Civil Aviation Safety Authority of Papua New Guinea

Advisory Circular AC139-9.13

Operational Services – Pavement Surface Condition

Initial Issue

31 Aug 2022

GENERAL

Civil Aviation Authority Advisory Circulars (AC) contain information about standards, practices and procedures that the Director has found to be an Acceptable Means of Compliance (AMC) with the associated rule.

An AMC is not intended to be the only means of compliance with a rule, and consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices or procedures are found to be acceptable, they will be added to the appropriate Advisory Circular.

PURPOSE

This Advisory Circular guidance material on runway friction testing, assessment criteria and equipment requirements to assist aerodrome operators to meet Civil Aviation Rule Part 139 Aerodrome – Certification and Operation

RELATED CAR

This AC relates specifically to rule 139.79, Appendix J.2(d) of Part 139 applicable 4th December 2019

CHANGE NOTICE

AC 139-9.13 Initial Issue.

Published by Civil Aviation Authority of Papua New Guinea

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CHAPTER 1 – RUNWAY SURFACE CONDITION OVERVIEW

1.1 Introduction

1.1.1. Rule 139.79(a) requires aerodrome maintenance for aerodromes operating under an aerodrome operator certificate. Under rule 139.79(a) the certificate holder's maintenance programme is required to "provide for the surface of paved runways to be maintained in a condition that does not impair the safety, security, regularity or efficiency of aircraft operations".

The holder of an aerodrome operating certificate is required to have a maintenance programme that complies with rule 139.79(a).

1.1.2. This advisory circular provides details on the friction levels that should be used by aerodrome operators for runway friction testing and guidance on the processes to be used.

1.1.3. The purpose of this advisory circular is to —

(1) outline the procedures that should be used for undertaking runway surface friction assessments; and
(2) to define the criteria by which friction values should be assessed on runways under specified conditions.

1.1.4. Runway friction testing may be carried out by contractors unfamiliar with aerodrome operational requirements. An outline of requirements when working on aerodromes has been included in this advisory circular along with the training requirements for contractor's personnel to give potential contractors an appreciation of their responsibilities when working on an operational aerodrome.

1.1.5. These requirements are based on international best practice using material and requirements prescribed by the International Civil Aviation Organisation (ICAO) as well as other civil aviation authorities.

1.1.6. This advisory provides guidance material on;

(1) The overview of basic factors affecting friction;
(2) The correlation between friction measuring devices on paved surfaces;
(3) The description of the devices used for measuring friction levels;
(4) The assessment, collection and dissemination of pavement surface condition information which should all be in accordance with AC139-10;
(5) The clearance and removal of contaminants and debris from the movement area; and
(6) The practices and procedures for testing, measuring and reporting friction levels on runway surface for maintenance purposes;

Importance of Runway Surface Friction Characteristics/ Aeroplane Braking Performance

1.1.7. It is essential that the surface of a paved runway be constructed to provide good friction characteristics when the runway is wet.

1.1.8. Adequate runway friction characteristics are needed for three distinct purposes:

(1) deceleration of the aeroplane after landing or a rejected take-off;
(2) 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
(3) wheel spin-up at touchdown.

1.1.9. Runway surface friction plays an important role in counteracting the aerodynamic or other forces which can affect aeroplane braking performance or create moment about the yaw (vertical) axis.

1.1.10. The directional control of all aeroplanes are subject to specific limits regarding acceptable cross-wind components. These limits decrease as the runway surface friction decreases.

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

1.1.12. On landing, runway surface friction is particularly significant at touchdown for the spin-up of the wheels to full rotational speed.

1.1.13. Spin-up of aeroplane wheels are usually delayed as a result of inadequate runway surface friction caused by excessive rubber deposits.

1.1.14. Individual wheels may fail to spin-up, creating a potentially dangerous situation and possibly leading to tyre failure.

1.1.15. Generally, aeroplane certification performance and operating requirements are based upon the friction characteristics provided by a clean, dry runway surface, that is, when maximum aeroplane braking is achievable for that surface. A further increment to the landing distance is usually required for the wet runway case.

1.1.16. To compensate for the reduced stopping capability under adverse runway conditions (such as wet or slippery conditions), performance corrections are applied in the form of either increases in the runway length required or a reduction in allowable take-off mass or landing mass. To compensate for reduced directional control, the allowable cross-wind component is reduced.

Need for Assessment of Runway Surface Conditions

1.1.17. Runway surface friction/speed characteristics need to be determined under the following circumstances:

(1) the dry runway case, where only infrequent measurements may be needed in order to assess surface texture, wear and restoration requirements;
(2) the wet runway case, where only periodical measurements of the runway surface friction characteristics are required to determine that they are above a maintenance planning level and/or minimum acceptable level;
(3) the presence of a significant depth of water on the runway, in which case the need for determination of the aquaplaning tendency must be recognized;
(4) the slippery runway under unusual conditions, where additional measurements should be made when such conditions occur;

Note. — Runways should also be evaluated when first constructed or after resurfacing to determine the wet runway surface friction characteristics.

1.1.18. The above situations will and may require aerodrome operator to execute corrective maintenance action whenever the runway surface friction characteristics are below a maintenance planning level. If the runway surface friction characteristics are below a minimum acceptable friction level, corrective maintenance action must be taken, and in addition, information on the potential slipperiness of the runway when wet should be made available (see ICAO Doc 9137, Part 2, Appendix 5 for an example of a runway friction assessment programme).

1.1.19. The periodic measurement serves two purposes. First, it identifies the sub-standard runways, the location of which should be made known to pilots. Second, it provides qualitative information to airport authorities on the condition of the runway surface, thus permitting the develop- mint of more objective maintenance programmes and justifying development of budgets.

1.1.20. The criteria used for evaluating runway surfaces is to be published in the Aeronautical Information Publication (AIP). When a runway surface that does not meet the criteria is found, a NOTAM should be issued until such time as corrective action has been taken.

1.1.21. It is desirable to measure the friction/speed characteristics of a new or resurfaced runway in order to verify whether or not the design objective has been achieved. The measurements should be made with a friction-measuring device using self-wetting features at two or more different speeds. An average value at each test speed for the entire runway should be obtained when the runway is wet but clean. To this end, friction-measuring devices providing continuous measurements of runway friction characteristics are preferable to those providing only spot measurements, as the latter may give misleading information. This information is considered of operational value as it gives an overall indication of the available surface friction of the relatively long central portion of the runway that is not affected by rubber build-up.

Measurement

1.1.22. The reasons for the requirement to measure the friction characteristics of a wet paved runway are:

(1) to verify the friction characteristics of new or resurfaced paved runways;

(2) to assess the slipperiness of paved runways;

(3) to determine the effect on friction when drainage characteristics are poor; and

(4) to determine the friction of paved runways that become slippery under unusual conditions.

1.1.23. Continuous friction-measuring devices requirements are detailed in 3.2 and the devices are to be used for measuring the friction values for wet runways. Other friction-measuring devices can be used provided they meet the criteria and have been correlated with at least one of the required types mentioned in 5.3 of ICAO Doc 9137, Part 2. A method of estimating the friction value when no friction-measuring devices are available at an airport is also described in ICAO Doc 9137, Part 2, Appendix 6.

Reporting

1.1.24. There is a requirement to report the presence of water within the central half of the width of a runway and to make an assessment of water depth, where possible. To be able to report with some accuracy on the conditions of the runway, the following terms and associated descriptions should be used:

(1) Damp — the surface shows a change of colour due to moisture.

(2) Wet — the surface is soaked but there is no standing water.

(3) Water patches — significant patches of standing water are visible.

(4) Flooded — extensive standing water is visible.

Interpretation of Low Friction Characteristics

1.1.25. The information that, *"due to poor friction characteristics, a runway or portion thereof may be slippery when wet"* must be made available since there may be a significant deterioration both in aeroplane braking performance and in directional control.

1.1.26. It is advisable to ensure that the landing distance required for slippery runway pavement conditions, as specified in the Aeroplane Flight Manual, does not exceed the landing distance available. When the possibility of a rejected take-off is being considered, periodic invest- nations should be undertaken to ensure that the surface friction characteristics are adequate for braking on that portion of the runway which would be used for an emergency stop. A safe stop from V1 (decision speed) may not be possible, and depending on the distance available and other limiting conditions, the aeroplane take-off mass may have to be reduced or take-off may need to be delayed awaiting improved conditions.

1.2 Runway Friction – Measuring Devices

Possibility for Standardization

1.2.1 Currently there are several types of friction-measuring equipment in operation at airports in various airports around the world. They incorporate diverse principles and differ in their basic technical and operational characteristics. The results of several research programmes for correlating the various friction-measuring equipment have shown that the correlation between the friction values obtained from the devices has been satisfactorily achieved on artificially wetted surfaces. However, consistent and reliable correlation between these devices and aeroplane stopping performance has not been achieved on wet surfaces. Measurements obtained by friction-measuring devices on artificially wetted surfaces can be used only as advisory information for maintenance purposes and should not be relied upon to predict aeroplane stopping performance.

1.3 Collection and Dissemination of Pavement Surface Information

General

1.3.1 The provisions in CAR 139.75 & 139 Appendix B.9 require that the aerodrome operators assess the conditions of pavements whenever it has not been possible to clear the contaminants fully, and make this information available to the appropriate units at the airport. Further, in accordance with the provisions in Annex 15, Chapter 5, a NOTAM notifying the presence or removal of or significant changes in hazardous conditions due to water on the movement area must be issued.

1.3.2 The requirements for an effective system of collecting and disseminating pavement surface state information may be set out as described in this chapter. (It is assumed that it is not always possible to achieve and maintain a clean, dry pavement surface.)

1.3.3 Before take-off or landing, the pilot needs information on all aspects of an airport, its aids and operational facilities. In many cases, an adverse combination of available take-off or landing distance, tail or cross-wind components, visibility and poor friction characteristics will make a take-off or landing impossible.

1.3.4 In order to enable aeroplane operators and pilots to readily appraise and use the information received, it is necessary to have the information and its presentation standardized. Reports must be in the form of a positive statement and must be as complete as possible. This, in turn, generates a great deal of information. A standardized code is, therefore, necessary in order to streamline the communications processes, particularly when severe meteorological conditions prevail over a large area, and to allow rapid updating.

1.3.5 Data collection must be swift, comprehensive and accurate, and accuracy necessarily calls for special aids or instruments for the measurement of the different parameters so as to avoid subjective judgements.

1.3.6 Transmission of the information must be quick, regular and timely; i.e., it must reach the pilot in time to be of use and yet be up to date. This aspect is especially important as much of the information is necessarily very transitory.

1.3.7 It is essential that arrangements be made for the timely provision of required information to the aeronautical information service by each of the operators associated with aeroplane operations. Before introducing changes to the air navigation system, due account shall be taken by the services responsible for such changes of the time needed by the aeronautical information service for the preparation, production and issue of relevant material for promulgation. Timely and close coordination between the services concerned, including the aeronautical information service, is therefore required to ensure timely provision of the information to the aeronautical information service.

1.4 Clearance of oil and/or grease

General

1.4.1 Free deposits of these materials may be blotted up with rags, sawdust, sand, etc., and the residue then scrubbed with detergent using a rotary power broom. It will likely be necessary to remove the deteriorated portions of the oil-impregnated asphalt areas in order to successfully repair or seal the surface.

1.5.1 Oil-soaked and stained areas on concrete surfaces are washed to remove imbedded material using a detergent compound of sodium met silicate and resin soap applied with water and scrubbed with a power broom. The loosened contaminants are flushed away with water. For asphaltic concrete pavements, an absorbent or blotting material, such as sawdust or sand, combined with a powdered alkaline degreaser, is used.

1.5 Clearance of debris

General

1.5.2 The provision of CAR Part 139 calls for surfaces of aprons, taxiways and runways to be kept clear of any loose stones or other objects that might cause damage to aeroplanes or engines or impair the operation of aeroplane systems. Turbine engines are extremely susceptible to damage as a result of foreign object ingestion. Other components of aeroplanes are vulnerable, and some operators experience aeroplane skin damage and incidents of nicked propellers as a result of loose stones or other debris becoming dislodged by slipstream, jet blast or tyre action.

1.5.3 Although damage to aeroplanes is usually associated with engine ingestion, substantial damage to tyres is also a significant aspect of the overall problem. Cuts or bursts resulting from contact with sharp objects, untreated joints, or deteriorating pavement edges are responsible for reduced tyre life and account for a large proportion of aeroplane tyres being scrapped prematurely. Of particular concern are tyre failures during the take-off run and the resulting risk of consequential failure of neighbouring tyres from overloading, thereby causing an aborted take-off.

1.5.4 Debris constitutes a potential hazard to the safety of operations and has in the past been directly responsible for aeroplanes abandoning take-offs or execute in emergency landings. Apart from the safety aspect, the unscheduled replacement of damaged parts may involve significant economic penalties.

1.5.5 The introduction of new aeroplane types with their engines installed closer to the ground has aggravated the problem. The cleanliness of the entire airport surface should, therefore, be a matter of ongoing concern, requiring attention by airport authorities.

1.5.6 Based on operational experience, the following are some of the aspects that should not be overlooked in the development of a suitable programme intended to achieve and maintain the required standard of cleanliness in the areas concerned.

1.5.7 Experience with turbine engine aeroplanes indicates that one of the most effective measures to minimize the problem of debris on the movement area is frequent inspection and sweeping, including the use of sweeping equipment with magnetic attachments. Where aeroplanes operate over an extensive route network, it is sometimes difficult to pinpoint the precise location where damage has occurred, but airports at which regular inspection and sweeping are known to be the practice are less likely to encounter this problem.

1.5.8 Regular inspection by CASA PNG together with a nominated representative of the operators, is already a recognized procedure at many airports and can form the basis for regular airport inspection reports testifying to the effectiveness of the cleaning programme. Arrangements for such joint inspections (which should permit access to all operational areas, including runways and taxiways, as well as the immediate apron area) and the development of a proper reporting form can be carried out in consultation with a representative of the operators. In one State, this procedure has been used to establish a sweeping priority/frequency programme, which includes analysis of the debris to determine its origin. Thus, areas where debris is most likely to occur can be isolated and cleaning operations in those areas increased. Where the source of debris can be established, remedial measures can also be taken with those responsible. In connection with this programme, a plan of the paved area is divided into conveniently sized squares, 20 m × 20 m, to assist in pinpointing the location of any debris found.

1.5.9 A potential source of debris, particularly on aprons, obviously stems from the activities of the operators themselves in the handling and servicing of their aero- planes. Airline personnel receive training and recurrent reminders on the need for apron cleanliness, but airport authorities can also assist by ensuring that covered receptacles for litter and other debris are provided in sufficient number and are used. Such receptacles should also be provided on all vehicles routinely used on the movement area, regardless of ownership.

1.5.10 Other apron users, such as aeroplane caterers, fuel suppliers, forwarding agents and handling agents, do not come under the direct supervision of the operators. Airport authorities should check that those engaged in the provision of such services have also taken steps to instruct their staff properly regarding the prevention of litter and the disposal of waste material. Widespread use of polythene bags and sheets by the catering services and aeroplane maintenance personnel, and as temporary protection for freight or components against weather, considerably increases the chance of engine ingestion of this type of material. Engine failures have occurred as a direct consequence. Sand used to clean fuel and oil spillage from aprons is a further potential cause of turbine engine and propeller damage and should be immediately and efficiently removed after use.

1.5.11 Cargo areas, by the very nature of the operations they support, are particularly susceptible to contamination from strapping, nails, paper and wood, which may become detached from crates or other containers in the course of freight handling. Other equipment which has been found in cargo areas includes loose buckles from cargo tied own nets, loose turnbuckles and large sheets of polythene film. To the extent that forwarding agents operate in these areas, the airport authority should require that they assume their share of the responsibility for keeping it in good condition. Where night activities are frequently involved, good illumination is necessary so that the areas can be kept clean.

1.5.12 On taxiways, bypass areas and holding bays, and on runways themselves, the presence of stones and other debris as a result of erosion of the adjacent areas can constitute a problem, and guidance on preventive measures, including the sealing of runway and taxiway shoulders, is already contained in Part 2 of the Aerodrome Design Manual (Doc 9157). The need for adequate sealing has been highlighted by the introduction of large jet aeroplanes with greater engine overhang. Until runway and taxiway shoulders are adequately sealed, care is needed to ensure that vegetation and grass cuttings do not present an ingestion problem to overhanging engines. Moreover, the areas immediately adjacent to the paved and sealed surfaces should also receive regular inspection and attention to ensure that debris which could subsequently find its way onto the more critical areas is not present.

1.5.13 Deterioration of the bearing surface itself, leaving loose sand, fragments of concrete and bitumen, is another possibility, and concrete joints, if not properly filled, are excellent traps for debris. Such joints should be filled to permit effective sweeping. There is also an indication that kerosene spillage on bitumen taxiways and runways, caused by the venting of fuel tanks of aeroplanes in motion, can result in deterioration of the surface and engine ingestion problems. These areas should be free- quaintly inspected and prompt repair work carried out, whenever necessary, so as to prevent further break-up of the pavement.

1.5.14 Sand and grit remaining on the runway, after serving to improve runway braking action under icy conditions, form debris which should be removed as soon as possible after their requirement ceases. Similarly, slush containing sand, grit and lumps of ice should be removed from the pavement as soon as possible.

1.5.15 Where construction is in progress on an airport, the authorities should, if possible, prohibit use of the movement area by contractors’ vehicles or at least minimize it by restricting them to marked lanes, particularly when they are engaged in transporting the type of loads from which spillage frequently occurs, such as building waste, gravel and fill. Earth and stones adhering to the wheels of such vehicles can also become dislodged and subsequently create a hazard to aeroplanes using the same areas. Where building construction is in close proximity to the movement area, it is important that some form of screening be provided to prevent sand and small stones from being blown onto the movement area by high winds or jet blast. Following the completion of construction, the contractor must remove all debris from the surrounding areas.

CHAPTER 2 — REQUIREMENT FOR FRISTION TESTING

2.1 Introduction

2.1.1 Part 139 refers to requirements the applicant must meet before a certificate is issued. In this advisory circular, reference may be made to the certificate holder, not the applicant as stated in the rule, because the holder must continue to comply with the same requirements that were met before the certificate was issued.

2.1.2 All matters are applicable to holders of an aerodrome operator certificate, but only those specifically included in a determination made by the Director are applicable for holders of a qualifying aerodrome operator certificate. The rules references are those applicable for aerodrome operator certificate holders.

2.1.3 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.

2.1.4 There are a range of runway surface types each with different characteristics requiring individual aerodrome operators to closely monitor the friction levels. This monitoring assists in ensuring that the runway friction levels are kept to an acceptable level and assists in the planning of maintenance.

2.1.5 A runway surface friction test 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.

2.2 Friction deterioration

2.2.1 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.

2.2.2 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.

2.2.3 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.

2.2.4 Contaminants, such as rubber deposits, jet fuel, oil spillage, moss, algae, water, 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.

2.3 ICAO requirement

2.3.1 *ICAO Annex 14 Chapter 10 - Aerodrome Maintenance* details the requirement for friction characteristics of runways under *section 10.2 - Pavements*. The Annex requirements cover measurement of friction characteristics and corrective maintenance action. These requirements are further detailed in the *ICAO Doc 9137 - Airport Services Manual – Part 2*.

2.3.2 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 is a significant safety concern.

2.3.3 Consideration should also be given to measuring the friction characteristics of runways serving heavy turboprop aeroplanes (MCTOW 15,000 kg or greater), that have runway take-off and landing distance requirements close to the limits of available runway length.

2.4 Friction testing frequency

2.4.1 Regular friction testing 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 testing should be performed on a regular basis with accurate readings performed on the same calibrated device.

2.4.2 Initially, when setting up a runway friction testing programme, the frequencies outlined in Table 1 and Table 2 are recommended. Aerodrome operators should monitor the results of friction tests and, if necessary, vary the interval between assessments based on the results.

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

(1) the type, mix and frequency of aircraft operating on the runway; and
(2) the specific micro- and macro-texture characteristics of the pavement surface; and
(3) the presence, extent and severity of surface contaminants especially rubber build-up; and
(4) the existence of pavement surface problems which may directly affect friction levels; and
(5) pilot reports of low friction levels being experienced during aircraft braking; and
(6) the frequency of past programs for the removal of surface rubber contaminants; and
(7) any recent construction or maintenance of the pavement surface, and
(8) the results of past friction measurements.

2.4.4 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).

2.4.5 he aerodrome operator should record the justification for any variation from the recommended periodicity for assessments.

2.4.6 When it is suspected that a runway has become slippery under other than normal wet conditions, or due to unusual surface conditions, additional friction testing may need to be undertaken. Information detailing the nature, extent and severity of any unusual slippery runway conditions should be promulgated by NOTAM to provide a cautionary warning.

2.5 Turbojet aircraft operations

2.5.1 The operator of an aerodrome with significant jet aircraft traffic should schedule periodic friction testing of each runway that accommodates jet aircraft. It is recommended that every runway for jet aircraft be tested at least annually. Depending on the volume and type (weight) of traffic using the runway, testing may be needed more frequently, with the most heavily used runways needing testing as often as monthly, as rubber deposits build up.

2.5.2 Each runway end should be evaluated separately, for example: Runway 18 and Runway 36.

2.5.3 Runway friction measurements take time, and while tests are being conducted, the runway will be unusable by aircraft. Since this testing is not time critical, a period should be selected which minimizes disruption of air traffic.

2.5.4 Table 1 details the recommended frequency for friction testing for runways where turbojet aircraft operate. It is important the aerodrome operator assesses their own individual aerodrome needs.

Average number of turbojet operations on the runway per day	**Minimum frequency of friction testing**	
Less than 15	Annually	
16 to 30	6 months	
31 to 90	3 months	

Table 1 Friction testing frequency – Turbojet aircraft

2.6 Turboprop aircraft operations

2.6.1 The majority of Papua New Guinea aerodromes have exclusively, or a high proportion of, turboprop aircraft operations. Although the operational landing speeds of these aircraft is less than a turbojet the friction levels of the runway are still very important.

2.6.2 The recommended frequency depends on aircraft type, weight and number of movements. Table 2 details the recommended friction testing for runways where turboprop aircraft with a MCTOW of 15,000kg or greater operate. It is recommended that for aerodromes serving turboprops less than this weight perform friction testing at least once every 5 years.

2.6.3 Each runway end should be evaluated separately, for example: Runway 18 and Runway 36.

Average number of turboprop operations on the runway per day	Minimum frequency of friction testing
Less than 15	5 years
16 to 30	3 years
31 to 90	Annually

Table 2 Friction testing frequency – Turboprop aircraft (MCTOW 15,000kg or greater)

2.7 Testing following maintenance activities

2.7.1 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.

2.7.2 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, testing 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.

2.8 Testing following reports of poor braking action

2.8.1 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.

CHAPTER 3 — FRICTION TESTING PROCESS

3.1 Introduction

3.1.1 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 testing is required.

3.1.2 If a contractor is used it is important that that the CFME is appropriate for runway surface testing, and the operators are trained to perform runway friction testing3.2 About this listing

3.2 Equipment requirements

General Discussion on Friction-Measuring Devices

3.2.1 There are a variety of CFME on the market, however, all use on the same principles to determine the runway friction characteristics. In PNG, CASA PNG recommends the use of Grip Tester.

3.2.2 The success of friction measurements depends heavily on the personnel responsible for operating the device. Adequate professional training in the operation and maintenance of the device and procedures for conducting friction measurements is essential to ensure reliable friction data. Periodic instruction is also necessary to review, update and certify that the operator maintains a high proficiency level. If this is not done, then personnel fail to maintain their experience level over time and lose touch with the new developments in calibration, maintenance and operating techniques.

3.2.3 All friction-measuring devices should periodically have their calibration checked to ensure that it is maintained within the tolerances given by the manufacturer. Friction-measuring devices furnished with self-watering systems should be calibrated periodically to ensure that the water flow rate is maintained within the manufacturer's tolerances, and that the amount of water produced for the required water depth is always consistent and applied evenly in front of the friction-measuring tyre(s) throughout the speed range of the vehicle.

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

3.2.5 It is recommended that, before and after undertaking the runway friction tests, 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.

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

3.3 Personnel working on aerodromes

3.3.1 All personnel undertaking runway friction tests need to comply with the general requirements for personnel working on operational areas of an aerodrome, or be accompanied and supervised at all times by someone who does. In particular, they must—

(a) be familiar with, and follow the established procedures for working on an operational aerodrome; and

(b) be trained in radio procedures, including ATC phraseology and the importance of complying immediately with any instructions to vacate the maneuvering areas; and

(c) be provided with a two-way radio for communications with the air traffic services unit at the aerodrome; and

(d) have a vehicle equipped with a flashing or rotating beacon or a chequered flag for day time testing, or a flashing or rotating beacon for night time testing.

3.3.2 Before any work starts personnel should be fully briefed operational procedures, method of work plans (MOWP) and safety plans, and any other matters relevant to the work being carried out.

3.3.3 Advisory circular AC139-9.14 contains the requirements for personnel working on operational areas of an aerodrome.

3.4 CFME operators

3.4.1 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.

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

3.4.3 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 testing procedures; and
ii. requirements and procedures when working on operational areas; and

(c) assessed as competent to carry out runway friction testing; and

(d) where appropriate, have received recurrent training and assessments.

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

3.5 Environmental conditions for friction testing

3.5.1 Environmental conditions can affect the friction testing results. The test should be conducted when—

(a) the runway surface is dry, free from precipitation, and has no wet patches; and

(b) the ambient air temperature is above 2° C.

3.5.2 Dampness, fog and mist conditions may affect the outcome of the test and cross-winds may affect self-wetting testing.

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

3.6 Runway surface friction testing procedure

3.6.1 Friction readings for the survey run are collected by the CFME along the entire pavement length. Several runs are made along the runway, offset on either side of the centreline, and in both directions.

3.6.2 The runway is normally divided into zones 100 metres in length with an average friction value determined every 10 metres along a run, enabling a 100-metre rolling average to be calculated. Another method uses discrete averaging for interpretation immediately after the testing.

3.7 Location of friction testing runs

3.7.1 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.

3.7.2 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.

i. **Runways serving only narrow body aircraft:** Friction testing should be conducted 3 metres from the runway centreline.
ii. **Runways serving narrow body and wide body aircraft:** Friction testing should be conducted at both 3 and 6 metres from the runway centreline, to determine the worst-case condition. If, due to the undercarriage widths of certain aircraft operating, measurements at 5 and 7 metres can be used.

3.7.3 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.

3.7.4 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.

3.8 Friction testing work schedule

3.8.1 Ideally each runway direction should be tested separately, with friction test runs on either side of the runway centreline. The practice of one circular run for the whole runway results in only the friction values for one side of each direction of a runway being assessed.

3.8.2 If there are operational difficulties in conducting bi-directional tests, the aerodrome operator may implement a series of single direction tests to complete the testing programme. Appropriate processes should be in place to ensure the tests in both directions are completed.

3.9 Low friction values

3.9.1 When friction values below maintenance planning levels are measured, additional friction runs should be performed outside the wheel path area in order to assess the degree to which wear and contaminants have lowered friction levels in the centre trafficked area. A test track profile located 5 to 10 metres from the outer edge of the paved runway surface is normally optimum for the purposes of wear and contaminant comparison tests.

3.10. Vehicle testing speed

3.10.1 The tests should cover the maximum area of the runway, subject to the test 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, starting with the run closest to the runway edge.

3.10.2 The friction test 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.

3.10.3 A complete survey should include tests at both speeds although operational requirements may limit this.

CHAPTER 4 - EVALUATION OF FRICTION TESTING RESULTS

4.1 Friction assessment levels

4.1.1 CASA PNG has opted to adopt friction levels which should be determined by aerodrome operators according to the levels listed below:

(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.

4.1.2 Table 3, which is based on the CFME device mentioned in 3.2.1, shows the criteria proposed to be used for specifying the friction characteristics of new or resurfaced runway surfaces, for establishing maintenance planning levels and for setting minimum friction levels.

4.1.3 It is recommended that the ICAO standards be used as the primary reference by the aerodrome operators, and other standards are only used if there are compelling reasons why ICAO should not be used

4.1.4 The standard adopted by an aerodrome operator must be specified in the operator's Part 139 exposition.

4.1.5 Table 3 details the friction level standards for the acceptable friction measurement device as adopted by CASA PNG. Levels for other CFME can be found in Doc 9137 - Airport Services Manual - Part 2 - Pavement Surface Condition table 3-1.

Test Equipment	Test tyre			Test Water Depth (mm)	Design Objective for New Surface	Maintenance Planning Level	Minimum Friction Level
	Type	Pressure (kPa)	Test Speed (km/h)				
(1)		(2)	(3)	(4)	(5)	(6)	(7)
GRIPTESTER	C	140	1.1.27. 65	1.0	0.74	0.53	0.43
Trailer	C	140	95	1.0	0.64	0.36	0.24

Table 3 - Guidelines for establishing the design objective, maintenance planning level and minimum friction levels of runways in use

4.2 Action following a runway friction assessment

4.2.1 The raw data from the friction test should be interpreted by trained maintenance personnel familiar with friction testing requirements.

4.2.2 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.

4.2.3 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 MPL, maintenance should be arranged to restore the friction level, ideally to a value equal to or greater than the DOL.

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

(c) If the friction level is below the MFL, maintenance should be arranged urgently to restore the friction level. In accordance with rule 139.123 a NOTAM should be issued advising that the runway may be slippery when wet.

(d) 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.

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

4.3 Trend analysis

4.3.1 Friction testing 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 (see 2.4).

4.3.2 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 normalisation of test result data and factoring in issues that might affect the measurement data.

4.4 Rubber removal

4.4.1 One of the main causes of reduced runway friction levels is rubber deposits on the runway surface. There are various methods for rubber deposits removal, depending on the level of rubber deposits and the type of runway surface.

4.4.2 Rubber deposited in the touchdown zone by tyres of landing aeroplanes obliterates runway markings and, when wet, creates an extremely slick area on the run- way surface. The removal of rubber is carried out by means of:

(a) chemical solvents;

(b) high-pressure water blasting;

(c) chemical solvents and high-pressure water blasting; and

(d) hot compressed air.

4.4.3 In assessing the effectiveness of any system for rubber removal, the objective must be clearly understood, i.e. to restore a good coefficient of friction in wet conditions so as to provide safe operational conditions for all aeroplanes. A change in surface colour, for example, from black to grey on Portland cement concrete can be very misleading, because even a small amount of residual rubber in the pores of the pavement can produce low friction values, while giving an overall clean appearance. It is therefore essential to quantify the friction coefficient by means of a reliable friction-measuring device.

4.4.4 In most cases, high-pressure water blasting is reasonably effective on lightly contaminated areas, but its effectiveness decreases as the depth of contamination increases. Depending upon the type and volume of traffic, cleaning may be required twice a year. A modern practice is to dissolve rubber deposits with chemical solvents followed by thorough flushing with high-pressure water blasting.

4.4.5 In order to determine the amount of rubber needed to be removed from the pavement to provide an acceptable surface condition, it is recommended that a test area be used to predetermine the water pressure and rate of travel required to produce this acceptable surface. Observed productivity of high-pressure water blasting during normal working conditions indicates a rate of 278 m2 per hour per unit while cleaning. Refilling of a typical water tank accounts for approximately two hours in each eight-hour shift. Therefore, one touchdown zone 900 m × 24 m would require approximately 100 hours per unit.

4.4.6 The hot compressed air technique uses high- temperature gases to burn away the rubber deposits left by aeroplane tyres and can be used on both Portland cement concrete and asphaltic concrete runways. It has been claimed that as no mechanical action takes place at the runway surface, there is little danger of the surfacing material becoming loose and causing foreign object ingestion. However, caution should be exercised and the condition of the pavement should be closely monitored when using this technique on asphaltic concrete runways.

4.4.7 Rubber deposit removal processes 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. Guidance on the removal of rubber can be found in ICAO Airport Services Manual Part 2, Chapter 8.

4.5 Records

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

The following items should be recorded for each assessment —

(a) Date and time of assessment.

(b) Type of CFME used.

(c) Name of operator.

(d) Runway assessed.

(e) Runway number and runway direction.

(f) Distance from the centreline and which side of centreline the run was performed.

(g) Distance from threshold the run was performed.

(h) Constant run speed (Km/h) for each run.

(i) Runway length.

(j) Amount of water film used.

(k) Surface condition (dry/damp/wet).

(l) Weather conditions and ambient temperature, and the runway surface and measuring wheel temperatures if available.

(m) Friction levels for each portion of the pavement. This can include average friction level for each third of the runway at each offset, direction, and speed.

(n) Overall friction level for full length of the runway and, if required the 10m friction averages in the touchdown zones.

(o) A comparison of the results with any previous surveys conducted, providing the same CFME has been used.

(p) Evaluation of friction levels between the reference non-trafficked test strip and the trafficked runway during the current survey.

(q) Any evaluations of the reference non-trafficked test strip between successive surveys.

(r) Any additional comments.

APPENDIX A - Related INFORMATION

F1 Documents

ICAO

Annex 14 - Part 1 - Aerodrome Design and Operations

Doc 9137 - Airport Services Manual - Part 2 - Pavement Surface Conditions

Doc 9137 - Airport Services Manual - Part 8 - Airport Operational Services

Doc 9157 - Aerodrome Design Manual - Part 1 – Runways

Other States

Federal Aviation Administration Advisory Circular AC150/5320-12C

Transport Canada Runway Friction Testing Programme ASC 2004-024

United Kingdom Civil Aviation Authority CAP 683

Civil Aviation Authority Singapore Manual of Aerodrome Standards

CASA PNG

Advisory Circular AC139-9.10 - Operational Services – Surface Inspections

Advisory Circular AC139-9.14 - Operational Services – Control of Work in Progress on the Movement Area
Advisory Circular AC139-10.1 Maintenance – Pavements

Advisory Circular AC139-10.2 Maintenance – Removal of Contaminants

Advisory Circular AC139-10.3 Maintenance – Runway Pavement Overlays