# Tiger Deck™

Safety & Health Services

HIGH SAFETY CONSULTING SERVICES, LTD.

# Slip-Resistance Assessment of Tiger Deck™ Hardwood Decking

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**SLIP REISTANCE TESTING REPORT**

Prepared by

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## Project & Results Overview

High Safety Consulting Services, Ltd. was retained to provide slip-resistance testing services of surfaces sold as Tiger Deck™.

Tests were performed in accordance with ASTM F-1679 and the manufacturers' operating guidelines for the English XL Variable Incidence Tribometer (VIT). All testing was performed by a Certified XL Tribometrist. Two sections of material were tested with several sets of dry and wet readings in four cardinal directions. Results where averaged to determine wet and dry slip resistance values.

This surface is a hardwood referred to as Astronium species from the Anacardiacea family. The wood is kiln dried to 8% moisture content. The wood plank is used in decking applications primarily out-of-doors where the presence of water could be expected. The product provided was consisted of three smooth-topped planks approximately 2.3 cm thick with a width of 13.6 cm. The product had a fine grain that ran lengthwise. There was some directional variation in slip-resistance such that cross-grain slip-resistance was improved over readings obtained in the same direction of the grain. This variation was not significant, but can be observed in the data tables.

In summary, the product performed well for slip-resistance in both dry and wet states. A summary of the testing results is presented in the table below:

### Summary of Test Results of Surfaces Tested ASTM 1679

| Surface Tested | Average Dry (COF) | Average Wet (Slip-Resistance Index) |
|---|---|---|
| Tiger Deck ™ | **>0.96** | **0.61** |

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## Laws, Standards, and Consensus Guidelines in Slip-Resistance

The threshold for safety for slip-resistance for walking surfaces has long been established as 0.5. The most commonly referred to federal standards include the Occupational Safety and Health Administration (OSHA) rules and the Americans with Disabilities (ADA) guidelines.

### OSHA

OSHA's proposed a rule in April of 1990 which contained a non-mandatory appendix that specified a walking surface coefficient of friction at 0.5 for those workplaces where lubricating contaminates could make footing hazardous. This standard was never promulgated as law but has been used by many as guidance on slip-resistance requirements.

In 1999, OSHA issued a final rule under the construction regulations. 29 CFR 1926.754 (c)(3) addresses the slip resistance of skeletal structural steel. "Steel workers shall not be permitted to walk the top surface of any structural steel member installed after July 18, 2006 that has been coated with paint or similar material unless documentation or certification that the coating has achieved a minimum average slip resistance of 0.50 when measured with an English XL tribometer or equivalent tester on a wetted surface at a testing laboratory is provided. Such documentation or certification shall be based on the appropriate ASTM standard test method conducted by a laboratory capable of performing the test. The results shall be available at the site and to the steel erector." This standard will represent the most "enforceable" federal standard on slip-resistance. OSHA does not regulate producers or manufacturers' products so the burden will rest with the users to assure their coatings meet the standard. Non-compliant coatings will become legally obsolete for these applications.

Note that OSHA specifically recognizes by name the ASTM 1679 standard to the exclusion of other methods.

### Americans with Disabilities Act

The American's with Disabilities Act guidelines specify a slip-resistance coefficient of friction of 0.6 for surfaces and 0.8 for ramps where they are accessible by the handicapped (ADA 28CFR36 - ATBCB). Again these specifications are recommendations only. Subsequent to the enactment of the ADA, it was determined that the methods used to validate the slip-resistance values was flawed.

The Architectural and Transportation Barriers Compliance Board (ATBCB) was established to assure compliance with the ADA. This group adopted the ADA recommendations as a guideline for surfaces. These guidelines also do not specify a test method.

**Consensus Standards**

Most of the available consensus standards do not specify a particular number for slip-resistance. Instead, they defined methods and equipment for the testing of surfaces. The ASTM D-2047 and UL 410 specify a threshold of safety at 0.50 using the James Machine.

In addition to these guidelines, case law has supported the 0.50 level as an appropriate threshold of safety.

**The 0.50 Level**

Slip hazards do not immediately start at 0.49. A surface that tests at 0.48 or 0.47 does not indicate a surface that has a severe hazard.

Other characteristics of the exposure need to be considered. This guideline (0.50) provides a reasonable level of safety with some margin for safety. Surfaces that change COF or slip-resistance significantly are the most dangerous (an unexpected patch of ice) to a walker. Most people can walk on slippery surfaces if they are aware of the hazard. Levels of below 0.40 begin to be questionable as to the ability of a walker to safely travel on the surface and would be perceived by most as more slippery than typical walking surfaces. In addition, various levels of friction demand are observed with walkers in different age categories.

## Detailed Measurements

Dry testing was performed on September 3, 2003

Environmental Data

Temperature: 76 Degrees F
Relative Humidity: 66%

Dry testing was performed on September 4, 2003

Environmental Data

Temperature: 74 Degrees F
Relative Humidity: 70%

## Material Description and Preparation

This surface tested is a hardwood referred to as Astronium species from the Anacardiacea family. The wood is kiln dried to 8% moisture content. The wood plank is used in decking applications primarily out-of-doors where the presence of water could be expected. The product provided was consisted of three smooth-topped planks approximately 2.3 cm thick with a width of 13.6 cm. The product had a fine grain that ran lengthwise

Each test sample provided by the manufacturer was marked with a label to identify the test sample (# 1 and # 2). A third piece was labeled but not used in testing. Each surface on which testing was performed was checked for level.

The sample orientation was such that the length of the wood surface was labeled North and South (top and bottom). The grain pattern also followed the North-South direction. The width of the surface was labeled East and West. These were indicated on each surface with a permanent marker using the letters "N, S, E, W".

The samples were wiped clean with a paper towel. This was the only preparation made prior to testing.

## Testing Protocols

The test instrument for these tests was a variable incidence tribometer (VIT) which was calibrated by the manufacturer on June 4, 2003. This calibration is valid until June 4, 2004.

The test foot material for this test was a Neolite® test foot. Neolite® is specified by the ASTM standard and offers a standard test material that is homogenous, consistent in its performance over time, and produced to a defined standard.

Prior to each measurement the VIT was inspected and the test foot was checked for freedom of movement. The VIT was then charged. The operating pressure was set to 25 p.s.i. The Neolite® test pad was sanded in a circular motion five times with 180 grit silicon carbide paper with a block backing. Sanding was done in a separate location of the room to avoid dust contamination. The Neolite® test foot was brushed clean with the supplied brush prior to bring the EnglishXL into the sample test area.

All dry tests were performed first and the test foot was sanded between each slip event to prevent polishing of the test foot. Additional sanding was needed on some slip events to re-surface the pad due to the abrading action this material produced.

Under wet testing the foot does not need to be re-sanded as polishing is not typically observed. The actuation button was depressed for ½ a second while the mast was lowered by ¼ turn each stroke until a slip-event occurred. The measurement was taken at this point.

**Data Tables**

Any values above 1.0 were reported as > 1.0 as the VIT scale is not graduated for readings above 1.0. In some dry testing a slip could not be created by the VIT. These values on the data tables are identified by >1.0 n/s. If a slip occurred, but was over-scale the result was identified as >1.0 s.

| Slip Resistance Testing Results<br>Product: Tiger Deck™ | | | | ASTM 1679<br>DRY TEST RESULTS | | | |
|---|---|---|---|---|---|---|---|
| **Direction** | **Piece 1<br>1** | **Piece 1<br>2** | **Piece 1<br>3** | **Piece 2<br>4** | **Piece 2<br>5** | **Piece 2<br>6** | **Avg** |
| **N** | 0.95 | 1.00 | >1.00 s | 0.86 | 0.87 | 0.87 | >0.93 |
| **S** | 0.81 | 0.95 | 1.00 | 0.86 | 0.91 | 0.83 | 0.89 |
| **E** | >1.00 s | >1.00 n/s | >1.00 s | >1.00 s | >1.00 n/s | 0.96 | >0.99 |
| **W** | >1.00 n/s | >1.00 n/s | >1.00 n/s | >1.00 n/s | >1.00 n/s | >1.00 n/s | >1.00 |
| **Average** | >0.94 | >0.99 | >1.0 | >0.93 | >0.95 | >0.92 | **>0.96** |

| Slip Resistance Testing Results<br>Product: Tiger Deck™ | | | | ASTM 1679<br>WET TEST RESULTS | | | |
|---|---|---|---|---|---|---|---|
| **Direction** | **Piece 1<br>1** | **Piece 1<br>2** | **Piece 1<br>3** | **Piece 2<br>4** | **Piece 2<br>5** | **Piece 2<br>6** | **Avg** |
| **N** | 0.56 | 0.47 | 0.49 | 0.58 | 0.54 | 0.52 | 0.53 |
| **S** | 0.53 | 0.53 | 0.56 | 0.61 | 0.56 | 0.64 | 0.57 |
| **E** | 0.61 | 0.59 | 0.65 | 0.70 | 0.72 | 0.66 | 0.66 |
| **W** | 0.64 | 0.58 | 0.66 | 0.70 | 0.79 | 0.66 | 0.67 |
| **Average** | 0.59 | 0.54 | 0.59 | 0.65 | 0.65 | 0.62 | **0.61** |

## Discussion of Results:

The product demonstrated excellent slip-resistant properties when dry. In eight of the twenty-four measurements taken, a slip could not be created with the VIT. The lowest value for slip-resistance was 0.81. Most values approached unity.

Wet testing demonstrated results exceeding the recognized threshold of safety (0.50) in all but two of the twenty-four measurements. There also appeared to be individual variation between the pieces tested with one piece showing improved slip-resistance in comparison to the other. This individual variation in a natural product is to be expected. An average slip-resistance value provided by this test provides a reasonable estimation for this product. None of the values individually exceeded three standard deviation units from the average reported value.

The other notable and perhaps expected finding is that the material shows some directionality in slip resistance. In nearly all tests the east-west testing direction resulted in values higher than the north-south directional testing. In other words, slip resistance across the grain is greater than with the grain.

The material performed well in either direction. However, if there is a known travel direction, it may be best to install the material so that pedestrian travel occurs in the east-west direction (against the grain) when possible. It would seem that this would be the most common installation orientation as a deck material. The average directional variation ranged from 0.09 (dry) to 0.12 (wet).

**Qualifications and Credentials:**

Steven D. High of High Safety Consulting Services, Ltd. conducted all tests and developed this report. Mr. High has been involved in the safety and health field since 1988 and is a member of the ASTM F-13 Committee. He holds a B.S. in Business Administration from Elizabethtown College (1986) and a M.S. in Sciences Sciences at the Indiana University of Pennsylvania, with a thesis in sticktion as a function of residence time on drag-sled devices. Mr. High is certified as an XL tribometrist (CXLT) (Certificate No: F0202-0891) He is a board certified safety professional (CSP) (Certificate No:12394 ). Mr. High also completed coursework and testing obtaining the designation Associate in Risk Management (ARM) by the Insurance Institute of America. He is a recognized accident and illness prevention provider by the State of Pennsylvania and is currently certified as an Emergency Medical Technician. (#012414). Mr. High is an authorized OSHA instructor for both general industry and construction and has taught thousands of students in occupational safety topics.

He has been employed as a Safety Specialist, Safety & Training Coordinator, Corporate Manager of Safety, Industrial Hygiene, and Environmental Services. Currently Mr. High is the President of High Safety Consulting Services, Ltd. (HSCSL), an affiliate of High Industries, Inc. HSCSL provides slip-resistance testing services, indoor air quality assessments, compliance surveys, safety training, noise monitoring and abatement design, and general consultation services.

**Summary of the ASTM F1679 Test Method**

The definition of static coefficient of friction (SCOF) is well defined in many physics texts as a ratio of the horizontal force required to start a fixed mass moving divided by the mass of the object. This method of testing a surface has been used for years prior to more advanced developments in test methods.

Other methods used to determine slip resistance include using an articulated strut which is increasingly inclined until such point that the strut slips. The tangent of the angle at which the slip occurred is the SCOF.

While both of these methods will provide valid data for slip resistance on dry floor surfaces, they are subject to sticktion when testing wet. Since nearly every surface is "slip-resistant" in a dry state, the concern in measurement of slip-resistance is on a wetted surface. Both of the drag-sled and articulated strut testers are subject to sticktion which can result in artificially high readings. Sticktion is the cohesion bond that is established between the surfaces and the liquid interface. This force will be measured by the drag-sled and articulated strut devices.

The ASTM F1679 Method offers a number of advantages over other testing methods available. First, the EnglishXL Variable Incidence Tribometer (VIT) is portable and can be used to test surfaces in the field. This allows for off-site testing which can be beneficial when assessing user complaints or concerns. By testing the manufactured surface with the same method, valid comparisons can be made.

Second, the VIT device is not gravity dependant for its operation, unlike most other tribometers. This means the device can be used on inclined surfaces without complex trigometric correction factors applied.

Third, the VIT is specifically designed to avoid sticktion. Sticktion will result in an overstatement of slip-resistance when testing wet. Sticktion has been shown to be a function of residence time and any drag-sled testing device, such as a James Machine will be subject to this problem. The EnglishXL device applies both horizontal and vertical forces simultaneously, thus preventing residence time. Since this testing method does not over-estimate wet surface results, it provides a conservative approach for flooring companies when representing the slip-resistance of a surface.

Fourth, the small test foot more appropriately approximates the area of contact of a human heel at set down and the articulation of the device more approximately imitates the gait of a human foot.

The method is rapidly gaining popularity with testing companies and users of such services because of the many advantages it offers.

**Limitations of Measurements**

The surfaces as tested in this report were new and tested under ideal conditions. Many factors affect walking surface safety. The purpose of this test is to determine the relative safety of the surfaces as produced and/or treated.

As surfaces wear over time, slip-resistance may change. Coatings, floor treatments, and cleaning products may affect slip resistance. Build up of contaminants on a surface may also affect slip-resistance. This test did not simulate use, wear or coatings.

Activities performed by the users of the surface may require higher slip-resistance for certain tasks. Activities involving pushing and pulling or similar activities may require additional slip-resistance. To date, no specific research study provides for clear guidance on varying levels of slip-resistance needed based on task.

This test is not intended to represent this product as being appropriate for any particular application.

Measurements made under the ASTM 1679 method should not be equated to test results using other methods.

**List of Sources**

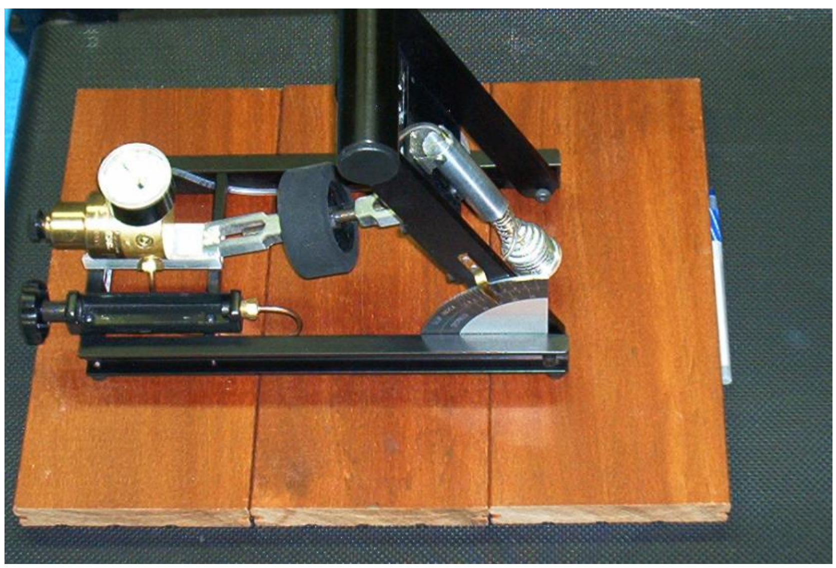

English, William. Pedestrian Slip Resistance: How to Measure it and How to Improve it. Alva: William English Inc., 1996.

English, William. Instruction Manual for the English XL Variable Incidence Tribometer, 2002.

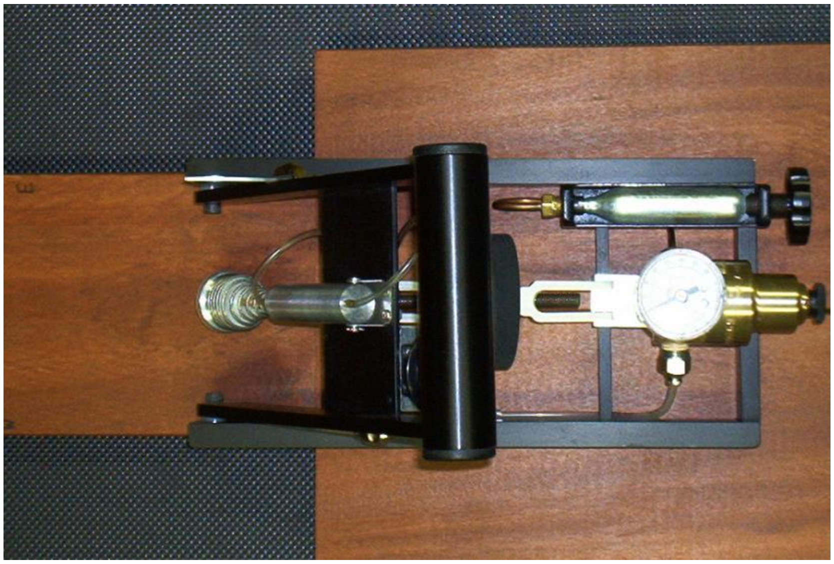
American Society of Testing Materials (ASTM). Standard Test Method for Using a Variable Incidence Tribometer (VIT). (F-1679-00).

**Photographic Documentation of the Testing:**

**Tiger Deck™ Boards after Labeling & Wiping**
**(Ready for Testing)**



**Dry Testing in East-West Direction**



**Dry Testing in a North-South Direction**

**Wet Testing in a North-South Direction**