
Performance de aterrizaje y criterios de aproximación estable

Seminario sobre prevención de excursión de pista 2014

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Contenido

1 Operación de LAN

2 Cálculo de la Performance de Aterrizaje

3 Dispatch and Inflight Landing Distances

4 Criterios de Aproximaciones Estables

Operación LATAM



Flota LATAM

- 319 Aviones en LATAM
 - 161 Aviones en TAM
 - 158 Aviones en LAN
 - 105 Aviones Narrow Body (A320 Fam y Dash)
 - 53 Aviones Wide Body (B767, B787, B777F y A340)
 - Nuevos A321 ,B787-9 y A350 se incorporarán próximamente

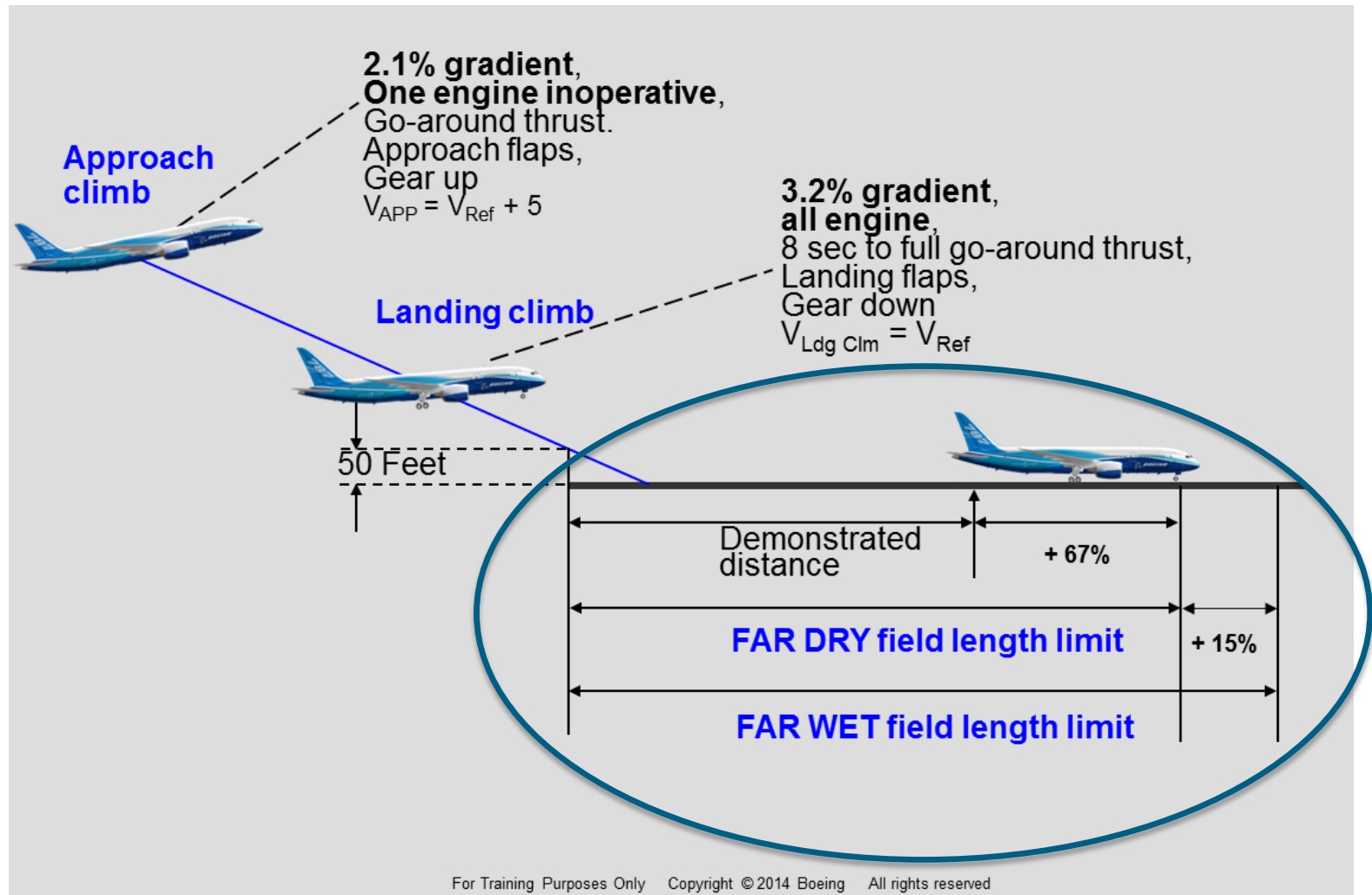
Operación LAN

- Aproximadamente 700 operaciones diarias , 255.000 al año
- 84 % de las operaciones son en flota NB
- 16% son en flota WB.
- 95% son operaciones en flota Pax.
- 5% de la operación es en flota carguera.
- Mas de 100 Aptos son operados por LAN (carga y pax)
- Mas del 90% son aeropuertos en Sudamérica
- Operación Domestica en Argentina, Chile, Colombia, Ecuador y Perú,
- y en el domestico Brasil considerando la operación de TAM.

Cálculo de la performance de aterrizaje

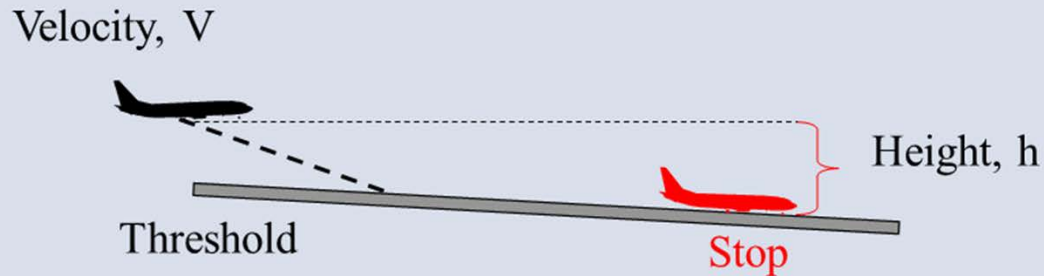


Cálculo del peso máximo de aterrizaje



Cálculo de la distancia de aterrizaje

El aterrizaje es un asunto de manejo de la energía



$$\text{Initial Energy} = \frac{1}{2} m V^2 + m g h$$

$$\text{Final Energy} = 0$$

Change in energy is equal to the work done to cause that change in energy

- Aerodynamic drag
- Wheel brakes
- Thrust (forward idle, reverse)
- Gravity

Factores Ambientales.

- Elevación del aeropuerto
- Meteorología
- Fricción de la Pista

Cálculo de la Distancia de Aterrizaje

1

Landing Distance Calculation at Dispatch

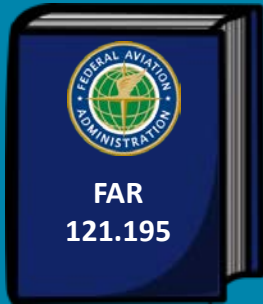
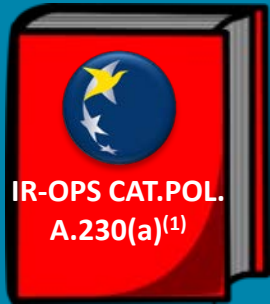


2

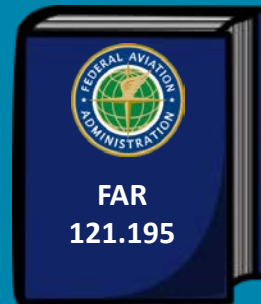
Landing Distance Calculation in Flight



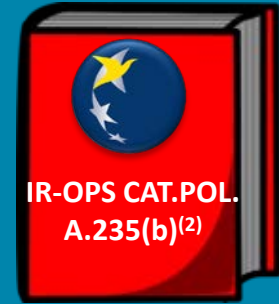
Actual Regulación para los cálculos en el despacho



$$RLD_{dry} = ALD / 0.6$$



$$RLD_{wet} = 1.15 \times RLD_{dry}$$

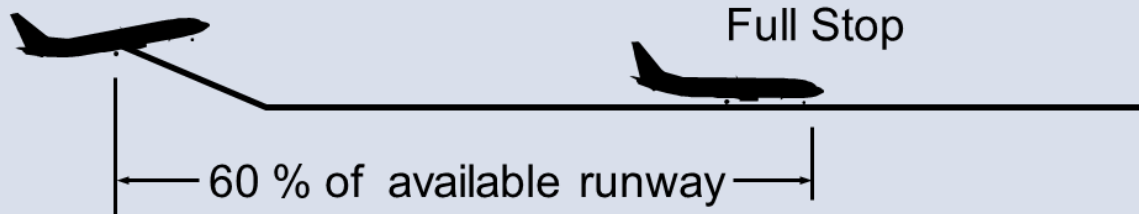


$$\text{Max of } \begin{cases} RLD_{conta} = \\ 1.15 \times ALD_{conta} \\ RLD_{wet} \end{cases}$$

RLD shorter than Landing Distance Available (LDA)

Actual Landing Distance

$$V_{APP} = V_{REF} = 1.23 V_{S 1-G} \text{ or } 1.30 V_{S FAR}$$



- Based on demonstrated distance:

- V_{REF}
- Aggressive touchdown
- Maximum manual braking and automatic speedbrakes
- No reverse thrust
- ISA and no runway slope
- Pressure altitude and wind accounted for
- Distance is measured from a 50 ft threshold height to full stop

ALD are not representative of daily operations

$$RLD_{dry} = ALD / 0.6$$

$$RLD_{wet} = 1.15 \times RLD_{dry}$$

Evolución de Aviones y del ACN

FCOM Tables

RLD CONF FULL

The RLD in the first table considers: Sea Level (SL), ISA, no wind, no slope, no engine reverse thrust, manual landing, and VAPP=VLS.

Required Landing Distances (m)

Runway State Weight (1000 kg)	Dry	Wet	Compacted snow	Slush	Standing Water
42	1 150	1 320	1 350	1 380	1 410
46	1 140	1 310	1 360	1 390	1 430
50	1 190	1 370	1 440	1 490	1 520
54	1 240	1 420	1 510	1 580	1 630
58	1 280	1 470	1 570	1 660	1 730
62	1 330	1 530	1 640	1 740	1 830
66	1 390	1 590	1 710	1 830	1 940

Corrections on Landing Distances (m)

Runway State		Dry	Wet	Compacted snow	Slush	Standing Water
Altitude	Per 1 000 ft ABOVE SL	+ 50	+ 60	+ 80	+ 130	+ 120
Speed	Per 5 kt	+ 70	+ 90	+ 90	+ 140	+ 170
Wind	Per 5 kt TW	+ 150	+ 170	+ 160	+ 260	+ 340
Reverse	Per Thrust Reverser Operative	-	-	- 80	- 100	- 90

Valores Conservadores

Landing Charts Dispatch

A320214 - JAL AIRBUS CITY AIB - LFZZ		14		IL-14 V20 OLL NF 3 IP	
Elevation 0 FT					
Isa temp 15 C					
rwy slope 0.00 %					
LDA 2100 M					
All reversers operating		DRY SNOW		WET SNOW	
Wet check				Compacted snow	
No reversers on dry/wet runway					
-30	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1600/ 2100	74.7 145 2 1710/ 2100	74.7 145 2 1560/ 2100
-25	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1600/ 2100	74.7 145 2 1710/ 2100	74.7 145 2 1560/ 2100
-20	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1600/ 2100	74.7 145 2 1710/ 2100	74.7 145 2 1560/ 2100
-20	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1600/ 2100	74.7 145 2 1710/ 2100	74.7 145 2 1560/ 2100
-15	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1600/ 2100	74.7 145 2 1710/ 2100	74.7 145 2 1560/ 2100
-10	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1600/ 2100	74.7 145 2 1710/ 2100	74.7 145 2 1560/ 2100
-5	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1600/ 2100	74.7 145 2 1710/ 2100	74.7 145 2 1560/ 2100
0	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1600/ 2100	74.7 145 2 1710/ 2100	74.7 145 2 1560/ 2100
5	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1600/ 2100	74.7 145 2 1710/ 2100	74.7 145 2 1560/ 2100
10	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1600/ 2100	74.7 145 2 1710/ 2100	74.7 145 2 1560/ 2100
15	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1600/ 2100	74.7 145 2 1710/ 2100	74.7 145 2 1560/ 2100
20	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1710/ 2100		
25	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1741/ 2100		
30	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1772/ 2100		
35	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.7 145 2 1802/ 2100		
40	82.3 153 2 1260/ 2100	74.7 145 2 ****/ 2100	74.5 145 2 1826/ 2100		

MLW limited
by RLD

Incorporación en LAN de EFB para Cálculos de Landing Performance

Mantenición de la información actualizada



Calculos Optimizados considerando las condiciones reales de cada operacion

LPC-NG Para Flotas Airbus

CONDITIONS <F3>

COMPUTATION: DISPATCH

WIND: 0kt HD0

OAT: 15 °C ISA +1

QNH: 1013 hPa

RWY COND: Dry

A-ICE: Off

LW: 60.0

LDG CONF: CONF FULL (STD)

AIR COND: On (STD)

APPR TYPE: Normal (STD)

GA GRADIENT: Min (STD)

VPilot: 0

LDG TECHNIQUE: MAN-ATHR on

SINGLE RWY COMPUTATION <F2>

TOULOUSE / BLAG... LFBO / TLS RWY: 32R

ELEV: 497 ft SLOPE: -0.08%

LENGTH: 3000 m

FOR FLIGHT TEST USE ONLY. RUNWAY DATA REVISION DATE: 20130723

RESULTS

RWY: 32R LW: 60.0T MLW(perf): 77.8T

LIMITATION CODE: WGT

FLAPS: 3 FULL

DISPATCH LD: 1393 m (RLD)

GA SPEED: 131 kt VAPP: 131 kt

GA GRADIENT: 4.7 %

ACFT STS <F5> COMPUTE <F8> CLEAR <F6>

OPT Para Flotas Boeing

PERFORMANCE - LANDING - ENROUTE

ARPT INFO: KEN 787

ARPT: KSEA / SEA Go-Around RTG

ADD ARPT: RWY 34R

NOTAMS: COND DRY

WIND: 0 KT (0 TW(0) XW) KT

OAT: 15 C (59 F)

QNH: 1012.0 HPa (29.88 IN HG)

LANDING WT: 170000 KG VREF ADD: 5

SHOW TAKEOFF

EXIT

SEND OUTPUT

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Landing Distance In Flight

2

Landing Distance Calculation in Flight

FCOM Standard Operating Procedures



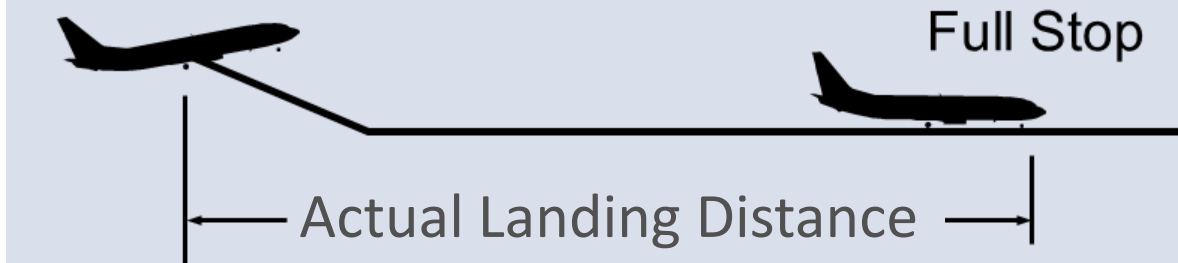
DESCENT PREPARATION - LANDING PERFORMANCE

LANDING PERFORMANCE CONFIRM
Perform an in-flight landing performance assessment if the landing conditions changed compared with the landing computation at dispatch, or with a previous computation (e.g. runway, weather conditions, in-flight failure affecting performance, diversion).

Landing Distance In Flight

- Factor(s) must be applied to account for:

- Runway surface condition
- Temperature and runway slope
- Actual approach speed flown
- Braking configuration (autobrake and reverser)
- Reported braking action
- Landing category (manual or autoland)
- ***Pilot technique***



No considera ningún factor adicional

Landing Distance In Flight

Flight Operations Engineering & Documentation regional seminars Additional Airbus Recommendation

In-Flight Landing Distances represent a realistic and representative landing distance achievable in line operations, without margin.

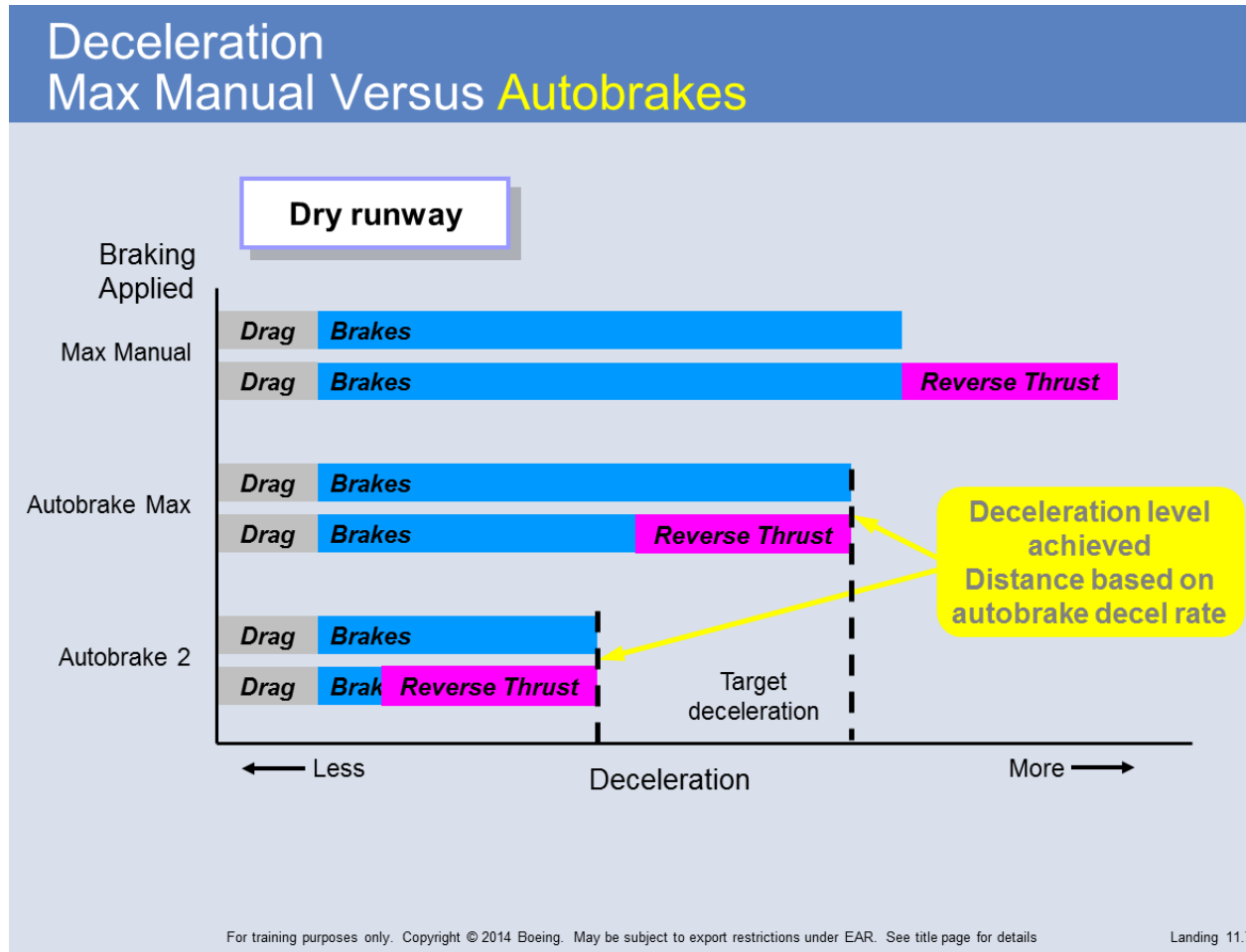
To cover variability in flying techniques and unexpected conditions at landing, the flight crew should apply an appropriate margin to the In-Flight Landing Distances



Airbus recommends to add a 15% safety margin to the In-Flight Landing Distance
Factored Landing Distance = In-Flight Landing Distance x 1.15

Landing Distance In Flight

Efecto del Uso de Autobrake y Reversos dependiendo del estado de la pista



Cálculo de la Landing Distance In Flight

QRH Tables



QRH values do not include the safety margin

AIRBUS <small>A318/A319/A320/A321 QUICK REFERENCE HANDBOOK</small>		IN FLIGHT PERFORMANCE						PER-D 1/2 <small>06 MAR 14</small>		
LANDING DISTANCE WITHOUT FAILURE										
The Reference Distance (REF DIST) considers : Sea Level (SL), ISA, no wind, no slope, no engine reverse thrust, manual landing ⁽¹⁾ , VAPP=VLS without APPR COR.										
3 - MEDIUM										
Corrections on Landing Distance (m)		WGT ⁽²⁾	SPD	ALT	WIND	TEMP	SLOPE	REV	OVW	
Braking Mode	LDG CONF	REF DIST (m) for 66T	Per 1T above 66T	Per skt	Per 1000ft above SL	Per skt TW	Per 10°C above ISA	Per 1% Down Slope	Per Thrust Reverser Operative	If OVW PROC applied
Maximum MANUAL	FULL	1 770	+40	+90	+80	+210	+60	+90	-110	+640
	3	1 920	+50	+110	+80	+220	+60	+110	-140	+840
AUTOBRAKE MED	FULL	1 820	+40	+100	+80	+210	+70	+90	-140	+210
	3	1 990	+40	+110	+80	+230	+70	+110	-180	+220
AUTOBRAKE LOW	FULL	1 990	+50	+130	+80	+230	+70	+70	-40	+240
	3	2 120	+50	+140	+90	+240	+70	+90	-70	+270
(1) Automatic Landing correction: if CONF FULL, add 240m. If CONF 3, add 320m. (2) Weight correction: subtract 20m per 1T below 66T.										



Incorporación en LAN de EFB para Cálculos de Inflight Landing Performance

Performance Application

COMPUTATION IN-FLIGHT

WIND °/kt HD0 [-]

OAT °C 10 ISA -5

QNH hPa 1013

RWY COND 6-Dry

A-ICE Off

LW T 50.0

LDG CONF CONF FULL (STD)

AIR COND On (STD)

APPR TYPE Normal (STD)

GA GRADIENT % Min (STD)

VPilot kt 0

LDG TECHNIQUE MAN-A/THR on

BRK MODE Med

REV Yes

NORMAL

ACFT STS <F5>

COMPUTE <F8> CLEAR <F6>

SINGLE RWY COMPUTATION<F2>

REYKJAVIK BIRK / RKV RWY 01

ELEVN 24 ft SLOPE 0.16% MODIFY RWY

LENGTH 1487 m

FOR FLIGHT TEST USE ONLY. RUNWAY DATA REVISION DATE: 20120914

RESULTS

RWY 01 LW50.0T MLW(perf) 61.4T

LD: 1116 m 3 FULL

FACTOR/INCREMENT: 1.15

FACTORED LD: 1284m PP: 121kt

GA SPEED: 120 kt

GA GRADIENT: 7.9 %

MORE <F10>

Optimized results taking into account the selected conditions

Incorporación Proyecto iPad en LATAM

Paper on board



EFB on board



TO-BE

EFB as Standard Ops



Crterios de Aproximación Estable



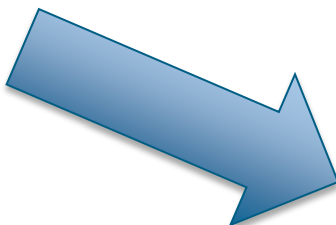
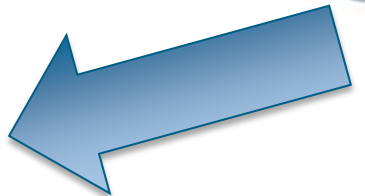
Criterios de Aproximación Estable

Event
7910 - Speed High During App
7911 - Speed Low During App
7940 - Flaps Late Configuration at Landing
7950 - Thrust Low During App
7920 - ROD High
7933 - Roll Exceed
7932 - Heading Change In Final Approach
7942 - Speedbrake
7930 - Glideslope Deviation
7931 - Localizer Deviation
7941 - Ldg Not Locked Down

Parámetros de Vuelo



Data FOQA



Estandarización LAN y TAM

Seguimiento y Mejora Continua



Directorio Seguridad Operaciones de Vuelo Grupo LATAM



Martes 29 Julio, Santiago

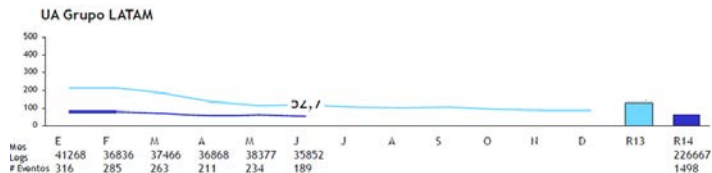


GRUPO LATAM.
PASIÓN ES LO QUE NOS HACE VOLAR.

Unstable Approach LATAM

Acum. Junio 2014

Tasa: # Eventos cada 10.000 Legs



N° Parámetros vulnerados durante UA



- Highlights
1. Indicador estable con **Temp.Lay 1.0%** la baja.
 2. No hay eventos UA relacionados a HL o DL.
 3. Julio: Mejor mes del año.
 4. GA: Porcentaje aumenta v/s cierre 2013

Actores:
Seguridad
Instrucción
Pilotos (Flotas)
Estándares



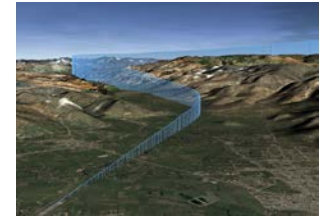
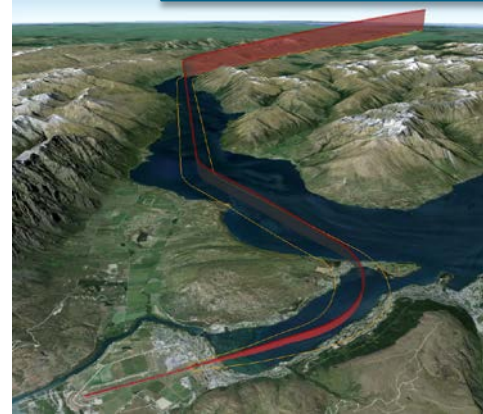
Mejores Prácticas

Criterios de Aproximación Estable

Iniciativas Aplicadas en LATAM:

- Criterio de Pista Corta
- Instrucción Pilotos en Pista Corta
- MEL Despacho en Pista Cortas
- Priorización de aproximaciones con Guía Vertical (RNP)
- Aplicación de margen de seguridad a los cálculos de landing distance Inflight
- Uso de tecnología y cálculos mas precisos (iPAD)
- Evitar aproximaciones visuales
- Diseño de aproximaciones del tipo Visual RNAV (ejemplo Canarsi en JFK)

RNP Procedure Design





GRACIAS!



— LATAM AIRLINES GROUP —