American National Standard

B101.1 Test Method for Measuring Wet SCOF of Common Hard-Surface Floor Materials

Approved October 13, 2009

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Foreword
(This Foreword is not a part of American National Standard ANSI/NFSI B101.1-2009.)

This Standard, through four iterations by the National Floor Safety Institute (NFSI), was further developed by a subcommittee of the NFSI B101 Standards Committee, national in scope, functioning under the procedures of the American National Standards Institute with the NFSI as the ANSI Accredited Standards Developer. This Standard establishes a test method that specifies the procedures and devices used for both laboratory and field testing to measure the wet Static Coefficient of Friction (SCOF) of common hard-surface floor materials.

The B101.1 Standard was originally published as a test method by the NFSI in 2002 under the title NFSI 101-A and has served as the basis of materials testing and product certification under the NFSI’s product certification program. It was the intent of the NFSI to develop a voluntary test method whose purpose is to establish a uniform test method for measuring the wet SCOF of floor coverings, polishes, and walkway coatings.

The National Floor Safety Institute was founded in 1997 with the mission: “To aid in the prevention of slips, trips-and-falls through education, research, and standards development.” The development of the ANSI/NFSI B101.1-2009 Standard is a direct result of the mission of the NFSI answering a recognized need for a walkway measurement methodology.

It is intended that the procedures and performance requirements contained herein will be adopted by affected professionals and property owners as the measurement procedure for determining traction levels that facilitate remediation of walkway surfaces when warranted. Contained as a part of this Standard is an informative appendix that will serve to assist the user in developing a comprehensive floor safety assurance program.

Neither the B101 Standards Committee, nor the accredited Standards developer perceive that this Standard is perfect or in its ultimate form. It is recognized that new developments are to be expected, and that revisions of the Standard may be necessary as the combination of science and art progresses and further experience is gained. The Committee does believe, however, that the Standard in its present form provides performance requirements necessary in developing and implementing a comprehensive floor safety assurance program.

Suggestions for improvement of this Standard will be welcome. They should be sent to the National Floor Safety Institute, P.O. Box 92607, Southlake, TX 76092.
This Standard was processed and approved for submittal by the NFSI B101 Committee on Safety Requirements for Slip, Trip and Fall Prevention. Committee approval of the Standard does not necessarily imply that all Committee members voted for its approval. At the time it approved this Standard, the B101 Standards Committee had the following members:

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Artech Testing, L.L.C.
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Building Services Magazine
Carpet and Rug Institute (CRI)
Center for Disease Control (CDC)
Cerny & Ivey Engineers, Inc.
Consolidated Safety
Consumer Product Safety Commission (CPSC)
Daimler Chrysler Corp.
Dal-Tile Corporation
Fleisher Forensics

Heavyweight Solutions
Institute of Inspection, Cleaning and Restoration (IICRC)

ISSA- The Worldwide Cleaning Industry Association
Jessup Manufacturing
Ludlow Composites Corporation
Marble Institute of America (MIA)
Maximum Floor Safety
Murray State University
National Floor Safety Institute (NFSI)
National Safety Council (NSC)
Nu-Safe Floors
Procter & Gamble
Professional Safety Consultants
Regan Scientific Instruments

Safety Management Consultants

Safety Systems America
SAM’s Club/Wal-Mart Corporation
State Farm Insurance Company
Stone Peak Ceramics
Tile Council of North America (TCNA)
Traction Auditing L.L.C.
U.S. Department of Labor (OSHA)

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Section 1: Scope/Purpose/Application/Exception

1.1 Scope

This test method specifies the procedures and devices used for both laboratory and field testing to measure the wet static coefficient of friction (SCOF) of common hard-surface floor materials.

1.2 Purpose

This test method provides a measurement procedure setting forth traction ranges that facilitate remediation of walkway surfaces when warranted.

1.3 Application

This test method does not apply to carpeting of any type or mechanically polished tile such as polished porcelain, marble, etc., but does address the common hard-surfaced flooring materials such as ceramic tile, vinyl floor coverings, and wood laminates, as well as coatings, polishes, etc.

Note: This test method does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. No express or implied representation or warranty is made regarding the accuracy or significance of any test results in terms of slip resistance.

1.4 Exceptions

This test method is not recommended for dry-surface testing and does not propose to be an accurate measurement method for determining dry-surface slip resistance. Dry-surface test data should not be compared to wet-surface data. No inferences should be implied or concluded regarding dry vs. wet SCOF test results or data.

Section 2: Reference to other Standards and Publications

ASTM D2240-05 Standard Test Method for Rubber Property—Durometer Hardness

Section 3: Definitions

3.1 Friction. Resistance to the relative motion of two solid objects in contact. This force is parallel to the plane of contact and is perpendicular to the normal force.

3.2 Grout Joint. The space between two (2) or more pieces of tile. This space may be filled or unfilled.

3.3 Grain. A characteristic of many natural materials such as wood that may exhibit directional bias as it relates to slip resistance.
3.4 **High-Traction.** The physical property of a floor or walkway surface that is designed to mitigate slipping during normal human ambulation by providing a reasonably sufficient level of available contact friction.

3.5 **Neolite®.** A laboratory-grade standard testing material. The test contact material for this test method shall be Neolite® material that has an average Specific Gravity of 1.27 +/- .02 as determined by ASTM D297, and an average Shore A Hardness of 93 – 96 as determined by ASTM D2240 test methods. The test surface of the Neolite® material shall be maintained as to prevent buildup of contaminants that may affect the SCOF test results. The Neolite® test material must be soaked in distilled or de-ionized water for a minimum of five minutes before testing commences.

3.6 **Slip Resistance.** The property of a floor or walkway surface that acts in sufficient opposition to those forces and movements exerted by a pedestrian under all normal conditions of human ambulation.

3.7 **Static Coefficient of Friction (SCOF).** The ratio of the horizontal component of force applied to a body that just overcomes the resistance to slipping to the vertical component of the weight of the object or force applied.

3.8 **Static Friction.** The resistance opposing the force required to start the movement of one surface on or over another.

3.9 **Test Area.** The physical space required for the testing apparatus to perform its primary function.

3.10 **Traction.** The friction between the sole material of a shoe and the fixed surface it moves upon.

3.11 **Tribometer.** An instrument or device specifically designed to measure the available level of traction upon a floor or walkway surface.

**Section 4: Test Procedure**

This test procedure may be conducted using any recognized tribometer designed to measure the wet static coefficient of friction (SCOF) of a floor or walkway surface under anticipated use. Materials that are not anticipated to be used as a walkway surface are excluded from this test method and include: sand or gravel beds, stones, rough asphalt, any cloth or textile materials, or any surface that would inhibit the normal operation of the recognized testing device.
4.1 Testing Device
The tribometer manufacturer’s operating and calibration directives shall be followed. If an apparent conflict should arise between this document and the recognized tribometer operating instructions, the tribometer operating instructions shall prevail.

4.2 Measuring the Wet SCOF of Uninstalled Flooring Material (Lab Procedure)

4.2.1 Clean the test surface with de-ionized or distilled water. Wipe dry with a lint-free cloth or untreated paper towel. Avoid contamination of test surfaces by fingerprints, chemicals, dust, etc. Do not use “low-lint.” or “lint-free” towels, as they may contain chemicals that can affect the SCOF test results.

4.2.2 Wet the test surface with distilled or de-ionized water. Follow the tribometer manufacturer’s operating instructions for performing wet SCOF testing.

*NOTE: The test surface of the Neolite material shall be maintained as to prevent buildup of contaminants that may affect the SCOF test results. The Neolite test material must be soaked in distilled or de-ionized water for a minimum of five minutes before the testing procedure begins.*

4.2.3 Place the measuring device on the test surface and conduct the test in one direction. Record the average SCOF value.

4.2.4 Rotate the device 180 degrees and conduct the test in the second direction. Record the average SCOF value.

4.2.5 Rotate the test surface 90 degrees, place the device on the tiles and conduct the test in the third direction. Record the average value.

4.2.6 Rotate the device 180 degrees and conduct the test in the fourth direction. Record the average SCOF value.

*NOTE: Additional de-ionized water may be applied to the test surface as needed.*

4.2.7 The average of the four (4) measurements is the result for the surface.

4.2.8 Repeat the four (4) measurements on three (3) separate tiles or test areas.

4.2.9 Record the final SCOF test results.

4.3 Measuring the Wet SCOF of Installed Flooring Material (In-Situ Procedure)

**Test Area**
The floor/walkway surface area to be tested must be spacious enough to fully accommodate the normal operation of the testing device without restriction. Effort should be made to test each sample area using a minimum of two directions, 90 degrees apart; often referred to as an “X-Y”

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1 The NFSI should be informed of the conflicting procedures or instructions.
pattern. If possible, one of the tests should be performed in the direction of normal pedestrian traffic. If a situation exists where both X-Y test directions prove impossible to perform, (such as a stairway step) the final test report should indicate the restricted test area. In no instance should a testing device be modified or manually “helped” to compensate for a difficult situation. This prohibition may include, but is not be limited to, pushing, pulling, lifting, tilting, or other such manipulation methods. When testing on tiled floors, whenever possible, every attempt should be made to avoid testing directly on grout joints.

The test surface of the Neolite material shall be maintained as to prevent buildup of contaminants that may affect the SCOF test results. The neolite test material must be soaked in distilled or de-ionized water for a minimum of five minutes before testing commences.

1. Create a wet test path using distilled or de-ionized water of sufficient length and width in accordance with the test device instructions for wet SCOF testing.

2. Place the measuring device on the surface and conduct the test in one direction. Record the resulting SCOF value.

3. Dry the test surface by blotting with a dry lint-free cloth. Use care to not contaminate the surface condition.

4. Check the Neolite testing material for contamination or deformation after each test and recondition per the device manufacturer’s directions if required.

5. Repeat the above procedure at a 90-degree angle from the original test path.

6. Repeat both directional test measurements for each area to be tested.

NOTE: If a test area surface exhibits an obvious directional bias or grain (such as a wood floor tile) the test should be conducted in four (4) directions, ninety (90) degrees apart.

Section 5: Calculations/Data Interpretation

Calculate the test result data in accordance with the testing device manufacturer’s directions. The final test results shall be recorded as SCOF values on a linear scale from 0.00 to 1.00µ.
Table 1.

<table>
<thead>
<tr>
<th>Wet SCOF Value (μ)</th>
<th>Available Traction</th>
<th>Remediation</th>
</tr>
</thead>
<tbody>
<tr>
<td>mμ ≥ 0.60</td>
<td>High Traction</td>
<td>Monitor SCOF regularly and maintain cleanliness.</td>
</tr>
<tr>
<td></td>
<td>- Lower probability of slipping</td>
<td></td>
</tr>
<tr>
<td>0.40 ≤ mμ &lt; 0.60</td>
<td>Moderate Traction</td>
<td>Monitor SCOF regularly and maintain cleanliness. Consider traction-enhancing products and technologies.</td>
</tr>
<tr>
<td></td>
<td>- Increased probability of slipping</td>
<td></td>
</tr>
<tr>
<td>mμ &lt; 0.40</td>
<td>Minimal Available Traction</td>
<td>Seek professional intervention. Consider replacing flooring and/or coating with high-traction products.</td>
</tr>
<tr>
<td></td>
<td>- Higher probability of slipping</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: It is important to note that these categories are not indicative of all possible conditions. There are numerous variables that may add to, or take from, the available traction of any given floor surface. (i.e: type or style of footwear, types and frequency contaminants, pedestrian preoccupation, etc). These ranges were established based on a list of approved tribometers, which were in turn based on a specific set of selection criteria. As such, these values contained in Table 1. have not been validated against the full range of other tribometers. Data produced by tribometers which are not designed to measure wet SCOF do not necessarily correlate to the values listed in Table 1.

Section 6: Test Report

The Test Report shall include as a minimum:
1. types of floor or walkway materials tested
2. location(s) of test areas and sites
3. average values for each area tested
4. description of areas tested (e.g. greasy, always wet, dusty, damaged tile, etc.)
5. copies of test results
6. signature of auditor/technician.

Section 7: Safety and Environmental Information

7.1 Potential Hazards in Test Area Vicinity

Never leave a test area unattended. People may trip over objects left in the test area, even if they are obvious. Always wipe dry the residual water left on a floor or walkway after each test, even if you plan on returning shortly. It is recommended to place a safety cone, barrier, or sign alerting personnel to the situation.
7.2 Testing Environment

The tribometer manufacturer's instructions or procedures regarding temperature and humidity requirements for the proper operation and storage of the device shall be followed. Conduct SCOF wet testing in the environmental conditions that are regarded as normal for the test area.

User Notes:
Appendix A
(Informative)

Note: To provide additional data/information, this appendix offers significant reference materials. The documents and Standards herein, while in the broad subject area of slips, trips and falls, are not in the exact context or scope of the B101 Standards series, but do suggest authoritative citations for this field of injury prevention. This appendix is not a part of the Standard and is for informational purposes only.


Effective August, 31, 2010 replaces previous version dated November 30, 2009

Q: What does it mean when the standard says the tribometer must be “approved” or “recognized”? By whom must the tribometer be “approved”? What is the difference between “approved” and “recognized”?

A: An approved tribometer is one that is in compliance with the criteria set forth by the National Floor Safety Institute’s (NFSI) Tribometer Selection Process (TSP). For information on the NFSI’s TSP please visit: www.nfsi.org

A recognized tribometer is one that, while not approved by the NFSI, is capable of measuring wet static coefficient of friction (SCOF) within the ranges listed in Table 1 of the ANSI/NFSI B101.1-2009 standard, and used with a reference calibration tile. The reference calibration tile must be measured before the surface of interest according to the procedure below and a calibration factor determined to calibrate tribometer readings to a known reference value.

The reference calibration tile, available from NFSI or Tile Council of North America, has a known value of 0.50 (NFSI calibration tile) or 0.52 (TCNA calibration tile), and the resulting calibration factor must be no more than ±0.05. The calibration procedure is as follows:

1. Follow tribometer manufacturer’s instructions for reconditioning the sensor.

2. Clean the calibration tile surface with de-ionized or distilled water. Wipe dry with a lint free cloth or untreated paper towel.

3. Saturate the calibration tile with de-ionized or distilled water.

4. Make a total of four static measurements, each perpendicular to the previous measurement.

5. Calculate the calibration factor as follows: \( X_w = 0.50 - C_w \) (when using the NFSI calibration tile) or \( X_w = 0.52 - C_w \) (when using the TCNA calibration tile) where \( X_w = \) calibration factor and \( C_w = \) average of the four measurements recorded.

6. Once measurements of the surface of interest are made use the following equation to calculate wet static coefficient of friction: \( F_w = T_w + X_w \) where: \( F_w = \) static coefficient of friction, \( T_w = \) average of measurements recorded for the test sample, and \( X_w = \) calibration factor

**NOTE:** Only those devices that are capable of measuring wet SCOF within the ranges listed in Table 1 and within the specified reference calibration tolerance shall be recognized for use under this standard.
NFSI Tribometer Selection Process (TSP)

An NFSI “Approved Tribometer” is one that is determined by the NFSI Technical Review Committee to have met the following criteria:

1. Demonstrate laboratory accuracy of the device through submission of:
   - Statement of Precision (per ASTM E-177-08, ASTM E-691, or equivalent)
   - Statement of Bias (per ASTM E-177-08, ASTM E-691, or equivalent)

   The Statement of Precision will include published Repeatability (r) and Reproducibility (R) limits. The statements must be based on an Inter Laboratory Study (ILS) whose design fulfills the requirements covered in the NFSI ILS Guideline (below).

2. Demonstrate the field accuracy of the device through a verification process utilizing an NFSI Certified reference calibration tile.

3. The tribometer manufacturer shall be capable of providing calibration, repair, maintenance, revision control, and other services necessary to ensure device reliability.

4. The device shall be capable of measuring Static Coefficient of Friction (SCOF) to the hundredths (2 decimal places) using a scale of 0.00 to (at least) 1.00.

5. SCOF measurements shall be displayed via a digital display.

6. Pending the final and full release of the ASTM F13 WK6587 – Standard Practice for Validation and Calibration of Walkway Tribometers using Reference Surfaces, The Technical Review Committee intends to add the related Validation Report and Calibration Report to this list of mandatory approval criteria.
NFSI Inter-Laboratory Study  
(ILS) Guideline Overview

This ILS guideline was developed for the specific purpose of evaluating the laboratory accuracy of portable tribometers.

Structure

<table>
<thead>
<tr>
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<th>Repeatability (r) Conditions</th>
<th>Reproducibility (R) Conditions</th>
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<tr>
<td>Laboratory</td>
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</tr>
<tr>
<td>Operator Skill Level</td>
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<td>• Average</td>
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<tr>
<td></td>
<td>• Skillset</td>
<td>• Skilled</td>
</tr>
<tr>
<td>Device</td>
<td>same</td>
<td>4 Different**</td>
</tr>
<tr>
<td>Test Material</td>
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<td>4 Different Reference Surfaces</td>
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<tr>
<td>Environmental Conditions</td>
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<td>normal/wet or dry</td>
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<tr>
<td>Interval</td>
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<td>Not specified</td>
</tr>
<tr>
<td>Expression</td>
<td>Probability Value 95%</td>
<td>Probability Value 95%</td>
</tr>
</tbody>
</table>

* Within same day

** Four uniquely serialized units of the same design.