Presented by

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Manager A380 Operational Performance

Airbus Perspective

Pushing for Regulatory Harmonization on Landing

Contents

Regulatory Situation

- Certification
  - Dry Runway Landing Distance
    - EASA CS 25.125 identical with FAR 25.125
  - Dry and Wet Runway ASD Performance
    - EASA CS 25.109 identical with FAR 25.109
  - Contaminated Runway Performance
    - EASA CS 25.1591 (and AMC) Supplemental Performance
      - Information may be provided
      - Operations restricted to published conditions
      - Standing Water / Slush / Dry & Wet Snow, Compacted Snow, Ice
    - FAA AC 91-6A & Draft AC 91-6B
      - Restrictions on operations
      - Recommends performance adjustments to be applied

Regulatory Situation (cont'd)

- Operations
  - Dispatch
    - Dry Runway EU-OPS 1.515 / FAR 121.195
      - most favourable runway, in still air
      - or runway most likely to be assigned / most suitable considering the probable wind speed and direction
      - Regulatory factor of 1.667 on 25.125 dry runway landing distance
    - Wet Runway EU-OPS 1.520 / FAR 121.195
      - Regulatory factor of 1.92 on 25.125 dry runway landing distance
    - Slippery / Contaminated Runway EU.OPS 1.520 / FAR 121.195
      - FAR: Same as Wet Runway
      - EU-OPS: Maximum of
        - 1.15 x CS25.1591 Contaminated Runway Landing Distance
        - 1.92 x CS25.125 Dry Runway Landing Distance

Regulatory Situation (cont'd)

- Operations
  - In-Flight
    - EU-OPS 1.400
      - Before commencing an approach to land, 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, landing or missed approach, having regard to the **performance information contained in the Operations Manual**.
    - FAA SAFO 06012 & AC 91-79
      - Pilot must make in-flight landing performance assessment
      - Actual landing distance is additionally to 25.125 function of
        - Braking Action
        - Runway Slope
        - Outside Temperature
      - Safety Factor of 15% except in emergencies

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Contaminant Type and Depth

- Advantages
  - Simple Observation
    - No need for preceding aircraft
    - No need for friction tester
    - No interruption of operations
  - Simple entry point to published performance data
- Disadvantages
  - May be incomplete and/or misleading
    - Dry Snow / Slush over Ice
    - “Patchy”
    - Friction tends to be worse if contaminant melting
  - Depth Assessment difficult (just Wet or already Flooded?)

Friction Measurement

- Advantages
  - Precise Numbers
  - No need for preceding aircraft
- Disadvantages
  - No correlation with published (Airbus) aircraft performance
  - Issues with reproducibility
  - Optimistic on fluid contaminants
  - Requires runway closure for measurement
  - Lack in timeliness

Pilot Braking Action Report

- Advantages
  - Usually most recent information
  - Quantifies effect of contaminant on aircraft
- Disadvantages
  - Subjective assessment
    - Pilot experience
    - Aircraft characteristics
  - Mix of Braking friction, aerodynamic drag and reverse thrust effects
  - No correlation with published (Airbus) aircraft performance
  - Risk of confusion with SNOWTAM Estimated Runway Friction

Runway State Reporting Formats

(CLEARED RUNWAY LENGTH, IF LESS THAN PUBLISHED LENGTH *(m)*)	D) →
(CLEARED RUNWAY WIDTH, IF LESS THAN PUBLISHED WIDTH *(m; if offset left or right of centre line add "L" or "R")*)	E) →
(DEPOSITS OVER TOTAL RUNWAY LENGTH *(Observed on each third of the runway, starting from threshold having the lower runway designation number)* NIL — CLEAR AND DRY 1 — DAMP 2 — WET or water patches 3 — RIME OR FROST COVERED *(depth normally less than 1 mm)* 4 — DRY SNOW 5 — WET SNOW 6 — SLUSH 7 — ICE 8 — COMPACTED OR ROLLED SNOW 9 — FROZEN RUTS OR RIDGES)	F) →
(MEAN DEPTH *(mm)* FOR EACH THIRD OF TOTAL RUNWAY LENGTH)	G) →

Contaminant Type and Depth

(FRICTION MEASUREMENTS ON EACH THIRD OF RUNWAY AND FRICTION MEASURING DEVICE		H)
MEASURED OR CALCULATED COEFFICIENT	*or* ESTIMATED SURFACE FRICTION	
0.40 and above	GOOD — 5	
0.39 to 0.36	MEDIUM/GOOD — 4	
0.35 to 0.30	MEDIUM — 3	
0.29 to 0.26	MEDIUM/POOR — 2	
0.25 and below	POOR — 1	
9 — unreliable	UNRELIABLE — 9	
(When quoting a measured coefficient, use the observed two figures, followed by the abbreviation of the friction measuring device used. When quoting an estimate, use single digit))		→

Friction Coefficient and/or Braking Action

- SNOWTAMS are snapshot data, no prediction or forecast
- ATIS, METAR, TAF do not contain runway condition information
- ATC reporting practices are variable and inconsistent

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Objectives of the TALPA ARC

- Shared operational landing performance computation
  - Realistic Air Distance
  - Representative Friction
  - All physical effects considered
- Standardized performance to match reported conditions
  - Standardized runway condition assessment
  - Allow performance determination for all types of reports

TALPA ARC Proposals for Landing

- Paved Runway Condition Assessment Table
  - Standardized runway state reporting
  - Clear Entry Point into Performance Computation
- Operational Landing Distances
  - Realistic Airborne Distance of 7 sec at VAPP
  - Account for
    - Outside Ambient Temperature
    - Runway Slope
  - 6 new levels of runway performance
    - Labels GOOD / MEDIUM / POOR
    - New tyre to runway friction coefficients
    - Reduced accounting for contaminant drag
- 15% Safety Factor except in emergencies






TALPA ARC Runway Condition Assessment

Code	Runway Contaminant 	DEGRADATION CONDITION ONLY	
		 Rep. Mu (μ)	 PIREP
6	• Dry	-	Dry
5	• Wet (Smooth, Grooved or PFC) · Frost 1/8" or less of: · Water · Slush · Dry Snow · Wet Snow	0.40 or higher	GOOD
4	*At or below -13ºC:* · Compacted Snow	0.39-0.35	GOOD TO MEDIUM
3	• Wet (Slippery) *At or below -3 ºC:* · Dry or Wet Snow greater than 1/8” *Above -13ºC and at or below -3ºC:* · Compacted Snow	0.34-0.30	MEDIUM
2	*Greater than 1/8” of:* · Water · Slush *Above -3 ºC:* · Dry or Wet Snow greater than 1/8” · Compacted Snow	0.29-0.25	MEDIUM TO POOR
1	*At or below -3ºC:* · Ice	0.24-0.21	POOR
0	• Wet Ice · Water on top of Compacted Snow · Dry or Wet Snow over Ice *Above -3ºC:* · Ice	0.20 or lower	Nil

90% of demonstrated dry runway μ

wet runway μ

μ = 0.20

μ = 0.16

½ wet runway μ capped at 0.16, aquaplaning, reduced contamination drag

μ = 0.08

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Airbus Commitment

- We support the TALPA ARC proposals
  - Strong contribution to enhanced safety level
  - Developments already started within Airbus
    - For operational documentation
    - For computation tools
    - Availability to operators by mid 2011
  - Interim Guidance provided
    - As soon as May 2009
    - Practical Guidelines available
- For all operators, not just FAA
- BTV/ROPS design consistent with TALPA ARC

Airbus Current Situation

- Current In-Flight Data
  - Certified Landing Distance on Dry
    - Maximum aircraft capability
    - Clean runway friction
  - Landing Distance on Wet
    - Regulatory friction and demonstrated anti-skid efficiency
  - Landing Distance on Contaminated
    - Contaminant Type and Depth
  - No correction for runway slope and ambient temperature

What are the Issues?

- Performance available only for specific contaminant types and depths
- Some contaminant types and depths covered by equivalences (dry and wet loose snow)
- No means for flight crew to consider reported braking action or friction reports as indicators for degraded conditions
- No standards for runway condition reporting that actually match published aircraft performance levels

Typical Effect – Airbus Single Aisle Aircraft

- Increment of new OLD over current ALD
  - CONF FULL / SL / ISA / No Runway Slope

OLD	ALD	DIFFERENCE OLD - ALD	
DRY	DRY	+210 M	+22 %
GOOD	WET	+160 M	+13 %
GOOD TO MEDIUM	COMPACT SNOW	+110 M	+8 %
MEDIUM TO POOR	SLUSH 1/4"	+410 M	+23 %
POOR	ICE	-520 M	-23 %

- Differences:
  - Dry and Good increment mostly due to airborne distance
  - Good to Medium mostly due to increased touchdown speed
  - Medium to Poor is slightly penalized on friction and there is no accounting for contaminant drag
  - Poor has higher friction (0.08) compared to JAR Ice (0.05)

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Comparison Dispatch RLD vs TALPA ARC OLD

- Increment of new OLD over current RLD
  - Representative Airbus Single Aisle Aircraft
  - No additional margin on OLD

CONF FULL (Dvref=0 - No Wind)		WEIGHT	Zp (DISA=0; Slope=0)				Zp (DISA=15; Slope=0)				Zp (DISA=30; Slope=0)				Zp (DISA=0; Slope=-1%)				Zp (DISA=15; Slope=-1%)				Zp (DISA=0; Slope=-2%)				Zp (DISA=15; Slope=-2%)			
			0	4000	8000	10000	0	4000	8000	10000	0	4000	8000	10000	0	4000	8000	10000	0	4000	8000	10000	0	4000	8000	10000	0	4000	8000	10000
DRY - DRY	No Rev	40	-27%	-26%	-25%	-25%	-25%	-23%	-22%	-22%	-22%	-21%	-19%	-19%	-26%	-25%	-24%	-24%	-24%	-22%	-21%	-21%	-26%	-24%	-23%	-23%	-23%	-22%	-20%	-20%
		53	-26%	-25%	-24%	-24%	-23%	-22%	-21%	-21%	-20%	-19%	-18%	-18%	-25%	-24%	-23%	-23%	-22%	-21%	-20%	-20%	-24%	-23%	-22%	-22%	-21%	-20%	-19%	-19%
		66	-28%	-28%	-28%	-28%	-24%	-25%	-25%	-25%	-21%	-21%	-22%	-22%	-27%	-27%	-27%	-27%	-23%	-24%	-24%	-24%	-26%	-26%	-26%	-26%	-22%	-22%	-23%	-23%
GOOD - WET	No Rev	40	-25%	-22%	-19%	-17%	-21%	-18%	-15%	-13%	-18%	-14%	-11%	-9%	-23%	-20%	-17%	-16%	-20%	-16%	-13%	-11%	-22%	-19%	-15%	-14%	-18%	-15%	-11%	-9%
		53	-21%	-17%	-14%	-13%	-17%	-13%	-10%	-8%	-13%	-9%	-5%	-3%	-19%	-16%	-12%	-10%	-15%	-11%	-7%	-5%	-17%	-14%	-10%	-8%	-13%	-9%	-5%	-3%
		66	-19%	-19%	-18%	-17%	-15%	-14%	-13%	-12%	-11%	-10%	-9%	-7%	-17%	-17%	-16%	-15%	-13%	-12%	-11%	-10%	-15%	-15%	-13%	-12%	-11%	-10%	-8%	-7%
	With Rev	40	-30%	-28%	-25%	-24%	-27%	-24%	-21%	-20%	-24%	-21%	-18%	-16%	-29%	-27%	-24%	-22%	-26%	-23%	-20%	-18%	-28%	-25%	-22%	-21%	-25%	-22%	-19%	-17%
		53	-26%	-23%	-20%	-19%	-23%	-20%	-16%	-15%	-19%	-16%	-12%	-10%	-25%	-22%	-19%	-17%	-21%	-18%	-15%	-13%	-23%	-20%	-17%	-15%	-20%	-16%	-13%	-11%
		66	-24%	-24%	-24%	-23%	-21%	-21%	-20%	-19%	-17%	-17%	-15%	-14%	-23%	-23%	-22%	-21%	-19%	-19%	-18%	-17%	-21%	-21%	-20%	-19%	-17%	-17%	-16%	-15%
GOOD to MEDIUM - SNOW	With Rev	40	-18%	-15%	-13%	-13%	-15%	-12%	-9%	-9%	-11%	-8%	-5%	-5%	-16%	-13%	-11%	-10%	-12%	-10%	-7%	-7%	-14%	-11%	-8%	-8%	-10%	-7%	-4%	-4%
		53	-13%	-11%	-12%	-13%	-10%	-7%	-8%	-9%	-6%	-3%	-4%	-5%	-11%	-9%	-9%	-10%	-7%	-5%	-5%	-6%	-8%	-6%	-6%	-8%	-5%	-2%	-2%	-3%
		66	-13%	-15%	-15%	-15%	-10%	-11%	-11%	-11%	-6%	-7%	-7%	-7%	-11%	-12%	-13%	-13%	-7%	-8%	-9%	-9%	-8%	-10%	-10%	-10%	-4%	-6%	-6%	-6%
MEDIUM - SNOW	With Rev	40	-11%	-8%	-5%	-5%	-8%	-5%	-1%	-1%	-4%	-1%	3%	4%	-9%	-6%	-3%	-2%	-5%	-2%	2%	2%	-6%	-3%	1%	1%	-2%	2%	5%	6%
		53	-5%	-3%	-3%	-4%	-2%	1%	1%	0%	2%	6%	6%	5%	-2%	0%	0%	-1%	2%	5%	5%	4%	1%	4%	4%	3%	5%	8%	8%	7%
		66	-5%	-6%	-7%	-7%	-1%	-2%	-2%	-2%	3%	2%	2%	2%	-2%	-3%	-3%	-3%	2%	1%	1%	1%	2%	0%	0%	0%	6%	5%	5%	5%
MEDIUM to POOR - WATER	With Rev	40	-8%	-4%	1%	4%	-4%	1%	4%	4%	0%	4%	4%	4%	-5%	-1%	5%	8%	-1%	4%	8%	8%	-2%	3%	9%	12%	3%	8%	12%	12%
		53	0%	4%	4%	4%	4%	4%	4%	4%	5%	4%	4%	5%	4%	8%	8%	9%	8%	8%	8%	9%	8%	13%	13%	14%	13%	13%	13%	14%
		66	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	8%	8%	8%	9%	8%	8%	9%	9%	13%	13%	14%	14%	13%	13%	14%	14%
MEDIUM to POOR - SLUSH	With Rev	40	-8%	-4%	0%	0%	-4%	1%	5%	5%	0%	6%	11%	11%	-5%	-1%	3%	3%	-1%	4%	9%	9%	-2%	3%	7%	7%	3%	8%	13%	13%
		53	0%	3%	1%	0%	5%	9%	7%	6%	11%	15%	13%	12%	4%	7%	6%	4%	9%	13%	11%	10%	8%	12%	10%	9%	14%	18%	16%	15%
		66	5%	4%	1%	0%	11%	10%	7%	6%	16%	16%	13%	12%	10%	8%	6%	4%	15%	14%	12%	10%	14%	13%	11%	10%	20%	20%	17%	16%
POOR - ICY	With Rev	40	-21%	-23%	-25%	-26%	-17%	-20%	-22%	-23%	-14%	-16%	-18%	-19%	-17%	-19%	-21%	-22%	-13%	-15%	-17%	-18%	-11%	-14%	-16%	-17%	-8%	-10%	-12%	-13%
		53	-22%	-24%	-26%	-27%	-18%	-21%	-23%	-24%	-15%	-17%	-19%	-20%	-17%	-19%	-22%	-23%	-14%	-16%	-18%	-19%	-12%	-14%	-16%	-17%	-8%	-10%	-12%	-13%
		66	-22%	-24%	-27%	-28%	-19%	-21%	-23%	-24%	-15%	-17%	-19%	-21%	-18%	-20%	-22%	-23%	-14%	-16%	-18%	-19%	-12%	-14%	-16%	-17%	-8%	-10%	-12%	-13%

- For some contaminants dispatch is legal to a runway that according to TALPA ARC it is not safe to land on

Comparison with TALPA ARC 15% Margin

- Increment of new Factored OLD (FOLD) over current RLD
  - Representative Airbus Single Aisle Aircraft
  - 15% additional margin on OLD

CONF FULL (Dvref=0 - No Wind)		WEIGHT	Zp (DISA=0; Slope=0)				Zp (DISA=15; Slope=0)				Zp (DISA=30; Slope=0)				Zp (DISA=0; Slope=-1%)				Zp (DISA=15; Slope=-1%)				Zp (DISA=0; Slope=-2%)				Zp (DISA=15; Slope=-2%)			
			0	4000	8000	10000	0	4000	8000	10000	0	4000	8000	10000	0	4000	8000	10000	0	4000	8000	10000	0	4000	8000	10000	0	4000	8000	10000
DRY - DRY	No Rev	40	-16%	-15%	-14%	-13%	-13%	-12%	-11%	-10%	-10%	-9%	-7%	-7%	-15%	-14%	-13%	-12%	-12%	-11%	-9%	-9%	-14%	-13%	-12%	-11%	-11%	-10%	-8%	-8%
		53	-15%	-14%	-13%	-12%	-12%	-10%	-9%	-9%	-9%	-7%	-6%	-6%	-14%	-13%	-12%	-11%	-11%	-9%	-8%	-8%	-13%	-11%	-11%	-10%	-9%	-8%	-7%	-7%
		66	-17%	-18%	-18%	-17%	-13%	-14%	-14%	-14%	-9%	-10%	-10%	-10%	-16%	-16%	-16%	-16%	-12%	-12%	-12%	-12%	-14%	-15%	-15%	-15%	-10%	-11%	-11%	-11%
GOOD - WET	No Rev	40	-13%	-10%	-7%	-5%	-10%	-6%	-2%	0%	-6%	-1%	3%	5%	-12%	-8%	-5%	-3%	-8%	-4%	0%	2%	-10%	-6%	-3%	-1%	-6%	-2%	2%	5%
		53	-9%	-5%	-1%	1%	-4%	0%	4%	6%	0%	5%	9%	12%	-7%	-3%	1%	3%	-2%	2%	6%	9%	-5%	-1%	4%	6%	0%	4%	9%	12%
		66	-7%	-7%	-6%	-5%	-2%	-2%	0%	1%	3%	3%	5%	6%	-5%	-4%	-3%	-2%	0%	1%	2%	4%	-2%	-2%	0%	1%	3%	4%	5%	7%
	With Rev	40	-20%	-17%	-14%	-12%	-16%	-13%	-10%	-8%	-13%	-9%	-5%	-3%	-19%	-16%	-12%	-11%	-15%	-12%	-8%	-6%	-17%	-14%	-11%	-9%	-14%	-10%	-6%	-4%
		53	-15%	-12%	-8%	-7%	-11%	-8%	-4%	-2%	-7%	-3%	1%	3%	-13%	-10%	-7%	-5%	-9%	-6%	-2%	0%	-12%	-8%	-5%	-3%	-8%	-4%	0%	3%
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GOOD to MEDIUM - SNOW	With Rev	40	-5%	-3%	0%	0%	-2%	1%	4%	5%	2%	5%	9%	9%	-3%	0%	3%	3%	1%	4%	7%	7%	-1%	2%	5%	6%	3%	6%	10%	10%
		53	0%	2%	2%	1%	4%	7%	6%	5%	8%	11%	11%	10%	3%	5%	5%	3%	7%	10%	9%	8%	5%	8%	8%	6%	10%	13%	12%	11%
		66	0%	-2%	-2%	-2%	4%	3%	2%	2%	8%	7%	7%	7%	3%	1%	0%	0%	7%	5%	5%	5%	6%	4%	3%	3%	10%	8%	8%	8%
MEDIUM - SNOW	With Rev	40	2%	5%	9%	9%	6%	10%	13%	14%	10%	14%	18%	19%	5%	9%	12%	13%	9%	13%	17%	18%	9%	12%	16%	17%	13%	17%	21%	22%
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		66	9%	8%	7%	8%	14%	12%	12%	13%	18%	17%	17%	18%	13%	11%	11%	11%	18%	16%	16%	16%	17%	15%	15%	15%	22%	21%	20%	21%
MEDIUM to POOR - WATER	With Rev	40	5%	10%	16%	20%	10%	16%	19%	19%	16%	20%	19%	20%	9%	14%	21%	24%	14%	20%	24%	24%	13%	18%	25%	29%	18%	24%	28%	29%
		53	15%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	25%	25%	25%	24%	25%	25%	25%	24%	30%	30%	31%	29%	30%	30%	31%
		66	20%	20%	19%	20%	19%	19%	20%	20%	20%	19%	20%	20%	24%	25%	25%	25%	24%	24%	25%	25%	30%	30%	31%	31%	30%	30%	31%	32%
MEDIUM to POOR - SLUSH	With Rev	40	5%	10%	15%	15%	10%	16%	21%	21%	16%	22%	27%	27%	9%	14%	19%	19%	14%	20%	25%	25%	13%	18%	23%	23%	18%	24%	30%	30%
		53	15%	19%	17%	15%	21%	25%	23%	22%	27%	32%	30%	28%	20%	23%	21%	20%	26%	30%	28%	27%	24%	29%	27%	25%	31%	36%	34%	32%
		66	21%	20%	16%	15%	27%	26%	23%	21%	34%	33%	30%	28%	26%	25%	21%	20%	33%	32%	28%	27%	31%	30%	27%	26%	38%	38%	35%	34%
POOR - ICY	With Rev	40	-9%	-11%	-14%	-15%	-5%	-7%	-10%	-11%	-1%	-3%	-6%	-7%	-4%	-7%	-9%	-10%	0%	-2%	-5%	-6%	2%	-1%	-3%	-5%	6%	4%	1%	0%
		53	-10%	-13%	-15%	-16%	-6%	-9%	-11%	-12%	-2%	-4%	-7%	-8%	-5%	-7%	-10%	-11%	-1%	-3%	-6%	-7%	2%	-1%	-3%	-5%	6%	4%	1%	0%
		66	-11%	-13%	-16%	-17%	-7%	-9%	-12%	-13%	-3%	-5%	-7%	-9%	-5%	-8%	-10%	-12%	-1%	-3%	-6%	-7%	2%	-1%	-4%	-5%	6%	4%	1%	0%

- On contaminated runways, relatively small dispatch factor exceeded by effect of higher touchdown speed and TALPA 15%
- On wet runway, non-physical dispatch construction proves unconservative

In-Flight Performance Margin

- FAA has recommended 15% since SAFO 06012
- Rationale
  - OLD is realistic maximum performance
  - Examples of effects not covered analytically
    - Some effects still neglected in OLD (like bleed configuration)
    - Operational variance (like in wind)
    - Piloting accuracy in airborne phase and during braking
    - Rubber contamination
    - Flooded runways reported as simply wet
    - Lack of timeliness in contamination assessment by airport
    - Aircraft failures (including reversers) in short final
    - Subjectivity of PiRep
    - Reporting and assessment issues on mixed contaminants

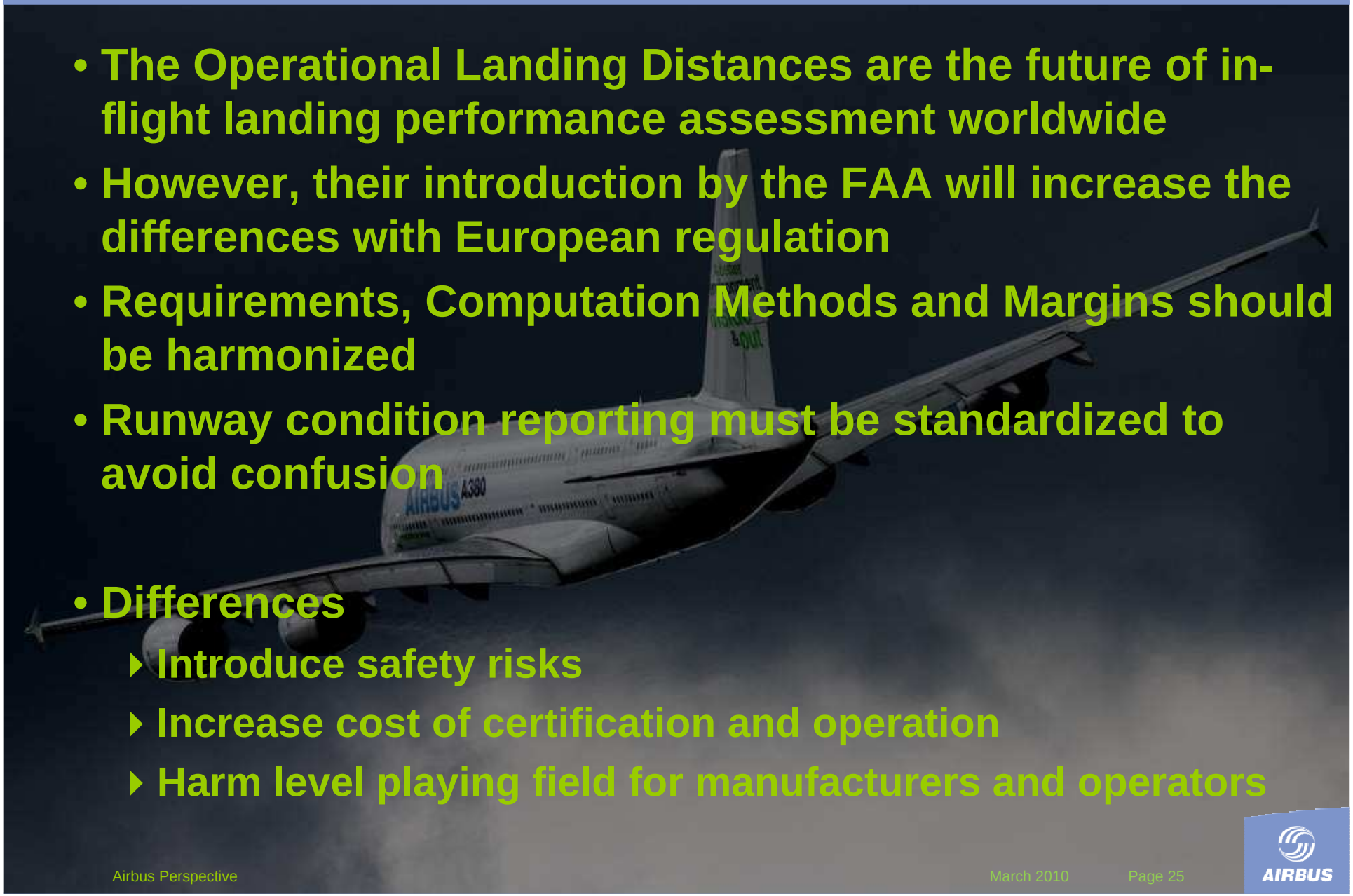
Other Open Issues

- In-Flight Automatic Landing computation

- Grooved/PFC runway regulation
  - Covers dispatch only
  - JAA A320 CRI-F12
    - Generic friction coefficient
    - Benefit applied to wet runway dispatch
  - FAA AC 121-195(d)-1A
    - Specific runway friction from flight tests
    - Operational restrictions

- Landing with System Failures

Conclusions



- **The Operational Landing Distances are the future of in-flight landing performance assessment worldwide**
- **However, their introduction by the FAA will increase the differences with European regulation**
- **Requirements, Computation Methods and Margins should be harmonized**
- **Runway condition reporting must be standardized to avoid confusion**

- **Differences**
  - **Introduce safety risks**
  - **Increase cost of certification and operation**
  - **Harm level playing field for manufacturers and operators**