CIVIL AVIATION PUBLICATION

AGA 05

FRICTION TESTING OF RUNWAY PAVEMENT SURFACES

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AGA 05

FRICTION TESTING OF RUNWAY PAVEMENT SURFACES

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CHAPTER 1

GENERAL

1.1 Introduction

The Bahamas, as a signatory to the Chicago Convention on International Civil Aviation, has adopted all the provisions specified in Annex 14 to the Convention, published by the International Civil Aviation Organisation (ICAO). ICAO publishes standards and recommended practices (SARPs) that address runway friction testing and minimum friction levels. These SARPs are contained in CAR AGA 1 and CAR AGA 3, as appropriate.

Aircraft braking performance is directly related to the friction coefficient between the pavement surface and the aircraft tyre. Chapter 2 establishes the values of friction coefficients for the different services, based on international experience.

This document describes the minimum level of assessment that should be employed for the Continuous Friction Measuring Equipment (CFME) listed in CAR AGA 1 and CAR AGA 3. Other types of CFME may be used if their performance can be demonstrated, to the satisfaction of the CAA-B, that it provides comparable results with currently accepted CFME.

The criteria, which is detailed in this CAP, reflect the CAA-B’s interpretation of the SARPs in Annex 14 to the Convention on International Civil Aviation in so far as these have been adopted by the CAA-B in respect of runway surface friction testing.

1.2 Requirements

In order to comply with CAR requirements, Aerodrome Operators will regularly inform the CAA-B of the runway friction coefficient. The reporting period will depend on the number of operations per year of the runways.

1.3 References

▷ CAR AGA 1 and 3

▷ Annex 14 Volume I – Aerodromes (Eighth Edition July 2018)

▷ ICAO Doc 9137 – Airport Services Manual, Part 2 – Pavement Surface Conditions (Fourth Edition 2002)

▷ CAR DEF – Definitions

1.4 Measuring device

Measuring devices should comply with Chapter 3 specifications.

1.5 Personnel responsible for operating the equipment

Personnel that are responsible for operating the equipment should comply with Chapter 4. These personnel should be qualified and competent to perform tasks in the airport movement area.

1.6 Measuring procedures

The measuring procedure should comply with Chapter 5.

1.7 Measuring periods

The Aerodrome Operator will perform measurements as necessary. It will also perform preventive maintenance tasks according to their programme as established in Chapter 6, according to the annual aircraft traffic movements.

Despite the programme or established measuring periods, airport personnel will perform unscheduled measurements and any extraordinary maintenance, if they observe or receive reports from pilots regarding the slippery state of the runway.

The CAA-B may request a measurement for verification purposes. Each case will follow the criteria established in this norm.

1.8 Aerodrome Operator responsibilities.

The Aerodrome Operator is responsible for performing periodic, and where required, ad hoc runway friction measurements, the distribution of the data to the relevant stakeholders and the accurate record keeping and filing of information.

The Aerodrome Operator should immediately submit to the CAA-B the results of runway friction measurements. The Aerodrome Operator should reveal and quantify all areas that, according to the observations made, present the following deficiencies:

- Runway flooded zones, when the average of standing waters is 350 meters in length and 3 mm in depth.
- Runway low groove zones, when the height of the grooves has been reduced to half its original height.
- Runway cracks zones.

According to the obtained runway friction coefficients, the Aerodrome Operator should follow Chapter 7 specifications, informing the CAA-B of the runway friction readings together with any corrective actions plans if required.

1.9 Notification of the Runway Conditions

When the friction coefficients are below the acceptable minimum value defined in Chapter 2 or any abnormal condition is detected, The Aerodrome Operator shall publish the corresponding information in a NOTAM.

The CAA-B will notify the Aerodrome Operator to implement any corrective action in a timely manner. Once the deficiencies have been rectified, the Aerodrome Operator will notify the CAA-B. A physical inspection will then be made by a qualified engineer.

The appropriate terminology shall be:

(a) **Dry runway -** A runway is considered dry if its surface is free of visible moisture and not contaminated within the area intended to be used.

(b) **Wet runway -** The runway surface is covered by any visible dampness or water up to and including 3 mm deep within the intended area of use.

(c) **Slippery wet runway -** A wet runway where the surface friction characteristics of a significant portion of the runway have been determined to be degraded.

(d) **Contaminated runway -** A runway is contaminated when a significant portion of the runway surface area (whether in isolated areas or not) within the length and width being used is covered by one or more of the substances listed in the runway surface condition descriptors.

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CHAPTER 2

FRICTION LEVEL CLASSIFICATION

2.1 Objective

The classification of friction levels Classify between the runway pavement surfaces and aircraft tyres, in order to evaluate the surface friction deterioration and take the appropriate corrective actions to ensure safety is maintained.

2.2 Scope

The friction levels defined in this Chapter are applicable to all runway pavement friction measurements.

2.3 Introduction

There are a variety of different types of friction measuring devices with different operational techniques and characteristics that are being used in 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.

Regarding this Norm, the friction coefficient values will exclusively be obtained by measuring value Mu (μ) described in Chapter 2 or its equivalent from another compatible method, used to determine the friction coefficient on runway pavements not covered with ice or snow.

2.4 Runway Friction Measuring Devices - Basic technical specifications

2.4.1 Mode of measurement: continuous measurement in motion should be taken along the part of the pavement areas to be tested.

2.4.2 Ability to maintain calibration: the equipment should be designed to withstand rough use and still maintain calibration, thereby ensuring reliable and consistent results.

2.4.3 Mode of braking: During friction measurement operations using:

(a) a fixed slip device, the friction-measuring wheel should be continuously braked at a constant slip ratio within a range of 10 to 20 per cent; and

(b) a side force device, the included angle (single wheel) should be within a range of 5° to 10º.

2.4.4 Excessive vibrations: the design of the equipment should exclude any possibility of sustained vertical vibrations of the cushioned and uncushioned mass occurring in all travel speed ranges during the measuring operations, particularly in respect of the measuring wheel.

2.4.5 Stability: the equipment should possess positive directional stability during all phases of operation, including high-speed turns, which are sometimes necessary to clear a runway.

2.4.6 Friction coefficient range: the recording range of the friction coefficient should be from 0 to at least 1.0.

2.4.7 Presentation of the results of measurements: the equipment should be able to provide a permanent record of the continuous graphic-trace of the friction values for the runway, as well as allowing the person conducting the survey to record any observations and the date of time of the recording.

2.4.8 Acceptable error: the equipment should be capable of consistently repeating friction averages throughout the friction range at a confidence level of 95.5 per cent, ± 6 μ (or two standard deviations).

2.4.9 Measured and recorded parameter:

(a) For a fixed slip device, the recorded friction value should be proportional to the ratio of the longitudinal friction force to the vertical wheel loading.

(b) For a side force device, the recorded friction value should be proportional to the ratio of the side force to wheel loading.

2.4.10 Speed range: When concluding friction measurements, the speed range for friction-measuring devices should be from 40 to at least 130 km/h.

2.4.11 Averaged μ increments: the equipment should be capable of automatically providing μ averages for at least the following conditions:

(a) the first 100 m of the runway;

(b) each 150 m increment;

(c) each one-third segment of the runway.

2.4.12 Horizontal Scale: To minimise substantial variations in scale between the various friction devices, the manufacturer may provide, as one option, a scale of 25 mm equals 100 m. This may simplify data comparisons when two or more friction-measuring devices are used at an airport.

2.4.13 Standard tyre specifications: For testing on rain-wet or artificially wetted surfaces, the tread should be smooth with a pressure of 70 kPa for yaw-type friction-measuring devices. Braking slip friction-measuring devices must use smooth tread tyres inflated to 210 kPa.

2.4.14 Allowable tyre variations: To minimise variations in the physical dimensions of the friction-measuring tyre and the physical properties of tread compounds, the tyre manufacturer should follow the requirements in the ICAO Airport Services Manual Appendix 1, Part 2, Pavement Surface Conditions. The tyre is a very critical component of the friction-measuring device; it is important to ensure that it will always be dependable and provide consistent and reliable results.

The procedures for evaluating the performance and reliability of friction-measuring equipment and tyres are given in Chapter 3.

2.4.15 All-weather operation: the design of the friction-measuring device should be such as to ensure its normal operation at any time and in all weather conditions.

2.4.16 Equipment maintenance: the technical maintenance of the friction-measuring device should be such as to ensure the safe execution of the work during both measurement operations and transportation.

2.4.17 Artificial wetting: friction-measuring devices should have the capability of using self-wetting features to enable measurements of the friction characteristics of the surface to be made at a controlled water depth of at least 1 mm.

2.5 General analysis of friction-measuring devices

Several friction-measuring devices are used throughout the world, such as: the Mu-meter, Runway Friction Tester, Surface Friction Tester, Skiddometer and Grip Tester.

Although the operational modes of the continuous friction-measuring devices are different, certain components operate in a similar manner. When conducting a friction survey for the maintenance programme, they all use the same smooth tread friction-measuring tyre, size 4.00 – 8 (16 x 4.0, 6 ply, RL2) (refer to Appendix 1), with the exception of the Grip Tester which uses a smooth tread tyre, size 10 x 4.5 – 5. The friction-measuring tyres mounted on the Mu-meter operate at an inflation pressure of 70 kPa, whereas the Grip Tester uses 140 kPa. The remaining three devices use an inflation pressure of 120 kPa in the test tyres. They all use the same friction scale, which ranges from 0.00 to 1.00, and they all provide friction averages for each 150 m of the runway length surveyed.

It is required to provide information on the friction averages for each one-third segment of the runway length. An option available to the Mu-meter, Runway Friction Tester and Surface Friction Tester is a keyboard that allows the equipment operator the flexibility to record commands, messages and notes on observations taken during the time of the friction survey. All of these continuous friction-measuring devices are equipped with a self-watering system that provides a specified water depth in front of the friction-measuring tyre (s). Friction surveys can be conducted at speeds up to 130 km/h.

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.

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.

2.6 Mu-meter

Described in Chapter 3.

2.7 Runway Friction Tester

The Runway Friction Tester is a vehicle which has a tyre mounted on a fifth wheel connected to the rear axle by a gear chain drive. The vehicle is equipped with front-wheel drive and a powerful engine. The friction-measuring wheel is designed to operate at a fixed slip ratio of 13 per cent. The test mode utilises a two-axis force transducer, which measures both the drag force and the vertical load on the friction-measuring wheel.

This method eliminates the need to filter the vehicle's deflections and the effects of tyre wear, this giving instantaneous measurement of dynamic friction. A vertical load of 136 kg is generated on the friction wheel by weights mounted on a double shock absorber spring assembly. The Runway Friction Tester is supplied with a self-water system and tank.

Vehicle speed and distance travelled are computed in a digital computer from pulses supplied by an optical encoder. The drag force and vertical load forces on the test wheel are sensed by a strain-gauged, two axis force transducer and amplified for input into the digital computer. The digital computer samples these values approximately five times for each metre of travel and computes the dynamic friction coefficient. The friction coefficient, along with vehicle velocity (and, optionally, water flow rate), is stored in the memory of the digital computer. All the menu selections and functions are entered into the digital computer from the keyboard.

When conducting a friction survey, the data are processed and sent to a printer, which provides a continuous strip chart recording of μ and velocity. Average values of μ are printed alongside the chart. Transmission continues throughout the survey at appropriate intervals until the entire length has been surveyed. Three chart scales are available to the operator: 25 mm equals approximately 30 m, 90 m and 300 m.

2.8 Skiddometer

The BV-11 Skiddometer is a trailer equipped with a friction-measuring wheel with a tyre, designed to operate at a fixed slip ratio between 15 and 17 per cent, depending on test tyre configuration. It consists of a four-sided welded frame supported by two independently sprung wheels. The three wheels are connected together by roller chains and sprocket wheels, with a gear ratio to force the centre friction-measuring wheel to rotate with a motion relative to the surface at the desired slip ratio. A vertical load of 105 kg is applied on the friction-measuring wheel by a weight via a spring and shock absorber.

Since the Skiddometer is a trailer, it requires a tow vehicle. If a self-water system is required, a water tank must be mounted on the tow vehicle, along with a water supply line to the nozzle which is mounted ahead of the test wheel on the BV-11 Skiddometer.

A special torque transducer measures the torque applied to the friction-measuring wheel. A tachometer generator, driven by one of the roller chains, measures the speed of the trailer. A cable between the trailer and the towing converts the analogue signals to a strip chart recorder located inside the tow vehicle.

The data taken on a friction survey are processed by a digital computer and recorded in a strip chart as a continuous trace of friction values to the operator for measuring distance on the strip chart: 25 mm equals approximately 112 m, 225 m, 450 m and 900 m.

2.9 Surface Friction Tester

The Surface Friction Tester is an automobile, which uses a fifth wheel with a tyre located in the trunk to measure the coefficient of friction. The automobile is equipped with front-wheel drive; an optional turbo-charged engine is also available. The friction-measuring wheel is designed to operate at a fixed slip ratio of between 10 and 12 per cent, depending on the type of friction-measuring tyre used in the survey. It is connected to the rear axle of the free rolling rear wheels by a chain transmission that is hydraulically retractable. A vertical loss of 140 kg is generated by a weight via a spring and shock absorber on the friction-measuring wheel.

The Surface Friction Tester is supplied with a self-water system and tank mounted in the rear seat area of the vehicle.

The torque acting on the friction-measuring wheel and the distance travelled are fed into a digital computer where the information is converted into coefficient form. The electric current flowing through the strain gauges within the torque sensor located on the friction-measuring wheel is affected by any minute changes in the tension of the chain transmission. Therefore, any variations in the frictional forces are monitored by the digital computer, which measures these variations of the electric current and converts the analogue signals into coefficient of friction data.

The μ values are continuously stored in the digital computer; upon completion of the survey, they are recorded on a strip chart as a continuous trace of μ values for the entire length surveyed. Speeds during the test, as well as data to identify the test, are also recorded on the strip chart. The scale for measuring distance on the strip chart is 25 mm equals 100 m.

2.10 Grip Tester

The Grip Tester is a lightweight, three-wheel trailer weighing 83 kg. The Grip Tester may be towed by a vehicle or manually pushed. It has a single measuring wheel fitted with a smooth tread tyre, which skids at 14.5 per cent of the forward velocity, through a chain transmission from the two-wheeled axle. The sensors are mounted on a single axle of the measuring wheel and provide continuous data displayed on the instrument panel screen. Data is transmitted to a computer carried in the cab of the towing vehicle. The total values and average friction readings for each third of the runway are displayed in the computer. When the survey has been completed averages over the width and length of the runway are displayed. The computer may display the trace of friction readings compared to the distance travelled. The results may be printed immediately or stored in a database.

2.11 Table of equivalent friction values

Friction values are expressed in Table A, which absolute values will be strictly and inflexibly applied. These values were obtained as a result of research studies and international experience. The table also provides the criteria to establish a design level for newly constructed or resurfaced runway surfaces, a maintenance friction level and a minimum friction level.

2.12 New Pavements

Upon completion of newly constructed or resurfaced runway surfaces to expand capacity or as corrective maintenance, the airport administrator will measure the friction level to verify compliance with the design level parameters, proposed by the new pavement project. The corresponding report will follow specifications in Chapter 2.

Table A

	Tyre Type	Tyre Pressure (Kpa)	Test speed (Km/h)	Test water depth (mm)	Design objective for new surface	Maintenance planning level	Minimum friction level
Mu	A	70	65	1,0	0,72	0,52	0,42
Mu	A	70	95	1,0	0,66	0,38	0,26
Skiddometer	B	210	65	1,0	0,82	0,60	0,50
Skiddometer	B	210	95	1,0	0,74	0,47	0,34
Surface Friction Vehicle	B	210	65	1,0	0,82	0,60	0,50
	B	210	65	1,0	0,74	0,47	0,34
Runway Friction Vehicle	B	210	65	1,0	0,82	0,60	0,50
	B	210	65	1,0	0,74	0,54	0,41
TATRA	B	210	65	1,0	0,76	0,57	0,48
TATRA	B	210	95	1,0	0,67	0,52	0,42
GRIPTESTER	B	210	65	1,0	0,74	0,53	0,43
GRIPTESTER	B	210	95	1,0	0,64	0,36	0,24

2.13 Friction Levels - Description

2.13.1 Minimum friction level

The minimum friction value is **μ = 0,42** (determined by measurements made at 65 km/h) and **μ = 0,26** (at 95 km/h).

2.13.2 Maintenance friction level

Maintenance levels are defined as **μ = 0,52** (determined by measurements made at 65 km/h) and **μ = 0,38** (at 95 km/h)

2.13.3 Design level

Design levels are defined as values of **μ = 0,72** (determined by measurements made at 65 km/h) and **μ = 0,66** (at 95 km/h).

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CHAPTER 3

FRICTION MEASURING EQUIPMENT

3.1 Objective

To describe the equipment that will be used to measure the runway friction coefficients.

3.2 Scope

The equipment described in this Chapter is used to define the corresponding values of different friction levels to determine the friction coefficient of runway pavements.
This equipment is not exclusive and any other equipment that correlates the measurements according to Chapter 1 descriptions and performed according to the system here forth described may be used.

3.3 Introduction

There are several friction-measuring devices with different technical and operational characteristics used in ICAO Member States airports; such as the one described below.

3.4. Description

(a) The Mu-meter (identified hereafter as MM) is a 245 kg trailer designed to measure side force friction generated between the friction-measuring tyres passing over the runway pavement surface at an included angle of 15 degrees.

(b) The trailer is constructed with a triangular frame on which are mounted two friction-measuring wheels and a rear wheel. The rear wheel provides stability to the trailer during its operation.

(c) A vertical load of 78 kg is generated by ballast via a shock absorber on each of the friction-measuring wheels.

(d) The friction-measuring wheels operate at an apparent slip ratio of 13.5 per cent.

(e) The Mu-meter also has a rear wheel, which has a patterned tread tyre, size 4.00-8 (16x4.0, 6 ply, RL2). The tyre operates with an inflation pressure of 70kPa.

(f) The Mu-meter, being a trailer device, requires a tow vehicle; if the self-water system is required, a water tank must be mounted on the tow vehicle to supply water to the nozzles.

(g) The distance sensor is a sealed photoelectric shaft encoder mounted on the rear wheel of the trailer. The distance sensor reads digital pulses in increments of a thousand-per-wheel revolution, transmitting them to the signal conditioner for calculation each time the trailer travels one metre.

(h) The load cell is an electronic transducer mounted between the fixed and movable members of the triangular frame. The load cell reads minute tension changes from the friction-measuring wheels.

(i) The signal conditioner is mounted on the frame and amplifies analogue μ data received from the load cell and digital data from the distance sensor.

(j) The signals from the rear wheel distance sensor provide both distance measurement and, combined with increments of real time, speed measurement.

(k) The computer located in the tow vehicle is called a processor and it uses two microprocessors to display, calculate, store and process μ data received from the load cell and distance sensor. There is also a keyboard, which has command and function keys for selecting menus.

(l) The processor provides a continuous chart of friction values for the entire length surveyed.

(m) Five chart scales are available to the operator: 25 mm equals approximately 20 m, 40 m, 85 m, 170 m and 340 m.

(n) The expanded scales can be sued to conduct a micro-investigation of areas where potential problems are suspected.

3.5 Vehicle characteristics

(a) The vehicle should be capable of maintaining test speeds of 65 and 95 km/h, within ±5 km/h. The vehicle, loaded with water, should be capable of attaining a speed of 65 km/h in 150 m and a speed of 95 km/h in 300 meters.

(b) The vehicle should be equipped with electronic speed controls.

(c) The vehicle should be kept painted, labelled and lighted, according to current regulations for service vehicles in operating areas.

(d) The vehicle should be equipped with communicating devices that provide a permanent radial link with the operations office and the aerodrome/airport air traffic control tower.

(e) The vehicle should have a lightweight water tank built with a resistant material with the capacity to test a runway of 4.200 meters and all the elements necessary to drop the required water quantities on the friction-measuring wheels.

(f) The vehicle is equipped with shocks and suspension for heavy-duty services and that allow the towing of all loads.

(g) The vehicle should be adequately equipped to regulate water flow from the inside of the vehicle and near the driver. If such a system is automatic all these elements are not required.

(h) The vehicle should have control of the lateral lighting. In order to illuminate the friction measuring system and the vehicle's rear end, towing vehicles that drag equipment should have two lights with a minimum level of 20 candles per square foot in the areas located on each side, in front and on the rear of the measuring equipment.

(i) The vehicle should have test tyres specially designed for pavement tests, in accordance with ASTM standard regulations E670, E-5551, or E-1844. The tyres will have a smooth tread to ensure great sensibility to the pavement surfaces texture variations. The manufacturer of the friction-measuring equipment should provide the aerodrome/airport a calibrated pressure indicator.

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CHAPTER 4

PERSONNEL RESPONSIBLE OF OPERATING THE EQUIPMENT

4.1 Objective

To describe the competency levels that personnel responsible for performing the friction coefficient measurements should maintain. These personnel reports to the airport administrator.

4.2 Scope

All personnel involved with the friction coefficient measuring equipment operation should comply with this Chapter's dispositions and attain the rating certification issued by the CAA-B.

4.3 Introduction

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.

4.4 Description

4.4.1 Training

If a programme for periodic instruction is not in place, then personnel fail to maintain their experience level over time and lose touch with the new developments in calibration, maintenance and operating techniques.

The personnel responsible for operating friction-measuring equipment should be periodically trained in order to supervise and certify they maintain their experience level updated and perform their duties with a high efficiency level.

Training is the Aerodrome Operator's responsibility and the manufacturer should provide it as part of the equipment-purchasing package or as a complementary contract.

The training programme should include a theory and practical section on the measuring and self-watering equipment calibration, operation and maintenance and an evaluation of acquired knowledgebase.

At the end of the training session, the participant will receive a certificate crediting the received and approved training. The training programme should include:

(a) Training programme objective

(b) Regulations related to friction measurements, equipment, tyres and self-watering system used in friction measuring, in accordance with the International Civil Aviation Organisation.

(c) Friction coefficient definition. Factors affecting friction conditions. Software used by ICAO to calculate friction coefficients, calibration, equipment operation and maintenance (measuring and self-watering).

(d) Notification procedures of friction values and pertinent information to CAA-B AIM for the corresponding NOTAM issuance.

4.5 Basic Competence

To ensure reliable measurements, CFME operating personnel should know the calibration, maintenance and operation techniques of the specific CFME in use at the aerodrome. Individuals should also be familiar with the necessary procedures and cycles to verify and calibrate the friction measuring devices to ensure the equipment maintains within the tolerable range provided by the manufacturer.

CFME operating personnel should be capable of calibrating the self-water devices with the determined periodicity to maintain the water flow within the tolerance range provided by the manufacturer, in order to ensure a uniform water flow applied in front of the friction measuring tyre at all speeds.

4.6 Available Documentation

The personnel responsible for CFME operation will have a “Training Manual” on the equipment permanently updated and provided by the manufacturer.

CHAPTER 5

MEASURING PROCEDURES

5.1 Objective

To describe the friction coefficient measuring procedures.

5.2 Scope

The procedures defined within this Chapter are applicable to all friction coefficient measurements performed on the aerodrome runways within The Bahamas.

5.3 Introduction

This Chapter develops the working methodology of the μ friction coefficient measurement procedure and the necessary controls to ensure measurement standardisation.

5.4 Description

5.4.1 Applicable Documentation

The technical documentation applicable on the control process execution corresponds to the equipment used. All equipment protocols should be retained in protected areas with easy access for authorised persons and Authorities.

The Aerodrome Operator should be able to demonstrate that the technical documentation used is the last authorised version of the issuing organisation and with the corresponding annexes proposed by the qualified technical personnel.

5.4.2 Calibration

The CFME should be calibrated once a month, as established in the Manual, except if an event or transportation of the equipment may require a recalibration. Prior to the calibration of the CFME, the user will record the equipment tyre pressures in **Format A** of this Chapter.

The pressure gauge will be periodically controlled, as established by the official entity, and the records will be filed accordingly.

The Aerodrome Operator will retain all records printed from the CFME on each of the calibrating attempts. These documents will be retained in the operator's files and will be available for review by all the personnel involved with its control.

The information recorded once the equipment has been calibrated will be filed. This information will also remain on the computer's memory to be reviewed as required. The user will sign Format A and attach all the records of each runway measurement.

The user in accordance with the manufacturer specifications will programme calibration. The programme existence does not exclude unscheduled calibration when the circumstances require it.

These calibrations should also be recorded. Any final comment regarding calibration will be recorded in **Format A**.

5.4.3 Runway friction coefficient measurements

Measurements should strictly follow the dispositions established in the Operators Manual, taking special consideration of:

(a) Equipment calibration

(b) Water flow adjustments.

5.4.4 Necessary data to start operations

The operator will report each measurement in **Format B**, where it should include the following information:

(a) Date

(b) Runway: identification, dimensions, orientation and pavement type.

(c) General weather conditions and wind velocity and direction.

(d) forward speed.

(e) Preselected value 65 or 95 km/h.

(f) When the operating conditions are different from the preselected speed values, refer to the Measurement Graph Records.

(g) At 65-km/h water flow will be 66 gallons/minute and at 95-km/h 99 gallons/minute.

5.4.5 Measurement Requirements

(a) The Airport Operator will have complete information of the runway status, including areas with drainage problems, groove deterioration and structural deficiencies. Any of these three situations should be recorded in Format B “comments” column.

(b) The equipment operator, when measuring friction on runways at 65 km/h, should start recording data 150 meters before the test area, to allow an adequate accelerating distance, and stop testing approximately 150 meters after, to allow a safe vehicle deceleration. When measuring at 95 km/h these distances would be of 300 meters.

(c) Mu-meter measurements will be performed on the entire runway, approximately 3 meters to the right of the axis for airports where non-wide body aircraft operate and 3/6 meters to the right of the axis for airports where wide-body aircraft operate, always in the landing direction and recording averages every 100 meters. Except if the surface conditions are notably different on both sides of the central runway line, it is sufficient to test only one side of the runway in the landing direction.

(d) If it is deemed necessary to evaluate both ends, due to an aircraft breaking performance interest, the vehicle should test the runway in both directions.

(e) The measuring direction of the vehicle should always be in the landing direction, maintaining a constant speed on all the testing sectors, especially those contaminated.

(f) Measurements will always be taken with a wet runway (self-water system).

5.4.6 Records (Format B)

(a) MuMeters will automatically record the average values every 100 meters.

(b) Any additional comments will be included in **Format B** under "Comments".

(c) The operator will sign the completed records.

(d) The MGR will be attached to **Format B**.

5.4.7 Formats

- **Format A**: Equipment Calibration
- **Format B**: Friction coefficient record

Format A

CALIBRATION EQUIPMENT MU METER MARK 5			
EQUIPMENT Nº		USER NAME	
PLACE OF CALIBRATION		TYRE PRESSURE	
FIRST CALIBRATION DATE		LAST CALIBRATION DATE	
QUANTITY OF CALIBRATION TESTS			
USER COMMENTS (IF NECESSARY)			
USER SIGNATURE			
ATTACHED PAGES TO THIS REPORT:			

Format B

FRICTION COEFFICIENT RECORD			
EQUIPMENT Nº		DATE	
PLACE		TIME	
WEATHER CONDITIONS			
WIND		DIRECTION	
		PAVEMENT TYPE	
		TEST SPEED	
RESULTS			

Sectors with coefficient μ **< minimum level**	Sectors WITH coefficient μ **< minimum level**:
Runway: Side: Right Left	**Runway: Side: Right Left**
Rw 000- 100	Rw 1700-1800
Rw 100- 200	Rw 1800-1900
Rw 200- 300	Rw 1900-2000
Rw 300- 400	Rw 2000-2100
Rw 400- 500	Rw 2100-2200
Rw 500- 600	Rw 2300-2400
Rw 700- 800	Rw 2500-2600
Rw 800- 900	Rw 2600-2700
Rw 900-1000	Rw 2700-2800
Rw 1100-1200	Rw 2800-2900
Rw 1200-1300	Rw 2900-3000
Rw 1300-1400	Rw 3000-3100
Rw 1400-1500	Rw 3100-3200
Rw 1500-1600	Rw 3200-3300
Rw 1600-1700	Rw 3300-3400
Rw: Progressive	

COMMENTS:

Note: When values μ < minimum level (μ less than the minimum level) are recorded, the information will be published on the NOTAM, emphasising the affected sector of the runway.

CHAPTER 6

FRICTION COEFFICIENT MEASUREMENT FREQUENCY

6.1 Objectives

To establish the friction-testing periods on runway-paved surfaces.

6.2 Scope

This Chapter’s contents are applicable to all aerodrome runways within The Bahamas .

6.3 Introduction

The friction-testing frequency of runway-paved surfaces depends on the number of landings and aircraft weight that operate at the aerodrome.

6.4 Description

The minimum frequency to determine runway friction coefficient is indicated in this Chapter under **Format C**. Any future aerodromes will be required to have an adequate level of analysis which must include type of aircraft operations per year which must be included in **Format C**.

The Aerodrome Operator will review the testing frequency and the results on an annual basis to analyse and determine whether **Format C** requires an amendment. Every year, the Aerodrome Operator shall record the number of aircraft landings and take offs during the previous calendar year. The record should also specify aircraft type, weight and the relevant operated runway.

Example:

Aircraft B 737/200, maximum take-off weight (MTOW) and maximum landing weight (MLW), number of operations per runway (Example: 05) and number of operations in opposite runway (Example: 23), specifying between landings and take offs.

AIRCRAFT: B 737/200 MTOW MLW

Runway	14	1.500 Ops.
Runway	32	3.000 Ops.

AIRCRAFT: B 757/200 MTOW MLW

Runway	14	2.000 Ops.
Runway	32	4.500 Ops.

Format C

Movements per year	**Minimum cycle for a highly use runway**	**Minimum cycle for a least use runway**
150.000 to 200.000	Each 7 days	Each 90 days
100.000 to 150.000	Each 15 days	Each 180 days
75.000 to 100.000	Each 30 days	Each 360 days
75.000 to 50.000	Each 90 days	Each 360 days
50.000 to 25.000	Each 180 days	Each 360 days
25.000 to 1.000	Each 360 days	Each 720 days

Based on statistics obtained from the friction tests, Format C can be adjusted to optimise the frequency of the measurements.

CHAPTER 7

SURFACE FRICTION CORRECTIVE ACTIONS

7.1 Objective

To determine the corrective actions the Aerodrome Operator should take to ensure safe operations when the runway surface friction deteriorates,

7.2 Scope

The defined actions are mandatory to all aerodrome/airport administrators referred to in this Standard.

7.3 Introduction

The evaluation and maintenance indications are based on Chapter 1 friction levels of this standard, which determine the Friction Coefficient of Runway Pavements. These indicators consider that low friction coefficients in short sectors of the runway do not necessarily present a safety issue for aircraft, whereas longer sectors of a below minimum friction level reading may have serious consequences that affects aircraft performance and hence, contributing to an aircraft accident or incident. These sectors require corrective actions.

7.4 Corrective Action Opportunities.

Corrective actions depend on the friction coefficient value; such is the case of the following situations:

7.5 Friction coefficient under maintenance level in a 150-metre sector

When the average μ value on a runway paved wet surface is less than the maintenance level but greater than the minimum level in a 150 m distance, and the next 150 m sectors are equal to or above the maintenance level, no corrective action is required.

These readings indicate that pavement friction is deteriorating but it is still above the established minimum limits or above the minimum acceptable conditions.

The Aerodrome Operator should perform a through follow up of the situation, establishing periodic controls to determine the percentage and extent of the friction loss, in order to carry out required maintenance tasks and verify the inspection periods.

7.6 Friction coefficient under maintenance level in a 300-metre sector

When the average μ value on a runway paved wet surface is less than the maintenance level but greater than the minimum level in a 300 m distance or more, the Aerodrome Operator should conduct a detailed analysis to determine the root causes, the extent of the friction loss and take the appropriate corrective actions.

7.7 Friction coefficient under minimum level

When the average μ value on a runway paved wet surface is less than the minimum level in a 150 m distance, and the next 150 m sectors are also less than the minimum level, **immediate corrective actions are required**. Friction loss causes should also be immediately determined.

Before taking any corrective actions, the Aerodrome Operator should investigate the runways paved surface general conditions to determine if there are other deficiencies that require corrective actions.

7.8 Complementary Measurements

When friction values do not reach the values established in Chapter 2 and the causes are non-comprehensive; the Aerodrome Operator should perform deep texture measurements.

The recommended average texture depth to establish adequate slip resistance on new concrete or asphalt pavements is 1.14 mm. A lower value indicates macro texture deficiencies that require corrective actions as the surface deteriorates. Corrective actions will depend on the average depth of the runway surface texture.

7.9 Surface texture under 1.14 mm

When the average depth texture measurements of a runway sector (touchdown area, central sector, exits) are under 1.14 mm, the Aerodrome Operator should measure texture depth each time it verifies the runway friction.

7.10 Surface texture between 0.76 mm and 0.40 mm

When the average texture depth is under 0.76 mm but above 0.40 mm, the Aerodrome Operator should develop a corrective maintenance plan to rectify the surface texture deficiencies within six (6) months.

7.11 Surface texture under 0.25 mm

When the average texture depth measurement of a runway sector (touchdown zone, central area, and exits) is under 0.25 mm, the Aerodrome Operator should develop a corrective maintenance plan to rectify the surface texture deficiencies within forty-five (45) days.

7.12 Corrective Actions

Corrective actions will basically include:

(a) Contamination removal to restore μ values to a parameter of more than 10 per cent of the non-contaminated central values, ensuring that both measurements are at an acceptable friction levels for aircraft safe operations.

(b) Pavement surface retexture should have an average texture depth of at least 0.76 mm.

To remove rubber deposits, paint markings and other surface contamination on the runway, the Aerodrome Operator could use any of the following methods: high-pressure water blasting, chemical solvents, hot compressed air, or a combination of these methods.

None of these methods should be performed with water, snow, ice or mud deposits on the runway. Chemical solvents and high-pressure water blasting should not be used if there is a probability of fluid freezing.

Certain conditions may produce significant pavement damage; the Aerodrome Operator should prevent runway surface damage and areas essential for aircraft operations.

The effectiveness of removal procedures cannot be assessed by a visual inspection. After removing the polluting agents using any of the above methods, the Aerodrome Operator should measure friction levels to evaluate the effectiveness and efficiency of work performed.

7.13. NOTAM Issuing Procedure for Notifying Contaminant on a Runway

When the friction test is below the minimum friction level shown in Table A or any abnormal condition of the runway is detected a NOTAM shall be issued to highlight this.

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