



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

MAY 12 2004

FROM: HQ AFCESA/CESC
139 Barnes Drive Suite 1
Tyndall AFB FL 32403-5319

SUBJECT: Engineering Technical Letter (ETL) 04-10 (Change 1): Determining the Need for Runway Rubber Removal

1. Purpose. This ETL supercedes ETL 02-14, *Determining the Need for Runway Rubber Removal*, 4 September 2002. This ETL provides optional guidance for using continuous friction measuring equipment (CFME) to determine the need for rubber removal on Air Force runways. Currently, the airfield manager visually inspects the runway surface to determine when rubber removal is required. This procedure is subjective and can result in removing rubber too often (friction characteristics are good and markings are visible) or, in some cases, not removing rubber at the proper time. The procedure outlined in this ETL provides an objective basis for determining when rubber should be removed. It is based on procedures currently used by the Federal Aviation Administration (FAA). The procedure should be used only to determine rubber removal requirements; the Air Force Civil Engineer Support Agency (HQ AFCESA) will continue to conduct routine baseline friction characteristics tests.

Note: The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this ETL does not imply endorsement by the Air Force.

1.1. Some bases have CFME available to determine runway condition rating (RCR) values. Other bases or major commands may want to obtain CFME to perform friction testing, or they can contract for these services. Adding friction testing to existing indefinite delivery indefinite quantity (IDIQ) contracts appears to be the most economical approach.

1.2. This ETL provides the minimum requirements for rubber removal. Note that factors other than friction may drive the need for rubber removal, such as the obscuring of airfield markings by excess rubber buildup, or the need for a clean surface before applying markings.

2. Application: Requirements in this ETL are optional. The major command (MAJCOM) civil engineer (CE) should determine if requirements should be implemented. Operational risk management (ORM) procedures as outlined in Air Force Instruction (AFI) 90-901, *Operational Risk Management*, should be considered in determining use of this ETL.

2.1. Authority: Unified Facilities Criteria (UFC) 3-260-03, *Airfield Pavement Evaluation*.

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

2.2. Effective Date: Immediately.

2.3. Ultimate Recipients:

- MAJCOM engineers
- Base civil engineers (BCE)
- Base Airfield Management

2.4. Coordination: MAJCOM pavement engineers.

3. Referenced Publications:

3.1. Air Force:

- AFI 90-901, *Operational Risk Management*, available at <http://www.e-publishing.af.mil/>

3.2. Federal Aviation Administration:

- FAA Advisory Circular (AC) 150/5200-30A, *Airport Winter Safety and Operations*, 1 October 1991, available at <http://www.faa.gov/>
- FAA AC 150/5210-5B, *Painting, Marking, and Lighting of Vehicles Used on an Airport*, 11 July 1986, available at <http://www.faa.gov/>
- FAA AC 150/5320-12C, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, 18 March 1997, available at <http://www.faa.gov/>

3.3. American Society for Testing and Materials (ASTM):

- ASTM E670-94(2000), *Standard Test Method for Side Force Friction on Paved Surfaces Using the Mu-Meter*, available at <http://www.astm.org/cgi-bin/SoftCart.exe/index.shtml?L+mystore+bcnj0112>
- ASTM E1551-93a(1998), *Standard Specification for Special Purpose, Smooth-Tread Tire, Operated on Fixed Braking Slip Continuous Friction Measuring Equipment*, available at <http://www.astm.org/cgi-bin/SoftCart.exe/index.shtml?L+mystore+bcnj0112>
- ASTM E1844-96, *Standard Specification for A Size 10 x 4-5 Smooth-Tread Friction Test Tire*, available at <http://www.astm.org/cgi-bin/SoftCart.exe/index.shtml?L+mystore+bcnj0112>

3.4. International Civil Aviation Organization (ICAO):

- Airport Services Manual, Part 2: *Pavement Surface Conditions*, Doc 9137, Third Edition, 1994, available at <http://www.icao.int/>

3.5. Joint Publications:

- UFC 3-260-03, *Airfield Pavement Evaluation*, available at http://65.204.17.188/report/doc_ufc.html

4. Acronyms and Terms:

AC	– Advisory Circular
AFI	– Air Force Instruction
ASTM	– American Society for Testing and Materials
BCE	– base civil engineer
CE	– civil engineer
CFME	– continuous friction measuring equipment
ETL	– Engineering Technical Letter
FAA	– Federal Aviation Administration
HQ AFCESA	– Air Force Civil Engineer Support Agency
ICAO	– International Civil Aviation Organization
IDIQ	– indefinite delivery indefinite quantity
km/h	– kilometers per hour
MAJCOM	– major command
mph	– miles per hour
Mu	– friction coefficient
NASA	– National Aeronautics and Space Administration
NOTAM	– Notice to Airmen
ORM	– operational risk management
RCR	– runway condition rating
UFC	– Unified Facilities Criteria

5. Background.

5.1. Over time, the skid resistance of runway pavement deteriorates due to a number of factors. The primary factors are: 1) mechanical wear and polishing action from aircraft tires rolling or braking on the pavement, and 2) 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.

5.2. The most persistent contaminant problem is the deposition of rubber from tires of landing jet aircraft. Rubber deposits principally occur on the touchdown areas of runways and can be quite extensive. Heavy rubber deposits can completely cover the pavement surface texture, causing the loss of aircraft braking capability and directional control, particularly when runways are wet. It should be noted that even if the data indicate that friction values are acceptable, rubber deposits might still need to be removed. An example is when rubber deposits obscure markings and/or numerals.

6. Evaluation Criteria.

6.1. Minimum Friction Survey Frequency. Table 1 provides criteria for scheduling runway friction testing for rubber removal. This table is based on an average mix of turbojet aircraft operating on any particular runway. When any runway end has 20 percent or more wide body aircraft (e.g., C-5, C-17, C-141, C-130, KC-10, KC-135) in the total aircraft mix, a higher frequency of testing is required; therefore, the next higher level of aircraft operations in Table 1 should be used to determine the minimum testing frequency. As data are accumulated 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 degraded friction conditions in time to take corrective actions.

Table 1. Friction Testing Frequency

Number Of Daily Minimum Aircraft Landings Per Runway End	Minimum Friction Testing 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

Note: Each runway end should be evaluated separately (e.g., Runway 18 and Runway 36).

6.2. CFME – General.

6.2.1. Performance Standards. Attachment 1 contains the performance specifications for CFME.

6.2.2. Qualified Product List. The equipment listed in Attachment 2 has been tested and meets FAA standards for CFME for use in conducting maintenance friction tests. For future updates to this listing, check the FAA website at: http://www.airweb.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/MainFrame?OpenFrameSet

6.2.3. Training. 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 operators maintain a high level of proficiency. Experience has shown that unless this is done, personnel will lose touch with new developments

on equipment calibration, maintenance, and operating techniques. A suggested training outline for CFME operators is provided in Attachment 3. Testing personnel should be trained not only on the operation and maintenance of the CFME, but also on the procedures for conducting friction surveys. These procedures are provided in paragraph 6.3.

6.2.4. Calibration. Before conducting friction surveys, all CFME should be checked for calibration within tolerances provided by the equipment manufacturer. The CFME self-wetting system should be calibrated periodically to ensure that the water flow rate is 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.

6.3. Conducting Friction Evaluations with CFME.

6.3.1. Preliminary Steps. Friction measurement operations should be preceded by a thorough visual inspection of the pavement to identify inadequacies such as drainage problems, including ponding and groove deterioration, and structural deficiencies. Careful and complete notes should be taken, not only of the CFME data, but of the visual inspection as well. Appropriate communications equipment and frequencies should be provided on all vehicles used in conducting friction surveys, and all personnel should be fully cognizant of airfield safety procedures. Personnel operating 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.

6.3.2. Location of Friction Surveys on Runway.

6.3.2.1. When conducting friction surveys on a runway at 65 kilometers per hour (km/h) (40 miles per hour [mph]), the test equipment operator should begin recording data at the threshold when an adequate overrun with in-ground lighting is present. If the overrun will not allow the operator to accelerate to speed before crossing the threshold, then data should be collected as soon as the vehicle reaches 65 km/h (40 mph). The friction survey should be terminated approximately 152 meters (500 feet) from the opposite end of the runway if the overrun will not allow the operator to use it for deceleration; otherwise, the survey should be terminated at the threshold. When conducting friction surveys on a runway at 95 km/h (60 mph), the operator should begin recording data at the threshold when an adequate overrun with in-ground lighting is present. If the overrun will not allow the operator to accelerate to speed before crossing the threshold, then data should be collected as soon as the vehicle reaches 95 km/h (60 mph). The friction survey should be terminated approximately 305 meters (1000 feet) from the opposite end of the runway if the overrun will not allow the operator to use it for deceleration; otherwise, the survey should be terminated at the threshold. Whatever the test speed, where travel beyond the end of the

runway or overrun could result in equipment damage or personal injury, additional runway length should be allowed for stopping.

6.3.2.2. The lateral location on the runway for performing the test should be 3 and 6 meters (10 and 20 feet) from the centerline. Unless surface conditions are noticeably different on either side of the runway centerline, a test on one side of the centerline, in the same direction that aircraft primarily land, should be sufficient. When both ends of the runway are to be evaluated, however, vehicle runs can be made to record data on the return trip (both ways).

6.3.3. Vehicle Speed for Conducting Surveys. All of the approved CFME in Attachment 2 can be used at either 65 or 95 km/h (40 or 60 mph). The lower speed test determines the overall macrotexture/contaminant/drainage condition of the pavement surface. The higher test speed provides an indication of the condition of the surface's microtexture. A complete survey should include tests at both speeds.

6.3.4. Use of CFME Self-Wetting System. Since wet pavement always yields the lowest friction measurements, testing should mirror such "worst case" conditions. Testing should be conducted with CFME that is equipped with a self-wetting system to simulate wet pavement surface conditions and that provides the operator with a continuous record of friction values along the length of the runway. In these systems, the attached nozzle(s) are designed to provide a uniform water depth of 1 millimeter (0.04 inch) in front of the friction-measuring tire(s). The wetted test surface produces friction values that are most meaningful in determining whether or not corrective action is required.

6.3.5. 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 identifying appropriate corrective actions required for safe aircraft operations. Table 2 depicts the friction values for two classification levels for qualified CFME operated at test speeds of 65 and 95 km/h (40 and 60 mph). This table was developed from qualification and correlation tests conducted at the National Aeronautics and Space Administration's (NASA) Wallops Flight Facility in 1989. See Attachment 2 for contact information for various test devices.

Table 2. Friction Level Classifications For Runway Pavement Surfaces Using CFME with Self-Wetting Systems

Test Device	65 km/h (40 mph)		95 km/h (60 mph)	
	Action Level	Planning Level	Action Level	Planning Level
Airport Surface Friction Tester	0.50	0.60	0.34	0.47
BV-11 Skiddometer	0.50	0.60	0.34	0.47
GripTester Friction Tester	0.43	0.53	0.24	0.36
Mu Meter	0.42	0.52	0.26	0.38
RUNAR (operated at fixed 16% slip)	0.45	0.52	0.32	0.42
Runway Friction Tester (M 6800)	0.50	0.60	0.41	0.54
Safegate Friction Tester	0.50	0.60	0.34	0.47
Tatra Friction Tester	0.48	0.57	0.42	0.52

6.3.6. Evaluation and Maintenance Guidelines. The following evaluation and maintenance guidelines are recommended based on the friction levels classified in Table 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.

6.3.6.1. Friction Deterioration Below the Planning Level (152-meter [500-foot] segment). When the average Mu value on the wet runway pavement surface at both 65 and 95 km/h (40 and 60 mph) is less than the Planning Level but above the Action Level in Table 2 for a distance of 152 meters (500 feet), and both of the adjacent 152-meter (500-foot) segments are at or above the Planning Level, no corrective action is required. These readings indicate that the pavement friction is deteriorating, but that the situation is still within an acceptable overall condition.

6.3.6.2. Friction Deterioration Below the Planning Level (305-meter [1000-foot] segment). When the average Mu value on the wet runway pavement surface in a rubber deposit area at both 65 and 95 km/h (40 and 60 mph) is less than the Planning Level in Table 2 for a distance of 305 meters (1000 feet) or more, the airfield manager should initiate a project to have rubber removed from the affected areas of the runway before the next friction test is scheduled. If low friction is due to factors other than rubber accumulation (e.g., aggregate polishing), the airfield manager should initiate a project to take appropriate corrective measures.

6.3.6.3. Friction Deterioration Below the Action Level. When the average Mu value on the wet pavement surface in a rubber deposit area at both 65 and 95 km/h (40 and 60 mph) is below the Action Level in Table 2 for a distance of 152 meters (500 feet), and both of the adjacent 152-meter (500-foot) segments are below the Planning Level, action should be taken immediately to remove rubber from the affected areas of the runway and a Notice to Airmen (NOTAM) should be issued, warning pilots of the loss in friction. If low friction is due to factors other than rubber accumulation (e.g., aggregate polishing), the airfield manager should initiate a project to take appropriate corrective measures.

6.3.7. Computer Evaluation of Friction Test Data. As required by the criteria in paragraph 6.3.6, a manual evaluation of friction test data can be tedious and prone to human error. A computer program that performs this evaluation is available free of charge and may be downloaded from the FAA Internet site at <http://www.faa.gov/arp/software.htm>. Computer programs to evaluate data can also be obtained from some of the manufacturers of the various CFME.

7. Point of Contact . Recommendations for improvements to this ETL are encouraged and should be furnished to the Pavements Engineer, HQ AFCESA/CESC, 139 Barnes Drive, Suite 1, Tyndall AFB, FL 32408-5319, DSN 523-6334, commercial (850) 283-6334, e-mail AFCESAReachbackCenter@tyndall.af.mil.

JOSUELITO WORRELL, Colonel, USAF
Director of Technical Support

- 4 Atchs
1. Performance Specifications for CFME
 2. FAA-Approved CFME
 3. Training Requirements Outline for CFME
 4. Distribution List

PERFORMANCE SPECIFICATIONS FOR CFME

A1.1. Friction Equipment Performance Standard. The CFME 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 must meet all applicable Federal and state laws and/or regulations for vehicles and/or trailers for use on public highways. The side force friction-measuring device, the Mu Meter, must meet the Standard Test Method given in American Society for Testing and Materials (ASTM) E670-94(2000), *Standard Test Method for Side Force Friction on Paved Surfaces Using the Mu-Meter*. The Standard Test Method for fixed brake slip devices is under preparation by the ASTM Committee.

A1.2. Friction Measuring Equipment. The friction measuring equipment must:

A1.2.1. 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.

A1.2.2. Be designed to sustain rough usage and still function properly, and provide efficient and reliable methods of equipment calibration.

A1.2.3. Be capable of automatically providing the operator with a selection of average friction values for both a 152-meter (500-foot) segment and a one-third segment of runway length. In addition, it must be capable of providing data with which the average friction value for any length of runway can be calculated manually.

A1.2.4. Be capable of producing a permanent trace of friction measurements versus pavement length at a scale of at least 25 millimeters (1 inch) equals 90 meters (300 feet).

A1.2.5. Be capable of consistently repeating friction averages throughout the friction range on all types of pavement surfaces. Friction averages for each 152-meter (500-foot) segment located on the pavement surface must be within a confidence level of 95.5 percent, or two standard deviations of ± 0.06 Mu numbers.

A1.2.6. Contain a self-wetting system that distributes water in front of the friction-measuring wheel(s) at a uniform depth of 1 millimeter (0.04 inch). The manufacturer must provide documentation to show that the flow rate is within a tolerance of ± 10 percent for both standard test speeds (i.e., 65 and 95 km/h [40 and 60 mph]).

A1.2.7. Be able to conduct friction surveys at speeds of 65 and 95 km/h, within a tolerance of ± 5 km/h (± 3 mph).

A1.2.8. Include a complete set of the latest operation and maintenance manuals, including guidelines for training airfield personnel. The training manuals must include a copy of ETL 04-10, *Determining the Need for Runway Rubber Removal*.

A1.2.9. Have electronic instrumentation (solid-state electronics), including a keyboard for data entry, that enhances the information gathering and analysis capability of the equipment and provides 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 must 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 30-meter (100-foot) increment of the runway length so the operator can easily identify specific areas on the runway pavement surface; average friction value for 152-meter (500-foot) segments and one-third segments of the runway length, as pre-selected by the operator, and average vehicle speed for each segment.

A1.3. Vehicle Requirements. The vehicle must:

A1.3.1. Be able to conduct friction surveys at speeds of 65 and 95 km/h (40 and 60 mph), within a tolerance of ± 5 km/h (± 3 mph). The vehicle, when fully loaded with water, must be capable of accelerating to these speeds within 152 and 305 meters (500 and 1000 feet) from the starting position, respectively.

A1.3.2. Be equipped with electronic speed control.

A1.3.3. Conform to the requirements of FAA AC 150/5210-5, *Painting, Marking, and Lighting of Vehicles Used on an Airport*, for airfield service vehicles.

A1.3.4. Be equipped with one or more transceivers necessary for communication with airfield operations and air traffic control.

A1.3.5. Be equipped with a water tank that is constructed of strong, lightweight material, that has sufficient capacity to complete a friction survey on a 4,267-meter (14,000-foot) runway in one direction, and that has all necessary appurtenances to deliver the required water flow rate to the friction measuring wheel(s).

A1.3.6. Be equipped with appropriate heavy-duty suspension to adequately handle imposed loads.

A1.3.7. Be equipped with a device that will regulate the water flow. Unless flow regulation is automatic, the device must be located within the confines of the vehicle, near the driver's position. If flow regulation is automatic, no device is required in the vehicle.

A1.4. Tire Performance Standard. The CFME must be furnished with measuring tires that are designed for use in conducting friction surveys and that meet ASTM standard E670-94, E1551-93a, *Standard Specification for Special Purpose, Smooth-Tread Tire, Operated on Fixed Braking Slip Continuous Friction Measuring Equipment*, or E1844-96, *Standard Specification for A Size 10 x 4-5 Smooth-Tread Friction Test Tire*, as appropriate. Non-ribbed (blank) tires must be used to eliminate the effect of tread wear and to provide greater sensitivity to variations in pavement surface texture. The tires must be furnished with split rims and the tubes must have curved stems. In addition, the manufacturer of the friction equipment must provide the airfield user with a calibrated pressure dial gauge.

FAA-APPROVED CFME

CFME	Company	Contact
Airport Surface Friction Tester	AIRPORT SURFACE FRICTION TESTER INDUSTRIES AB Metallgatan 7 271 39 Ystad SWEDEN	+46 0 411 651 00 FAX: +46 0 411 190 12 E-mail: sales@asft.se
BV-11 Skiddometer	PATRIA VAMMAS, AEC P.O. Box 18, Vammaksentie FIN-38201 Vammala FINLAND	+358 20 4694041 FAX: +358 20 4694250 Web: www.patria.fi
GripTester Friction Tester	FINDLAY, IRVINE, LTD. 42-44 Bog Road, Penicuik Midlothian EH 26 9 BU SCOTLAND	+44 1968 672111 FAX: +44 1968 671237
Mu Meter	DOUGLAS EQUIPMENT LTD Douglas House, Village Road Arle, Cheltenham Gloucestershire GL51 0AB UK	+44 1242 531219 FAX +44 1242 571667 E-mail: spd@douglas-equipment.com
NAC Dynamic Friction Tester (DFT)	NEUBERT AERO CORP. 4105 West De Leon Street Tampa, FL 33609	(727) 538-8744 FAX: (727) 538-8765 E-mail: airportnac.com Web: www.airportnac.com
RUNAR (Runway Analyser and Recorder)	NORSEMETER P.O. Box 125 Bogstadvien 0323 0310 NORWAY	+47 23 20 1270 FAX: +47 23 20 1271
Runway Friction Tester (M 6800)	DYNATEST CONSULTING, INC. (Formerly K. J. Law Engineers, Inc.) 13953 U.S. Highway 301 South Starke, FL 32901	(904) 964-3777 FAX: (904) 964-3749
Sarsys Friction Tester	SCANDANAVIAN AIRPORT AND ROAD SYSTEMS AB (SFT) Box 31, Sjoviksvagen 4 23121 Trelleborg Sweden U.S./Canada: Tradewind Scientific Ltd.	+46 410 46 110 Fax: +46 410 46 111 Web: www.tradewindscientific.com
Safegate Friction Tester	No Longer Available	
Tatra Friction Tester	No Longer Available	

TRAINING REQUIREMENTS OUTLINE FOR CFME

A3.1. Introduction. Paragraph A3.2 lists the major items that should be considered in developing a training program for the personnel responsible for operating and maintaining CFME. Whenever a major change in equipment design occurs, the training and instruction manuals should be revised. The manufacturer should always provide the personnel with a current training and instruction manual.

A3.2. Training Requirements Outline.

A3.2.1. Classroom Instruction

A3.2.1.1. Purpose of Training Program

A3.2.1.2. General Discussion on Pertinent Air Force Regulations

A3.2.1.3. General Discussion on Pertinent FAA ACs

A3.2.1.4. General Discussion on Pertinent ASTM Standards

A3.2.1.5. General Overview of Program

A3.2.1.6. Review of Requirements in ETL 04-10 and Discussion of Related Topics

- Coefficient of Friction Definition
- Factors Affecting Friction Conditions
- ASTM Standards for CFME
- ASTM Standards for Friction Measuring Tires
- Operation of CFME
- Programming the Computer for Air Force and ICAO Formats
- Maintenance of CFME
- Procedures for Reporting Numbers
- Preparation and Dissemination of NOTAMs

A3.2.1.7. Orientation to the Calibration, Operation, and Maintenance of CFME

A3.2.2. Field Experience: Operation and maintenance of CFME

A3.2.3. Testing: Solo test and written examination on all items covered in the course

A3.2.4. Award of Training Certificate.

DISTRIBUTION LIST

DEPARTMENT OF DEFENSE

Defense Commissary Agency Design and Construction Division 2250 Foulis St., Suite 2 Lackland AFB, TX 78236	(1)	AAFES ATTN: RE-C PO Box 660202 Dallas, TX 75266-0202	(1)
---	-----	---	-----

SPECIAL INTEREST ORGANIZATIONS

Information Handling Services 15 Inverness Way East Englewood, CO 80150	(1)	Construction Criteria Database National Institute of Bldg. Sciences 1201 L Street NW, Suite 400 Washington, DC 20005	(1)
---	-----	---	-----