

**ICAO Asia Pacific Regional
Aviation Safety Team/2 Meeting
Bangkok, August 21-24, 2012.**

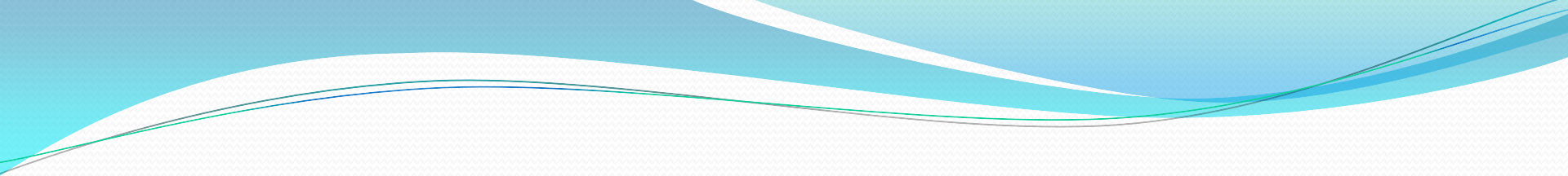
**RUNWAY CONDITION REPORTING
BY ATC/AIS
(APrAST – 1/RE 6)**

- Mukesh Chand Dangi
General Manager (ATM)
Airports Authority of India

- APRAST/1 identified AAI as ‘Champion’ to develop **Industry Best Practice Manual for Timely & Accurate Reporting of Runway Condition (RCR) – APAC Region.**
- A Draft Manual has been submitted to APRAST Chair.
- A Survey Questionnaire to understand RCR Practices in the Region has been circulated by ICAO APAC Office.

REFERENCE -Documents and Presentations

- 1 ICAO
- 2 EASA – RuFAB
- 3 TALPA-ARC
- 4 FAA
- 5 Flight Safety Foundation
- 6 Transport Canada
- 7 Skybrary
- 8 Alaska Airlines
- 9 Winter Operations Plan 2011-12 Manchester Airport
- 10 National Aero Corp. USA (Tim Neubert President NAC)
- 11 Filled up Survey Questionnaire.



RWY CONDITION REPORTING – [RCR] IS ABOUT REPORTING EFFECTS ON RUNWAY FRICTION LEVEL DUE TO THE ABSENCE OR PRESENCE OF CONTAMINANTS.

What follows ?

- A presentation to share information on RCR:-
 - to generate interest in the subject.
 - A gentle reminder to ANSPs for sending the filled up RCR Survey Questionnaire to ICAO APAC Office.
 - A request to all Stakeholders to provide Sample NOTAMs/SNOWTAM to develop the

Industry Best Practice Manual for Timely & Accurate Reporting of Runway Condition – APAC Region.

WHY FRICTION MEASUREMENT IS REQUIRED ?

ICAO Draft Circular 329 on Runway Surface Condition Assessment, Measurement and Reporting – Para 2.2 states

“It is common knowledge that pavements tend to become slippery to both pedestrians and vehicles when they are wet or flooded or are covered with slush, snow or ice; however, no one yet has a complete understanding of the physical effects causing this slipperiness which in turn can cause accidents. The same applies to aircraft operation on the movement areas. For this reason, many papers on friction issues have been produced within the aviation community since the late 1940’s.”

WHY PICTURE IS YET TO COMPLETE since 1940's ?

EASA – RuFAB Study most aptly summarises :-

‘Probably, the most important item to recognize is that the friction coefficient is a “SYSTEM” measurement rather than an intrinsic property of, say, the **pavement**, the **tyre**, or the **material on the surface of the pavement**.

The result of a friction measurement is governed by the interaction of all components of the system which include the **tyre**, the **pavement**, the **material on the pavement**, and the **atmospheric conditions**.’

ADEQUATE FRICTION ?

ICAO Airport Services Manual Doc 9137 Part II – Pavement Surface Condition – Para 1.2.1 and 1.2.2 state

“1.2.1 Evidence from aeroplane overrun and run-off incidents and accidents indicates that in many cases inadequate runway friction characteristics/aeroplane braking performance was the primary cause or at least a contributory factor.

1.2.2 Adequate runway friction characteristics are needed for three distinct purposes:

- a) deceleration of the aeroplane after landing or a rejected take-off;
- b) maintaining directional control during the ground roll on take-off or landing, in particular in the presence of cross-wind, asymmetric engine power or technical malfunctions; and
- c) wheel spin-up at touchdown.”

Transport Canada Aerodrome Safety Circular ASC-024

April 2002 also states :-

- Friction measurements are specified for all hard-surfaced runways serving turbojet aeroplanes because the higher weights and operating speeds of turbojet versus turboprop aeroplanes make turbojet-braking performance on runway surfaces, particularly when wet, a significant safety concern.
- Consideration should also be given to measuring the friction characteristics of runways serving heavy turboprop aeroplanes (operating weights of approximately 125 kN or greater) that have runway takeoff and landing distance requirements close to the limits of available runway length.



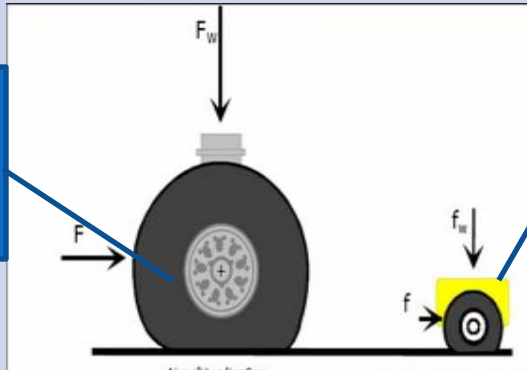
RCR IS ABOUT REPORTING OF RUNWAY FRICTION AT TWO LEVELS

- **FUNCTIONAL LEVEL**
- **OPERATIONAL LEVEL**

Friction Value μ -

Aircraft Tyres /
Surface Friction Tester Tyre

Aircraft
Landing
Gear



Surface Friction
Tester Tyre

Self Wetting Tyres

μ is a “non-dimensional number” that relates horizontal force to vertical load.

CFME equipment measures the ratio of Horizontal force divided by the Vertical force, which would give a value between 0 to 1.0



Measured Friction Value μ - *by various devices*
also depends on

- *Braking slip*
- *Tyre pressure*
- *Tyre design*
- *Tyre tread and material*
- *Method used to derive μ*
- *Self wetting method used*

FUNCTIONAL FRICTION LEVEL:-

- Used for Planning and Maintenance for existing RWYs and Design Criteria for New Pavements.
- **'Standard' in Annex 14, clause 2.9.6.**
- Included in AIP by States
- ICAO Airport Services Manual Doc 9137 Part II – Pavement Surface Condition – para 3.2.11 states

Contd..

“States should specify **three** friction levels as follows:

a) **a *design level*** which establishes the minimum friction level for a newly constructed or resurfaced runway surface;

b) **a *maintenance friction level*** below which corrective maintenance action should be considered; and

c) **a *minimum friction level*** below which the information that a runway may be **slippery when wet** should be made available and corrective action initiated.”

Generally Notified – water, rubber deposit, dirt

OPERATIONAL FRICTION LEVEL:-

- Pavement condition on day to day basis.
- **'Recommendation'** in Annex 14, clause 2.9.9.— that runway condition should be assessed and coefficient of friction measured and notified.
- Notified through NOTAMs

Generally Notified:-water, snow, slush, ice...

Contd..

OPERATIONAL FRICTION LEVEL:-

- Herein lies the ‘variety’ in Methods of Assessment & Notification on Contaminants by States:
- Multiple Methods of Assessing/Measuring
- Multiple Formats of Reporting RCR
- No Harmonization between What is Reported & its Usefulness for Flight Crew

THIS IS OUR AREA OF INTEREST & CONCERN !!

OPERATIONAL FRICTION LEVEL:-

- No Harmonization between What is Reported by airport & its Usefulness for Flight Crew... in that ...
 - the ESTIMATE of μ notified by airport operator *is a Wheel-to-Pavement Friction Value*
 - Whereas an aircraft manufacturer's μ represents *Internal Friction between Wheels and Brakes*

RUNWAY SURFACE CONDITIONS:-

- a) Dry Runway
- b) Contaminated Runway
- c) Wet Runway

CONTAMINANTS:-

FROZEN

Slush,
Loose Snow,
Wet Snow,
Compact Snow,
Frost,
Ice

NON-FROZEN:-

Damp,
Wet,
Standing Water
(water overflowing on runway
surface)

Reporting of Runway Friction Level - μ

-- wet runways

- In AIP AD Section 2.1.2 Physical Characteristics of Runway , functional values of μ are published.
- State decides the Minimum Friction Level [MFL] μ and promulgates it.
- MFL could be 0.34 or any other higher value (say μ^*) !
- During Operations, if μ is $> 0.34/\mu^*$ – No NOTAM is issued.
- When μ is $< 0.34/\mu^*$ – State issue NOTAM ‘*Slippery when wet*’

Reporting of Runway Friction Level - μ

--wet runways -- NOTAM

- *NOTAM D0342/11: Milos Airport (LGML)*
-
- D0342/11 NOTAMR D0196/11
- Q) LGGG/QMRXX/IV/BO /A /000/999/3641N02428E005
- A) LGML B) 1112311015 C) 1206302359
- E) DUE TO UNKNOWN FRICTION COEFFICIENT
BREAKING ACTION RUNWAY COULD BE **SLIPPERY
WHEN WET.**
- CREATED: 31 Dec 2011 10:17:00
- SOURCE: LGGGYNYX
-

Reporting of Runway Friction Level - μ

-- wet runways -- NOTAM

- *NOTAN A1713/11 Chennai Airport (VOMM), India*
- A1713/11 1111220910/1112231200 EST RWY
- RWY 07/25 LIABLE TO BE **SLIPPERY WHEN WET.**
- THE VALUE OF COEFFICIENT OF FRICTION IS BLW THE NOTIFIED VALUE OF 0.34 FOR RWY 07/25
- IN SECTION AS BLW :-
- RWY07 BTN 400M AND 650M
- RWY25 BTN 300M AND 500M

Reporting of Runway Friction Level - μ

-- wet runways --NOTAM

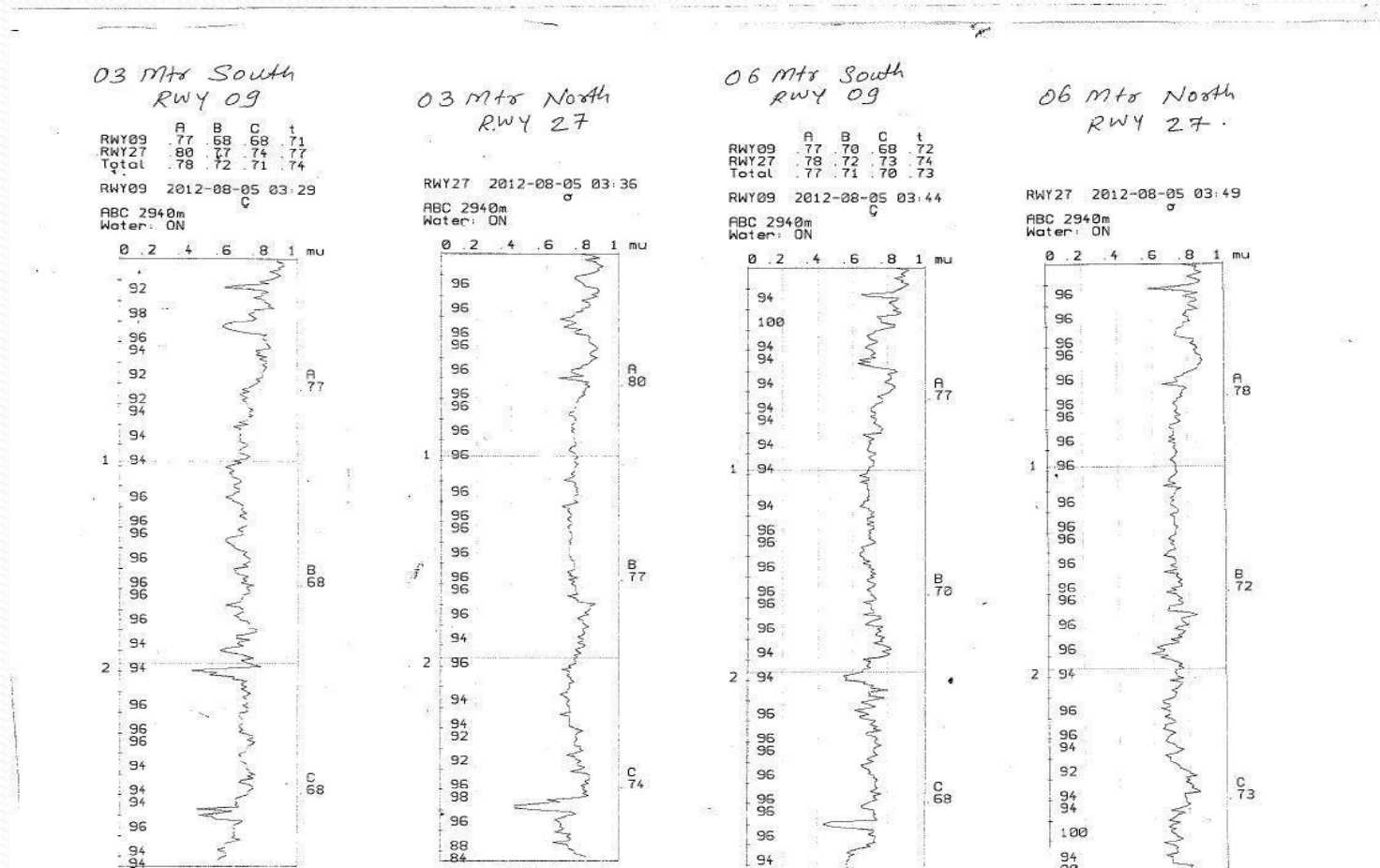
-
- *NOTAMN A0662/10 Dubai Airport.*
-
- A0662/10 NOTAMN Dubai Airport.
- Q)OMAE/QMRAL/IV/NBO/A /000/999/2515N05522E005
- A) OMDB B) 1010051200 C) 1010170800
- D) H24
- E) RWY 12L/30R AND RWY 12R/30L **MAY BE SLIPPERY WHEN WET.**
- CTN BLW MNM FRICTION READINGS **DUE SFC RUBBER.**

ICAO Airport Services Manual Doc 9137 Part II – Pavement Surface Condition – table 3-1

Table 3-1. Runway surface condition levels

Test equipment	Test tire		Test speed (km/h)	Test water depth (mm)	Design objective for new surface	Maintenance planning level	Minimum friction level
	Type	Pressure (kPa)					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Mu-meter Trailer	A	70	65	1.0	0.72	0.52	0.42
	A	70	95	1.0	0.66	0.38	0.26
Skiddometer Trailer	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.47	0.34
Surface Friction Tester Vehicle	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.47	0.34
Runway Friction Tester Vehicle	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.54	0.41
TATRA Friction Tester Vehicle	B	210	65	1.0	0.76	0.57	0.48
	B	210	95	1.0	0.67	0.52	0.42
RUNAR Trailer	B	210	65	1.0	0.69	0.52	0.45
	B	210	95	1.0	0.63	0.42	0.32
GRIPTESTER Trailer	C	140	65	1.0	0.74	0.58	0.43
	C	140	95	1.0	0.64	0.36	0.24

Rwy Friction Report : Mumbai Airport



ICAO Airport Services Manual Doc 9137 Part II

– Pavement Surface Condition – table 4-1

- Friction Coefficient for Compacted snow –and/or ice covered runways. Refer para 4.5.2

Measured coefficient	Estimated braking action	Code
0.40 and above	Good	5
0.39 to 0.36	Medium to good	4
0.35 to 0.30	Medium	3
0.29 to 0.26	Medium to poor	2
0.25 and below	Poor	1

ICAO Doc 9137 Part II — table 4-1 NOTAMs

- Friction Coefficient for Compacted snow –and/or ice covered runways – NOTAM
- [Fair (FAA) = Medium to Good (ICAO)]

USA

A0438/10 NOTAMN

Q)KZBW/QMNXX/IV/NBO/A/000/999/4255N07126W005

A)KMHT

B)101222231 C)1012242231 EST

E)RAMP ALL RAMPS THIN LOOSE WET SNOW BRAKING ACTION FAIR

A5189/09 NOTAMN

Q)KZBW/QMRXX/IV/NBO/A/000/999/4221N07100W005

A)KBOS

B)0912311815 C)1001021815 EST

E)RWY 09/27 COV BY THIN LSR -LOOSE SN ON RWY- DEICED LIQUID 100 FT WIDE BRAKING ACTION FAIR

ICAO Airport Services Manual Doc 9137 Part II – Pavement Surface Condition – table 4-1 NOTAMs

- Friction Coefficient for Compacted snow –and/or ice covered runways – SNOWTAM

GG CYZZNYXX

151121 CYHQADMS

SWCY0066 CYXX 06151120

(SNOWTAM 0066

A) CYXX B) 06151120

C) 01 E) 36 F) 2/2/2 G) XX/XX/XX

C) 07 F) 3/3/3 G) XX/XX/XX H) 35/35/35

T) 000000 NOTAMJ CYXX ABBOTSFORD/ABBOTSFORD

CYXX RSC 01/19 120 FT CL 100 PCT BARE AND WET. REMAINING WID 100

PCT FROST. 1206151120

CYXX RSC 07/25 100 PCT FROST. 1206151120

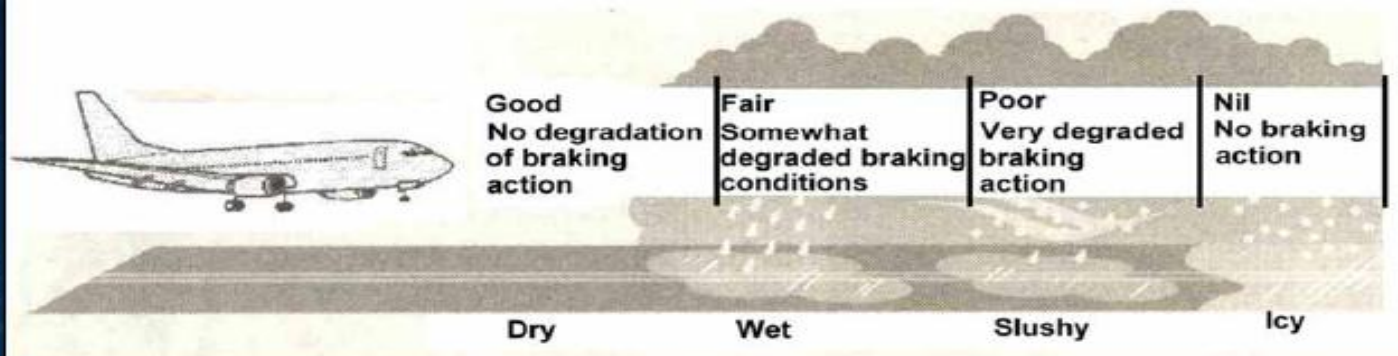
CYXX CRFI 07/25 0C .35 1206151120)

Runways covered with compacted snow- and/or ice – another view



Traditional Information given to the Pilot

How pilots describe conditions



Measurement of Runway Friction:-

- Continuous Friction-Measuring Devices:-
 - Mu-meter, Rwy Friction Tester, Skiddometer, Grip Tester, -- can be used over compacted snow-and/or ice covered runways
- Decelerometer:-
 - Brakemeter-Dynometer, Tapley Meter
 - May be used **ONLY** on surfaces covered by compacted snow and/or ice + additional thin layers of dry snow.
 - **Not** to be used on loose snow/slush or ice covered with water film (due misleading values)

Reporting – (Doc 9137 Part II para 4.5.5/6/7)

- 4.5.5 It has been found necessary to provide surface friction information for **each third of a runway**. The one third segments are called A, B and C.
- 4.5.6 Friction measurements are made **along two tracks parallel to the runway**, i.e. a track on each side of the runway centre line, approximately 3 m from the centre line or that distance from the centre line at which most aeroplane operations take place. The object of the tests is to determine the mean friction (μ) value for segments A, B and C.
- 4.5.7 When reporting the presence of dry snow, wet, snow or slush on a runway, an assessment of the mean, depth over each one-third segment of a runway should be made to an accuracy of approximately **2 cm for dry snow, 1 cm for wet snow and 0.3 cm for slush**.

Reporting – (Doc 9137 Part II para 4.5.5/6/7)

- Example – using simple description.

Runway surface state is Touchdown Zone XX% coverage, contaminant Type, Depth XXX mm Mid Point XX% coverage, Contaminant Type, Depth XXX mm Stop End XX% coverage, Contaminant Type, Depth XXX mm”

- **SNOWTAM-**
- Field F- Contaminant deposit,
- Field G – Mean Depth of contaminant each third of runway length
- Field H- Friction Measurement μ /estimated surface friction

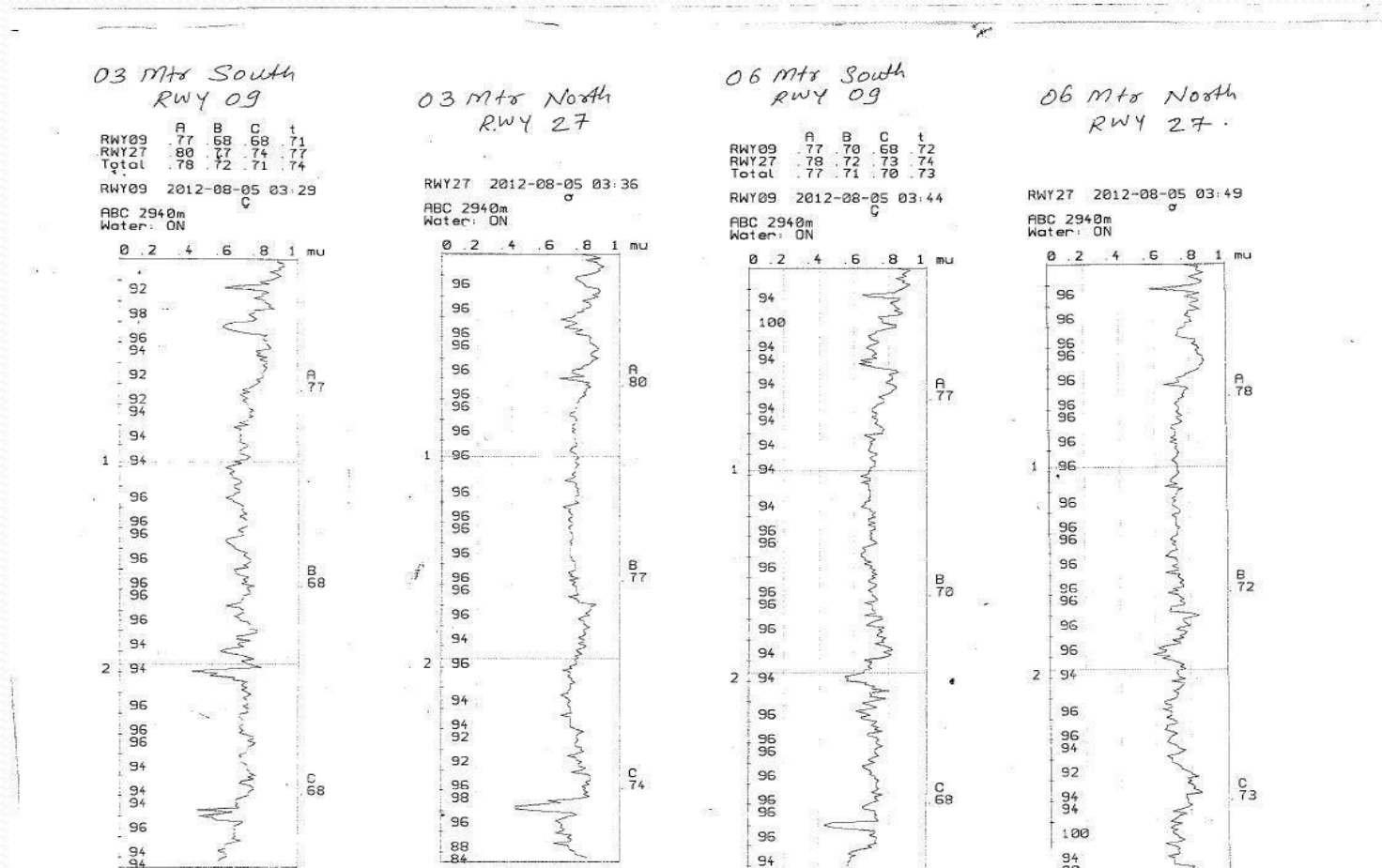
ACCURACY OF REPORTING

- FUNCTIONAL FRICTION LEVEL
- OPERATIONAL FRICTION LEVEL

ACCURACY OF REPORTING:- Functional Friction Level -- published in AIP.

- **RECORD MAY CONTAIN:-**
- **Date and time of assessment, including operative's name;**
- **Runway Designator**
- **Distance from the centreline and on which side of centreline the run was performed;**
- **Constant run speed (km/h) for each run;**
- **Run length;**
- **Test water depth;**
- **Test tyre type;(smooth/tread type)**
- **Measure of tyre wear;**
- **Surface condition and air temperature;**
- **Average friction level per run; and**
- **Friction levels indicating 100 m rolling average by Portion.**

Rwy Friction Report : Mumbai Airport



ACCURACY OF REPORTING:- Functional Friction Level -- published in AIP.(Refer Annex 14 Clause 2.9.4)

- *Water on a runway*
- **2.9.4 Recommendation.**— *Whenever water is present on a runway, a description of the runway surface conditions on the centre half of the width of the runway, including the possible assessment of water depth, where applicable, should be made available using the following terms:*
- **DAMP** — *the surface shows a change of colour due to moisture.*
- **WET** — *the surface is soaked but there is no standing water.*
- **WATER PATCHES** — *significant patches of standing water are visible.*
- **FLOODED** — *extensive standing water is visible.*

.... Contd..

ACCURACY OF REPORTING:- Functional Friction Level -- published in AIP.(Refer Annex 14 Clause 2.9.4)

.... contd

- 2.9.6 Information that a runway or portion thereof **may be slippery when wet shall** be made available.
- 2.9.7. A runway or portion thereof shall be determined as **being slippery** when wet when the measurements with a CFME + self wetting tyre shows that the runway surface friction characteristics are below the minimum friction level specified by the State.

ACCURACY OF REPORTING

- FUNCTIONAL FRICTION LEVEL
- **OPERATIONAL FRICTION LEVEL**

ACCURACY OF REPORTING:-

Operational Friction Level

- Measurements of Contaminant's Extent and Depth

ACCURACY OF REPORTING:-

- Measurements of Contaminant's Extent and Depth.
 - States may adopt suitable methods of measuring Extent of Contaminant.
 - Doc 9137 Part II – para 6.6 – SNOWTAM FORMAT Item 'T' provides for:-

PLAIN LANGUAGE REMARKS (including contaminant coverage and other operationally significant information e.g. sanding, de-icing)

Runway Contamination

10% -- if < 10% of rwy contaminated

25%-- if 11-25% of rwy contaminated

50%-- if 26-50% of rwy contaminated

100% -- if 51-100 of rwy contaminated

ACCURACY OF REPORTING:-

- Measurements of Contaminant's Extent
 - TALPA-ARC recommends to notify Extent of Contaminant (*inter alia*) as follows:

Whenever a runway is NOT bare and dry, runway condition NOTAM are to be issued.

Runway Contamination

10% -- if 10% or less of rwy contaminated

25%-- if 11-25% of rwy contaminated

50%-- if 26-50% of rwy contaminated

75%-- if 51-75% of runway contaminated

100% -- if 76-100 of rwy contaminated

ACCURACY OF REPORTING:-

- Measurements of Contaminant's Depth
 - Doc 9137 Part II – para 4.5.7 states

WHEN REPORTING THE PRESENCE OF DRY SNOW, WET SNOW OR SLUSH ON A RUNWAY, AN ASSESSMENT OF THE MEAN DEPTH OVER EACH ONE-THIRD SEGMENT OF A RUNWAY SHOULD BE MADE TO AN ACCURACY OF APPROXIMATELY

- 2 cm for DRY SNOW,
- 1 cm for WET SNOW, &
- 0.3 cm for SLUSH

ACCURACY OF REPORTING:-

- Measurements of Contaminant's Depth
- Doc 9137 Pert II – para 4.5.7 requires accuracy in measurement to the extent of 2 cm for DRY SNOW, -- 1 cm for WET SNOW, &

0.3 cm for SLUSH !!



0.3 cm

EASA-RuFAB- ppt
by Paul Fraser Bennisan

ACCURACY OF REPORTING:-

- Measurements of Contaminant's Depth
 - EASA –RuFAB Studies indicate – this accuracy in measuring DEPTH of Contaminants is possible by using
 - LASER DEPTH PROFILING
 - LATERAL LASER SCANNING
 - CONTMINANT IMPACT ENERGY MAEASUREMENT

States and Stakeholders may decide on this issue !!

Reporting – (Doc 9137 Part II para 4.5.5/6/7)

- NOTAM – format may be ---

Runway surface state is Touchdown Zone XX% coverage, Contaminant Type, Depth XXX mm Mid Point XX% coverage, Contaminant Type, Depth XXX mm Stop End XX% coverage, Contaminant Type, Depth XXX mm.

- **SNOWTAM-**
- Field F- Contaminant deposit,
- Field G – Mean Depth of contaminant each third of runway length
- Field H- Friction Measurement μ /estimated surface friction

TIMELY REPORTING- of- OPERATIONAL FRICTION:-

- ATC/AIS get report on runway condition from airport operator and convey to flight crew a.s.a.p.

PREFERABLY before arriving aircraft reaches 20 miles from touchdown/ departing aircraft taxi out.

(proposed here)

- Removal of contaminants – top priority
- Need to balance priority of runway check-vs-traffic

TIMELY REPORTING- of- OPERATIONAL FRICTION:-

- Runway Inspection Team to inform ATC/AIS/Airlines directly from runway using —
 - R/T (to SMC or TOWER if National Rules permit)
 - Walkie -Talkie
 - Cell phones to Tower Supervisor (recorded channel)
 - e-mail directly from Tester to all concerned

TIMELY REPORTING- of- OPERATIONAL FRICTION:-

- **Computerized Information Recording and Transmission** . Runway inspection team may use vehicle mounted computerized systems to record the conditions and transmit the resulting **report** to the ATC/AIS/Airlines via cellular modem/WiFi/dedicated frequency.
- Computerized reports may contain a data element sequence.
- In this mode delay in transmission can be minimized.

TIMELY REPORTING- of- OPERATIONAL FRICTION:-

- Regionally acceptable FORMAT for reporting runway friction measurement in runway-contaminated/wet condition is required.

(we may consider to adopt)

‘Runway surface state is Touchdown Zone XX% coverage, Contaminant Type, Depth XXX mm
Mid Point XX% coverage, Contaminant Type, Depth XXX mm
Stop End XX% coverage, Contaminant Type, Depth XXX mm.’

+ add here the μ observed on inspection of the contaminated runway.

The Manual on RCR

- Survey Questionnaire (SQ) on RCR Practices in APAC Region – circulated by ICAO on 16th June 2012.
- Draft Manual submitted to APRAST Chair. The draft manual is based on ‘ICAO Circular 329 - Runway Surface Condition Assessment, Measurement and Reporting’.
- Information on practices adopted by ANSPs/Airport Operators to issue NOTAMs/SNOWTAMs in APAC Region needed to complete Draft Manual
- Filled up SQ received only from 5 States.

The Manual on RCR- a few findings from the Survey

- MFL is not necessarily 0.34. States have adopted higher values (μ^*) also.
- AIP contains details on Functional Frictional Level, including provision for ‘Slippery when wet’ NOTAM
- States have adopted other than 3 mtrs from C/L of Rwy - values for measuring friction.

contd...

The Manual on RCR- a few findings from the Survey

...contd

- Surface Friction Tester with self wetting feature at 95 kmph is a preferred choice.
- Telephone, R/T used for immediate reporting to ATC. Followed by FAX.
- PIREPs encouraged.
- Issue of SNOWTAM not required.

The RCR Survey :-

- ANSPs /Airport Operators are requested to send filled up SQ.
- Other Stakeholders are requested to provide copies of NOTAMs /SNOWTAMs relevant to the Survey

preferred - gmatmsqms@aai.aero

alternate - mcdangi@gmail.com



THANKS

Attachment-1 REFERENCE Documents and Presentations

- 1 **ICAO - Annex 14 Vol- I**
- Airport Services Manual Part II – Doc 9137.
-Draft Circular 329 ---
(Runway Surface Condition Assessment, Measurement and Reporting)
- 2 **EASA – RuFAB -RUNWAY Friction Characteristics Measurement & Aircraft Braking**
- 3 **TALPA-ARC-** The Take-off and Landing Performance Assessment Aviation Rule making Committee-- Airport/Part 139 Working Group Recommendations Dated April 9, 2009.
- 4 **FAA Safety Alert for Pilots (SAFO 0612 Dated 8/31/2006)**
- 5 **Flight Safety Foundation ALAR Tool Kit (Approach and Landing Accident Reduction)**
- 6 **Transport Canada – Aerodrome Safety Circular ASC 2004-024**
- 7 **Skybrary – documents**
- 8 **Alaska Airlines -- Presentation Made by Chel Collett Manager Flight Standards Alaska Airlines 2010 Operation and Technical Affairs Conference.**
- 9 Winter Operations Plan 2011-12 Manchester Airport
- 10 **Mr. Tim Neubert President NAC.** Presentation made at IFPA (International Friction Pavement Association)—with his permission
- 11 Filled up **Survey Questionnaire** Received from States.

Attachment-2 Definitions of Contaminants (specific gravity not included)

Term	Recognizable Characteristics
Slush	Water-saturated snow with a heel-and-toe slap down motion against the ground will be displaced with a splatter .
Frost	A condition where ice crystals formed from air borne moisture condense on a surface whose temperature is below zero. Frost differs from ice in that the frost crystals grow independently and, therefore, have a more granular texture
Loose Snow	Sometime called “Dry” snow. Snow which can be blown if loose or, if compacted by hand, will fall apart upon release Snow that is not bonded to the AMS and will compact under vehicular traffic
Wet Snow	Snow that will stick together when compressed but will not readily allow water to flow from it when squeezed
Compact Snow	Snow which has been compressed and will not compress further under vehicular traffic or aircraft wheels, at representative operating pressures and loadings
Ice	A frozen liquid with a continuous surface and includes the term “black ice” and the condition where compacted snow transitions to a polished surface with the density of ice
Damp	A surface is Damp when it is non-reflective and moisture is present
Wet	A Wet surface has liquid present and is reflective
Standing Water	Sometimes called ‘Flooded’. Includes localized and continuous surface coverage, whether during precipitation or not