सत्यमेव जयते **GOVERNMENT OF INDIA**

OFFICE OF DIRECTOR GENERAL OF CIVIL AVIATION **AD AC NO. 1 of 2019**

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AERODROME ADVISORY CIRCULAR

Subject: **Guidance on Assessment and Measurement of Runway Surface Friction Characteristics at Aerodromes.**

1. Introduction

1.1 Para 10.2.3 of Civil Aviation Requirement Section 4, Series B, Part I mandates the aerodrome operators in India to maintain a paved runway in a condition so as to provide surface friction characteristics at or above the minimum friction level as specified.

1.2 Para 10.2.4 of CAR Section 4, Series B, Part I mandates that runway surface friction characteristics for maintenance purposes shall be periodically measured with a continuous friction measuring device using self-wetting features and documented. The frequency of these measurements shall be sufficient to determine the trend of the surface friction characteristics of the runway.

1.3 Para 10.2.5 of CAR Section 4, Series B, Part I mandates that corrective maintenance action shall be considered by aerodrome operator when the friction characteristics for either the entire runway or a portion thereof are below a specified maintenance planning level.

1.4 This circular is promulgated to guide the aerodrome operators regarding the elements to be included in their maintenance programme on assessment and measurement of Runway Surface Friction Characteristics and should be read in conjunction with DGCA AD AC No. 02 of 2017 dtd. 05th July 2017.

1.5 As an integral part of an Aerodrome License Holder's 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.

2. Requirement of Runway Surface Friction Assessment

2.1 The surface condition of a runway has a major safety impact on aircraft operations in particular on aircraft landing performance. Low friction levels and contaminated runway surface can result in aircraft overruns and run-off incidents.

2.2 A runway surface friction measurement is conducted under controlled conditions using self-wetting equipment to establish the friction characteristics of a runway and to identify those areas of a runway surface that may require attention.

2.3 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 utilizing this data, aerodrome operators should be in a position to target maintenance as required in order to help ensure aircraft braking performance is optimized.

3. Friction Characteristics Deterioration

3.1 The skid-resistance of runway pavement deteriorates due to a number of factors, the two predominant ones being mechanical wear and polishing action from aircraft tyres rolling or braking on the pavement, and the accumulation of contaminants, chiefly rubber, on the pavement surface. The effect of these factors is directly dependent upon the volume and type of aircraft traffic.

3.2 Other influences on the rate of deterioration are local weather conditions, the type of pavement, the materials used in original construction, any subsequent surface treatment and airport maintenance practices.

3.3 Structural pavement failure such as rutting, cracking, joint failure, settling, or other indicators of distressed pavement can also contribute to runway friction losses. It is important that runway inspections identify any changes in surface condition so that appropriate and timely remedial action can be undertaken.

3.4 Contaminants, such as rubber deposits, jet fuel, oil spillage, moss, algae, water, snow, ice, and slush, all cause friction loss on runway pavement surfaces. The most persistent contaminant problem is deposit of rubber from tyres of landing aircraft. This happens predominately 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.

4. Runway Surface Friction Measurement

4.1 Regular friction measurement enables an aerodrome operator to build up an overview of the runway condition over a period of time to identify any deterioration. This enables runway maintenance to be planned and targeted to enable levels to remain above the specified minimum friction level (MFL). The measurement should be performed on a regular basis with accurate readings performed on the same calibrated device.

4.2 Friction measurement operations should be preceded by a thorough visual inspection of the pavement to identify deficiencies such as drainage problems, including ponding and groove deterioration, and structural deficiencies. Careful and complete notes should be taken not only of the CFME data but of the visual inspection as well.

4.3 If historical data indicates the surface is deteriorating faster or slower than the rate used to establish the measurement frequency, the frequency can be adjusted taking into account—

(a) the type, mix and frequency of aircraft operating on the runway; and
(b) the specific micro- and macro-texture characteristics of the pavement surface; and
(c) the presence, extent and severity of surface contaminants especially rubber build-up; and
(d) the existence of pavement surface problems, which may directly affect friction levels; and
(e) pilot reports of low friction levels being experienced during aircraft braking; and
(f) the frequency of past programs for the removal of surface rubber contaminants; and
(g) any recent construction or maintenance of the pavement surface, and
(h) the results of past friction measurements.

4.4 The objective is to ensure that, when the friction level has reached the maintenance planning level (MPL), maintenance can be arranged and completed efficiently and in a timely manner, to ensure the friction characteristics do not deteriorate below the minimum friction level (MFL).

4.5 When it is suspected that a runway has become slippery under other than normal wet conditions, or due to unusual surface conditions, additional friction measurement should be conducted by aerodrome operator.

4.6 Each runway end should be evaluated separately.

4.7 The following table details the recommended frequency of friction measurement for runways. It is important that aerodrome operator should assess their own individual aerodrome needs.

Average number of aircraft movements on the runway per day	Annual aircraft weight for runway (million kg)	Minimum Frequency of Friction Measurement
Less than 15	less than 447	Once per year
16-30	448 to 838	Once every 6 months
31-90	838 to 2404	Once every 3 months
91-150	2405 to 3969	Once every month
151-210	3970 to 5535	Once every 2 Weeks
Greater than 210	Greater than 5535	Once every Week

Note: After calculating the first two columns, the aerodrome operator must select the column, which has the higher value and then select the appropriate value in the last column.

4.8 Measurement following maintenance activities

A. The friction characteristics of a runway can 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 as soon as practicable, following any significant maintenance activity conducted on the runway. If possible, this should be done before the runway is returned to service.

B. 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 acceptable levels additional assessments, measurement 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.

4.9 Measurement following reports of poor braking action

Runway surface friction assessments should also be conducted following a period of poor braking action reports on a dry, damp or wet run surface, if there are visible signs of runway surface wear, or for any other relevant reason.

5. Friction Measurement Process

5.1 Runway friction testing requires the use of continuous friction measuring equipment (CFME) together with trained personnel to conduct the tests. If an aerodrome operator does not have CFME and trained staff to operate it, arrangements should be in place to access a unit with trained operators, whenever measurement is required.

5.2 Runway friction measurements take time, and while tests are being conducted, the runway will be unusable by aircraft. Since this measurement is not time critical, a period should be selected which minimizes disruption of air traffic. Airport operations management should work closely with air traffic control, fixed base operations, and/or airlines.

Equipment requirements

5.3 There are a variety of CFME on the market, however, all use on the same principles to determine the runway friction characteristics. Irrespective of whether the aerodrome owns the CFME or has hired a contractor, before conducting friction surveys the aerodrome operator should ensure:

(a) the equipment has been serviced and maintained in accordance with the manufacturer's requirements, and is in full working order; and

(b) the friction measuring system and components have been calibrated in accordance with the manufacturer's instructions and its performance has been confirmed to be within the manufacturer's specified tolerances; and

(c) for CFME fitted with self-wetting systems-

(i) the water flow rate is correct; and

(ii) the amount of water produced for the required water depth is consistent and applied evenly in front of the friction measuring wheel(s).

5.4 It is recommended that, before and after undertaking the runway friction measurements, the CFME is checked on a defined test strip of pavement that is not used for aircraft operations. Comparison of the sample readings with previous results will quickly verify the CFME performance.

5.5 Additional information on specifications for CFME can be found in the ICAO Airport Services Manual Part 2, Chapter 5.

CFME operators

5.6 The success of friction measurement in delivering reliable friction data depends heavily on the personnel, who are responsible for operating the equipment. It is important that CFME operators are fully trained and competent, to use the equipment and are aware of the critical factors affecting the accuracy of friction measurements.

5.7 Where a contractor carries out the measurement it is the responsibility of the aerodrome operator to be satisfied as to the competency and experience of the CFME operator.

5.8 CFME operators should have been—

(a) trained to—
  (i) service and maintain the equipment; and
  (ii) check its calibration and verifying it is working properly; and
  (iii) operate the machine and carry out friction testing; and
(b) understand—
  (i) runway friction measurement procedures; and
  (ii) requirements and procedures when working on operational areas; and
(c) assessed as competent to carry out runway friction measurement; and
(d) where appropriate, have received recurrent training and assessments.

5.9 Records must be kept as evidence that training and competency assessments have been completed.

Environmental conditions for friction measurement

5.10 Environmental conditions can affect the friction measurement results. The measurement should be conducted when—

(a) the runway surface is dry, free from precipitation, and has no wet patches; and
(b) Dampness, fog and mist conditions may affect the outcome of the measurement and cross-winds may affect self-wetting measurement.

(c) Where necessary, aerodrome operators should seek advice on any environmental issues from the CFME manufacturer.

Location of friction measurement runs

5.11 The friction measurements are to be taken on tracks parallel to the runway longitudinal centreline, at right and left offsets, and in both landing directions.

5.12 The right and left offsets from runway centreline specified for friction measurements are based on the type and/or mix of aircraft operating on the runway. The lowest friction levels will generally occur in the wheel path areas, as a result of the wearing action of aircraft tires on the pavement surface texture characteristics, and the build-up of surface contaminants such as tire rubber.

Friction measurement should be conducted at both 3 and 6 metres from the runway centreline, to determine the worst case condition.

If the worst case condition is found to be consistently limited to one track, future surveys may be limited to this track. Care should be exercised, however, to account for any future and/or seasonal changes in aircraft mix.

5.13 It is recommended that two friction measurement runs be performed at each of the right and left three and six metre offsets, as applicable. Results of the four measured runs can be averaged to determine "100 Metre Section Average Friction" values along the length of the runway and the overall "Runway Average Friction" value. The use of discrete values can be applied if the software is available, allowing a quick assessment of problem areas.

Vehicle's speed during measurement

5.14 The measurements should cover the maximum area of the runway, subject to the measurement vehicle having sufficient area to accelerate to the required speed and decelerate and stop safely. Standard runs should be carried out along the entire pavement length at a constant speed.

5.15 The friction measurement runs should be performed at two speeds, 65 km/h (40 mph) and 95 km/h (60 mph). The lower speed determines the overall mix of macro-texture and micro texture/contaminant/-drainage condition of the pavement surface. The higher speed provides a further indication of the condition of the surface's macro-texture alone.

5.16 A complete survey should include measurements at both speeds although operational requirements may limit this.

6. Evaluation of Friction Measurement Results

6.1 Friction assessment levels

(a) There are three published friction levels for runways—

(i) Design objective level (DOL) - The friction level to be achieved or exceeded on a new or resurfaced runway.

(ii) Maintenance planning level (MPL) - The friction level below which a corrective maintenance action should be initiated.

(iii) Minimum friction level (MFL) - The friction level below which information that a runway may be slippery when wet should be made available.

(b) The following table shows the friction levels with different friction-measuring devices for new or resurfaced runway surfaces, maintenance planning levels and minimum friction levels.

Runway Friction 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	0.53	0.43
	C	140	95	1.0	0.64	0.36	0.24

6.2 Action following a runway friction assessment

(a) The raw data from the friction measurement should be interpreted by trained maintenance personnel familiar with friction testing requirements.

(b) A report should be compiled from the raw data and compare the friction levels from the test against the published required friction levels. The report should also identify any areas where there are deficiencies, and make recommendations to address these.

(c) The aerodrome operator should review the results of each runway friction assessment and where appropriate take the following action—

i. 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 DOL.

ii. If the friction level is trending downwards, the aerodrome operator should increase the frequency of assessments to ensure any further or rapid deterioration is identified in time for appropriate remedial action to be taken.

iii. If the friction level is below the MFL, maintenance should be arranged urgently to restore the friction level. In accordance with para 2.9.7 of CAR Section 4 Series B Part I, Notification be given to aerodrome users about friction level of a runway or portion thereof is less than as specified and caution that the runway may become slippery when wet.

iv. 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.

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

7. Trend Analysis

7.1 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. Friction measurement results should be systematically recorded to allow the results to be monitored to identify trends and patterns. This enables analysis of the condition of the runway surface so timely preventative and/or corrective actions can be taken and, where appropriate, adjustments to the intervals between friction testing can be made.

7.2 Any trend analysis must take into account the effects of using different CFME, equipment tyre wear and environmental factors. Effective interpretation of results can require normalization of test result data and factoring in issues that might affect the measurement data.

7.3 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 buildup of rubber deposits, runway surface wear, or for any other relevant reason.

8. Rubber removal

8.1 Rubber deposits in the touch-down zone of the runway are one of the primary cause of reduction of friction values when runways are wet. Aerodrome Operator

should keep a watch over rubber deposits and take necessary actions for its removal, whenever frictional values are nearing minimum friction values.

8.2 There are various methods for rubber deposits removal, depending on the level of rubber deposits and the type of runway surface. Guidance on the removal of rubber can be found in ICAO Airport Services Manual Part 2, Chapter 8.

8.3 Rubber deposit removal process can impact on other aspects of the runway surface condition. Aerodrome operators should get specialist advice when necessary to ensure that rubber removal does not adversely affect other characteristics of the runway surface.

9. Records

Aerodrome operators should keep records of all runway surface friction measurements. The friction measurements should be incorporated into the aerodrome maintenance plan, and used to monitor the overall health and condition of the runway surface.

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