



International Civil Aviation Organization

European and North Atlantic Office

EASA Workshop

Runway Friction and Aircraft Braking

DGAC France, Paris
11th-12th March 2010

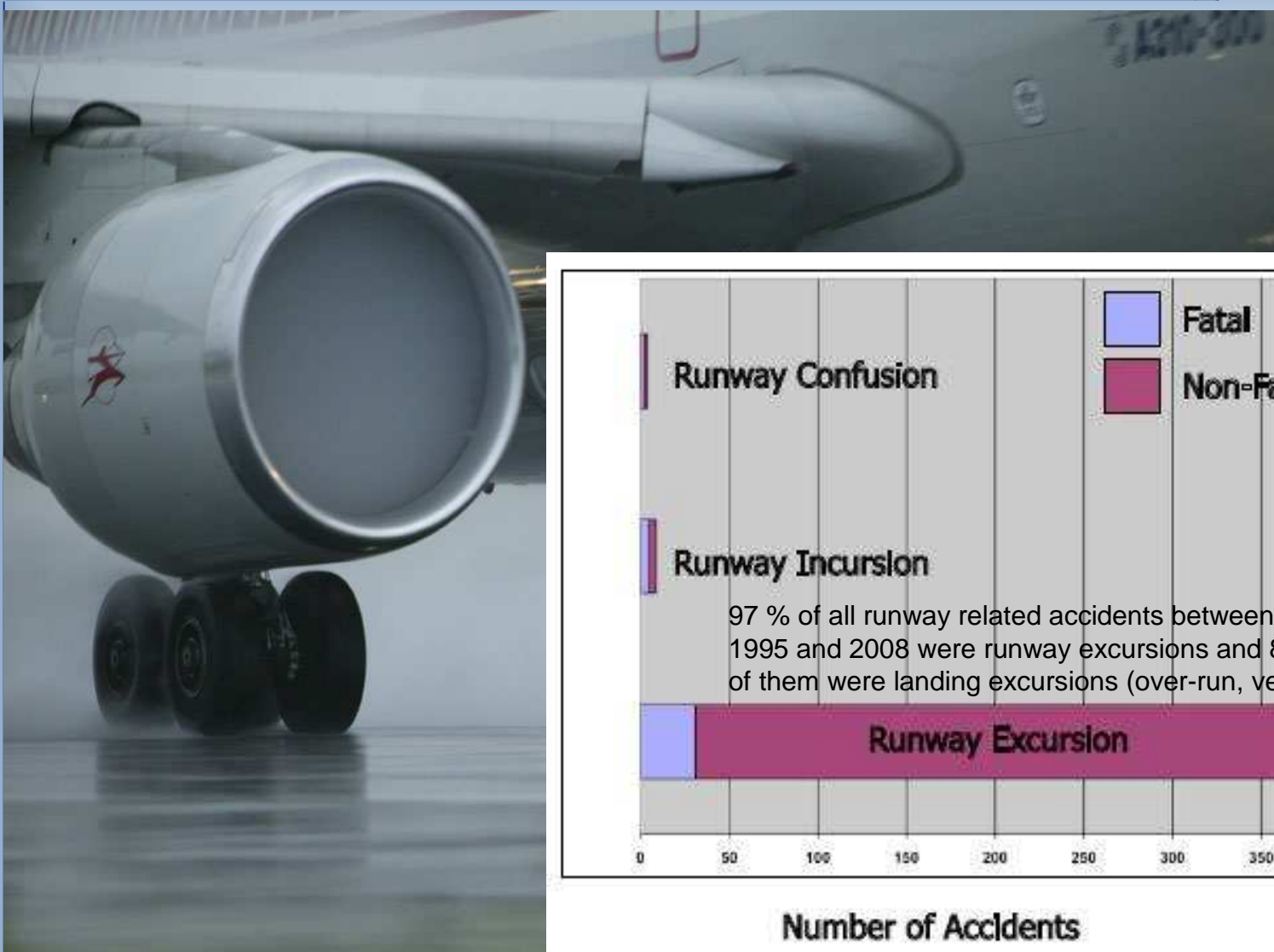
Sven Halle

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Runway Safety

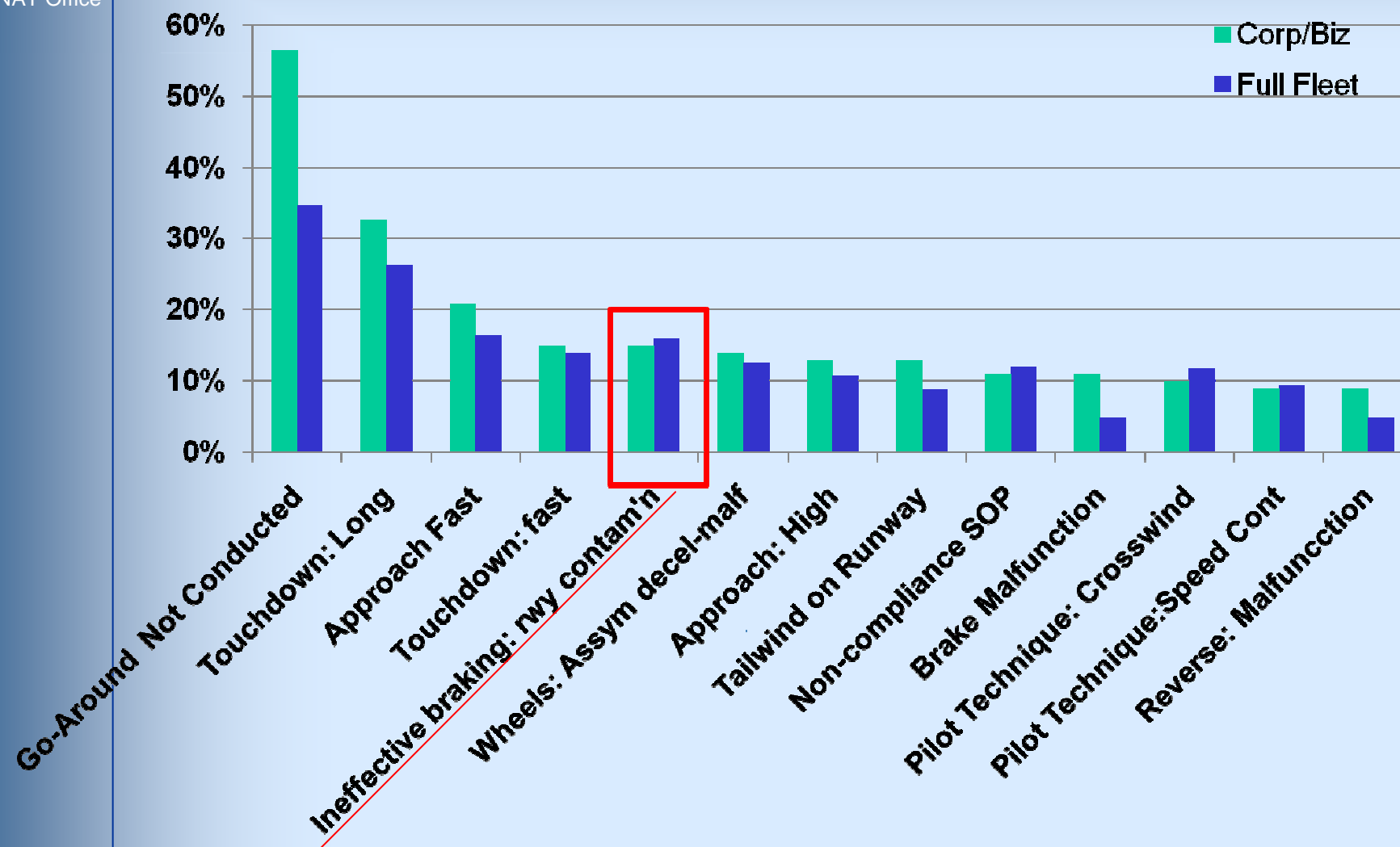


Flight Safety Foundation, Runway Safety Initiative Report, May 2009



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Runway Safety



Flight Safety Foundation, Runway Safety Initiative Report, May 2009



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Runway Safety Risk Factors



Contaminated runways increase the risk of runway excursions (stakeholder issues) :

➤ Airports

- Runways not constructed/maintained to maximize effective friction and drainage
- Late or inaccurate runway condition reports
- Inadequate snow and ice control plans

➤ Aircraft Manufacturers

- lack of appropriate operational and performance information for operators (aircraft stopping characteristics) that includes the full spectrum of runway conditions



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Runway Safety Risk Factors



➤ Flight Operations

- Ineffective braking, Thrust reverser issues

➤ Regulators

- Lack of regulatory requirement to provide flight crews a consistent format for take-off and landing data for all runway conditions
- Inadequate regulation for the provision of correct, up-to-date and timely runway condition reports to aircrews
- Currently there is no international standard for measuring and reporting runway conditions



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ICAO Provisions



➤ **The Annexes to the Chicago Convention:**

Annex 1- Personnel Licensing

Annex 2- Rules of the Air

Annex 3- Meteorological Service for International Air Navigation

Annex 4- Aeronautical Charts

Annex 5- Units of Measurement to be used in air and ground operations

Annex 6- Operation of Aircraft

Annex 7- Aircraft Nationality and Registration Marks

Annex 8- Airworthiness of Aircraft

Annex 9- Facilitation

Annex 10- Aeronautical Telecommunications

Annex 11- Air Traffic Services

Annex 12- Search and Rescue

Annex 13- Aircraft Accident and Incident Investigation

Annex 14- Aerodromes

Annex 15- Aeronautical Information Services

Annex 16- Environmental Protection

Annex 17- Security

Annex 18- The Safe Transport of Dangerous Goods by Air



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ICAO Annex 14



➤ Volume 1

- §2 – Promulgation of aerodrome data including condition of movement area and related facilities such as:
 - a) water on a runway
 - b) snow, slush and ice on a runway
- §3 – Physical characteristics including slopes, drainage & friction characteristics of movement areas
- §10 – Maintenance and inspection of pavements including friction measurement, contaminants & overlays
- Attachment A (green pages, guidance):
 - Section 6 – determining and expressing friction characteristics of snow- and ice-covered paved surfaces
 - Section 7 – determination of friction characteristics of wet paved runways



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Doc 9137 Airport Services Manual



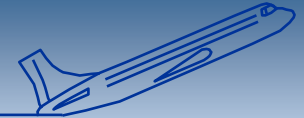
➤ Part 2 – Pavement Surface Conditions

- provide guidance in ensuring adequate measures are taken to overcome problems relating from contaminants, debris on, or weathering of, the movement area
- provide guidance on:
 - basic factors affecting friction,
 - correlation between friction measuring devices,
 - description of devices,
 - measuring and reporting friction values on snow-, ice- and water-covered surfaces,
 - collection and dissemination of pavement surface condition information
 - clearance and removal of contaminants



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➤ **Part 8 – Airport Operational Services**

- **Identification of a number of duties to be carried out by airports:**
 - **§ 3 Surface Inspections**
 - **§ 6 Adverse Weather Conditions**
 - **§ 7 Measurement of Surface Friction**



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➤ **Part 9 – Airport Maintenance Practices**

- **Maintenance practices required at an airport to maintain safety, efficient and regular aircraft operations**
- **§ 4 Maintenance of pavements including cleaning of contaminants, removal of snow and ice**
- **§ 5 Maintenance of drainage systems**



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Doc 9157 Aerodrome Design Manual



- **Part 3 – Pavements**
 - Guidance on design of pavements
 - § 5 Runway surface texture and drainage characteristics



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- **§ 4.1.1 – Promulgation of information related to, inter alia, aerodromes in AIP (Appendix 1)**
 - **Appendix 1 – Contents of AIP, Part 3 Aerodromes**
 - AD 1.1 : Friction measuring device used and runway friction level below which the State will declare the runway to be slippery when wet**
 - AD 1.2.2 : Details of snow plan**
 - AD 2.7 : Seasonal availability – clearing**
 - AD 2.12 : Runway physical characteristics – slopes of runways and stopways**



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➤ § 5.2.3 – Information on snow, slush, ice and standing water using SNOWTAM (Appendix2)

APPENDIX 2. SNOWTAM FORMAT (see Chapter 5, 5.2.3)

(COM heading)	(PRIORITY INDICATOR)	(ADDRESSES)	◀		
(Abbreviated heading)	(SWAA* SERIAL NUMBER)	(LOCATION INDICATOR)	(DATE/TIME OF OBSERVATION)	(OPTIONAL GROUP)	◀
S	W	*	*		
SNOWTAM (Serial number) →					
(AERODROME LOCATION INDICATOR)					
A) →					
(DATE/TIME OF OBSERVATION (Time of completion of measurement in UTC))					
B) →					
(RUNWAY DESIGNATORS)					
C) →					
(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))					
F) →					
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					
G) →					
(MEAN DEPTH (mm) FOR EACH THIRD OF TOTAL RUNWAY LENGTH)					
H) →					
(FRICTION MEASUREMENTS ON EACH THIRD OF RUNWAY AND FRICTION MEASURING DEVICE 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)					
(CRITICAL SNOWBANKS (if present, insert height (cm)/distance from the edge of runway (m) followed by "L", "R" or "LR" if applicable))					
J) →					
(RUNWAY LIGHTS (if obscured, insert "YES" followed by "L", "R" or both "LR" if applicable))					
K) →					
(FURTHER CLEARANCE (if planned, insert length (m)/width (m) to be cleared or if to full dimensions, insert "TOTAL")					
L) →					
(FURTHER CLEARANCE EXPECTED TO BE COMPLETED BY ... (UTC))					
M) →					
(TAXIWAY (if no appropriate taxiway is available, insert "NO"))					
N) →					
(TAXIWAY SNOWBANKS (if more than 60 cm, insert "YES" followed by distance apart, m))					
P) →					
(APRON (if unusable insert "NO"))					
R) →					
(NEXT PLANNED OBSERVATION/MEASUREMENT IS FOR) (month/day/hour in UTC)					
S) →					
(PLAIN LANGUAGE REMARKS (including contaminant coverage and other operationally significant information, e.g. sanding, de-icing))					
T) →					

NOTES: 1. *Enter ICAO nationality letters as given in ICAO Doc 7910, Part 2.
2. Information on other runways, repeat from C to P.
3. Words in brackets () not to be transmitted.

SIGNATURE OF ORIGINATOR (not for transmission)

ANNEX 15

APP 2-1

25/11/04

ATTACHMENT C. AEROPLANE PERFORMANCE OPERATING LIMITATIONS

1. Purpose and scope

The purpose of this Attachment is to provide guidance as to the level of performance intended by the provisions of Chapter 5 as applicable to turbine-powered subsonic transport type aeroplanes over 5 700 kg maximum certificated take-off mass having two or more engines. However, where relevant, it can be applied to all subsonic turbine-powered or piston-engine aeroplanes having two, three or four engines. Piston-engine aeroplanes having two, three or four engines which cannot comply with this Attachment may continue to be operated in accordance with Examples 1 or 2 of this Attachment.

Note.— This Attachment is not intended for application to aeroplanes having short take-off and landing (STOL) or vertical take-off and landing (VTOL) capabilities.

2. Definitions

Accelerate-stop distance available (ASDA). The length of the take-off run available plus the length of the stopway, if provided.

CAS (calibrated airspeed). The calibrated airspeed is equal to the airspeed indicator reading, corrected for position and instrument error. (As a result of the sea level adiabatic compressible flow correction to the airspeed instrument dial, CAS is equal to the true airspeed (TAS) in Standard Atmosphere at sea level.)

Declared temperature. A temperature selected in such a way that when used for performance purposes, over a series of operations, the average level of safety is not less than would be obtained by using official forecast temperatures.

Expected. Used in relation to various aspects of performance (e.g. rate or gradient of climb), this term means the standard performance for the type, in the relevant conditions (e.g. mass, altitude and temperature).

Grooved or porous friction course runway. A paved runway that has been prepared with lateral grooving or a porous friction course (PFC) surface to improve braking characteristics when wet.

Height. The vertical distance of a level, a point, or an object considered as a point, measured from a specified datum.

Note.— For the purposes of this example, the point referred to above is the lowest part of the aeroplane and the specified datum is the take-off or landing surface, whichever is applicable.

Landing distance available (LDA). The length of runway which is declared available and suitable for the ground run of an aeroplane landing.

Landing surface. That part of the surface of an aerodrome which the aerodrome authority has declared available for the normal ground or water run of aircraft landing in a particular direction.

Net gradient. The net gradient of climb throughout these requirements is the expected gradient of climb diminished by the manoeuvre performance (i.e. that gradient of climb necessary to provide power to manoeuvre) and by the margin (i.e. that gradient of climb necessary to provide for those variations in performance which are not expected to be taken explicit account of operationally).

Reference humidity. The relationship between temperature and reference humidity is defined as follows:

- at temperatures at and below ISA, 80 per cent relative humidity,
- at temperatures at and above ISA + 28° C, 34 per cent relative humidity,
- at temperatures between ISA and ISA + 28° C, the relative humidity varies linearly between the humidity specified for those temperatures.

Runway surface condition. The state of the surface of the runway: either dry, wet, or contaminated:

a) **Contaminated runway.** A runway is contaminated when more than 25 per cent of the runway surface area (whether in isolated areas or not) within the required length and width being used is covered by:

- water, or slush more than 3 mm (0.125 in) deep;
- loose snow more than 20 mm (0.75 in) deep; or
- compacted snow or ice, including wet ice.

b) **Dry runway.** A dry runway is one which is clear of contaminants and visible moisture within the required length and the width being used.

ANNEX 6 — PART I

ATT C-1

19/11/09
No. 33-A

ICAO Annex 6



➤ Amendment 33 introduced definitions to grooved or PFC runway and runway surface conditions

- Grooved or porous friction course (PFC) runway :

A paved runway that has been prepared with lateral grooving or a PFC surface to improve braking characteristics when wet

- Runway Surface Conditions*

- a) Contaminated runway :

A runway is contaminated when more than 25% of the runway surface area (whether in isolated areas or not) within the required length and width being used is covered by:

- water, or slush more than 3mm deep;
- loose snow more than 20mm deep;
- compacted snow or ice, including wet ice

- b) Dry runway :

A dry runway is one which is clear of contaminants and visible moisture within the required length and width being used.

- c) Wet runway :

A runway that is neither dry or contaminated

* plus 2 notes



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Doc 4444 PANS-ATM



➤ Chapter 12, Phraseologies § 12.3.1.10 Aerodrome Information

Chapter 12. Phraseologies

12-9

Circumstances	Phraseologies
12.3.1.10 AERODROME INFORMATION	<p>a) [(location)] RUNWAY SURFACE CONDITION RUNWAY (number) (condition);</p> <p>b) [(location)] RUNWAY SURFACE CONDITION RUNWAY (number) NOT CURRENT;</p> <p>c) LANDING SURFACE (condition);</p> <p>d) CAUTION CONSTRUCTION WORK (location);</p> <p>e) CAUTION (specify reasons) RIGHT (or LEFT), (or BOTH SIDES) OF RUNWAY (number);</p> <p>f) CAUTION WORK IN PROGRESS (or OBSTRUCTION) (position and any necessary advice);</p> <p>g) RUNWAY REPORT AT (observation time) RUNWAY (number) (type of precipitant) UP TO (depth of deposit) MILLIMETRES. BRAKING ACTION GOOD (or MEDIUM TO GOOD, or MEDIUM, or MEDIUM TO POOR, or POOR or UNRELIABLE) [and/or BRAKING COEFFICIENT (equipment and number)];</p> <p>h) BRAKING ACTION REPORTED BY (aircraft type) AT (time) GOOD (or MEDIUM, or POOR);</p> <p>i) BRAKING ACTION [(location)] (measuring equipment used), RUNWAY (number), TEMPERATURE [MINUS] (number), WAS (reading) AT (time);</p> <p>j) RUNWAY (or TAXIWAY) (number) WET [or DAMP, WATER PATCHES, FLOODED (depth), or SNOW REMOVED (length and width as applicable), or TREATED, or COVERED WITH PATCHES OF DRY SNOW (or WET SNOW, or COMPACTED SNOW, or SLUSH, or FROZEN SLUSH, or ICE, or ICE UNDERNEATH, or ICE AND SNOW, or SNOWDRIFTS, or FROZEN RUTS AND RIDGES)];</p> <p>k) TOWER OBSERVES (weather information);</p> <p>l) PILOT REPORTS (weather information).</p>
12.3.1.11 OPERATIONAL STATUS OF VISUAL AND NON-VISUAL AIDS	<p>a) (specify visual or non-visual aid) RUNWAY (number) (description of deficiency);</p> <p>b) (type) LIGHTING (unserviceability);</p>

22/11/07



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ICAO Friction Task Force (FTF)



➤ **Background Aerodrome Operations and Services WG AOSWG/1 (2005):**

- Measurements to be used for maintenance purposes
- Updates required in ICAO provisions related to friction
- Need to improve and standardize information that are passed to aircrews on contaminated runways

➤ **Background AOSWG/3 (2006):**

- Issues associated with Continuous Friction Measuring Equipment (CFME)-reliability, accuracy, repeatability
- Data produced does not correlate with the data used by aircraft manufacturers
- CFME indicated misleading results when operated in slush and wet snow
-



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➤ Background AOSWG/3 (2005):

- Estimated braking action in Annex 14, Vol. 1, Attachment A is only for compacted snow and ice
- No international consensus regarding direct relation between μ -values that are obtained from CFME and aircraft landing performance values:
 - In one State, μ -values were only used for maintenance planning purposes
 - In one State, where μ -values conducted on runway with slush/wet snow, estimated braking action based on μ -values shall not be provided to aircraft operators
- AOSWG/3 agrees to establish a FRICTION TASK FORCE (FTF) with specific Terms of References
- FTF was agreed by Aerodrome Panel-WG/WHL-4 (2008)



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➤ Terms of Reference :

1. Review and update ICAO provisions for runway surface friction measurement & reporting
2. Review and determine requirements for friction measurement (CFME, PIREPS, DEC'LS, etc) according to each type of contaminants
3. Ensure clear distinction between runway maintenance and operational issues
4. Collect data to establish correlation between runway surface condition and aircraft braking action
5. Examine methodologies for friction measurement, taking into account different types of surface/contaminant/equipment & differences between friction measurement for runway maintenance and aircraft operations
6. interpretation, use and promulgation of operational runway friction characteristics information
7. Establish links to other ICAO Panels/WGs and other bodies



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➤ Deliverables

- ☐ PROPOSED AMENDMENTS to SARPS and GM in ANNEX 14, VOL I (AP/2) & other related ANNEXES
- ☐ ICAO CIRCULAR on FRICTION ISSUES (end 2009)
- ☐ ACTION PLAN for further improvement

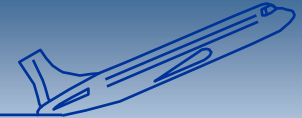
➤ Documentations to be used

- Annex 14, Vol 1
- Annex 3
- Annex 6
- Annex 8
- Annex 11
- Annex 15
- Doc 9137 Airport Services Manual (Part 2, 8, 9)
- Doc 9157 Airport Design Manual (Part 3)



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ICAO Friction Task Force (FTF)



➤ FTF Key Competencies

- Pavements (Design, Friction, Maintenance)
- Aerodrome Operations
- Aircraft Operations
- Aircraft Manufacturing
- ATS Operations
- AIS Promulgation

➤ FTF Composition

- States: Canada, France, Germany, Japan, Netherlands, Norway, UK, USA
- International Organisations: ACI, IATA, IFALPA, IFATCA & ICCAIA
- FTF Rapporteur: Mr. Armann Norheim (Norway)
- FTF Secretary: Mr. Angelo Boccanfuso (Canada)

➤ FTF Results ...Session 2

Conclusions



- **Runway Friction and Aircraft Braking ...**
 - is spread out in various ICAO Annexes and Documents
 - an issue not only for the flight crew & aircraft operators, but also for airports, manufacturers and ATM regulators
 - requires global-uniform standards for runway condition measuring & reporting and aircraft performance data
- **Solutions should ...**
 - ✓ build on existing results from the developments
 - ✓ connect the different elements from the proposals and concentrate the efforts
 - ✓ be developed towards a global application / implementation
 - ✓ reduce the risk of runway excursions

