



## Engineering Sciences Section - 2015

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### D19 A Test Program to Validate a Step Meter Using Neolite® Test Liner (NTL) as a Test Foot per the ASTM F-2508 Protocol

*Mark I. Marpet, PhD, PE, 14 Cowie Road, Chester, NJ 07930-9715; Marcus P. Besser, PhD, Pennsylvania State University Abington College, 1600 Woodland Road, Abington, PA 19001-3900; and Howard P. Medoff, PhD\*, Pennsylvania State University, 1600 Woodland Road, Abington, PA 19001*

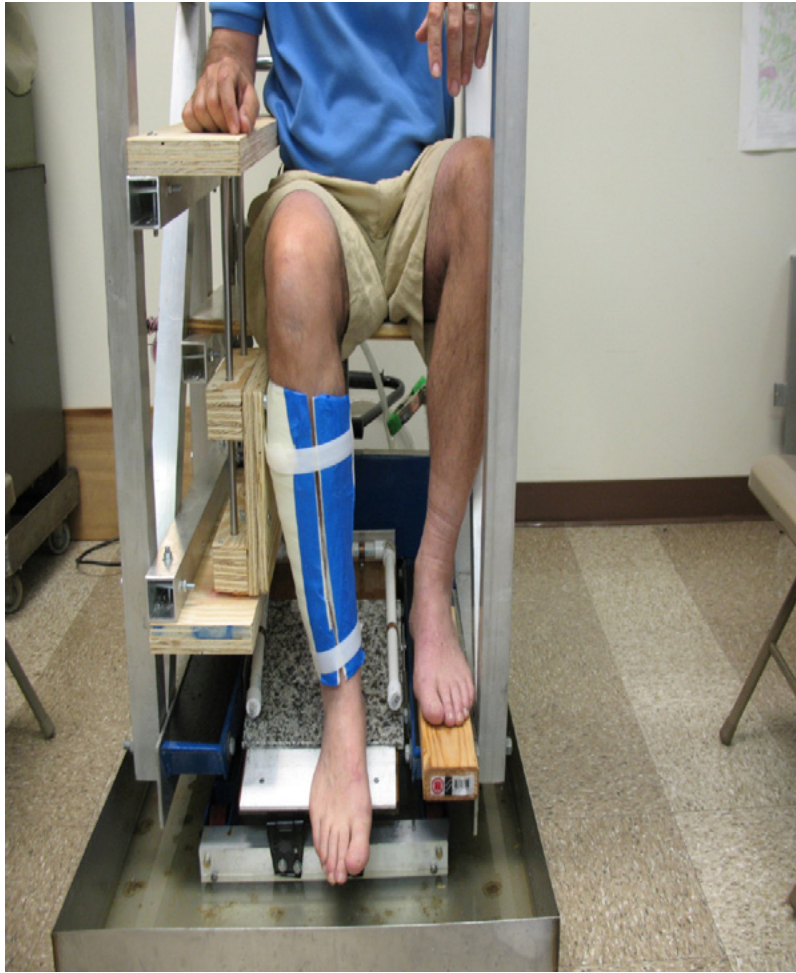
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After attending this presentation, attendees will understand the steps needed to validate a new tribometer under the American Society for Testing and Materials (ASTM) F2508.

This presentation will impact the forensic science community by showing how tribometer validation, important under the *Daubert* and *Frye* court decisions, can be accomplished.

ASTM committee F13 (Pedestrian/Walkway Safety and Footwear and Walkway Safety) is charged with developing standards and procedures to increase pedestrian-ambulation safety. “A primary focus of the Committee is the measurement of slip resistance” (ASTM F13). To that end, over the years, this committee has approved specific tribometers (devices to measure on-site slip resistance between flooring and shoe bottoms) (e.g., ASTM F1677 — Portable Inclined Articulated Strut Slip Tester, ASTM F1678 Portable Articulated Strut Slip Tester, and ASTM F1679 — Using a Variable Incidence Tribometer). A number of years ago, each of these standards were withdrawn from active development, mainly because these standards referenced proprietary instruments. Replacing them was a non-proprietary standard (ASTM F2508 — Standard Practice for Validation, Calibration, and Certification of Walkway Tribometers Using Reference Surfaces) to verify the ability of a tribometer to measure the slip resistance (between the floor and test foot.) This standard included four reference surfaces: black granite, porcelain tile, vinyl composition tile, and ceramic tile (with an increasing slip resistance in the referenced order). Essentially, if a tribometer’s test results were ordinally correct (with the test results in same order as the reference surfaces as listed above) and statistically discriminated, the tribometer was “validated” as per ASTM F2508.

**Preliminary Studies:** (1) In a previous study, a step meter (variable inclinable) was developed to compare slip-resistance results of a test subject and a tribometer.<sup>1</sup> The device is similar to a ramp test, except the test subject stood in the device and stepped down (successively) on a test surface that had its inclination increased until a slip occurred. The test results were comparable between the step meter and a Portable Inclined Articulated-Strut Tribometer (PIAST); and, (2) In a later study, the step meter was modified to allow the test subject to remain seated.<sup>2</sup> The test subject’s leg was raised and dropped on a test surface that had its inclination increased until a slip occurred. The leg was constrained to move vertically. This seated configuration for the test subject (as compared to standing) was found to have increased reliability as shown by a steeper logistic-regression curve.



**The Current Experiment:** The goal is to verify that the step meter equipped with a grooved Neolite® Test Liner (NTL) test foot will pass validation under the ASTM F2508 protocol. This same NTL test foot, when used in a PIAST, had been found to meet the ASTM F2508 criteria. The hypothesis is that the step meter-measured available friction will result in these reference surfaces being “placed” in the rank order (section 9.2.1, ASTM F2508) and the differentiation between these surfaces will be statistically different (section 9.2.2, ASTM F2508).

In order to validate (as per ASTM F2508) the seated step meter, it was equipped with an articulated tribometer strut (hinged at the top and dropping vertically) with a grooved NTL test foot, contacting water-wet ASTM F 508 reference surfaces. The surfaces (resting on a bottom plate) could be rotated, changing the orientation between the grooved NTL test foot and these surfaces. The reference surfaces were bathed in a continuous film of water supplied by a recirculating pump. (Triton™ X-100 was not used as a wetting agent on the black granite surface as the test surface was continuously bathed in the water.) The NTL test foot was dropped onto the reference surfaces successively (with the reference surfaces initially horizontal). The reference surface was rotated toward the vertical in small increments until slip occurred.



Figure 2: The Modified (Hybrid) Step Meter.

The articulated strut moves vertically down onto the test surface. The test foot (grooved NTL) is attached to the strut by means of a clip. Water is continuously sprayed onto the test surface by means of PVC drilled tubes (on either side of test surface). The test surface rests on a flat surface (shown in photo). The test surface is “tilted” to provide any angle between the vertical strut and the test surface. The strut “drops” onto an angled, water-wet test surface. When slip occurs, the angle of the test surface is measured.

The testing was conducted as per the ASTM F2508 protocol (10 tests in each of four perpendicular directions). The angle of the reference surface was measured and recorded when the test foot slipped. The results were statistically analyzed as per ASTM F2508.

The results show that this modified step meter, using the ASTM F2508 reference surfaces, was able to differentiate the slip resistance of these surfaces in the proper order, and met the F 2508 criteria for validation of a tribometer.

## Grooved Neolite Test Foot Step Meter Tangent of Slip Angle

	Black Granite	Porcelanosa	OVCT	Ceramic
Mean	0.1801	0.2137	0.403925	0.756625
Std Dev	0.027192	0.02252998	0.03283321	0.053789565
LCL	0.171673	0.20671789	0.39374988	0.739955441
UCL	0.188527	0.22068211	0.41410012	0.773294559



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## References:

1. Medoff H, Brungraber R, Hilferty C, Patel J, Mehta K. 2002. Variable inclinable step-meter: using test subjects to evaluate walkway surface/footwear combinations. In: Marpet MI, Sapienza MA, editors. Metrology of pedestrian locomotion and slip resistance, ASTM STP 1424. West Conshohocken, PA: *ASTM*:51-72.
2. Besser, M., Marpet, M., Medoff, H. 2008 Barefoot-pedestrian tribometry: in vivo method of measurement of available friction between the human heel and the walkway. *Industrial Health National Institute of Occupational Safety and Health*, Japan 46:51-58.

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**Neolite® Test Liner, Daubert, Frye**