KINGDOM OF BAHRAIN
Ministry of Transportation and Telecommunications

مملكة البحرين
وزارة المواصلات والاتصالات

CIVIL AVIATION PUBLICATION

CAP-103

Dated: 30 February 2017

FRICTION TESTING AND MAINTENANCE OF PAVED RUNWAY SURFACES

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RECORD OF AMENDMENTS

Amendments				
Serial No.	Issue No.	Revision No.	Date	Description
01	01	0	30, Feb 2017	Initial Issue
02	01	01	15, Jan 2018	CAP. serial number revised (CAP- 62 revised as CAP.103)

Table of Contents

1. Preface

This Civil Aviation Publication (CAP) provides guidance for testing and measuring of friction characteristics of the runway provision of maintenance measures to abraded surfaces and determination of water coverage on pavements.

2. REFERENCES

2.1 ICAO ANNEX 14 – Volume I. (Aerodromes)
2.2 ICAO Doc 9157 – Part 3 (Pavements)
2.3 Civil Aviation Regulation.CAR001 -14 March 2016

3. DEFINITION OF TERMS

For the purpose of a runway surface friction assessment the following definitions apply:

Term	Definition/Description
Continuous Friction Measuring Equipment (CFME)	A devise designed to produce continuous measurement of runway friction values
Design Objective for New Surface (DONS)	Target friction level to be on a new or overlaid pavement surface within one year
Friction Level	The overall average friction value calculated from a minimum of 10 average friction values obtained over a rolling distance of 100 metres within a portion of pavement

Term	Definition/Description
Surface Grooving	A mechanized maintenance method of creating transversal grooves across the pavement as a measure to improve abrasive properties of the pavement surface
Macro texture	Created by coarser visible texture depth which has dual functions of allowing water paths and causes distortion (or hysteretic losses) to the aircraft tyre rubber where it contacts aggregate asperities
Maintenance Planning Level (MPL)	The friction level of a pavement below which runway maintenance programme should be undertaken
Micro texture	A fine degree of surface coarseness usually felt by touch
Minimum Friction Level (MFL)	The friction level of a runway pavement below ***which a notifier*** **—**may be slippery when wet‖ should be issued
Wet Runway Surface	A runway that is soaked but no significant patches of water are visible
Single chip seal (or single surface dressing)	A bituminous layer consisting of single sized aggregate chippings rolled on top of pre-sprayed penetration graded bitumen normally 80/100 bitumen
Skid resistance	Amount of friction derived from the top of the pavement surfacing being manifestation of Micro texture and macro texture characteristics of a runway

4. Introduction

4.1 General

4.1.1 Section 10.2.2,10.2.3,10.2.4 of Civil aviation regulations CAR001.-2016 provides the requirement to undertake regular tests of runway surface friction characteristics by using the self wetting continuous friction measuring equipment (CFME) and to ensure that the friction level does not fall below an acceptable level.

4.1.2 This Civil Aviation Publication (CAP) describes the minimum level of assessment that should be employed for the group of ICAO recommended Continuous Friction Measuring Equipments (CFME) as recommended in Annex 14 (Aerodromes) Attachment A. Other types of CFME may be used if their performance can be demonstrated, to the satisfaction of the CAA, to provide comparable results with currently recommended CFME.

4.1.3 The criteria, which are given in this CAP, reflect the CAA‘s compliance to the Standards and Recommended Practices of Annex 14 to the Convention on International Civil Aviation in so far as adopted by the State in respect of runway surface friction testing and associated maintenance.

5 Intent /Applicability

5.2.1 The purpose of this Civil aviation Publication CAP is to outline the procedures for undertaking runway surface friction assessments and to define the criteria by which friction values should be assessed on runways under specified conditions.

5.2.2 This CAP also provides guidance to aerodrome operators on how they may assess the friction of runway surfaces in order to adjust maintenance schedules to ensure that the runway surface condition is adequate for safe operation of aircraft.

5.2.3 This CAP applies to all aerodrome operators in the Kingdom of Bahrain Certified under Civil aviation Regulations CAR001.

6 Scope

6.3.1 The criteria in this document apply to all paved runways exceeding 1200 meters in length and all paved runways used for public transport operations. It is not applicable to grass runways or heliports for obvious reasons.

6.3.2 On paved runways of 1200 meters or less, where regular public transport (RPT) operations are not carried out, the application of the procedures is at the discretion of the aerodrome operator.

6.3.3 The procedures in this document are only to be used for the acquisition of friction levels of a runway surface for understanding existing macro texture of the pavement that may lead to the surface rejuvenation.

6.3.4 The runway surface friction assessment is a mandatory regulatory requirement in accordance with Civil Aviation Regulations,CAR001.2016. An aerodrome operator should carry out additional friction testing as an integral part of their Safety Management System (SMS) to establish macro texture friction condition during adverse weather conditions and to identify areas of the runway where rubber build up may have occurred over a given period of time. These tests should be conducted using any of the ICAO recommended list of CFME self-wetting devices. In addition, accumulated rubber deposits should be assessed by employing an ICAO observation approach described in Airport Services Manual: Part 2.

7. Technique for Runway Surface Friction Measurements

7.1 A runway surface friction assessment is conducted under controlled conditions using self-wetting CFME devices, to establish the friction characteristics of a runway and to identify those areas of a runway surface that may require rejuvenation for safe aircraft operation. A list the ICAO recommended CFME is shown in Table 1 below:

Table 1: ICAO list of CFME and their recommended target friction levels (extract from Annex 14 – Attachment A)

Test Equipment	Test Tyre		Test speed km/hr	Test water depth (mm)	Design objective for new surface (DONS)	Maintenance planning level (MPL)	Minimum friction level (MFL)
	Type	Pressure (kPa)					
Mu-meter trailer	A	70	65	1.00	0.72	0.52	0.42
	A	70	95	1.00	0.66	0.38	0.26
Skiddometer	B	210	65	1.00	0.82	0.60	0.50
Trailer	B	210	95	1.00	0.74	0.47	0.34
Surface Friction	B	210	65	1.00	0.82	0.60	0.50
Tester Vehicle	B	210	95	1.00	0.74	0.47	0.34
Runway Friction	B	210	65	1.00	0.82	0.60	0.50
Tester Vehicle	B	210	95	1.00	0.74	0.54	0.41
TATRA Friction	B	210	65	1.00	0.76	0.57	0.48
Tester Vehicle	B	210	95	1.00	0.67	0.52	0.42
Griptester	C	140	65	1.00	0.74	0.53	0.43
Trailer	C	140	95	1.00	0.64	0.36	0.24

Note: List of CFME is progressively updated by ICAO to account for new and emerging technologies and out-of-manufacture devices. CAA *adapts and ratifies to new and ICAO updated list of equipment and friction assessment techniques as an obligation for continuous compliance with ICAO SARPs.*

7.2 Friction readings for the survey run are collected by the CFME along the line of the entire pavement length. An average friction value is determined every 10 metres along a run, enabling a 100-metre rolling average to be calculated. The runway width should be divided into equal thirds; these portions of the pavement are referred to as _central‘ and _outer‘ trafficked portions. The friction level for each portion is determined by the lowest of the rolling averages. The procedure for calculating the rolling average for each run is repeated in a similar fashion for each of the three portions across the runway. In each case, the applicable runs across the width of each portion are first averaged before undertaking the rolling average calculation as described above.

7.3 The aerodrome operator should determine the frequency of the assessments that will enable any significant change in runway surface friction characteristics to be identified and, if appropriate, for remedial maintenance to be conducted before the friction level falls below the MFL.

7.4 The recommended periodicity of runway surface friction assessments is a function of operating condition of turbo-jet aircraft at a respective runway pavement and should follow recommendations of Table 3 in Chapter 5 of this guidance material.

7.5 The friction characteristics of a runway vary over time as the runway is subject to tyre abrasive forces, rubber build up and to the effects of climate and other environmental conditions. Aerodrome operators should monitor the results of assessments and should vary the interval between assessments depending on the results. If historical data indicates that the surface is deteriorating relatively quickly, more frequent monitoring may be required in order to ensure that maintenance is arranged before the friction characteristics deteriorate to an unacceptable level. The aerodrome operator should record the justification for any variation from the recommended periodicity for assessments, for example on Assessment Report No. 2 – see Table 5.

7.6 The friction characteristics of a runway can also alter significantly following maintenance activities, even if the activity was not intended to affect the friction characteristics. Therefore, a runway surface friction assessment should be conducted

following any significant maintenance activity conducted on the runway and before the runway is returned to service. Runway surface friction assessments should also be conducted following pilot reports of perceived poor braking action, if there are visible signs of runway surface loss of macrotexture, or for any other relevant reason.

8. Procedures for Runway Surface Friction Assessment

8.1 Equipment Checks

The CFME operator should ensure that the equipment is in full working order and calibrated in accordance with the manufacturers‘ operating instructions.

8.2 Operator and Training Competency

8.2.1 The success of friction measurement in delivering reliable friction data depends greatly on the personnel who are responsible for operating the CFME. All operators should be trained in its operation and maintenance and be aware of the critical factors affecting the accuracy of friction measurements. General guidance on assessment speed, calculated water depth and tyre type and pressure should be sought from the CFME manufacturer.

8.2.2 Where a consultant carries out an assessment, it is the responsibility of the aerodrome operator to satisfy himself as to the competency and experience of the CFME operator.

8.2.3 For consistency purposes, one type of CFME and consultancy source(s) can be adopted to be used by an aerodrome operator over a given period of time to data integrity and prevent inadvertent confusions that may arise from using different CFME within a short period of time.

9 Assessment Conditions

9.1 The runway surface should be free from precipitation during the assessment, with no wet patches.

9.2 The assessment should be conducted at an ambient air temperature above 2° C.

9.3 Surface dampness and fog conditions might also affect the outcome of the assessment and aerodrome operators should be aware that cross-winds may affect self-wetting assessments. Aerodrome operators should seek advice on these issues from the CFME manufacturer.

10 Assessment Procedure

10.1 A runway surface friction assessment consists of two check runs supplementing a series of standard runs.

10.2 **Check Runs**

10.2.1 A check run is designed to confirm that the operation of the CFME is consistent throughout the full runway surface friction assessment and should be conducted before and after completion of the standard runs, under the same conditions.

10.2.2 A check run should be performed over the entire pavement length on a portion of the runway that does not traverse any other runs, and at a constant speed.

10.3 **Standard Runs**

10.3.1 Starting with the run closest to the runway edge, a standard run should be carried out along the entire pavement length at a constant run speed, allowing for acceleration and safe deceleration. Table 2 defines the recommended location of each run for nominal width runways.

10.3.2 The track(s) of the measuring wheel(s) should not run along the line of the pavement joints or longitudinal cracks.

10.3.3 The run pattern for a runway with Touchdown Zone (TDZ) markings should be planned so as to include one run either side of the centerline to pass through the centre of the painted TDZ markings.

10.3.4 If there is any reason to doubt the accuracy of the runway surface friction assessment, it should be repeated.

11 Records

11.1 Aerodrome Operators should keep records of all runway surface friction assessments. The following items should be recorded for each assessment, and made available upon request to the CAA:

- Date and time of assessment.
- Runway assessed.
- Run number and runway direction.

- Distance from the centerline and on which side of centerline the run was performed.
- Constant run speed (Km/h) for each run.
- Run length.
- Self-wetting system on/off (refers to check runs only).
- Surface condition.
- Average friction level per run.
- Friction levels for each portion of the pavement.
- Overall friction level.

11.2 Tables 4 and 5 depict typical assessment report sheets that can be used and retained as a record for each runway surface friction assessment.

12. Evaluation of Runway Surface Friction In-situ Test Results

12. 1 Introduction

12.1.1 The friction level values obtained should be compared with the following criteria:

- The Design Objective for New Surface (DONS)
- The Maintenance Planning Level (MPL)
- The Minimum Friction Level (MFL)

12.1.2 The friction level values produced by different CFME vary slightly for any given runway surface friction characteristics; therefore, correlation among assessment criteria of CFME devices can be established.

12.2 Action to be taken as a result of a runway friction assessment

12. 2.1 The aerodrome operator should review the results of each runway friction assessment and where appropriate take the following action:

- If the friction level is below the MPL, maintenance should be arranged to restore the friction level, ideally to a value equal to or greater than the DONS.

- If the friction level indicates a falling trend, the Aerodrome Operator should increase the frequency of runway friction assessments in order to identify any further or rapid deterioration and, if appropriate, the action to be taken.

- If the friction level is below the MFL, maintenance should be arranged urgently in order to restore the friction level and, in accordance with ICAO Annex 14 Volume 1 Paragraph 2.9.5, a NOTAM shall be issued advising that the *runway may be slippery when wet*.

- If the friction level is significantly below the MFL, the aerodrome operator should consider withdrawing the runway from use for take-off and/or landing when wet and issue a NOTAM in that respect.

- The friction measurement using the CFME should, if required for detailed analysis of pavement macro texture, be conducted in conjunction with measurements of *texture depth* for the purpose of assessing macro texture quality of the paved surface.

12. 3 Assessments made following maintenance activities

12. 3.1 The friction characteristics of some runway surface materials can improve over time, commonly as a result of the dispersal of oils in the surface layers. However, if the runway surface friction assessment indicates that the friction characteristics of an area of the runway that has been subject to maintenance work are poorer than anticipated or fall below the MPL, additional assessments should be performed over a period of time to ascertain whether the friction characteristics remain stable, improve, or if additional work should be carried out.

13. Frequency of Runway Surface Friction Testing

13.1 Standardized Survey Frequency

13.1.1 ICAO Airport services manual: Part 2 should be used for determination of the frequency and timing of friction measurements by employing a self – wetting CFME device. The frequency has been designated in regard to operating condition of turbo-jet aircraft at a respective airport. Table 3 below shows the friction testing frequency in accordance with the Airport services manual: Part 2:

Table 3: Recommended Friction Survey Frequency (extract from Annex 14 – Attachment A)

Daily turbo-jet aircraft arrivals for runway end	Annual aircraft weight for runway end (million kg)	Minimum Friction Survey Frequency
Less than 15	Less than 447	Once per year
16 to 30	448 to 838	Once every 6 month
31 to 90	839 to 2404	Once every 3 months
91 to 150	2405 to 3969	Once every month
151 to 210	3970 to 5535	Once every 2 months

Daily turbo-jet aircraft arrivals for runway end	Annual aircraft weight for runway end (million kg)	Minimum Friction Survey Frequency
Greater than 210	Greater than 5535	Once every week

13.1.2 The Aerodrome Operator is required to observe the testing frequency depicted above as a mandatory requirement for safe operation of aircraft:

14. Recommended Maintenance Practices

14.1 Operator's Obligation for Restoration of Runway Skid Resistance

41.1 On finding that the friction levels are well below the recommended values which trigger maintenance consideration, the Aerodrome Operator should devise engineering means for restoration of micro texture and macro texture of the pavement surface.

1. Macro texture and Micro texture restoration methods

For restoration of micro texture, the Aerodrome Operator should lightly grind the surface to cause sharpening of the exposed coarse aggregate by using the appropriate mechanical equipment.

2.2 For restoration of the macro texture, the Aerodrome Operator should judicially use high pressure water jetting to remove some of the matrix fines from the surface. Alternatively, pavement surface grooving using mechanical equipment should be used.

2.3 Single chip seal (surface dressing) consisting stones with adequate polishing values should be applied on top of rubberized or abraded pavement surface in case observed to be a necessary maintenance option for improving skid resistance.

2.4 Application of environmentally approved chemicals to remove accumulated rubber deposits should be used to remove built up rubber. Approval of a specific chemical reagent should be approved by relevant bodies

15. Determination and Reporting of Water Coverage on runways

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.

Normally, such an exercise is conducted by the Operations personnel (pavements) using the mapping sheet and the windscreen or walk-over visual assessment. The mapping sheet is used to indicate the coverage of water at the various locations of the runway.

A runway or portion thereof shall be determined as being slippery when wet when the measurements specified in Table 1 – chapter 2 show that the runway surface friction characteristics as measured by a continuous friction measuring device are below the minimum friction level specified.

Table 4: Friction Measurement Form 1

RUNWAY FRICTION MEASUREMENTS

Airport Name	
Runway	
Date of testing	

Run No	RWY Directi-on	Time	Distance from CL	Side of CL	Speed km/hr	Run length	Self-wet on/off	Surface condition	Average friction value
Check 1									
Check 2									

Remarks:

Table 5: Friction Measurement Form 2

RUNWAY FRICTION ASSESSMENT

Airport Name	
Runway	
Date of testing	

Description	Applicable Runs	Friction Level
Friction level for central portion	Run numbers:	
Friction level for outer portion (Right)	Run numbers:	
Friction level for outer portion (Left)	Run numbers:	
Overall friction level	Average value taken from all standard runs	
Is any portion of runway	YES/NO	

below MFL	
Remarks	
Remedial measures to be under taken	
Recommended date for next friction measurement	