Ethiopian Civil Aviation Authority

Aerodrome Safety and Standard Directorate

Runway Surface Friction measurement and reporting procedures

October, 2013

PREAMBLE

WHEREAS, it is desirable to consolidate and modernize the aviation Advisory Circular to bring them to international standards,

WHEREAS, it is important to set the Advisory Circular as to how the regulatory, administrative, technical and supervisory activities of the Authority shall be performed in the one hand and setting the duties, obligations and standards that shall be respected by operators and aviation personnel,

WHEREAS, it is necessary, to provide detailed Advisory Circular for the administration of license, certification, investigation and enforcement of aviation laws.

NOW THEREBY, The Authority under its power given by Article 92/2 of the Civil Aviation Proclamation No. 616/2008 issued the following Advisory Circular.

1. SHORT TITLE

This Advisory Circular may be cited as "Advisory Circular for Runway Surface Friction Measurement and Reporting Procedure, No. ECAA-AC-AGA008/2013"

2. REPEAL AND INAPPLICABLE LAWS

No law, directive, order or practice shall, in so far as it is inconsistent with this Advisory Circular, be applicable with respect to matters provided for by this Advisory Circular.

3. EFFECTIVE DATE

This Advisory Circular shall come into force as of October/ 2013.

Done at Addis Ababa, October, 2013

Hosenyelgh Hunegnaw (Col)
Director General

Federal Democratic Republic of Ethiopia CIVIL AVIATION AUTHORITY

AMENDMENTS

AMENDMENTS			
No.	Date Applicable	Date Incorporated	Entered By

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Ethiopian Civil Aviation Authority	**Advisory Circular** **ECAA-AC-AGA 008** **September,2013**

Runway Surface Friction Measurement and Reporting Procedures

Chapter 1 – Introduction

1.1 General

As an integral part of an Aerodrome Safety Management System (SMS), effective monitoring of the surface friction characteristics of runways should be clearly set out together with a methodology for documenting and dealing with the results of such monitoring.

As set out in ICAO Annex 14 Chapter 10, to undertake regular assessments of runway surface friction characteristics and to ensure that friction is maintained at an acceptable level, but in any case does not fall below the State-set Minimum Friction Level (MFL). If the runway friction characteristics fall below MFL a NOTAM must be issued stating the surface "may be slippery when wet" and promulgated until remedial action has restored friction values to at least Maintenance Planning Level (MPL).

This document describes the way the assessment should be carried out using the current available Friction Measuring Equipment (Skkidometer).

The criteria, which are given in this procedure, reflect the ECAA's interpretation of Standards and Recommended Practices of Annex 14 to the Convention on International Civil Aviation.

1.2 Purpose

The objective of this document is to offer guidance to Aerodrome Operators undertaking runway surface friction assessments by describing the key elements of

the procedure. It also sets out target values for surface friction levels that should prompt maintenance and/or NOTAM action by aerodrome operators following any such assessment.

This document also provides guidance to aerodrome operators on how they may vary the frequency of runway surface friction level assessments in order to adjust maintenance schedules to meet the objective of adequate runway conditions for safe aircraft operations.

1.3 Scope

The criteria in this document apply to all paved runways with an Accelerate Stop Distance Available (ASDA) 1,200 metres or greater in length and used for public transport operations by aeroplanes.

The procedures in this document should only be used for the acquisition of friction levels of a runway surface for maintenance purposes. Data gathered concerning friction characteristics should be made available to aerodrome users.

1.4 References

a) Manual of Implementing Standards Aerodrome in Ethiopia (MOIS)
b) Airport Service Manual ICAO Doc 9137 - Part 2 (Pavement surface condition)
c) Different web sites

1.5 Definition

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

Check Runs:-
Runs intended to confirm that the operation of the friction measuring equipment remains constant. These are performed before and after Standard Runs.

Continuous Friction Measuring Equipment (CFME):-
A device designed to produce continuous measurement of runway friction values.

Design Objective Level (DOL):-

The State-set friction level to be achieved or exceeded on a new or resurfaced runway within one year.

Friction Level:-

The lowest average friction value calculated from a minimum of 10 averaged friction values, of applicable Standard Runs, obtained over a rolling distance of 100 metres within a portion of the pavement.

Hydroplaning:-

The condition when a layer of water separates an aircraft's tyres from the runway surface.

Maintenance Planning Level (MPL):-

The State-set friction level below which a runway Maintenance programme should be undertaken.

Minimum Friction Level (MFL):-

The State-set friction level below which a runway shall be notified as 'may be slippery when wet'.

Portions of the Pavement:-

A rectangular area of the runway width running the declared length, referred to as the 'central' trafficked portion and two 'outer' portions.

Runway Surface Friction Assessment:-

The assessment of friction carried out under conditions of self wetting using friction measuring equipment.

Standard Runs:-

A series of runs to a prescribed pattern within an assessment.

Test Water Depth:-

Test water depth (also known as nominal test water thickness). The water flow rate produced by the CFME's self wetting equipment divided by the test speed multiplied by the width of application.

Wet Runway Surface:-

A runway that is soaked but no significant patches of standing water are visible.

NOTE: *Standing water is considered to exist when water on the runway surface is deeper than 3 mm.*

1.6 Why do we need friction Test?

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. Aside from this safety-related aspect, the regularity and efficiency of aeroplane operations can become significantly impaired as a result of poor friction characteristics. It is essential that the surface of a paved runway be so constructed as to provide good friction characteristics when the runway is wet. To this end, it is desirable that the average surface texture depth of a new surface be not less than 1.0 mm.

Heavy rubber deposits can completely cover the pavement surface texture causing loss of aircraft braking capability and directional control, particularly when runways are wet.

It is important to know that the runway won't be the cause of an incident due to poor friction. Aside from peace of mind, it is also an international requirement, ICAO Annex 14 formally regulating the procedures and equipment to ensure runway safety remains at the highest level.

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.

Reduced runway surface friction has a different significance for the landing case compared with the rejected take-off case because of different operating criteria.

1.7 Friction Deterioration

Over time, the skid-resistance of runway pavement deteriorates due to a number of factors, the primary ones being mechanical wear and polishing action from aircraft tires rolling or breaking on the pavement and the accumulation of contaminants, chiefly rubber, on the pavement surface. The effect of these two factors is directly dependent upon the volume and type of aircraft traffic. Other influences on the rate of deterioration are local weather conditions, the type of pavement (Hot-Mix Asphalt or Portland Cement Concrete), the materials used in original construction, any subsequent surface treatment, and airport maintenance practices. Structural pavement failure such as rutting, ravelling, cracking, joint failure, settling, or other indicators of distressed pavement can also contribute to runway friction losses. Prompt repair of these problems should be undertaken as appropriate.

Contaminants, such as rubber deposits, dust particles, jet fuel, oil spillage, water, snow, and slush, all cause friction loss on runway pavement surfaces. The most persistent contaminant problem is deposit of rubber from tires of landing aircraft. Rubber deposits occur at the touchdown areas on runways and can be quite extensive. Heavy rubber deposits can completely cover the pavement surface texture causing loss of aircraft braking capability and directional control, particularly when runways are wet.

Chapter 2 - Runway Surface Friction Assessments

2.1 Introduction

A runway surface friction assessment is conducted under controlled dry conditions, using the self-wetting, to establish the friction characteristics of a runway and to identify those areas of a runway surface that may require maintenance in order to restore surface friction values to the maintenance planning level or above.

To alleviate potential problems caused by reduced runway surface friction, two approaches are possible: provision of reliable aircraft performance data for take-off and landing related to available runway surface friction/aircraft braking performance, and provision of adequate runway surface friction at all times and under all environmental conditions.

The first approach has proved difficult, mainly because of the problem of determining runway friction characteristics in operationally meaningful terms in all conditions, and the problem of correlation between friction measuring equipment used on the ground and aircraft braking performance. This applies in particular to the wet runway case.

The second approach addresses specifically the wet runway. It consists of specifying the minimum levels of friction characteristics for pavement design and maintenance. Runways which have been constructed according to appropriate standards and are adequately maintained thereafter provide optimum operational conditions and meet this objective. Accordingly, aerodrome operators should concentrate on developing and implementing appropriate procedures for runway design, construction and continuing maintenance.

By adopting a systematic approach to the measurement of runway surface friction characteristics, the degradation of runway surface friction can be determined by the comparison and assessment of data over time. By utilising this data, aerodrome operators should be in a position to target maintenance as required in order to help ensure aircraft braking performance does not fall below internationally accepted levels.

2.2 Assessment Periodicity

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 Minimum Friction Level (MFL).

The recommended maximum intervals between runway surface friction assessments are outlined in Table 1.

Number Of Aircraft Landing Per Day	Minimum Measurement Frequency
8 times	24 month
9 – 15	12 month
16 – 30	6 month
31 – 90	3 month
91 – 150	1 month
151 – 210	2 weeks
211 above	1 week

Table 1:- Friction measurement frequency

2.3 Trend Analysis

The friction characteristics of a runway will vary over time as the runway is subject to wear and tear (polishing), accumulation of rubber deposits and to the effects of weather and other environmental conditions. Aerodrome operators should monitor the results of assessments and should alter the interval between assessments depending on the results. If historical data indicate 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 minimum friction level. The aerodrome operator should record the justification for any variation from the recommended periodicity for assessments.

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 a build up of rubber deposits, runway surface wear, or for any other relevant reason.

2.4 Additional Assessments

NOTE: *Any data gathering conducted on a wet runway with the self-wetting system turned off cannot be used for the purpose of friction monitoring assessment*.

Especially on new surfaces, or resurfaced runways, an aerodrome operator should carry out additional friction testing to establish friction readings during adverse weather conditions and to identify those areas of the runway where contamination (i.e. water) may build up over a short period of time. This is of particular importance where re-profiling of the runway's lateral, longitudinal or sloping planes has been accomplished as part of any rehabilitation project. These assessments should be conducted under natural conditions with the friction measuring equipment self-wetting system switched off. Under these circumstances, the values given in Table 3 do not apply.

When there are indications that the friction characteristics of a runway may be reduced because of poor drainage, an additional assessment should be conducted, but this time under natural conditions representative of local rain. This assessment differs in that water depths in the poorly drained areas are normally greater in local rain conditions. The results are thus more appropriate to identify problem areas having low friction values that could induce hydroplaning than the standard assessment method. If circumstances do not permit assessments to be conducted during natural conditions representative of rain, then dousing the runway surface with water may simulate this condition.

Chapter 3 - Runway Surface Friction Assessment Procedures

3.1 Equipment Checks

The friction measuring equipment operator should ensure that the equipment is in full working order and calibrated in accordance with the manufacturers' operating instructions. Those with responsibility for the provision of friction measuring equipment should ensure that the equipment is serviced regularly and that the measuring tyre is of the correct specification and remains within manufacturers' tolerance. General guidance on test speeds, nominal test water film thickness, test tyre type, test tyre pressure and test tyre condition should be sought from the friction

measuring equipment manufacturer, but the operator must be aware that if the parameters specified in Table 3 are not adhered to, the values therein will not apply.

3.2 Operators Training and Competence

The success of friction measurement in delivering reliable friction data depends greatly on the personnel who are responsible for operating the friction measuring equipment. All operators should be trained and competent in the equipment's operation and maintenance and be aware of the critical factors affecting the accuracy of friction measurements. Training may be conducted during normal assessment runs provided that suitable measures are in place to ensure that the results of the runs are valid. If additional runs are conducted for the purpose of training or maintenance of competence, the results may be included in the assessment system if they are known to be valid.

Where a contractor carries out an assessment, it is the responsibility of the aerodrome operator to satisfy himself as to the competence and experience of the friction measuring equipment operator.

3.3 Assessment Conditions

During assessment operations the runway surface should be free from precipitation with no wet patches. Runs should be completed in a timely manner, with coordination from ATC, so that during the period of assessment check runs and standard runs are completed under the same conditions.

Dampness, fog and mist conditions might also affect the outcome of the assessment and aerodrome operators should be aware that crosswinds might affect assessments utilising self-wetting.

3.4 Assessment Procedure

A runway surface friction assessment consists of at least two check runs in addition to a series of standard runs.

3.4.1 Check Runs

A check run is designed to confirm that the operation of the friction measuring equipment is consistent throughout the full runway surface friction assessment; one should be conducted before and the other after completion of the standard runs,

under the same conditions. Reference to manufacturers' guidelines should be made to determine the maximum variation between the two runs permissible.

Check runs should be performed over the entire pavement length at a constant speed on a part of the runway that does not traverse any other runs.

3.4.2 Standard Runs

A standard run should be carried out along the entire pavement length at a constant run speed, allowing for acceleration and safe deceleration. Consideration should be given to means of ensuring the target speed is maintained during the run. If cruise control is fitted to the vehicle it should be checked to ensure its accuracy. During assessment runs, any over/under speed warnings given by the friction measuring equipment should take precedence over the vehicle speedometer or cruise control. Table 2 defines the recommended location of each run for nominal width runways.

NOTE: *On heavily trafficked runways with a prevailing direction of use, friction measuring equipment operators may detect a difference in results when collecting data on reciprocal runs. The aerodrome operator may wish to seek expert opinion on the implications of any differences recorded*.

The track(s) of the measuring wheel(s) should not run along the line of the pavement joints or longitudinal cracks. Aerodrome operators should ensure that friction measuring equipment drivers have sufficient means of track keeping whilst engaged in standard runs. This is especially important at night and when conducting runs away from the centreline or edge markings.

Table 2: Recommended Format for Runway Surface Friction Assessment Standard Runs Based on Nominal Runway Width

Runway Width	Recommended lateral displacement at each side of the center line	
18m	1.5m	3.5m
23m	1.5m	3m
30m	1.5m	4m
45m	1.5m	4m
60m	1.5m	4m

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

On runways without displaced thresholds or paved areas before the start, or beyond the end, of landing distance available (LDA) and especially runways near to 1200 m accelerate stop distance available (ASDA), operators should ensure that drivers of friction measuring equipment are equipped with a suitable vehicle that can attain a steady target speed as soon as practicable. A safe method of delineating the braking zone at the end of the run should also be available to the driver to allow safe braking at the end of the run.

It has been found necessary to provide surface friction information for each third of a runway. The thirds are called A, B and C. For the purpose of reporting information to aeronautical service units, section A is always the section associated with the lower runway designation number. When giving landing information to a pilot before landing, the sections are however referred first, second or third part of the runway. The first part always means the first third of the runway as seen in the direction of landing. The objective of the tests is to determine the mean friction value for sections A, B and C.

3.5 Records

As with all elements of the aerodrome operator's SMS, procedures should ensure all appropriate records of all runway surface friction assessments are kept for a period of at least 24 months from the date of assessment.

The following items should be recorded for each assessment, and made available upon request to ECAA:

- Date and time of assessment, including operative's name;
- Runway assessed;
- Run number and runway direction;
- 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;

• Surface condition and air temperature;
• Average friction level per run; and
• Friction levels indicating 100 m rolling average by Portion.

Chapter 4 - Evaluation of Runway Surface Friction Assessment Results

4.1 Introduction

Aerodrome operators should make effective use of the assessment data produced by friction measuring equipment. Regular reviews coupled with planned maintenance activities driven by trend analysis will ensure that surface friction characteristics are consistently acceptable. A 'quick view' 100 m rolling average by Portion table is a convenient way of summarising the assessments. However, detailed examination of the data for each 10 m reading should be carried out after each assessment to identify areas of the runway, which may require maintenance or closer monitoring. Failure to follow this guidance could lead to a runway that "may be slippery when wet" or even require taking out of service under certain weather conditions.

The friction readings obtained should be compared with the following friction levels:

• The Design Objective Level (DOL)
• The Maintenance Planning Level (MPL)
• The Minimum Friction Level (MFL)

For any given runway surface, the friction readings produced by different friction measuring equipment are liable to differ from each other. Also, for any given runway surface the readings given by a particular friction measuring equipment are liable to alter if the test speed, test water depth or test tyre type are altered. A table 3 set out the test speed, test water depth and test tyre type required for the assessment, and gives the DOL, MPL and MFL in terms of the friction readings provided.

Test Equipment	Test tyre		Test Speed (km/h)	Test water depth (mm)	Design objective Planning level	Maintenance Planning level	Minimum Friction Level
	Type	Pressure (kpa)					
Skkidometer Trailer	B	210	65	1	0.82	0.6	0.5
	B	210	95	1	0.74	0.47	0.34

Table 3:- Friction Level Values

4.2 100 m Rolling Averages

ICAO Annex 14 Chapter 10 Aerodrome Maintenance in paragraph 10.2.4. States - Corrective maintenance action shall be taken when the friction characteristics for either the entire runway or a portion thereof are below a minimum friction level specified.

Note: - *A portion (area) of the runway in the order of 100 m long may be considered significant for maintenance or reporting action."*

4.3 Action to be taken as a Result of a Runway Friction Assessment

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

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

b) 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, any action to be taken.

c) i) If the friction level is below the minimum friction level, maintenance should be arranged urgently in order to restore the friction readings to an acceptable level.

ii) In accordance with ICAO Annex 14 Volume 1, if the lowest 100 m rolling average by portion is below MFL, a NOTAM shall be issued advising that the runway 'may be slippery when wet'.

NOTE: *The NOTAM should contain information to assist aircraft operators to adjust their performance calculations where possible. This should include the location and extent of where friction values are below MFL.*

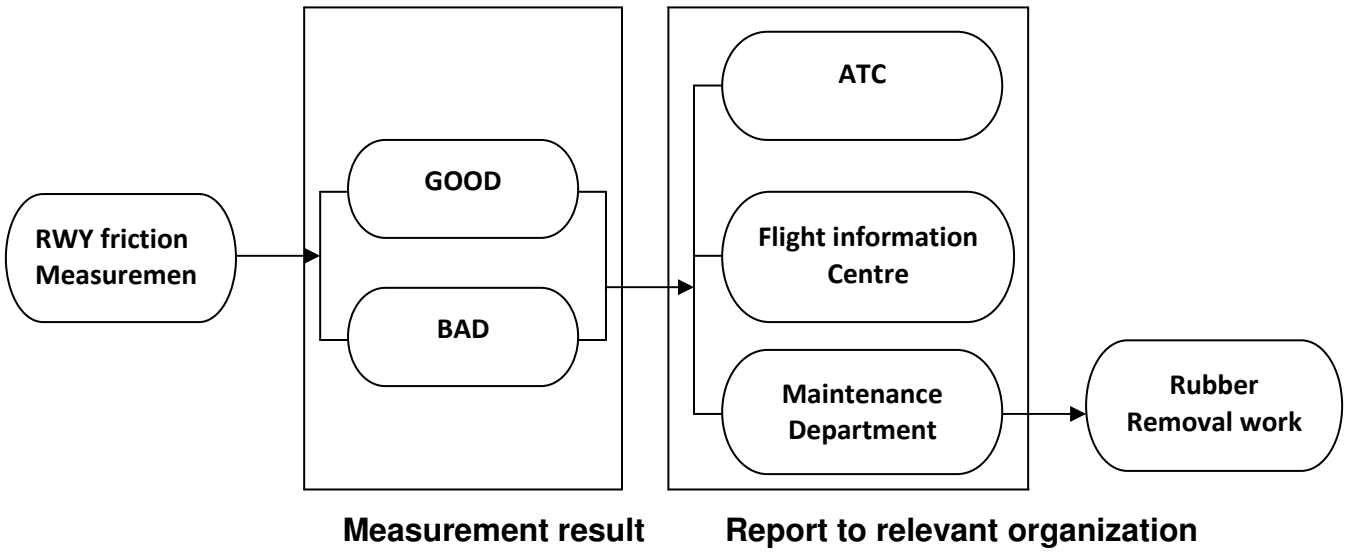
If the friction level is significantly below the MFL, the aerodrome operator should withdraw the runway from use for take-offs and/or landings when wet and inform to ECAA.

Caution should be exercised when choosing the most appropriate method of restoring friction values. Expert advice on the types of processes best suited to both

the surface and the cause of the reduced friction levels should be sought to guard against causing damage to the runway.

Aerodrome operator is expected to use friction measuring equipment manufacturers' software based report together with test reporting format. The runway friction assessment reporting format is attached as Appendix- A

Runway Friction Measurement reporting flow



4.4 Recommended Contaminant Removal Techniques.

Several methods are available for cleaning rubber deposits, other contaminants, and paint markings from runway surfaces. They include high pressure water, chemical, high velocity impact, and mechanical grinding. After the contaminants have been removed from the runway surface by any of these methods, the airport operator should conduct friction measurements to assure that the friction values have been restored to within 10 percent of those on the uncontaminated centre portion of the runway and that both measurements are well within the acceptable friction levels for safe aircraft operations. The effectiveness of rubber deposit removal procedures cannot be evaluated by visual inspection. It is highly recommended that rubber deposit removal contracts base payments on final tests by continuous friction measuring equipment. A brief description follows for each of the contaminant removal techniques. None of the techniques should be used unless the runway is free of standing water, snow and/or slush. Also, chemical or water impact removal methods should not be used if there is a danger of the fluids freezing.

The ultimate success of any method will depend on the expertise of the equipment operator. Results can vary from completely ineffective to a situation where all rubber deposits are removed, but the underlying pavement is significantly damaged. It is recommended that airport operators require that a test section be cleaned by the contractor to demonstrate that rubber deposits will be removed without damage to the underlying pavement.

4.5 Assessments made following Maintenance Activities

The friction characteristics of some runway surface materials can improve over time, commonly as a result of the dispersal of volatile oils in the surface layers following rehabilitation. 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.

Aerodrome operators contemplating major runway rehabilitation and/or re-profiling must contact the ECAA in advance to discuss management of the overall friction characteristics of the runway during the project.

Aerodrome operator should ensure that procedures in the aerodrome SMS that manage risks associated with the work in respect of friction characteristics of the runway are effective, both throughout the period of works, if the runway is to be taken back into service at times and during any wearing-in period following completion of the project.

Appendix – A

Test Report Form

Type of equipment _____. Tyre type_____.
Date of test_____. Time of test _____.
Weather_____. Wind _____.
Runway_____. Run No._____.
Surface description_____. Runway direction_____.

Test conducted by_____. Towing vehicle type_____.
Method of wetting_____. Depth of water _____.
Distance of run from centre line_____.
On which side of centreline the run was performed_____.
100m rolling average by portion_____.

Friction Result		
Speed	**65 Km/hr**	**95 Km/hr**
1st third (A)		
Middle third (B)		
3rd third (C)		

Note: - *The original recorder chart or print of it must be attached to this form.*