

AFSA FS101-25

AMERICAN FLOOR SAFETY ALLIANCE STANDARD METHOD FOR SLIP RESISTANCE TESTING
USING THE BRITISH PENDULUM



AFSA FS101-25

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This standard represents the authoritative benchmark in the science of pedestrian surface safety. Developed and ratified by the American Floor Safety Alliance (AFSA), this document is not merely a guideline—it is a mandate for those who demand quantifiable, verifiable, and enforceable safety performance from flooring systems.

The AFSA is a coalition of leading national and international authorities in slip resistance testing, tribometry, forensic engineering, human biomechanics, surface chemistry, and safety compliance auditing. Our members are not theorists—they are field practitioners, litigation experts, and standards architects responsible for raising the bar on slip-and-fall prevention across commercial, institutional, and public environments.

This standard provides rigorous, evidence-based criteria for the selection, testing, and maintenance of pedestrian surfaces, including but not limited to ceramic tile, natural stone, resilient flooring, composite systems, and coatings. It addresses both new construction and in-service performance, under real-world conditions—wet, dry, contaminated, inclined, and worn.

Consensus approval by the AFSA confirms that this document is the product of exhaustive technical scrutiny. While not every member may agree with every clause, the standard embodies the collective expertise and professional integrity of the most qualified minds in walkway safety.

This is not a check-the-box compliance tool. It is a performance-driven framework for preventing injury, reducing liability, and raising expectations for slip resistance in the built environment. Adoption of this standard is not only a matter of best practice—it is a matter of moral and professional responsibility.

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Disclaimer

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AFSA FS101-25 - Pendulum Slip Resistance Test Standard

1 SCOPE

- 1.2 This standard specifies the procedure for determining the slip resistance of pedestrian surface materials using a pendulum-type friction tester. The method is suitable for laboratory and field evaluations.
- 1.3 This method is applicable to:
 - 1.3.1 Newly manufactured pedestrian surface materials and flooring installed in situ.
 - 1.3.2 A broad range of surfaces, including both hard materials (e.g., porcelain tile, natural stone, concrete) and resilient surfaces (e.g., vinyl, laminate, hard coatings).
 - 1.3.3 Roadway surfaces, when tested using the softer TRL rubber slider in accordance with established highway friction measurement protocols.
- 1.4 The test provides quantifiable slip resistance data to assist stakeholders—such as architects, specifiers, manufacturers, building owners, and legal professionals—in evaluating pedestrian surface safety and in selecting appropriate surface materials. The data may also be used to inform corrective actions where insufficient traction is identified.

2 DEFINITIONS

- 2.2 **Pendulum Friction Tester:** An instrument designed to measure the dynamic coefficient of friction of pedestrian surfaces. It consists of a spring-loaded rubber slider affixed to a freely swinging arm. Upon release, the arm contacts the test surface and decelerates over a defined travel distance, producing a measurable result. To ensure accuracy, all pendulum testers must be verified using reference calibration surfaces before each day's testing. Instruments of inferior manufacture—particularly some imported variants may be non-compliant with calibration standards and should be avoided.
- 2.3 **Slider:** A standardized rubber element of specified hardness used to contact the test surface. The Four S (which means “standard shoe sole simulating”) rubber should have an International Rubber Hardness Degree of 96 +/-2. A soft TRL (Transport and Road Laboratories) rubber, should have an IRHD of 55 +/-5. The soft rubber is used for barefoot areas, but areas which can expect both sole types (shod and barefoot) should be subject to testing with both, the hard and soft rubber sliders.

- 2.4 **Pendulum Test Value (PTV):** The measured value resulting from the deceleration of the pendulum arm after the slider contacts the surface for 125-127mm (approximately 5 inches).
- 2.5 **Wet test:** Test performed with a distilled water applied generously to the test surface. Research has shown that the amount of water applied makes no difference, but the area being tested should be considered “saturated” with distilled water.
- 2.6 **Dry test:** Test performed with the surface free of water.

3 APPARATUS

3.2 Pendulum Friction Tester

- 3.2.1 The pendulum friction tester shall comply with relevant standards for tribometric evaluation (e.g., ASTM E303, BS EN 13036-4), and must include the following features:
 - 3.2.1.1 A mechanism enabling controlled release of the pendulum arm to ensure repeatable motion.
 - 3.2.1.2 An integrated leveling system (e.g., spirit level and adjustable feet) to maintain horizontal alignment during testing.
 - 3.2.1.3 A calibrated scale capable of displaying Pendulum Test Values (PTV) with a resolution of 1 unit.
 - 3.2.1.4 A stable base or footplate to prevent movement of the apparatus during operation.

3.3 Rubber Sliders

- 3.3.1 Two standardized rubber slider types are permitted, selected based on the intended use environment:
 - 3.3.1.1 **Slider 96 ("Four S" rubber):** A harder rubber compound (IRHD 96 ± 2), simulating standard shod pedestrian traffic.
 - 3.3.1.2 **Slider 55 (TRL rubber):** A softer compound (IRHD 55 ± 5), representing barefoot or soft-soled footwear conditions. It is also employed in roadway friction testing to simulate rubber tire interaction.
- 3.3.2 All rubber sliders shall be certified for hardness compliance by the manufacturer prior to initial use. Sliders must be conditioned and verified per UKSRG or equivalent guidance before testing.

3.4 Surface Preparation and Verification Tools

- 3.4.1 The following materials and instruments are required for surface preparation and apparatus verification:
 - 3.4.1.1 Spray bottle containing distilled water for wet condition testing.
 - 3.4.1.2 Float glass reference surface (calibrated to yield PTV 5–10) for verifying slider functionality.
 - 3.4.1.3 Conditioned tile (e.g., Pavigres tile) with expected PTV of 36 +/- 3 with the Four S #96 Slider.
 - 3.4.1.4 3M pink lapping film (261X, Part No. 51144 / C-PN 7000000282): Used for slider conditioning; expected PTV range 59–64.
 - 3.4.1.5 Microfiber or terry cloth towel for surface drying in dry test conditions.
 - 3.4.1.6 Path-length ruler (typically supplied with pendulum tester) for verifying the effective contact length (125–127 mm).

4 TEST SURFACE CONDITIONING

- 4.2 The test surface may be cleaned using a neutral pH detergent, followed by thorough rinsing and drying, if required. However, unless otherwise specified, testing should be conducted in the “as found” condition to reflect actual in-use performance.
- 4.3 For laboratory testing, the test surface must be securely affixed to prevent any movement during the pendulum test procedure
- 4.4 For profiled or textured surfaces, the pendulum arm should be oriented such that the slider impacts the surface in the direction anticipated to yield the lowest Pendulum Test Value (PTV). This is typically diagonal to surface protrusions. For directional materials such as wood, testing should be conducted parallel to the grain or in the direction likely to produce the lowest friction reading.
- 4.5 Where surface directionality is uncertain or under investigation, testing should be conducted in three orientations: parallel, perpendicular, and diagonal relative to the surface features. The resulting PTVs may be averaged. Alternatively, if the surface is homogeneous or directionally consistent, testing may be conducted in a single representative direction.

5 SLIDER PREPARATION AND CONDITIONING

- 5.2 Prior to testing each new surface type, the rubber slider shall be conditioned using 400-grit silicon carbide sandpaper adhered to a rigid backing (e.g., glass or plexiglass). The slider should be

drawn across the sandpaper in a consistent motion, a minimum of three times, or until a uniform and smooth contact edge is achieved. Heavily abraded sliders, such as after road surface testing, may require additional passes. Sandpaper must be securely fixed to the substrate (e.g., with packing tape) to prevent displacement.

- 5.3 Following the dry abrasion process, the slider must undergo wet conditioning. This consists of ten passes across 3M pink lapping film (Product 261X, Part No. 51144, C-PN 7000000282), wetted with distilled water. This step ensures consistent surface energy and contact profile.
- 5.4 Upon completion of slider preparation, proceed with wet testing.

6 PROCEDURES

6.2 Instrument Setup Procedure

- 6.2.1 Prior to testing, the pendulum friction tester must be properly configured as follows:
- 6.2.2 Position the pendulum tester securely on the test surface.
- 6.2.3 Use the instrument's integrated leveling mechanism to ensure the base is horizontally aligned in both axes.
- 6.2.4 With the pendulum arm freely swinging and the slider elevated off the surface, verify that the pointer returns to zero. Adjust friction rings if necessary.
- 6.2.5 Adjust the vertical height of the pendulum such that the rubber slider contacts the surface over a travel length of 125–127 mm, verified using the manufacturer-supplied ruler or gauge.

6.3 Wet Condition Testing Procedure

- 6.3.1 Apply a continuous, uniform film of distilled water across the test area to achieve surface saturation.
- 6.3.2 Perform two preliminary swings (warm-up) to ensure proper contact and consistent movement.
- 6.3.3 Record five consecutive test swings. Calculate and report the mean of these five values as the Wet Pendulum Test Value (PTV).
- 6.3.4 If any test swing produces a result significantly outside the expected range (± 5 PTV from the mean), discard and repeat testing until five consecutive values are within the specified tolerance.

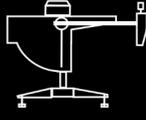
6.4 Dry Condition Testing Procedure

- 6.4.1 Confirm that the slider and test surface is dry and free of dust, debris, or residue.
- 6.4.2 Conduct two warm-up swings as per wet testing.
- 6.4.3 Perform five consecutive swings and compute the average PTV as the Dry Pendulum Test Value.
- 6.4.4 If the spread between the highest and lowest recorded values exceeds 5 PTV, continue testing until five consecutive values fall within this range.
- 6.4.5 Dry condition results are typically supplementary and not required unless specified. Their use is to indicate maximum potential slip resistance under ideal conditions. As most slip incidents occur in wet or contaminated conditions, dry PTVs are not indicative of real-world risk.
- 6.4.6 For dusty surfaces, only the first swing is to be recorded, as subsequent swings will alter the test area by removing surface dust. This single reading shall be reported as the dry PTV.

7 CALCULATION OF RESULTS

- 7.2 Record all five individual values used to calculate the average.
- 7.3 Record the average pendulum test value.
- 7.4 Record slider type used.
- 7.5 Record the surface condition (wet or dry).
- 7.6 Record the test temperature and humidity.
- 7.7 Record the pendulum calibration due date.

8 SLIP RESISTANCE CLASSIFICATION

 AFSA FS101-25 PENDULUM SLIP RESISTANCE TEST METHOD 	
High Slip Potential	0-24
Moderate Slip Potential	25-35
Low Slip Potential	36-54
Very Low Slip Potential	≥55

9 TEST REPORT REQUIREMENTS

9.2 A test report shall include:

- 9.2.1 Product identification (flooring name, batch, type, manufacturer, if available).
- 9.2.2 Slider type and hardness.
- 9.2.3 Full set of five readings used to determine the average, and the final mean PTV.
- 9.2.4 Test conditions (temperature, humidity).
- 9.2.5 Pendulum calibration due date.
- 9.2.6 Whether test was done wet, or done in wet and dry conditions, and recorded as such.
- 9.2.7 Location of test.
- 9.2.8 Test method used – AFSA FS101-25.
- 9.2.9 Name of testing agency and relevant contact information.
- 9.2.10 Sample size (typically for lab testing only).
- 9.2.11 When sample obtained by lab (for lab testing only).
- 9.2.12 Test number and date tested.
- 9.2.13 A photo or photos (general area tested, and closeup of surface, for instance) of surface tested. For lab testing, it is sometimes helpful to photograph the back of the sample as well for identification purposes.

10 CONSIDERATIONS

10.2 Slider Handling and Contamination

- 10.2.1 Rubber sliders must be handled with care to avoid contamination. Sliders exposed to substances other than distilled water—including but not limited to motor oil, hydraulic fluid, or food grease—must be discarded following use, as such contaminants can permanently alter friction characteristics.

10.3 Slider Certification and Expiry

- 10.3.1 Each slider shall be supplied with a manufacturer's test certificate verifying compliance with material and hardness specifications. Sliders must be removed from service if:
 - 10.3.2 Both contact edges exceed 4 mm in width, or
 - 10.3.3 Two years have passed since the date of the manufacturer's certificate.It is recommended that the disposal date be marked directly on the slider's backing plate for clear reference.

10.4 Pendulum Calibration Requirements

- 10.4.1 The pendulum friction tester must be calibrated annually by a qualified calibration laboratory.

10.5 Temperature Correction for TRL Rubber (Slider 55)

- 10.5.1 The softer TRL rubber is sensitive to ambient temperature variations. When testing outside the 64–73 °F (18–23 °C) reference range, apply the following PTV corrections



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TEMPERATURE CORRECTION FOR TRL SLIDER 55



Temperature (°F)	Correction (PTV)
<32°	-7
33-36°	-6
37-41°	-5
42-45°	-4
46-52°	-3
53-58°	-2
59-63°	-1
74-80°	+1
81-92°	+2
93-104°	+3

10.5.2 These adjustments compensate for changes in rubber elasticity that can affect measured friction.

10.6 Initial Conditioning of New Sliders

10.6.1 New sliders must be conditioned to create a uniform contact edge before testing:

10.6.2 Perform ten passes across 400-grit sandpaper (mounted to a flat substrate) over a 125–127 mm path.

10.6.3 Recheck and re-adjust the contact path length to 125–127 mm.

10.6.4 Repeat the sanding and adjustment process two more times.

10.6.5 Perform ten passes, wet with distilled water, over pink lapping film (3M 261X).

10.6.6 The slider is now ready for use.

10.7 Testing Profiled Surfaces

10.7.1 When testing profiled or textured surfaces, initiate the pendulum swing such that contact begins on a raised section of the surface, where possible. This improves repeatability and helps identify worst-case slip potential.

10.8 Slope Adjustments for PTV Classification

- 10.8.1 Where flooring has a measurable slope, a correction must be applied to account for the impact of gravity on slip potential:
- 10.8.2 Measure the slope angle in degrees.
- 10.8.3 Calculate the tangent of the slope angle.
- 10.8.4 Add the tangent value to the surface's measured Dynamic Coefficient of Friction (DCOF) *see Appendix B on last page of standard.*
- 10.8.5 Convert the corrected DCOF to a corresponding PTV using the reference chart in Appendix A.
- 10.8.6 Example minimum PTV thresholds for low slip potential (after slope correction):



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SLOPE ANGEL REQUIREMENT FOR LOW SLIP POTENTIAL (36 PTV)

Slope Angle	Minimum PTV Requirement
2°	38
4°	39
6°	41
8°	43
10°	44

This ensures that surfaces on an incline are assessed against appropriate slip resistance criteria.

11. Appendix A

		Location or function of area	Minimum wet PTV (or BPN)	
Building or walkway type	Line no.		Hard rubber slider	Soft rubber slider
External sidewalks and ramps	1	External ramps with slopes steeper than 1 in 14 (4.1 degrees)	55	45
	2	External ramps, slopes less than 1 in 14	45	40
	3	Level surfaces: external parking lots, external walkways, pedestrian crossings (including painted crosswalks and speedbumps), balconies, driveways, courtyards, decks	45	40
	4	Parking lots	36	36
Hospitals and assisted-living facilities	5	Bathrooms and bathtubs/showers in hospitals and assisted-living facilities	36	36
	6	Wards and corridors in hospital and aged care facilities	25	20
Hotels, office buildings, public buildings, schools, kitchens; entries and access areas	7	Dry area (such as an office)	12	12
	8	Hotel bathrooms, tubs and showers	36	36
	9	Kitchens	45	40
	10	Restroom facilities in offices, bars and shopping centers	36	36
	11	Serving areas – bars, kitchens, buffet lines	36	36
	12	Freezers in kitchens	45	40
Loading docks	13	Indoor loading docks	55	45
Sports/concert stadiums	14	All areas besides stairs	36	36
Supermarkets and shopping centers	15	Dry areas in shopping centers (canned goods aisles, for instance)	12	12
	16	Fast food outlets, buffets, food courts and fast food dining areas in shopping centers	36	36
	17	Fresh fruit and vegetable areas in supermarkets	36	36
	18	Shop entry areas with external entrances	36	36
Swimming pools and sports facilities	19	Locker rooms	36	36
	20	Showers	36	36
	21	Swimming pool decks	45	40
	22	Swimming pool ramps and stairs leading to water	55	45
Stairs	23	Dry stairs and landings	36	36
	24	Wet stairs and landings	45	40

Table 1. Recommended minimum PTV from the June 2014 Australian standard. The minimum values in this table are both more permissive (values below 36) and more conservative (values above 36) than the CTIOA and UKSRG standards discussed on the previous page. We consider the standard summarized on this page to be the world’s most sophisticated. However, the choice between the two is left to the reader. One area not specifically mentioned above is tubs and showers in hotels and homes. For these high-risk areas, we recommend a surface with “low slip potential”, or a minimum PTV of 36.

12. Appendix B

**Dynamic Coefficient of Friction (DCOF) x 100 to Pendulum Test Value (PTV)
Conversion Table**

DCOF x 100	PTV		DCOF x 100	PTV
1	1		51	48
2	2		52	48
3	3		53	49
4	4		54	50
5	5		55	51
6	6		56	51
7	7		57	52
8	8		58	53
9	9		59	54
10	10		60	55
11	11		61	55
12	12		62	56
13	13		63	57
14	14		64	58
15	15		65	58
16	16		66	59
17	17		67	60
18	18		68	60
19	19		69	61
20	20		70	62
21	21		71	63
22	22		72	63
23	23		73	64
24	24		74	65
25	25		75	65
26	26		76	66
27	27		77	67
28	28		78	68
29	29		79	68
30	30		80	69
31	31		81	70
32	32		82	70
33	32		83	71
34	33		84	72
35	34		85	72
36	35		86	73
37	36		87	74
38	37		88	74
39	38		89	75
40	39		90	76
41	39		91	76
42	40		92	77
43	41		93	77
44	42		94	78
45	43		95	79
46	44		96	79
47	44		97	80
48	45		98	81
49	46		99	81
50	47		100	82

Important Clarification on DCOF and PTV Measurements

Dynamic Coefficient of Friction (DCOF) values obtained from tribometers such as the BOT-3000E, and Pendulum Test Values (PTV) from the British Pendulum Tester (ASTM E303), are *not* interchangeable or directly convertible. While both are measures of slip resistance, they arise from fundamentally different test methods, devices, sensor materials, and dynamic mechanics.

Efforts to convert PTV to DCOF—or vice versa—are not scientifically reliable and can lead to misleading conclusions. Each method uses different contact materials, swing dynamics, and test surface interactions. For example:

- The British Pendulum Tester mimics a realistic slip by swinging a rubber foot across a surface to measure resistance, particularly effective in simulating hydrodynamic effects from contaminants.
- The BOT-3000E, measures DCOF using a motorized test foot and calculates average resistance over a sliding distance. The test parameters, including force, speed, and rubber hardness, differ significantly from pendulum methodology.

Even within DCOF measurements, results vary between tribometers (e.g., English XL vs. BOT-3000E) due to test foot materials, calibration standards, and operator variability. No single correlation formula exists that can accurately translate values between these systems.

In practice, only in-situ testing with the appropriate tribometer can provide meaningful results for a given standard. Converting results as if testing with a Pendulum is equivalent to testing with the BOT-3000E or a ramp test is not technically defensible and should be avoided in compliance documentation, litigation support, or risk analysis.