	+ 130	+ 50	+ 30	- 20
YELLOW	FULL	-	1180	- 10	+ 30	+ 90	+ 50	+ 110	+ 50	+ 30	- 20
	3	6	1270	- 10	+ 30	+ 90	+ 60	+ 120	+ 50	+ 30	- 30
GREEN + BLUE	3	25	1680	- 10	+ 30	-	+ 60	+ 130	+ 60	+ 40	- 50
GREEN + YELLOW	3	25	2430	- 20	+ 40	-	+ 80	+ 190	+ 90	+ 110	-
BLUE + YELLOW	FULL	-	1290	- 10	+ 20	+ 30	+ 40	+ 110	+ 50	+ 30	- 30
	3	6	1320	- 10	+ 30	+ 90	+ 50	+ 110	+ 50	+ 40	- 30
GOOD											
GREEN	FULL	-	1740	- 10	+ 30	+ 130	+ 70	+ 200	+ 70	+ 50	- 100
	3	6	1920	- 10	+ 30	+ 140	+ 80	+ 230	+ 90	+ 90	- 110
BLUE	FULL	-	1520	- 10	+ 30	+ 110	+ 60	+ 180	+ 70	+ 50	- 60
	3	6	1690	- 10	+ 30	+ 120	+ 70	+ 200	+ 80	+ 60	- 70
YELLOW	FULL	-	1610	- 20	+ 30	+ 120	+ 70	+ 190	+ 70	+ 50	- 80
	3	6	1790	- 20	+ 30	+ 130	+ 80	+ 210	+ 80	+ 70	- 100
GREEN + BLUE	3	25	2540	- 20	+ 40	-	+ 80	+ 210	+ 110	+ 120	- 170
GREEN + YELLOW	3	25	2740	- 30	+ 50	-	+ 110	+ 270	+ 120	+ 150	-
BLUE + YELLOW	FULL	-	1800	- 10	+ 30	+ 50	+ 70	+ 210	+ 80	+ 80	- 100
	3	6	1910	- 10	+ 40	+ 150	+ 80	+ 220	+ 90	+ 80	- 110
GOOD to MEDIUM											
GREEN	FULL	-	1890	- 10	+ 30	+ 120	+ 70	+ 190	+ 70	+ 90	- 100
	3	6	2050	- 10	+ 30	+ 120	+ 80	+ 190	+ 80	+ 100	- 110
BLUE	FULL	-	1770	- 10	+ 30	+ 90	+ 60	+ 170	+ 70	+ 70	- 80
	3	6	1940	- 10	+ 30	+ 100	+ 70	+ 180	+ 80	+ 80	- 100
YELLOW	FULL	-	1870	- 20	+ 30	+ 100	+ 70	+ 180	+ 70	+ 80	- 100
	3	6	2050	- 20	+ 30	+ 110	+ 70	+ 180	+ 80	+ 90	- 120
GREEN + BLUE	3	25	2580	- 20	+ 30	-	+ 80	+ 210	+ 90	+ 120	- 160
GREEN + YELLOW	3	25	2750	- 20	+ 40	-	+ 90	+ 210	+ 100	+ 140	-
BLUE + YELLOW	FULL	-	2070	- 10	+ 20	+ 40	+ 70	+ 190	+ 80	+ 100	- 120
	3	6	2180	- 10	+ 30	+ 120	+ 80	+ 190	+ 80	+ 110	- 140

Figure 5
In-flight failures correction table

But it is in case of in-flight failures that the capabilities are greatly enhanced by FSA: the computation of the landing performance in these cases will be based on a physical model of the aircraft in the degraded condition. It will be possible to combine them with automatic landing and breaking, overweight landing, and eventually dispatch under Minimum Equipment List (MEL) or Configuration Deviation List (CDL).

Furthermore, FSA provides flexibility to operators to enforce their company policy regarding margins to be taken on landing distances. While the paper charts in the QRH reflect the realistic maximum aircraft performance capability, materialized by the OLD, the Landing module will systematically consider the Factored OLD (FOLD). Only if the available margins are below the company requirements will the computation return a result based on the unfactored OLD, and clearly inform the crew with standard color coding of this reduced margin operation, as illustrated in fig 6,7 and 8.

Figure 6
RWY COND: 3-Medium
Runway not limiting, results displayed in green and MLW(perf) limited by FOLD

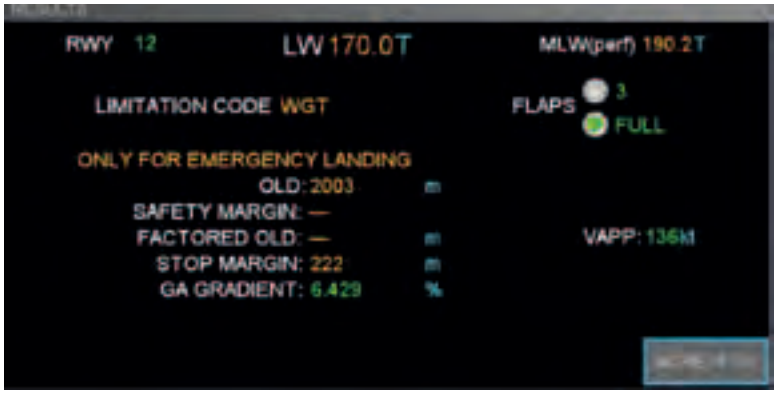

Figure 7
RWY COND: 2- Medium to poor
FOLD longer than Landing Distance Available (LDA), but OLD less than LDA, results displayed in amber and MLW(perf) limited by OLD.

Figure 8
RWY COND: 1-POOR
Runway too short even for OLD, no result and MLW(perf) limited by OLD less than actual landing weight shown in red.

6. Status

Airbus is working to a target date end of September this year for the EFB (Flysmart with Airbus) and the revision of the digital FCOM and QRH:

► The new electronic flight manual (OCTOPUS V28) has received approval from EASA end of April 2011. Aircraft database production has started. This is the basis for all the other work packages, since it provides the capability to actually calculate OLDs.

► For the operational documentation, the new layout of the landing distance tables is finalized. Internal tools for the semi-automatic computation of the tables are under development. Full scale production will start by June.

► The EFB Landing module for L3 standard is undergoing internal validation at this time. Several additional iterations seem likely to allow us to iron out any issues and make it robust for entry into service with the operators.

An update to the Flight Operations Information Letter should be issued beginning of summer, which will include a more detailed view on the final products.

7. Conclusion

Runway excursion is currently the number one safety risk in terms of occurrences according to ICAO accident statistics.

Let us hope that this risk will be significantly reduced thanks to the combination of:

► The implementation of the OLD concept.

► The introduction of upcoming design features that assist crews in the Go Around decision making process, by providing runway overrun warning (see article on Runway Overrun Prevention System in the eighth Safety First issue, dated July 2009).

Safety First

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