Belize Department of Civil Aviation

ADVISORY CIRCULAR

Subject:	FRICTION MEASUREMENT AND MAINTENANCE OF SKID RESISTANT AIRPORT PAVEMENT SUFACES	**Date:** 04/10/2018
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SUBJECT: To provide guidelines for maintenance for skid-resistant pavement surfaces.

1. THE PURPOSE OF THIS ADVISORY CIRCULAR.

This advisory circular (AC) contains guidelines and procedures for maintenance of high skid-resistant pavements.

2. WHAT THIS AC CANCELS

This AC is the first version of this subject.

3. WHO THIS AC AFFECTS.

Operations and maintenance managers, for, public or private, national and international aerodromes.

4. WHERE TO GET A COPY OF THIS AC. You can get a Copy of this AC in the Technical Library of the Belize Department of Civil Aviation (BDCA).

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1 PURPOSE

This AC provides guidelines for maintaining skid-resistant airport pavement surfaces and for conducting evaluations and surveys of runway friction for pavement maintenance purposes.

2 PAVEMENT EVALUATION.

Over time, the skid-resistance of runway pavement deteriorates due to a number of factors, the primary ones being mechanical wear and polishing action from aircraft tires rolling or braking on the pavement and the accumulation of contaminants, chiefly rubber, on the pavement surface. The effect of these two factors is directly dependent upon the volume and type of aircraft traffic. Other influences on the rate of deterioration are local weather conditions, the type of pavement the materials used in original construction, any subsequent surface treatment, and airport maintenance practices. Structural pavement failure such as rutting, ravelling, cracking, joint failure, settling, or other indicators of distressed pavement can also contribute to runway friction losses. Prompt repair of these problems should be undertaken. Contaminants, such as rubber deposits, dust particles, jet fuel, oil spillage, water, all cause friction loss on runway pavement surfaces. In tropical Countries like Belize the most persistent contaminant problem is deposit of rubber from tires of landing jet aircraft. Rubber deposits occur at the touchdown areas on runways and can be quite extensive. Heavy rubber deposits can completely cover the pavement surface texture causing loss of aircraft braking capability and directional control, particularly when runways are wet.

3 SCHEDULING PAVEMENT EVALUATIONS.

The operator of any airport with significant jet aircraft traffic should schedule periodic friction evaluations of each runway that accommodates jet aircraft. These evaluations should be carried out in accordance with the procedures outlined in either Section 2 or 3 of this chapter, depending upon the availability to the airport operator of continuous friction measuring equipment (CFME). Every runway for jet aircraft should be evaluated at least once each year. Depending on the volume and type (weight) of traffic on the runways, evaluations will be needed more frequently, with the most heavily used runways needing evaluation as often as weekly, as rubber deposits build up. 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. Airport operations management should work closely with air traffic control, fixed base operations, and/or airlines.

4 MINIMUM FRICTION SURVEY FRECUENCY

Table 3-1 should be used as guidance for scheduling runway friction surveys. This table is based on an average mix of turbojet aircraft operating on any particular runway. Most aircraft landing on the runway are narrow body, such as the DC-9, B-727, B-737, A-319, A-320, E-190 etc. A few wide body aircraft were included in the mix. When any runway end has 20 per cent or more wide body aircraft (L-1011, B-747, DC- 10, MD-11, C-5, etc.) of the total aircraft mix, it is recommended that the airport operator should select the next higher level of aircraft operations in Table 3-1 to determine the minimum survey frequency. As airport operators accumulate data on the rate of change of runway friction under various traffic conditions, the scheduling of friction surveys may be adjusted to ensure that evaluators will detect and predict marginal friction conditions in time to take corrective actions.

NUMBER OF DAILY MINIMUM TURBOJET AIRCRAFT LANDINGS PER RUNWAY END	MINIMUM FRICTION SURVEY FREQUENCY
LESS THAN 15	1 YEAR
16 TO 30	6 MONTHS
31 TO 90	3 MONTHS
91 TO 150	1 MONTH
151 TO 210	2 WEEKS
GREATER THAN 210	1 WEEK

TABLE 4-1 FRICTION SURVEY FRECUENCY

NOTE: Each runway end should be evaluated separately, e.g., Runway 07 and Runway 25.

5 SURVEY WHITHOUT CONTINOUS FRICTION MEASUREMENT EQUIPMENT

Research has shown that visual evaluations of pavement friction are not reliable. An operator of an airport that does not support turbojet operations who suspects that a runway may have inadequate friction characteristics should arrange for testing by CFME. Visual inspections are essential, however, to note other surface condition inadequacies such as drainage problems, including ponding and groove deterioration, and structural deficiencies.

6 GROOVE DETERIORATION

Periodically, the airport operator should measure the depth and width of a runway's grooves to check for wear and damage. When 40 per cent of the grooves in the runway are equal to or less than 1/8 inch (3 mm) in depth and/or width for a distance of 1,500 feet (457 m), the grooves' effectiveness for preventing hydroplaning has been considerably reduced. The airport operator should take immediate corrective action to reinstate the 1/4 inch (6 mm) groove depth and/or width.

7 MEASUREMENT OF PAVEMENT SURFACE

When a friction test identifies a pavement surface with inadequate friction characteristics, the cause, such as rubber accumulation, is often obvious. When the cause is not obvious, the following guidance may be helpful in determining if the deficiency is a result of deterioration in surface texture depth. Such deterioration may be caused by weather influences, wear/polishing effects of aircraft traffic, and contaminants including but not limited to rubber deposits. Visual inspections cannot be relied upon to identify pavement surfaces with poor texture. Pavement texture depths can only be determined by direct measurements. The operator of the equipment may affect even direct measurements, so they should be used as only part of an overall pavement friction evaluation.

8 CFME- General

8.1 General Requirements for CFME.

All airports with turbojet traffic should own or have access to use of CFME. Airports that have few turbojet traffic operations may be able to borrow the CFME from nearby airports for maintenance use, share ownership with a pool of neighbouring airports, or hire a qualified contractor.

8.2 Training of Personnel.

The success of friction measurement in delivering reliable friction data depends heavily on the personnel who are responsible for operating the equipment. Adequate professional training on the operation, maintenance, and procedures for conducting friction measurement should be provided either as part of the procurement package or as a separate contract with the manufacturer. Also, recurrent training is necessary for review and update to ensure that the operator maintains a high level of proficiency. Experience has shown that unless this is done, personnel lose touch with new developments on equipment calibration, maintenance, and operating techniques. A suggested training outline for the manufacturers is given in Appendix 3. Airport personnel should be trained not only in the operation and maintenance of the CFME but also on the procedures for conducting friction surveys. These procedures are provided in Section 4 below. At airports where friction tests are performed less frequently than quarterly, and CFME is not used for winter operations, consideration should be given to hiring a qualified contractor to perform tests.

8.3 Calibration

All CFME should be checked for calibration within tolerances given by the manufacturer before conducting friction surveys. CFME furnished with self-wetting systems should be calibrated periodically to assure that the water flow rate correct and that the amount of water produced for the required water depth is consistent and applied evenly in front of the friction measuring wheel(s) for all test speeds.

9 CONDUCTING FRICTION EVALUATION WITH CFME.

9.1 Preliminary Steps.

Friction measurement operations should be preceded by a thorough visual inspection of the pavement to identify deficiencies. Careful and complete notes should be taken not only of the CFME data but of the visual inspection as well. The airport operator should assure that appropriate communications equipment and frequencies are provided on all vehicles used in conducting friction surveys and that all personnel are fully cognizant of airport safety procedures. Personnel operating the equipment should be fully trained and current in all procedures. The CFME should be checked for accurate calibration and the vehicle checked for adequate braking ability.

9.2 Location of Friction Surveys on the Runway

The airport operator, when conducting friction surveys on runways at 40 mph (65 km/h), should begin recording the data 500 feet (152 m) from the threshold end to allow for adequate acceleration distance. The friction survey should be terminated approximately 500 feet (152 m) from the opposite end of the runway to allow for adequate distance to safely decelerate the vehicle. When conducting friction surveys at 60 mph (95 km/h), the airport operator should start recording the survey 1,000 feet (305 km) from the threshold end and terminate the survey approximately 1,000 feet from the opposite end of the runway. Where travel beyond the end of the runway could result in equipment damage or personal injury, additional runway length should be allowed for stopping. The lateral location on the runway for performing the test is based on the type of aircraft operating on the runway. Unless surface conditions are noticeably different on either side of the runway centreline, a test on one side of the centreline in the same direction the aircraft lands should be sufficient. However, when both runway ends are to be evaluated, vehicle runs can be made to record data on the return trip (both ways). The lateral location on the runway for performing friction surveys is based on the type and/or mix of aircraft operating on the runway:

a. **Runways Serving Only Narrow Body Aircraft.** Friction surveys should be conducted 10 feet (3 m) to the right of the runway centreline.

b. **Runaways Serving Narrow Body and Wide Body Aircraft.** Friction surveys should be conducted 10 and 20 feet (3 and 6 m) to the right of the runway centreline to determine the worst-case condition. If the worst-case condition is found to be consistently limited to one track, future surveys may be limited to this track. Care should be exercised, however, to account for any future and/or seasonal changes in aircraft mix.

9.3 Vehicle Speed for Conducting Surveys.

All of the approved CFME in Appendix 4 can be used at either 40 mph (65 km/h) or 60 mph (95 km/h). The lower speed determines the overall macro texture/contaminant/drainage condition of the pavement surface. The higher speed provides an indication of the condition of the surface's micro texture. A complete survey should include tests at both speeds.

9.4 Use of Self wetting System

Since wet pavement always yields the lowest friction measurements, CFME should routinely be used on wet pavement which gives the "worst case" condition. CFME is equipped with a self-wetting system to simulate rain wet pavement surface conditions and provide the operator with a continuous record of friction values along the length of the runway. The attached nozzle(s) are designed to provide a uniform water depth of 1 mm (0.04 inch) in front of the friction measuring tire(s). This wetted surface produces friction values that are most meaningful in determining whether or not corrective action is required.

9.5 Friction Surveys During Rainfall

One limitation in using the self-wetting system on a friction-measuring device is that it cannot by itself indicate the potential for hydroplaning. Some runways have depressed areas which pond during periods of moderate to heavy rainfall. These areas may exceed considerably the water depth used by the self-wetting system of the friction-measuring device. Therefore, the conduct of visual checks of the runway surface during rainfall, noting the location, average water depth, and approximate dimensions of the ponded areas. If the average water depth exceeds 1/8 inch (3 mm) over a longitudinal distance of 500 feet (152 m), the depressed area should be corrected to the standard transverse slope. If possible, the airport owner should conduct periodic friction surveys during rainfall through the ponded areas.

9.6 Friction Level Classification.

Mu numbers (friction values) measured by CFME can be used as guidelines for evaluating the surface friction deterioration of runway pavements and for identifying appropriate corrective actions required for safe aircraft operations. Table 3-2 depicts the friction values for three classification levels for FAA qualified CFME operated at 40 and 60 mph (65 and 95 km/h) test speeds. This table was developed from qualification and correlation tests conducted at NASA's Wallops Flight Facility in 1989.

	40 mph			60 mph		
	Minimum	Maintenance Planning	New Design/ Construction	Minimum	Maintenance Planning	New Design/ Construction
Mu Meter	.42	.52	.72	.26	.38	.66
Dynatest Consulting, Inc. Runway Friction Tester	.50	.60	.82	.41	.54	.72
Airport Equipment Co. Skiddometer	.50	.60	.82	.34	.47	.74
Airport Surface Friction Tester	.50	.60	.82	.34	.47	.74
Airport Technology USA Safegate Friction Tester	.50	.60	.82	.34	.47	.74
Findlay, Irvine, Ltd. Griptester Friction Meter	.43	.53	.74	.24	.36	.64
Tatra Friction Tester	.48	.57	.76	.42	.52	.67
Norsemeter RUNAR (operated at fixed 16% slip)	.45	.52	.69	.32	.42	.63

TABLE 9-1 FRICTION LEVEL CLASSIFICATIONS FOR RUNWAY PAVEMENT SURFACES

9.7 Evaluation and Maintenance Guidelines.

The following evaluation and maintenance guidelines are recommended based on the friction levels classified in Table 3-2. These guidelines take into account that poor friction conditions for short distances on the runway do not pose a safety problem to aircraft, but long stretches of slippery pavement are of serious concern and require prompt remedial action.

a. **Friction Deterioration Below the Maintenance Planning Friction Level (500 ft.).** When the average Mu value on the wet runway pavement surface is less than the Maintenance Planning Friction Level but above the Minimum Friction Level in Table 3-2 for a distance of 500 feet (152 m), and the adjacent 500-foot (152 m) segments are at or above the Maintenance Planning Friction Level, no corrective action is required. These readings indicate that the pavement friction is deteriorating but the situation is still within an acceptable overall condition. The airport operator should monitor the situation closely by conducting periodic friction surveys to establish the rate and extent of the friction deterioration.

b. **Friction Deterioration Below the Maintenance Planning Friction Level (1000 ft.).** When the averaged Mu value on the wet runway pavement surface is less than the

Maintenance Planning Friction Level in Table 3-2 for a distance of 1000 feet (305 m) or more, the airport operator should conduct extensive evaluation into the cause(s) and extent of the friction deterioration and take appropriate corrective action.

c. **Friction Deterioration Below the Minimum Friction Level.** When the averaged Mu value on the wet pavement surface is below the Minimum Friction Level in Table 3-2 for a distance of 500 feet (152 m), and the adjacent 500-foot (152 m) segments are below the Maintenance Planning Friction Level, corrective action should be taken immediately after determining the cause(s) of the friction deterioration. Before undertaking corrective measures, the airport operator should investigate the overall condition of the entire runway pavement surface to determine if other deficiencies exist that may require additional corrective action.

d. **New Design/Construction Friction Level for Runways.** For newly constructed runway pavement surfaces (that are either saw cut grooved or have a PFC overlay) serving turbojet aircraft operations, the averaged Mu value on the wet runway pavement surface for each 500 foot (152 m) segment should be no less than the New Design/Construction Friction Level in Table 3-2.

9.8 Computer Evaluation of Friction Test Data

A manual evaluation of friction test data as required by the criteria above can be tedious and prone to human error. An IBM PC-compatible computer program which performs this evaluation is available free of charge. The computer program may be downloaded from the FAA Airports Internet web site at http://www.faa.gov/arp/software.htm.

9.9 Recommended Testing.

When friction values meet the criteria in paragraphs 9.7.(a), 9.7.(b), and 9.7.(c), no texture depth measurements are necessary. When friction values do not meet the criteria in paragraphs 9.7.(a), 9.7.(b), or 9.7.(c), and the cause is not obvious (e.g. rubber deposits), the airport operator should perform texture depth measurements.

9.10 Recommended Texture Depths.

a. **Newly Constructed Pavements.** The recommended average texture depth to provide good skid-resistance for newly constructed concrete and asphalt pavements is 0.045 inch (1.14 mm). A lower value indicates a deficiency in macro texture that will require correction as the surface deteriorates.

b. **Existing Pavements.**

(1) When the average texture depth measurement in a runway zone (i.e., touchdown, midpoint, and rollout) falls below 0.045 inch (1.14 mm), the airport operator should conduct texture depth measurements each time a runway friction survey is conducted.

(2) When the average texture depth measurement in a runway zone is below 0.030 inch (0.76 mm) but above 0.016 inch (0.40 mm), the airport operator should initiate plans to correct the pavement texture deficiency within a year.

(3) When the average texture depth measurement in a runway zone (i.e., touchdown, midpoint, and rollout) falls below 0.010 inch (0.25 mm), the airport operator should correct the pavement texture deficiency within 2 months.

c. Retexturing.

Retexturing of the pavement surface should improve the average texture depth to a minimum of 0.030 inch (0.76 mm).

9.11 Location of Measurements.
Groove depths are never included in texture depth measurements. For grooved runway pavements, texture depth measurements should always be located in no grooved areas, such as near transverse joints or light fixtures, but as close as possible to heavily trafficked areas.

9.12 Test Methods.
A minimum of three texture depth measurements should be taken in any area noted as deficient. More measurements should be taken when obvious textural changes in the pavement surface computed for each area. Descriptions of the equipment and methods used and the computations involved in determining texture depths are as follows

a. Equipment. The U.S. NASA Grease Smear Method is used to determine the macro texture of the pavement surface by measuring the average distance between the peaks and valleys in the pavement texture. This method cannot be used to evaluate the pavement micro texture. On the left in Figure 9-1 is shown the tube, which is used to measure the 1 cubic inch (15 cc) volume of grease. On the right is shown the tight fitting plunger, which is used to expel the grease from the tube, and in the centre is shown the rubber squeegee, which is used to work the grease into the voids in the runway surface. The sheet rubber on the squeegee is cemented to a piece of aluminium for ease in use. Any general-purpose grease can be used. As a convenience in the selection of the length of the measuring tube, Figure 3- 2 gives the relation between the tube inside diameter and tube length for an internal tube volume of one cubic inch (15 cu cm). The plunger can be made of cork or other resilient material to achieve a tight fit in the measuring tube.

b. Measurement. The tube for measuring the known volume of grease is packed full with a simple tool, such as a putty knife, with care to avoid entrapped air, and the ends are squared off as shown in Figure 9-3. A general view of the texture measurement procedure is shown in Figure 9-4. The lines of masking tape are placed on the pavement surface about 4 inches (10 cm) apart. The grease is then expelled from the measuring tube with the plunger and deposited between the previously placed lines of masking tape. It is then worked into the voids of the runway pavement surface with the rubber squeegee, with care that no grease is left on the masking tape or the squeegee. The distance along the lines of masking tape is then measured and the area that is covered by the grease is computed.

9.13 Computation.
After the area is completed, the following equations are used to calculate the average texture depth of the pavement surface:

$$\text{Texture depth (inches)} = \frac{\text{Volume of grease (cu. in.)}}{\text{Area covered by grease (sq. in.)}}$$

$$\text{Average Texture Depth} = \frac{\text{Sum of individual tests}}{\text{Total number of tests}}$$

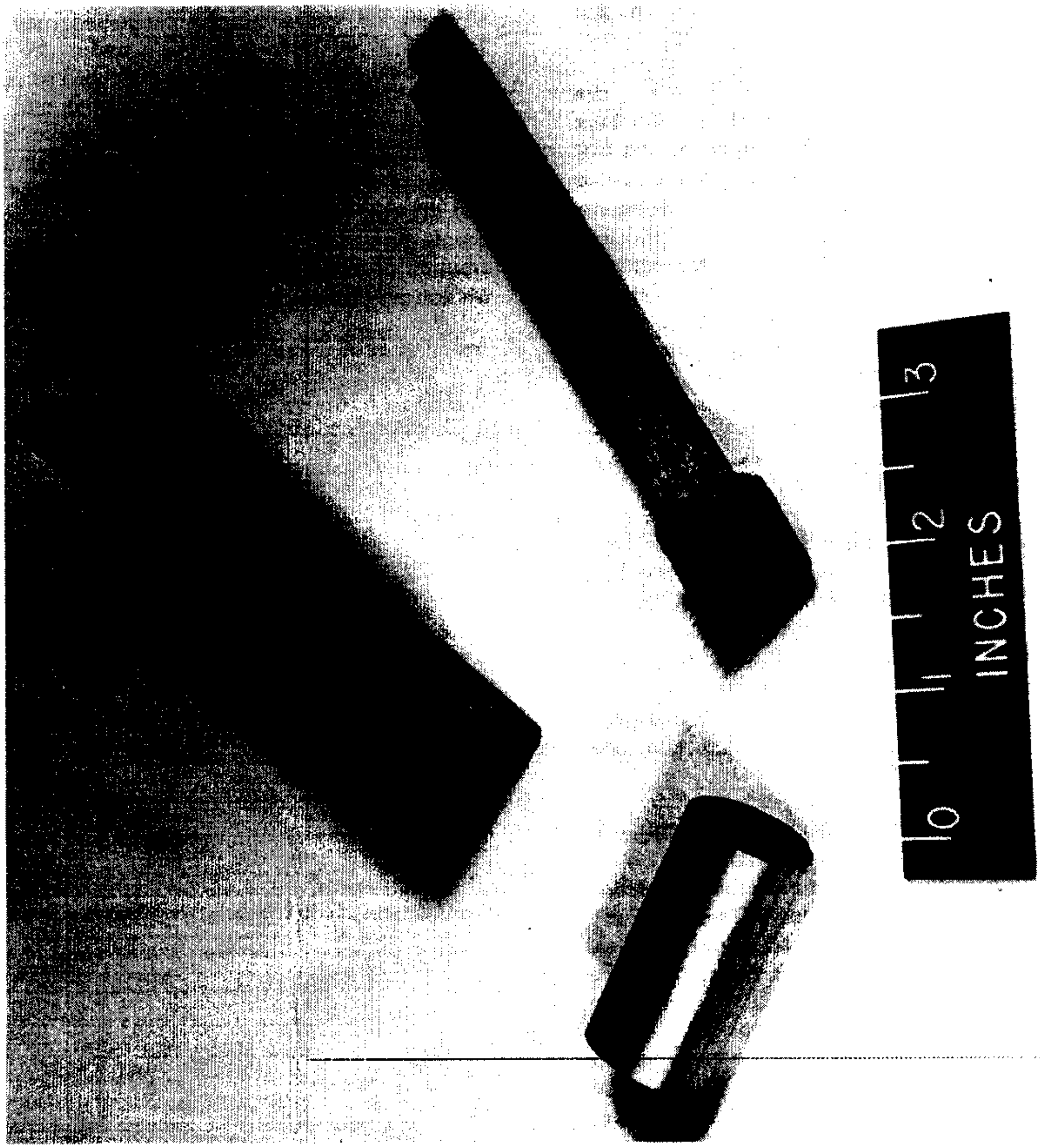

FIGURE 9-1. GREASE-VOLUME MEASURING TUBE, PLUNGER, AND RUBBER SQUEEGEE

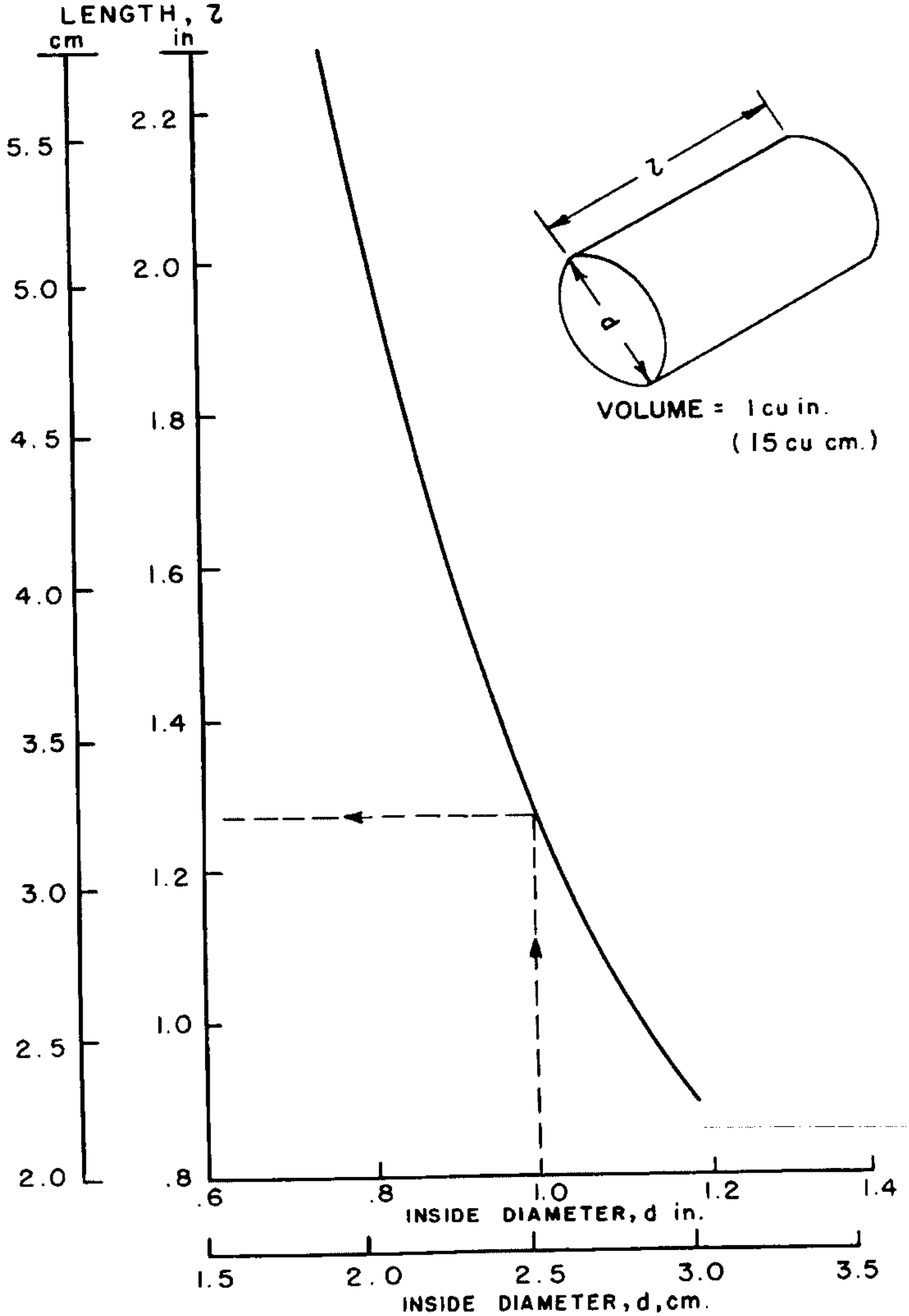

FIGURE 9-2. MEASURING TUBE DIMENSIONS TO MEASURE ONE CUBIC INCH OR FIFTEEN CUBIC CENTIMETERS

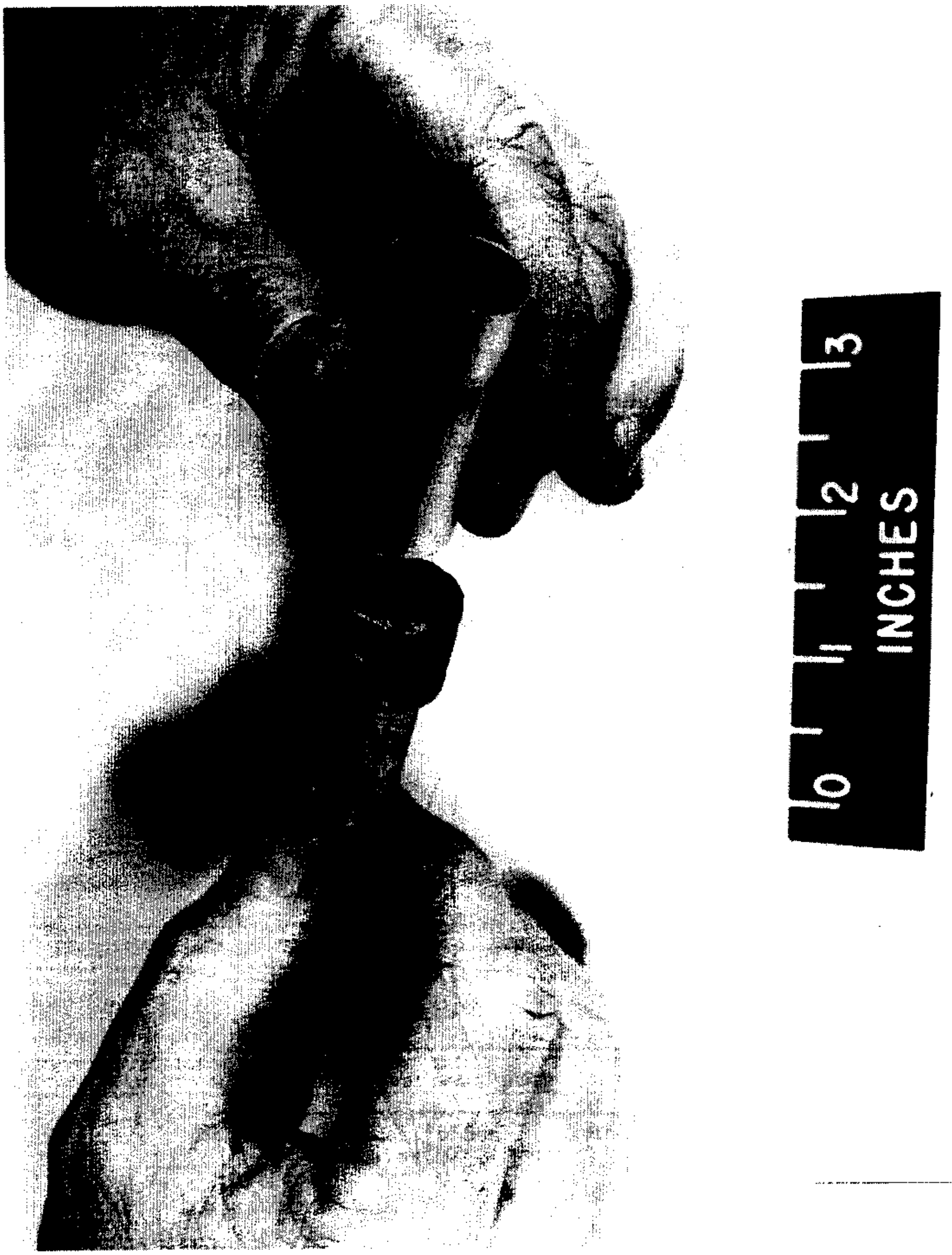

FIGURE 9-3. MEASURING TUBE FILLED WITH GREASE

FIGURE 3-4. ILLUSTRATION OF APPARATUS USED IN GREASE APPLICATION TECHNIQUE FOR MEASURING PAVEMENT SURFACE TEXTURE DEPTH

10 MAINTAINING HIGH SKID-RESISTANCE

Section 1 Maintenance Considerations

10.1 Need for Maintenance.

As traffic mechanically wears down micro texture and macro texture and as contaminants build up on runway pavements, friction will decrease to a point where safety may be diminished. At joint use airports, where high numbers of military aircraft operations occur, the venting of excess fuel can lead to serious loss of friction by either causing contaminant build-up or an oil film on the pavement surface. Also, fog seal treatment of HMA surfaces can substantially reduce the pavement's coefficient of friction during the first year after application. Surfaces, which already have marginally acceptable friction, can become unacceptable when given this type of surface treatment.

When the measured coefficient of friction values approach or drop below the Maintenance Planning Level as shown in Table 3-2. Table 4-1 may be used as a tool for budgeting for and scheduling appropriate and timely maintenance for removal of contaminants and restoration of good friction characteristics. As stated in chapter 3, the average aircraft mix was based on mostly narrow body aircraft with a few wide body aircraft operations included. Rubber accumulation is dependent on the type and frequency of aircraft landing operations; e.g., weight of aircraft, the number of wheels that touchdown on the surface, climate, runway length, and runway composition. When more than 20 percept of the total aircraft mix landing on any one runway end are wide body aircraft, it is recommended that the airport operator select the next higher level of aircraft operations in Table 4-1 to determine the rubber removal frequency. Experience and the use of CFME will allow the airport operator to develop a Schedule specific to each runway.

NUMBER OR DAILY TURBOJET AIRCRAFT LANDING PER RUNWAY END	SUGGESTED RUBBER DEPOSIT REMOVAL FREQUENCY
LESS THAN 15	2 YEARS
16 TO 30	1 YEAR
31 TO 90	6 MONTHS
91 TO 150	4 MONTHS
151 TO 210	3 MONTHS
GREATER THAN 210	2 MONTHS

TABLE 10-1. RUBBER DEPOSIT REMOVAL FREQUENCY

Note: Each runway end should be evaluated separately, e.g. Runway 07 and Runway 25.

Section 2. Methods for Removing Contaminants

10.2 Recommended Contaminant Removal Techniques.

Several methods are available for cleaning rubber deposits, other contaminants, and paint markings from runway surfaces. They include high-pressure water, chemical, high velocity impact, and mechanical grinding. After the contaminants have been removed from the runway surface by any of these methods, the airport operator should conduct friction measurements to assure that the Mu values have been restored to within 10 per cent of those on the uncontaminated centre portion of the runway and that both measurements are well within the acceptable friction levels for safe aircraft operations. The effectiveness of rubber deposit removal procedures cannot be evaluated by visual inspection. It is highly recommended that rubber deposit removal contracts base payments on final tests by CFME. A brief description follows for each of the contaminant removal techniques. None of the techniques should be used unless the runway is free of standing water or mud. Also, chemical or water impact removal methods should not be used if there is a danger of the fluids freezing. The ultimate success of any method will depend on the expertise of the equipment operator. Results can vary from completely ineffective to a situation where all rubber deposits are removed, but the underlying pavement is significantly damaged. It is recommended that airport operators require that a test section be cleaned by the contractor to demonstrate that rubber deposits will be removed without damage to the underlying pavement.

a. Removal by High Pressure Water. A series of high-pressure water jets is aimed at the allowing the water to transport the rubber particles to the edge of the runway. The technique is economical, environmentally clean, and effectively removes deposits from the pavement surface with minimal downtime to the airport operator. High-pressure water blasting also may be used to improve the surface texture of smooth pavements. Water pressures used vary significantly. There are so many other parameters that vary from one contractor's equipment to another, however, that the pressure of the water used is not a good indication of the potential for either effectiveness or pavement damage. The airport operator should rely on the contractor's experience, demonstrated expertise, and references.

b. Removal by Chemicals. Chemical solvents have been used successfully for removal of contaminants on both Portland cement concrete (PCC) and Hot Mixed Asphalt (HMA) runways. Any chemicals used on runways must meet, state, and local environmental requirements. For removal of rubber deposits on Portland cement concrete (PCC) runways, chemicals are used which have a base of cresylic acid and a blend of benzene, with a synthetic detergent for a wetting agent. For removal of rubber deposits on HMA runways, alkaline chemicals are generally used. Because of the volatile and toxic nature of such chemicals, extreme care must be exercised during and after application. If the chemicals remain on the pavement too long, the painted areas on the runway and possibly the surface itself could be damaged. It is also very important to dilute the chemical solvent that is washed off the pavement surface so that the effluent will not harm surrounding vegetation or drainage systems or pollute nearby streams and wildlife habitats. Detergents made of Meta silicate and resin soap can be used effectively to remove oil and grease from PCC runway surfaces. For HMA pavements, an absorbent or blotting material such as sawdust or sand combined with a rubber alkaline degreaser may be used.

c. High Velocity Impact Removal. This method employs the principle of throwing abrasive particles at a very high velocity at the runway pavement surface, thus blasting the contaminants from the surface. Additionally, the machine that performs this operation can be adjusted to produce the desired surface texture, if so required. The abrasive is propelled mechanically from the peripheral tips of radial blades in a high speed, fan like wheel. The entire operation is environmentally clean in that it is self-contained; it collects the abrasive particles, loose contaminants, and dust from the runway surface; it separates and removes the contaminants and dust from the abrasive; and it recycles the abrasive particles for repetitive use. The machine is very mobile and can be removed rapidly from the runway if required by aircraft operations.

d. Mechanical Removal. Mechanical grinding that employs the corrugating technique has been successfully used to remove heavy rubber deposits from both PCC and HMA runways. It has also been used to remove high areas such as bumps on pavement surfaces or at joints where slabs have shifted or faulted. This method greatly improves the pavement surface friction characteristics. Pavement surfaces that are either contaminated (rubber build-up or bleeding) or worn can have their surface friction coefficient greatly increased by a thin milling operation. This technique removes a surface layer between 1/8 and 3/16 inch (3.2 and 4.8 mm) in depth.

APPENDIX 1

PERFORMANCE SPECIFICATIONS FOR CFME

1. **FRICTION EQUIPMENT PERFORMANCE STANDARD.** The friction measuring equipment may be self-contained or towed. If towed, the tow vehicle will be considered an integral part of the device. The vehicles and/or trailers shall meet all applicable Laws and/or regulations for vehicles and/or trailers for use on public highways. The side force friction-measuring device, the Mu Meter, shall meet the Standard Test Method given in ASTM E 670. The Standard Test Method for the fixed brake slip devices is under preparation by the ASTM Committee.

a. The Friction Measuring Equipment shall do the following:

(1) provide fast, continuous, accurate, and reliable friction measurements for the entire length of the runway, less the differences required for accelerating and decelerating the vehicle at the runway ends.

(2) be designed to sustain rough usage and still function properly and provide efficient and reliable methods of equipment calibration.

(3) be capable of automatically providing the operator with a selection of average friction values for both a 500 foot (150 m) and one-third segment of runway length. In addition, it shall be capable of providing data, whereby, the average friction value for any length of runway can be manually calculated.

(4) be capable of producing a permanent trace of friction measurements versus pavement length at a scale of at least one inch (25 mm) equals 300 feet (90 m).

(5) be capable of consistently repeating friction averages throughout the friction range on all types of pavement surfaces. Friction averages for each 500-foot (150 m) segment located on the pavement surface must be within a confidence level of 95.5 percept, or two standard deviations of ±.06 Mu numbers.

(6) contain a self-wetting system that distributes water in front of the friction measuring wheel(s) at a uniform depth of 0.04 inch (1 mm). The manufacturer shall provide documentation to show that the flow rate is within a tolerance of ±10 percept for both test speeds.

(7) be able to conduct friction surveys at speeds of 40 and 60 mph (65 and 95 km/hr.), within a tolerance of ±3 mph (±5 km/hr.).

(8) include a complete set of the latest operation and maintenance manuals including guidelines for training airport personnel. The training manuals shall include the current copy of this AC.

(9) have electronic instrumentation (solid-state electronics), including a keyboard for data entry, that will enhance the information gathering and analysis capability of the equipment, and provide the operator more convenience in equipment operation and performance. The information gathered during a friction survey should be stored in an internal microprocessor memory and be readily visible to the operator of the vehicle. This will allow for the examination of data, printouts, and calculation of average friction values over all or any portion of the test run. Each printout of the chart produced by the microprocessor unit shall include the following recorded information: runway designation and date; time of friction survey; a continuous trace of the friction values obtained for the entire runway length minus the acceleration/deceleration distances; printed marks depicting each 100 foot (30 m) increment of the runway length so easy reference can be made by the operator in identifying specific areas on the runway pavement surface; average friction value for 500 foot (150 m) and one-third segments of the runway length as preselected by the operator; and average vehicle speed for that segment.

b. The vehicle shall:

(1) be able to conduct friction surveys at speeds of 40 and 60 mph (65 and 95 km/hr.), within a tolerance of ±3 mph (±5 km/hr.). The vehicle, when fully loaded with water, shall be capable of accelerating to these speeds within 500 and 1000 feet (150 and 300 m) from the starting position, respectively.

(2) be equipped with electronic speed control.

(3) conform to the requirements, Painting, Marking, and Lighting of Vehicles used on an airport and also for airfield service vehicles.

(4) be equipped with transceiver(s) necessary for communication with airport operations and air traffic control.

(5) be equipped with a water tank constructed of strong lightweight material, of sufficient capacity to complete a friction survey on a 14,000 foot (4,267 m) runway in one direction and all necessary accessories to deliver the required water flow rate to the friction measuring wheel(s).

(6) be equipped with appropriate heavy-duty shock absorbers and heavy-duty suspension to adequately handle imposed loads.

(7) be equipped with a device that will regulate the water flow within the confines of the vehicle near the driver's position. Where flow regulation is automatic, no device is required in the vehicle.

(8) be equipped with internally controlled spotlights on each side of the vehicle. For trailer mounted equipment, the tow vehicle shall also be equipped with at least two floodlights mounted such that the friction measuring device and rear portion of the tow vehicle is illuminated to a level of at least 20 foot-candles within an area bounded by lines 5 feet (2 m) on either side of the friction measuring device and 5 feet (2 m) in front of and behind the friction measuring device.

(9) be equipped with an air conditioner when specified by the purchaser.

2. TIRE PERFORMANCE STANDARD. The friction measuring equipment shall be furnished with measuring tires which are designed for use in conducting friction surveys and which meet ASTM standard E670, E-5551, or E-1844, as appropriate. No ribbed (blank) tire(s) shall be used to eliminate the effect of tire tread wear and provide greater sensitivity to variations in pavement surface texture. The tires shall be furnished with split rims and the tubes shall have curved valve stems. The manufacturer of the friction equipment shall provide the airport user with a calibrated pressure dial gauge.

APPENDIX 2

APPROVED CFME AND PROVIDERS

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APPENDIX 3.

TRAINING REQUIREMENTS OUTLINE FOR CFME

1. GENERAL DISCUSSION. The following paragraph lists the major items, which should be considered in developing a training program for airport personnel responsible for operating and maintaining CFME. Whenever a major change in equipment design occurs, the training and instruction manuals should be revised. A document titled *Training and Instruction Manual* should always be provided to the airport personnel by the manufacturer and kept updated.

2. TRAINING REQUIREMENTS OUTLINE.

a. Classroom Instruction.

(1) Purpose of Training Program.
(2) General Discussion on BCAR 14 Regulations
(3) General Discussion on Pertinent ACs.
(4) General Discussion on Pertinent ASTM Standards.
(5) General Overview of Program.
(6) Review of Requirements in this AC

(i) Coefficient of Friction Definition.
(ii) Factors Affecting Friction Conditions.
(iii) ASTM Standards for CFME.
(iv) ASTM Standards for Friction Measuring Tires.
(v) Operation of CFME.
(vi) Maintenance of CFME.
(vii) Procedures for Reporting Friction Numbers.
(viii) Preparation and Dissemination of NOTAMS.

(7) Orientation to the Calibration, Operation, and Maintenance of CFME.

(i). Field Experience. Operation and Maintenance of CFME.
(ii). Testing. Solo Test and Written Examination on All Items covered in course.
(iii). Award of Training Certificate.