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Standard Practice for Calculating the International Runway Friction Index[1]

This standard is issued under the fixed designation E2100; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the calculation of the International Runway Friction Index, IRFI, from measurements obtained by local friction-measurement devices[2] on movement areas under winter conditions.

1.2 The IRFI is the international friction index to be used for reporting the friction characteristics of airport movement areas.

1.3 The IRFI reported by this practice is a harmonized value of the pavement friction characteristics.

1.4 The IRFI obtained by using this practice has not been extended to address the braking performance of an aircraft.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are provided for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

E524 Specification for Smooth Tire for Pavement Skid-Resistance Tests

E867 Terminology Relating to Vehicle-Pavement Systems

E1551 Specification for Special Purpose, Smooth–Tread Tire, Operated on Fixed Braking Slip Continuous Friction Measuring Equipment

E1844 Specification for A Size 10 × 4–5 Smooth-Tread Friction Test Tire

E1859 Test Method for Friction Coefficient Measurements Between Tire and Pavement Using a Variable Slip Technique

E1960 Practice for Calculating International Friction Index of a Pavement Surface

3. Terminology

3.1 *Definitions:*

3.1.1 *base surface, n*—the type of surface evaluated; there are four classes (1) bare pavement dry, (2) bare pavement wet, (3) bare compacted snow and (4) bare ice.

3.1.2 *compacted snow, n*—a compressed solid mass of snow, which is sufficiently strong to prevent a normally loaded tire operating in a rolling mode from penetrating to the pavement or breaking up the surface.

3.1.3 *device configuration, n*—a term used to designate the entire test system as used for any friction measurement; it includes type of device (force or torque measurements), tire type, size and inflation pressure, slip ratio, normal load and braking system control mode.

3.1.4 *harmonization, n*—the adjustment of the outputs of different devices used for measurement of a specific phenomenon so that all devices report the same value.

3.1.5 *ice, n*—water with or without contaminants frozen into a continuous solid body with or without cracks.

3.1.6 *IRFI reference device, n*—a particular friction measuring device selected as a benchmark or reference; it is used to calibrate any local friction device to permit master or local friction device values to be converted to IRFI values for selected base surfaces.

3.1.7 *local friction device, n*—a particular friction testing device used at a given location to measure the friction level of selected base surfaces; the friction values evaluated with this device may be harmonized to IRFI values.

3.1.8 *master friction device, n*—a particular friction measuring device selected as a secondary reference that has been calibrated with the IRFI reference device; it is used to calibrate any local friction device to permit local friction device values to be converted to IRFI values for selected base surfaces.

3.1.9 *movement area, n*—that part of the airport (aerodrome) used for take-off, landing and taxiing of aircraft, consisting of the maneuvering area and the apron(s).

3.1.10 For additional definitions, see Terminology E867.

[1] This practice is under the jurisdiction of ASTM Committee E17 on Vehicle - Pavement Systems and is the direct responsibility of Subcommittee E17.21 on Field Methods for Measuring Tire Pavement Friction.

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[2] In Tribology, friction-measuring devices are referred to as Tribometers.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *international runway friction index (IRFI)*—a unified index of friction that is harmonized to the value measured by the IRFI reference device.

4. Summary of Practice

4.1 This practice outlines the procedure for calculating a value designated as the International Runway Friction Index, IRFI. This index is related to the available friction level of the surface. The IRFI for a local friction device is calculated by converting the measured friction value by means of a pre-established empirical relationship using the linear regression method.

4.2 The procedure as contained in this practice is applicable to base surfaces with no more than 25 mm of loose snow or 12 mm of slush.

NOTE 1—Some devices may not be able to measure at these depths.

4.3 The details of the IRFI reference device are given in Appendix X2.1.

4.4 A master friction device shall be a dedicated device used for calibration of local devices and shall not be used in ordinary friction measurement service except when not practical.

5. Significance and Use

5.1 This practice defines and prescribes how to calculate IRFI on aircraft movement areas in winter.

5.2 The local device is calibrated directly or indirectly to the reference device, thereby achieving harmonization of local friction devices to a common unit of measure regardless of the local friction device used.

5.3 The IRFI can be used by airport maintenance staff to monitor the winter frictional characteristics for surface maintenance actions.

6. Measurement Requirements

6.1 The local friction device shall be harmonized by conducting field-testing with the IRFI reference device (see Section 7). The field test shall collect friction data for each surface class for which the local device can be used. When a local friction device has different selectable modes of operation (for example: fixed or variable slip measurement) each mode of operation shall be treated separately.

6.2 The local friction device shall be operated according to the standard test method of the device and the manufacturer's instructions for the device.

6.3 The minimum length of the surface segment that shall be used for producing a friction value shall be equal to 100 m.

6.4 Average surface temperature shall be measured and reported (for runways each third).

6.5 The friction values shall be reported digitally (with separate data series for each segment) in one file for the runway. The file shall have record(s) ordered by segments.

6.6 The operator shall report the surface classes of the segments.

6.7 The local friction device shall be run within the range of speeds for which it was harmonized.

7. Harmonization

7.1 The local device shall be harmonized to report an IRFI by conducting parallel friction measurements on surfaces with the reference device or a master device on surfaces similar to those used to calibrate the master with the reference device. A minimum of 10 surfaces covering a range of 0.1 to 0.7 as measured by the master device shall be included. Harmonization constants shall be determined for the speed at which the device normally operates.

7.2 The master device shall be harmonized by conducting parallel friction tests with the IRFI reference device. All types of surfaces shall be included. A minimum of 35 segments covering a friction range of 0.1 to 0.7 as measured by the IRFI reference device shall be included. The harmonization constants shall be determined at speeds at which the device normally operates. Maintain test speeds within ±3 km/h (1.6 knots, 1.5 mph).

7.3 The measurements with the local friction device and the IRFI reference device or a master reference device shall be taken on a segment within 2 min of each other.

7.4 Linear regressions shall be of the following form (see Eq 1 and Eq 2):

$$FR_{\text{ref}} = A + B \times FR_{\text{master}} \quad (1)$$

$$FR_{master} = a + b \times FR_{local} \quad (2)$$

where:

FR_{ref} = the friction value reported by the reference device,
FR_{local} = the local device measured value, and
A, B = harmonization constants for the master device, and
a, b = harmonization constants for the local device.

The correlation coefficient of the regression and the standard error of estimate shall be reported. Typical values for devices that have been harmonized are given in Appendix X1. These results were for specific local devices that were harmonized during the Joint Winter Runway Friction Program. They are not applicable to other local friction devices or to other test speeds.

7.5 Subsequent measurements made by the local friction device can be harmonized using the regression constants of the device (see Eq 3):

$$\text{IRFI} = A + B \times a + B \times b\ FR_{\text{local}} \quad (3)$$

7.6 Any time the local friction device is recalibrated, new harmonization constants shall be determined. Harmonization of master devices and local devices shall be conducted as frequently as the time stability of the devices mandates.

8. Calculation

8.1 The runway is divided into segments (see Fig. 1). The minimum length of the segment is 100 m and the maximum is one third of the runway length. The harmonized friction value for an individual segment is designated, *irfi* (that is, by italics and lower case). The value, IRFI, for each third of the runway or base surface is computed as a weighted average of *irfi* values as given by Eq 4.