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SLIP AND FALL STUDY REPORT:

ENHANCING FLOOR SAFETY THROUGH SLIP RESISTANCE TESTING, MAINTENANCE PROTOCOLS AND RISK AWARENESS



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INTRODUCTION

Careful attention to the slip resistance of interior floors is a critical component of your business’s slip and fall prevention efforts. In the following study conducted by CNA Risk Control walkway specialists over a two-year period, hard surface floors in commercial settings were tested, in some cases pre- and post-cleaning, for their dynamic coefficient of friction (DCOF), i.e., the measurement of a surface’s slip resistance during motion.



Executive Summary

Slips and falls can happen anywhere, any time and to anyone. Whether it's a visitor, customer or your own employee, what matters most is that your business is taking the necessary steps to develop and implement a slip and fall prevention program. CNA Risk Control has found that a critical component of these programs is addressing the slip resistance and maintenance of interior floors to reduce exposures.

In the following study, CNA Risk Control walkway specialists examined and tested hard surface flooring in commercial settings. The results found that a significant percentage of businesses are failing to adequately address flooring selection and ongoing maintenance of these surfaces.

Key findings:

- Half of all facilities with public access and common areas that CNA studied have potential for slips and falls. In a two-year study of hard surface floors in commercial workplaces, 50 percent of surveyed sites did not produce a dynamic coefficient of friction (DCOF) level, the measurement of a surface's slip resistance while in motion, above the minimum threshold set by the American National Standards Institute (ANSI).
- Slip and fall claims occur overtime with more frequency than severity. In a six-year review of slip and fall liability claims, CNA found trends of high frequency, but low severity – a finding consistent with claim experiences in the greater risk control industry for commercial buildings. While many employers may worry about the high cost of severe slip and fall claims, frequency should not be ignored. Frequent, smaller claims add up overtime, potentially creating a significant financial burden

for your business. According to frequency data, retail trade and real estate businesses present the greatest potential for slip and fall accidents.

- Simple strategies can save you money by protecting the safety of your employees and clients, as well as your reputation. There are simple, yet effective strategies that your business can implement to reduce your slip and fall exposures. These include:
 - o Selecting the right flooring. Many factors should be considered when selecting flooring for your commercial building. This includes not only the properties of the flooring itself, but also the space and environment. Make an educated decision by fully assessing the flooring material, surface qualities, flooring condition, required cleaning agents and equipment, and the finishing of the surface.
 - o Testing your floors for slip resistance. CNA measures hard surface walkways, under prevailing conditions, using tribometry, the measurement of friction on a surface. By conducting routine slip resistance testing, your business is better prepared to comply with flooring manufacturers' specifications, and on how to remove contaminants on floors before a fall occurs. Testing further enables you to select cleaning agents, finishes and sealants that will help maintain a surface's original coefficient of friction.
 - o Choosing the proper cleaning agent and method. Selecting the right cleaning products for your flooring is critical. In fact, the very products and methods used to clean and maintain floor surfaces can be the direct cause of slip and fall accidents. Choosing products that are compatible with your flooring is only part of the equation. It is essential to ensure maintenance vendors are aware of the proper cleaning products and confirm they are financially stable, ethically sound and operate under a strong risk management structure.
 - o Promoting awareness of potential slip and fall hazards. Personal awareness of glare, surface variation and other risks, as well as removal of exterior contaminants (e.g., water, snow and dirt) are critical to safe walking. Promote awareness by removing walkway obstacles, displaying signage in areas with floor elevation changes, placing mats near doorway entrances with sufficient mat length for shoe contaminant removal, and using design/decorative selection to reduce glare and provide visual cues where needed. Reduced vision or environmental factors may delay the normal awareness of potential slip exposures. It is the business's responsibility to raise awareness about slip and fall prevention, and keep people safe on their feet.



The study tested walkways to determine:

- The presence of surface contaminants that potentially influence friction.
- The impact of the choice of cleaning equipment, agents or methods that potentially influence friction.

The results of the study reveal that tested floors in 50 percent of the surveyed sites failed to produce a DCOF level above the minimum threshold of 0.42 (American National Standards Institute (ANSI) [A137.1-2012](#), which is now integrated into ANSI 326.3). These findings suggest that many businesses' fall prevention programs may overlook the effects of flooring selection and ongoing maintenance on slip resistance.

Whether your business is a data center, allied healthcare facility, financial institution or retail store, flooring dangers represent a major risk exposure and a key source of liability due to fall-related injuries.

Part One of this study examines CNA slip and fall claims that occurred over a six-year period. The data uncovered that slip and fall claims overtime occur with more frequency than severity, and continue to pose challenges for businesses. Furthermore, the findings underscore the need for attention to floor safety and regular surface resistance testing to avoid fall accidents and related injuries.

In an effort to help your business apply safety measures, Part Two of this study gathers the slip and fall study into four principles of floor safety:

1 Choose

Choose flooring that is slip resistant; consider its properties and the space and environment.

2 Test

Test floors for their resistance under wet conditions; use a tribometer to measure DCOF levels.

3 Use

Use cleaning agents and methods that are compatible with the floor type, and apply them as directed by the manufacturers.

4 Promote

Promote awareness of risk conditions in the physical environment, along with those that are specific to the flooring

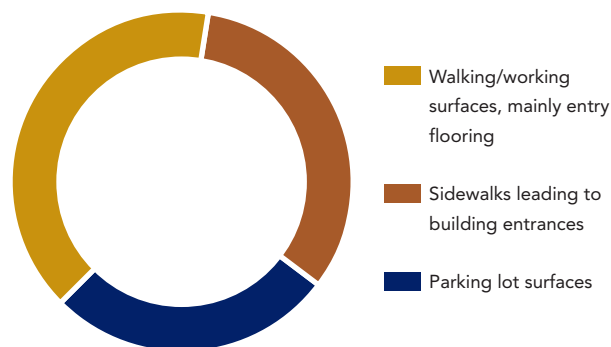


Part One:

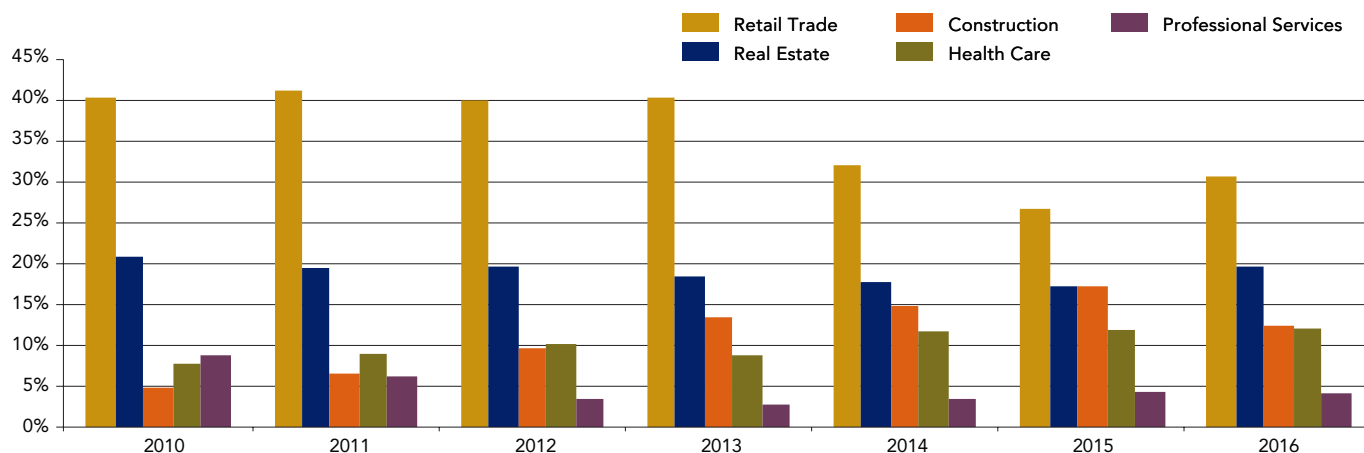
General Review of CNA Claims

A review of slip and fall liability claims occurring from Jan. 1, 2010, to Dec. 31, 2016, found high-frequency but low-severity trends. This finding is consistent with claim experiences in the greater risk control industry. (See *Figures 1 and 2*) According to frequency data, retail trade and real estate businesses present the greatest potential for slip and fall accidents, with harmful events occurring most often at these sites:

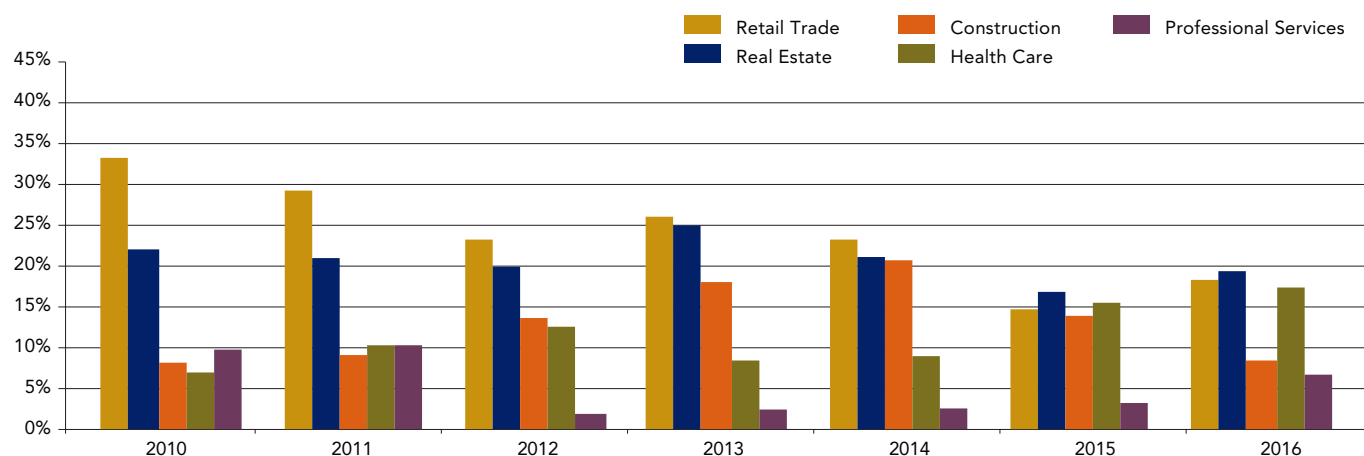
- 40 percent on walking/working surfaces, mainly entry flooring.
- 33 percent on parking lot surfaces.
- 27 percent on sidewalks leading to building entrances.
- Less than 1 percent on interior office floors.



1 Figure 1 - Slip & Fall Frequency %



2 Figure 2 - Slip & Fall Severity %

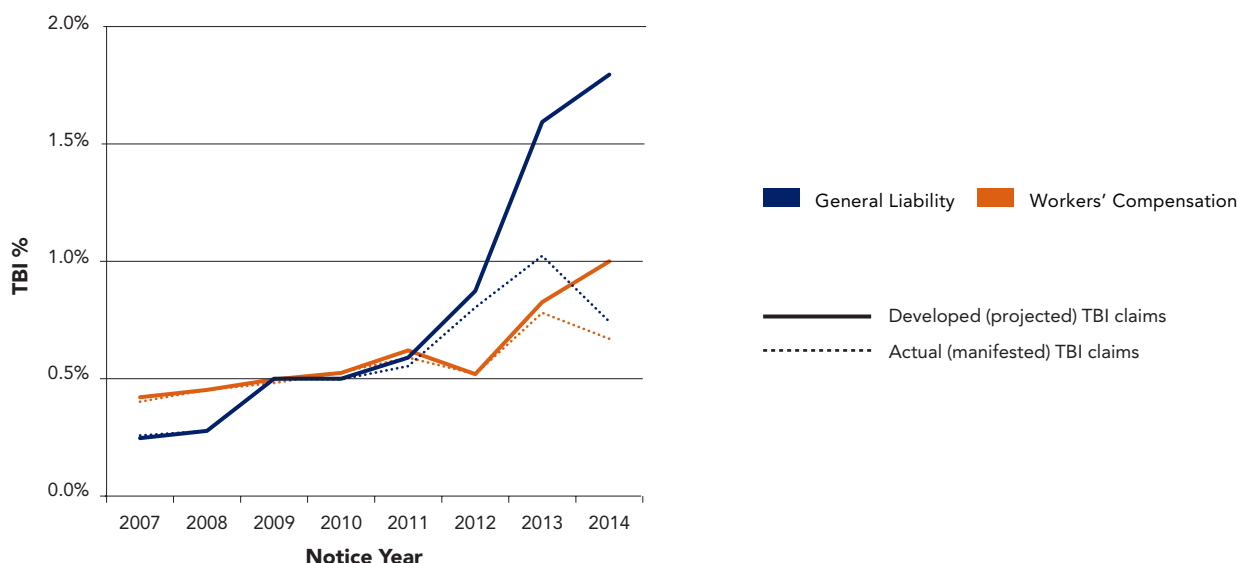


Part One:

General Review of CNA Claims (cont.)

Traumatic brain injury (TBI), i.e., the results from a violent blow or jolt to the head or body, is among the most severe of slip and fall claims. In fact, the Centers for Disease Control and Prevention (CDC) report that falls among adults are the most common cause of TBI. With the risks associated with TBI, this claim review used predictive modeling and data mining methods to link TBI in General Liability (GL) and Workers' Compensation (WC) claims between the years of 2007 and 2014. Based upon the results of the predictive analysis, both the rate and seriousness of claims involving TBI are higher for GL insureds than WC. (See *Figures 3, 4 and 5*) Of the GL insureds, small retail businesses experience the highest number of claims alleging TBI.

3 Figure 3 - TBI% of General Liability and Workers' Compensation Claims



4 Figure 4 - Frequency Summary: Change 2007 to 2014

	GL	WC
2014	1.79%	1.02%
2007	0.22%	0.42%
2014/2007	8.31	2.41

Development (ratio of the solid and dotted lines) varies tremendously across LOBs (examples for 2014):

GL: x2.6 (1.8/0.7)

WC: x1.6 (1.0/0.6)

This is because they have different development rates.

5 Figure 5 - Paid Loss: TBI vs. non-TBI

Closed claims, Notice years: 2007-2012, Excluding \$0 claims

	GL	WC
TBI	\$269,643	\$259,153
non-TBI	\$30,150	\$26,158
Ratio (TBI/non-TBI)	8.94	9.91

Note:

This severity would be higher, especially for WC, if we included open claims, which (for older claims) tend to be more severe.

Part Two:

Principles of Floor Safety

Discussion of floor safety is not new, but the role these programs play is important in decreasing slip and fall exposures. However, the topic of promoting safe walking and working surfaces is timely given the updated regulation from the Occupational Safety and Health Administration (OSHA). The final rule creates new standards specific to same-level slip, trip and fall risks.

Given the focus on floor safety, it's important to revisit your prevention efforts, in order to guarantee that floors and walkways are safe through the application of the following safety standards.

Flooring Selection

Flooring decisions can have unfavorable results over the life of a commercial building. During the selection process, it is important that your business carefully consider the makeup of the flooring and whether it is a proper surface for use. For example, a high-traffic lobby may require durable, slip-resistant flooring over a conference room. Floor finishes, sealants and maintenance needs may differ depending on location of the flooring in the business. By considering the following five flooring properties and the questions they may elicit, your business can make a more educated and safe choice:

OSHA Floor Safety Rule Update

The Occupational Safety and Health Administration's (OSHA) Walking-Working Surfaces regulation (29 CFR Part 1910, Subpart D) aims to protect workers from same-level falls and falls from heights. It has a two-fold goal:

- 1) To create a fall protection standard for industry
- 2) To enact new rules for minimizing the likelihood of same-level slip, trip and fall incidents in facilities.

The rule joins best practices from more than 30 industry standards and is performance-based. The rule offers you flexibility to correct walking-working surface risks in a way that fits your business and working conditions.

1 Material

Is the floor made of a natural slip resistant material, i.e., natural stone or a smooth ceramic tile?

2 Surface

Is the surface water resistant, and does it have a hard quality that is helpful to creating tension?

3 Condition

Is the floor surface new and clean, or does it display worn features that may invite hazards?

4 Cleaning

What cleaning agents, methods and equipment are best for the floor, and does your business have access to those supplies?

5 Finishing

Does the floor have a textured or smooth finish, and will aftermarket sealants, chemical treatments or coatings reduce the surface's DCOF?

The following is a summary of the major changes in the rule. Businesses must:

- Regularly inspect all walkways to guarantee they are free of debris, contaminants, or other defects that could cause a slip, trip or fall injury.
- Correct and guard any known walking-working risks to prevent a slip, trip or fall injury.
- Revise and consolidate requirements for all types of ladders.
- Modify vertical clearance requirements in stairways.
- Ensure scaffold requirements mirror those used in construction industries.
- Add requirements for the use of rope descent systems.
- Guard against fall-from-height hazards.
- Add new performance, care and use criteria for all personal fall protection systems.

Source: [New OSHA Floor Safety Rule Aims to Prevent Workplace Fall Incidents](#)

1 Table 1 - Slip Resistant Features by Floor Material

Floor Material	Slip Resistant Features
Quarry tile	<ul style="list-style-type: none"> • Tends to have a naturally high coefficient of friction (COF)* value. • Offers good slip resistance when clean due to its rough micro surface. • Slip resistant, but resistance may lessen when the surface is wet or soiled, mainly when cooking grease is present.
Glazed ceramic tile	<ul style="list-style-type: none"> • Resistance depends upon the glaze used and the texture of the tile. • Smooth surfaces tend to have a naturally low COF. • Textured surfaces are generally designed to have a high COF. • Is receptive to anti-slip coating additives that enhance floor traction, but they later wear away with heavy foot traffic. • Smooth glazed surfaces can be slippery when wet.
Mosaic tile	<ul style="list-style-type: none"> • Unglazed porcelain has a naturally high COF and good slip resistant properties. • Can be slippery when wet if waxed, despite manufacturers’ recommendations advising against waxing. • Glazed porcelain’s slip resistance depends upon the type of glaze used. • Decorative mosaics’ slip-resistance depends upon on tile size, grout joints and glaze. • Glass mosaics have a naturally low COF, but frequency of grout joints may help with drainage, thus improving traction.
Porcelain tile	<ul style="list-style-type: none"> • Unglazed porcelain is durable and offers good slip resistance when maintained properly. • Glazed porcelain is durable, but slip resistance depends upon the glaze used and texture of the tile. • Textured tiles also offer good slip resistant properties when wet. • Polished porcelain tiles are very slippery when wet and can only be used in dry applications.
Natural stone (e.g., granite, marble, limestone, slate and quartz)	<ul style="list-style-type: none"> • Most often available in polished materials, which are very slippery when wet and can only be used in dry applications. • Honed stone materials are also slippery when wet and generally have a low COF. • Flamed and texturized stone or concrete materials are typically recommended for exterior applications, but they must be properly maintained to preserve slip resistant properties.
Terrazzo	<ul style="list-style-type: none"> • Composed of granite and marble chips bonded with cement, then polished. • Is similar to polished natural stone in its slip resistant properties. • Can also be made with epoxy binder. • Has a naturally low COF. • Avoid at entrances in wet, humid climates or areas expected to come in contact with water.

*Coefficient of friction (COF) is the presence of traction between an individual's feet and a surface that allows the person to maintain an upright position.

1 **Table 1 (cont.) - Slip Resistant Features by Floor Material**

Floor Material	Slip Resistant Features
Resilient (e.g., linoleum, vinyl, cork, rubber)	<ul style="list-style-type: none"> • Surface is polished with acrylic or other polymer coating. • Intended only for dry applications, per coating manufacturers' recommendations. • Has a naturally low COF. • Slippery when wet.
Laminate	<ul style="list-style-type: none"> • Composed of a wood layer with a clear, smooth polymeric protective layer on top. • Has a naturally low COF. • Intended for dry applications only. • Slippery when wet.
Concrete	<ul style="list-style-type: none"> • A honed stone, but not a sealed surface, in interior applications has a naturally high COF, as liquids from spills are absorbed into the concrete. • A honed stone, but not sealed surface, in exterior applications is slippery when saturated by rain or other sources of water. • When sealed, it has a naturally low COF and is intended for dry applications.

As a general rule, obtain a floor's designated COF from the manufacturer at the time of purchase. Flooring that is properly maintained should continue to yield a DCOF of greater than 0.42 as set by ANSI A326.3. However, the usage of coatings, sealants and other finishing treatments may change an original surface COF. Therefore before proceeding with aftermarket treatments, it's important for you to review the flooring manufacturer's testing data.

+ **Key Takeaways:**
The 3 C's of Floor Selection

- **C**arefully review flooring choices with architects, interior designers and manufacturers who understand walkway safety.
- **C**onsider a number of comparison points for different types of floors before making a selection, including, but not limited to: slip resistance, chemical resistance, durability, and care and maintenance factors.
- **C**onsult the original DCOF from the manufacturer at the time of purchase and whenever any finishing product is considered.



Slip Resistance Testing

The science of tribometry (slip resistance testing), is the measurement of friction on a surface, as carried out with a tribometer. Tribometry measures a floor's coefficient of friction (COF), which is the presence of traction between an individual's feet and a surface that allows the person to maintain an upright position. The industry method for measuring COF changed in 2012. It shifted from a focus on resting objects to the preferred dynamic coefficient of friction (DCOF). DCOF measures the resistance force while an object is in motion. There are two well-recognized DCOF testing methods: ANSI A137.1-2012 (hereafter ANSI A137.1) and the National Floor Safety Institute (NFSI) standard ANSI/NFSI B101.3, which measures the wet DCOF of common hard-surface floor materials.¹

ANSI A137.1-2012 supplanted the ASTM International test method C1028 because the latter is unable to measure resistance when people are in motion, which is a relevant measurement in slip and fall prevention since individuals are technically moving when they lose their balance.

The Tile Council of North America (TCNA) published a new standard, ANSI A326.3, on April 20, 2017. ANSI A326.3 provides consumers, insurers and building owners a method to measure the DCOF of hard surface floors using the same core AcuTest® methodology as in ANSI A137.1.² Specifically, ANSI A326.3, Test Method for Measuring Dynamic Coefficient of Friction of Hard

Surface Flooring Materials, provides the test practice to measure DCOF for all types of hard surface flooring. The standard reflects years of collaboration among various professional flooring representatives, which first resulted in the adoption of the practice supported in the A137.1 tile standard, and now, the creation of the stand-alone A326.3 standard. The new standard is available for free download on the [TCNA website](#).

The new standard employs the same testing procedure for the BOT 3000E as does standard A137.1-2012.

When conducting resistance testing, CNA utilizes the Binary Output Tribometer (BOT) – 3000E, which employs the self-propelled drag sled principle originally defined by prominent safety researchers and scientists in Germany. The device has been designed to avoid the use of springs, actuators, dials, heavy weights or other components that can lead to premature device wear or mechanical fatigue.

CNA is proud to offer walkway safety guidance and tribometry testing with complete statistical analysis through its partnership with Safe Space Ingenuity, Inc. (SSI). SSI developed slip and fall software exclusive to CNA. Through computer-generated renderings, as represented in *Figures 6 and 7*, CNA is able to test outcomes and discern where walkways require immediate improvements, such as in the review of floor cleaning protocols.



¹ ANSI A137.1-2012 supplanted the ASTM International test method C1028 because the latter is unable to measure resistance when people are in motion, which is a relevant measurement in slip and fall prevention since individuals are technically moving when they lose their balance.

² The new standard employs the same testing procedure for the BOT 3000E as does standard A137.1-2012.

Background Information on the Tile Council of North America

The Tile Council of North America (TCNA) is a trade association of companies that produce ceramic tile, tile installation materials, tile equipment, raw materials and other tile-related products. It is a recognized leader in supporting the development of global quality standards intended to benefit tile consumers.

TCNA is the secretariat for the ANSI Accredited Standards Committee A108, which develops standards for ceramic, glass, stone and other hard surface tiles and panels. TCNA also represents ANSI on the International Standards Organization Technical Committee on ceramic tile and related installation

materials (commonly referred to as ISO TC/189). It is active in various committees sponsored by the American Society of Testing and Materials, including C21 on Ceramic Whitewares and Related Products, F13 on Pedestrian/Walkway Safety and Footwear, C18 on Dimension Stone, E60 on Sustainability and E35 on Pesticides, Antimicrobials and Alternative Control Agents.

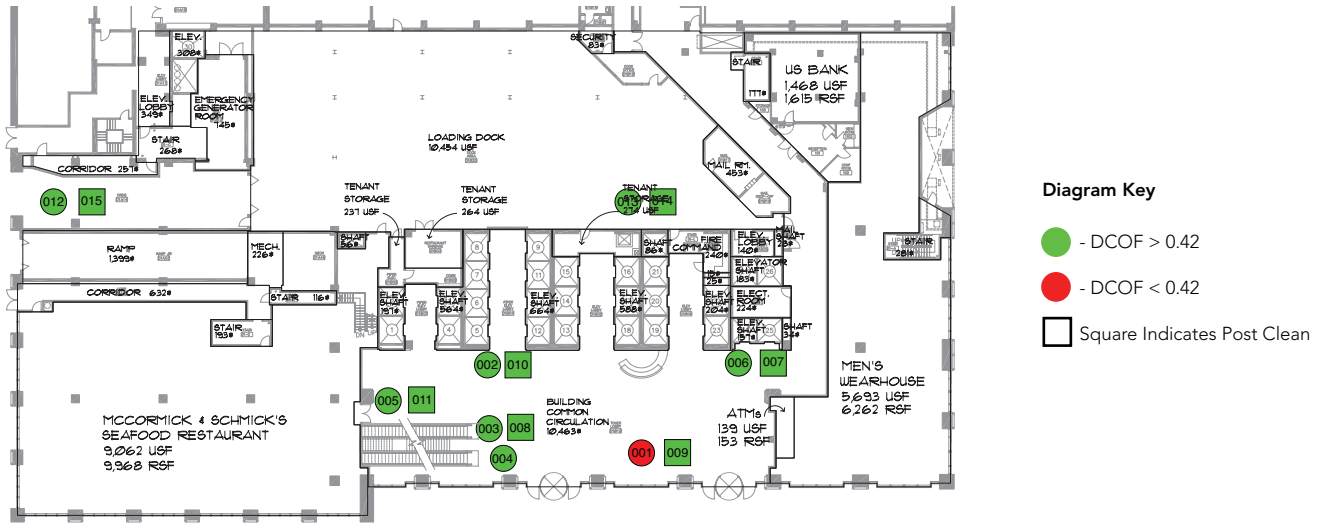
Regularly, the TCNA conducts independent research and product testing, and advises trade and government agencies. In addition, it publishes installation guidelines, standards, economic reports and marketing materials for the industry.

By conducting routine slip resistance testing, your business is better prepared to comply with flooring manufacturers' specifications, and on how to address the level of contaminants on walkway surfaces. Testing further enables you to select cleaning agents, finishes and sealants that will help maintain a surface's original COF. Surface testing may strengthen your defense of fall-related claims by starting a database of slip resistance measurements — taken both before and directly after an incident — which may prove beneficial in a later litigation setting.

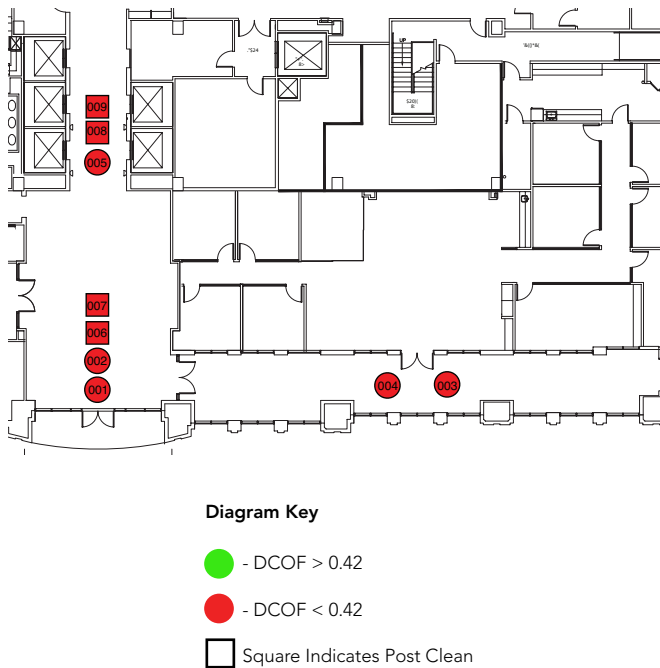
In order to highlight the value of tribometry testing, CNA recently conducted case studies in a variety of industry settings, measuring the DCOF of primary walkway surfaces.³ Findings revealed that floor surfaces in many different facilities fail slip resistance testing. To read the results of the studies in further detail, see "Case Studies on Slip Resistance Testing" on page 21.

³ When conducting resistance testing, CNA utilizes the Binary Output Tribometer (BOT) – 3000E, which employs the self-propelled drag sled principle originally defined by prominent safety researchers and scientists in Germany. The device has been designed to avoid the use of springs, actuators, dials, heavy weights or other components that can lead to premature device wear or mechanical fatigue.

6 Figure 6 - Example of Good Walkway Results



7 Figure 7 - Example of Bad Walkway Results



Key Takeaways: The 4 C's of Slip Resistance Testing

- Consult certified walkway specialists who are trained to conduct tribometry testing, in order to help in your analysis of current risks.
- Conform to the new industry standard, ANSI A326.3, for measuring DCOF of flooring surfaces.
- Create a comprehensive floor safety program, which includes regular resistance testing of hard floors by a certified walkway specialist.
- Create a database of DCOF measurements, and use it to inform both your cleaning product selection and your slip and fall prevention program.

Floor Maintenance

The choice of cleaning products that are friendly with a type of floor is a key element of a floor safety program. When flooring is not cleaned and maintained according to manufacturers' recommendations, floor contaminants — i.e., gravels, water, dirt and cleaning particles — can layer over an original surface, rendering your slip resistant floor dangerous. In fact, the very products and methods used to clean and maintain floor surfaces can be the direct cause of slip and fall accidents.

The following examples of floor maintenance-related errors may give rise to unnecessary risk exposures:

- Untimely removal of spills or accumulations of water.
- Improper selection of a cleaning product or finish for a type of flooring.
- Inadequate cleaning technique or drying time, leaving soap residue or water on the floor.
- Failure to clean a surface in accordance with the manufacturer's recommendations.
- Applying too much of a product, or too often.
- Failure to strip a surface of previously applied products and treatments.
- Failure to change dirty water before the rinse phase, thus contaminating a clean surface.
- Noncompliance with surface buffing specifications, when indicated.

Cleaning products are designed to sustain a floor's original COF. If they are improperly selected or applied, the friction measurement may be reduced. Cleaning products are derived from four major categories.

1 Alkaline-based

2 Acidic-based

3 pH neutral

4 Microbial enzymatic

To help ensure your business selects appropriate products, see *Table 2* on the following page for an overview of the four categories of cleaning agents and some of their attributes.



2 **Table 2 - Cleaning Agents and Attributes**

Cleaning Agents	Attributes
Alkaline-based	<ul style="list-style-type: none"> • May react with fats and oils, thereby converting contaminants into soap. • Floors must be fully rinsed with hot water to prevent polymerization, i.e., a buildup of contaminants. • May remove sealers, finishes and waxes. • Is often used in restaurants and dining areas. • Not recommended for natural stone surfaces.
Acidic-based	<ul style="list-style-type: none"> • Utilizes oxide reduction to remove rust, scale and other buildup from flooring surfaces. • Requires thorough rinsing after cleaning for maximum effectiveness. • Commonly used for cleaning porcelain, ceramic tile and grout. • Can scratch the flooring surface if used improperly. Eco-friendly agents, however, will not.
Neutral pH-based	<ul style="list-style-type: none"> • Often used on floors with glossy finishes, or surfaces damaged by acid or base cleaners, e.g., terrazzo and natural stone, such as marble and granite. • Requires thorough rinsing to be effective.
Microbial enzymatic	<ul style="list-style-type: none"> • Composed of scientifically created bacterial enzymes. • Requires no surface rinse post-cleaning. • Often used to clear drains and clean concrete, tiles and grout.



In addition to the type of product selected, the cleaning method plays an equally important role in achieving ideal maintenance results.

Wet and dry mopping are the most commonly used methods. Dry mops are designed to pick up soils before adding liquid and tend to make the cleaning process easier. Since this cleaning method requires no water-based solution, it permits cleaning while the soiled area remains in use. For an overview of the intended uses, benefits and/or drawbacks of different types of dry mops, see *Table 3 "Dry Mop Variations"* below.

3 Table 3 - Dry Mop Variations

Dry Mop Type	Description
<p>Cotton</p>	<ul style="list-style-type: none"> • A natural fiber that works well to absorb or collect dirt and debris, but is not very helpful for fine dust particles, which can get lodged in the mop fibers. • Often used in combination with a dust mop spray, i.e., a spray applied to the mop head to trap dust. Most sprays consist of natural oil, e.g., banana oil. Controlling the amount of spray used is important as floors can become slippery following application. Water-based solutions are less effective at trapping dust. • To remove residue, a degreasing chemical is needed, which may cause damage to the floor finish. • In high humidity situations, cotton dust mops can catch and drag over walkways, affecting their ease of use.
<p>Synthetic</p>	<ul style="list-style-type: none"> • Made of plastic or man-made yarn. • Often stitched in a looped end pattern that easily attracts particles and prevents fraying. • Plastic mop heads collect dust by static electricity, instead of using a dust mop spray. • Yarn mop heads create minimum static electricity, so they are easy to shake out. • Can be laundered. • Not affected by moisture and are much lighter to push regardless of humidity or presence of liquid.
<p>Microfiber</p>	<ul style="list-style-type: none"> • Similar to synthetic dust mops but are made of plastic fibers. • Can be used on both dry and damp floors. • Channels in the separate plastic fibers grab fine dust particles, stopping them from going airborne. • Can be rinsed clean or laundered, increasing their life.

Based, in part, upon information from [Katom Restaurant Supply, Inc.](#)

With respect to wet mopping, the rate of absorbency is determined by the size of the mop head rather than the material. The use of a two compartment bucket — one side for clean and another for dirty water – is ideal for cleaning. The importance of clean water to rinse walkways after cleaning cannot be emphasized enough. Finish becomes less effective when applied to an unclean walkway. For an overview of the different types of wet mops, see *Table 4 “Wet Mop Variations”* below.

4 Table 4 - Wet Mop Variations

Wet Mop Type	Description
Cut End	<ul style="list-style-type: none"> • Least expensive wet mop option. • Often disposable. • Cannot be laundered.
Looped End	<ul style="list-style-type: none"> • Designed to pick up floor contaminants. • More durable than cut-end mops because of its yarn ply-twisted design. • May be laundered. • Can be made with fibers locked into the yarn that kills or stops the growth of bacteria, mold, mildew and yeast.
Microfiber	<ul style="list-style-type: none"> • Made from a blend of polyester and synthetic fibers that easily traps dirt. • Tends to be the most sanitary of all mop types. • Designed to be hypo-allergenic and non-abrasive. • May be laundered. • Considered an eco-friendly mop as it requires fewer chemicals to clean.

Source: [Webstaurant Store](#)

+ **Key Takeaways:**
The 4 C's of Floor Maintenance

- **C**omplete full background checks on all likely maintenance vendors to confirm they are financially stable, ethically sound and operate under a strong risk management structure.
- **C**hoose cleaning products that are compatible with walkways, and ensure that floor maintenance vendors are aware of the proper cleaning products.
- **C**onfirm your vendor contracts are reviewed by your legal representation to minimize your liability exposure.
- **C**onsider compliance with the Leadership in Energy and Environmental Design (LEED) certification requirements with respect to the selection of cleaning products and maintenance methods.⁴

⁴ Organizations may earn points toward LEED certification through the selection of sustainable tile, as well as installation and maintenance products. The ANSI A138.1 standard — known as Green Squared® — contains specifications for sustainable ceramic tiles, glass tiles and tile installation materials. In particular, the use of tiles, mortar and grouts made by North American manufacturers that contribute to a North American Environmental Product Declaration may earn LEED points. For more information on the benefits of sustainable and eco-friendly selections, see [Tile: The Natural Choice – 2016 Edition](#). Also see the website of [TCNA's Green Initiative](#).

Risk Awareness and Control Measures

Most people are naturally aware of hazards that affect the safety of floors, and change their behaviors to avoid such hazards, such as slowing down while walking on a visibly wet floor. Known as “risk awareness,” changes in your gait and posture occur when the brain receives signals from body sensors. This triggers your body to adjust and position for the purposes of safety. When age, reduced vision or environmental factors delays the normal awareness of exposures, it is the businesses responsibility to raise a person’s “risk awareness.”

Insights to Slip and Fall Variables: Human Gait and Vision Acuity

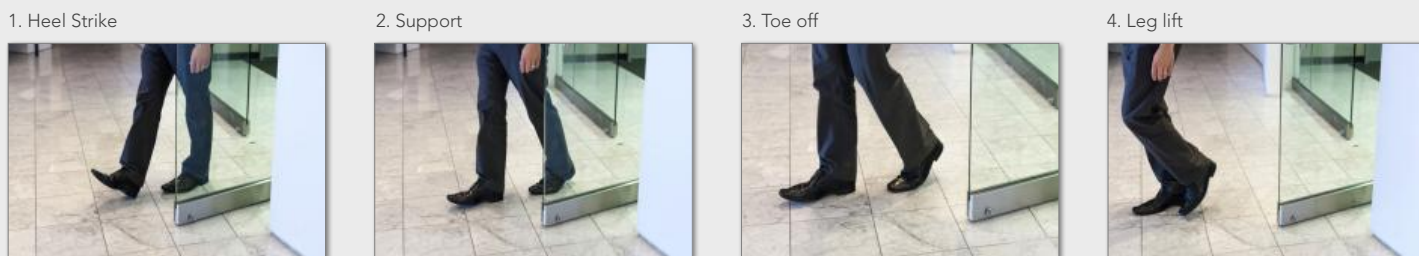
Human Gait

Knowledge of gait can help you offset the risk of slip and fall accidents in your business. Walking requires both horizontal and vertical forces to work together. Friction is a horizontal force created when feet contact the floor surface. Friction is strongest when a person pushes off from one foot and the weight shifts to

the other foot. Gravity is a downward force that alters the body’s center of gravity as a person shifts weight walking. The two forces create an altered center of gravity that is near constant, which results in people walking on average 80 percent of the time on one foot and 20 percent with both feet on the ground.

In addition, slip and fall accidents in certain phases of gait occurs. *Figure 1* illustrates the phases of walking. The first phase, i.e., the heel strike is the most common point at which a slip can occur. The increased heel speed between Phases 3 and 4 may increase the potential of a slip and fall on a slippery floor.

1 Figure 1 - Four Phases of Walking



Personal awareness of glare, surface variation and other risks are critical to safe walking. Signage and other reminders, including flooring design choices, play a key role in keeping people standing and safe.

Vision Acuity

People with visual disorders may have a higher risk of slip and fall. Changes in depth perception and spatial relationships due to aging eyesight can impact a person’s awareness of flooring and its properties. Designers must research and select flooring for the individuals who will walk on it — whether they are employees, customers, patients or residents.

Interior designers need to consider lighting that optimizes a person’s vision. The science of syntonics, which influences the function of light through the eyes focuses on selected visible-light frequencies delivered through the eyes can improve vision. Optometric phototherapy is a growing field, helping to define the effect of light on the body’s sensors, including the ability to focus and balance. Lighting choices that excite rather than delay the body’s natural sensors can be helpful in businesses that serve people subject to weakened vision.

The following risk control actions safeguard against risks in your internal environment and help promote an increased awareness of safety on the part of people and employees:

Be proactive.

Conduct a needs analysis of your walkway safety management efforts, including documentation of surface DCOF values and maintenance requirements by both floor type and usage. Understand premise liability and your obligation to customers, visitors and employees. Manage your walkway risks through property premise modifications and/or contract agreements.

Train employees, property managers or contracted vendors on fall-related safety principles.

Education is key in any sustained fall-management effort. This should include specific skill training in terms of both how to clean and maintain floors, especially walkways. Select proper cleaning equipment, including mops/buckets, for each floor type. Turn to floor experts for proper finish and sealant products.

Design safe walkways.

Make sure walkway routes and building entrances are visible, free from obstacles. Water should quickly drain away from pedestrian areas to keep feet dry when entering the building. Snow/ice management is also important. Post signs near building entrances to show walkway elevation changes.

Place floor mats inside each doorway entrance.

Mats help trap outside walkway dirt and water before they reach your floors and create a possible exposure. To be most effective, purchase floor mats with slip resistant backing and beveled edges, position the mats flat on the floor and ensure they are cleaned on a regular basis. Lastly, floor mats should cover an area for people to take three to four strides, approximately six to eight feet, before coming into contact with the flooring underneath. For more information on floor mat considerations, see the ANSI/NFSI standard [B101.6-2012](#).

Remain vigilant to the effects of glare and design contrast when selecting floors.

Slip and fall investigators have reported conditions in which a slip hazard could not be seen due to excessive glare and/or contrast in flooring color and design. (See *Figure 9*)

To help reduce floor glare, add a decorative planter or object that is away from the flow of traffic. In addition, create surroundings where color and design contrasts help signal changes in floor elevations rather than hinder their perception, in particular at door entrances. Keep in mind that the human brain requires time to adjust to changes in its surroundings before it signals a slowing of the gait. Limiting design-related barriers that may distract the brain from detecting hazards is a necessity.

9 Figure 9 - Glare and Contrast Hazards

1. Excessive glare



2. Too many contrasts



3. Excessive glare



Adhere to maintenance protocols.

Cleaning equipment should be regularly maintained and inspected. Mops should be the correct type for the floor and cleaned before each use. To avoid the risk of contamination between different floors in your facility, replace dirty mop heads before cleaning a new area. Likewise, when using a floor scrubber, examine the scrub brush or pad to ensure cleanliness. Clean mops should be hung up to dry to avoid damaging their ends.

Labeled equipment can help your maintenance workers select the proper equipment for marked areas. When cleaning takes place, your maintenance workers should display signage warning of wet hazards. This sign should be removed once the floor is dry. If an area is off-limits to people during cleaning, maintenance workers should know the procedure for setting up signage.

While a certain number of falls are usual in an active business, increased attention to floor safety standards can help reduce legal exposures. Floor care and maintenance are vital parts of a useful slip and fall program. Nevertheless, success requires flooring surfaces that are appropriate for their intended use, as well as cleaning products that maintain a desirable surface COF. By focusing on slip resistance testing, maintenance procedures and ongoing care to the surrounding and human-based risks, you can help keep people safe on their feet.

Resources

Fact Sheet: [OSHA's Final Rule to Update, Align, and Provide Greater Flexibility in its General Industry Walking-Working Surfaces and Fall Protection Standards](#), from the Occupational Safety and Health Administration. November 2016.

[Frequently Asked Questions: Walking-Working Surfaces and Personal Fall Protection Systems Final Rule](#), from the Occupational Safety and Health Administration.

Jabr, Ferris. "[Why Walking Helps Us Think](#)." The New Yorker, September 3, 2014.

Lehtola, C., et al. "[Preventing Injuries from Slips, Trips and Falls](#)." University of Florida Extension, Institute of Food and Agricultural Sciences. Updated February 2001.

[Preventing Slips, Trips, and Falls in Wholesale and Retail Trade Establishments](#), from the National Institute for Occupational Safety and Health. October 2012.

[Tile Council of North America, Inc.](#)

[Traumatic Brain Injury and Concussion](#), from the Centers for Disease Control and Prevention.

Case Studies on Slip Resistance Testing

Case Study 1: Real Estate

In this case study, floor surfaces in eight Class A, LEED-certified facilities were tested for slip resistance using the BOT-3000E digital tribometer. (See *Table 1* for floor type, cleaning methods and solutions used by facility.)

The surface DCOF was measured applying the wet testing method on pre-cleaned floors in all eight locations, and post-cleaned floors in four locations, following each facility's maintenance procedure. (See *Table 2*)

1 Table 1 - Flooring Type, Cleaning Methods and Solutions Used by Facility

Facility	Floor Type	Dry Mop	Wet Mop	Scrubber	Cleaning Solution
1	Terrazzo and Ceramic	X	X	X	Neutral
2	Natural stone	X	X	X	Neutral
3	Natural stone	X	X	X	Alkaline
4	Natural stone	X			Neutral
5	Natural stone	X	X		Neutral
6	Natural stone	X	X	X	Neutral
7	Terrazzo	X	X		Neutral
8	Natural stone	X	X		Neutral

2 Table 2 - Testing Conditions and DCOF Measurements by Facility

Facility	Pre-cleaned floor	Post-cleaned floor	DCOF measurement pre-cleaning*	DCOF measurement post-cleaning*
1	Yes	No	0.46	X
2	Yes	No	0.55	X
3	Yes	Yes	0.39	0.37
4	Yes	No	0.48	X
5	Yes	Yes	0.41	0.41
6	Yes	Yes	0.24	0.28
7	Yes	Yes	0.31	0.33
8	Yes	No	0.47	X

*Averages of various areas tested at each site.

The results showed that four of the eight facilities (signaled in red in *Table 2*) failed the slip resistance testing, as defined by a DCOF of less than 0.42. For many of the tested floor surfaces, both the pre- and post-cleaning results were similar, showing slight improvement after floor cleaning. In one test, a company ignored the manufacturer's proposed cleaner for a natural stone floor, using an alkaline-based cleaner. In most cases, failed results included the presence of floor debris, use of dirty water and/or cleaning equipment, and failure to use a two-compartment bucket.

RISK control lessons:

- Review recommended proper cleaning products and uniform maintenance flooring protocols for floor surfaces.
- Inform and educate maintenance vendors and workers to understand the appropriate floor cleaning products in their native language.
- Stick to the manufacturer's specifications on regarding the proper application method technique.
- Keep strong adherence to maintenance protocols, including clean water during regular floor maintenance.

Case Study 2: Banking

In this case study, a financial institution tested 11 bank branches for slip resistance of their walkways using the BOT-3000E digital tribometer. The testing occurred during winter months when floor surfaces are most hazardous. The branches selected for testing had suffered an overall higher level of slip, trip and fall claims.

Applying the wet testing method, all 11 locations measured the surface DCOF on pre-cleaned floors. Floors were tested at high traction levels with the exception of four bank branches. (See *Table 1*)

1 Table 1 - Floor Type and BOT Reading by Branch with Substandard Testing

Branch	Floor Type	BOT reading post-cleaning
1	Terrazzo	0.36
2	Terrazzo	0.37
3	Terrazzo	0.33
4	Vinyl tile	0.30*

**Average of various areas tested*

Post-testing, the bank took measures to decrease the slip and fall risk exposures. Branch four completed the scheduled replacement of the vinyl flooring prior to the testing date, and branch two, covered the small area of terrazzo flooring with adhesive-backed carpet.

The terrazzo floors at branches one and three posed a greater challenge, since related costs made it expensive to replace or cover with alternative flooring. The application of an anti-slip trend activator corrected the challenging floor surfaces.

In order to demonstrate the efficiency of the activator, branch three was tested in a pilot application, creating an increase in the BOT reading of 0.21 from pre- to post-application. A decision was later made by the bank to apply a more cost-effective, anti-slip floor restoration compound to the terrazzo floors.

RISK control lessons:

- Remove prior coatings, sealants or debris from original floor surface before applying anti-slip tread activators.
- Implement standardization of cleaning products and uniform maintenance protocols.
- Stress adopted guidelines and plans for the purchase of flooring types to ensure adequate DCOF rating.
- Keep slip and fall hazard signage on hand, and replace worn floor mats as needed.

Case Study 3: Healthcare

In this case study, the BOT-3000E digital tribometer tested the vinyl composition tile in four assisted living facilities for slip resistance. Applying the wet testing method, the measured surface DCOF on post-cleaned floors in all four locations and on one pre-cleaned floor, resulted in a DCOF of greater than 0.42, the desired level.

Prior to testing, a complete review of the floor maintenance program resulted in all four facilities demonstrating compliance with these five basic elements:

- 1) Regular floor inspections of surfaces and finishes recorded in a timely manner.
- 2) Thorough messaging strategy that simplified sharing of floor safety issues between business management and maintenance vendors and their workers.
- 3) Floor cleaning rules that outline equipment and product requirements for specific floor surfaces, and considered the adverse impact of climatic, traffic, and slip resistance.
- 4) Risk reduction through the use of floor mats, signage and ample lighting. A fall reporting and tracking system to allow quick treatment of fall victims, and address contributing factors.
- 5) Contractual safeguards between a business and its floor maintenance vendors in the form of waivers, hold-harmless agreements and proof of insurance.

RISK control lessons:

- Reoccurring cleaning and maintenance protocols can consistently yield slip resistant surfaces. Dedicate time and resources to improving your business's floor safety program.
- Improve floor safety communication between business management and maintenance vendors.
- Serve the population your business supports.
- Keep people from falls (e.g., the elderly and people with disabilities) and proactively take safety measures in your business to ensure these individuals remain standing.

Case Study 4: Healthcare

In this case study, the BOT-3000E digital tribometer tested floor surfaces in five long-term care facilities during the spring and summer months for slip resistance. The floors lie in high-traffic exposure or prone to slip and fall accidents areas due to water, food or other debris.

The location of the tested surface nine areas:

- | | |
|--------------------------------|--|
| 1) Main entrances | 6) Resident bathrooms and shower rooms |
| 2) Elevator lobbies | 7) Physical therapy rooms |
| 3) Main corridors and hallways | 8) Kitchens and dining halls |
| 4) Stairwell landing areas | 9) Laundry areas |
| 5) Resident rooms | |

Floor coverings consisted of wood and tile laminate, linoleum, vinyl composition tile, concrete and concrete surfaces treated with an epoxy grip finish. No surfaces received additional cleaning prior to the test. Testing occurred under normal conditions with all floors kept on regular cleaning schedules. Using the wet DCOF testing method, each location received four tests.

The tests resulted in these seven findings:

- 1) Floors found in main entrances, resident rooms and shower rooms scored the lowest DCOF and, in some cases, less than the standard of 0.42 as set by the ANSI A137.1.
- 2) In all cases, scheduled cleaning complete cleaning of the area and/or the wrong cleaning method lead to poor results.
- 3) The buildup of soap on floor surfaces in bathrooms and shower rooms was a factor in low test results.
- 4) Despite similar floor types and cleaning schedules, DCOF measurements often varied from one resident room to another.
- 5) Floors in common areas that were not exposed to water hazards on a regular basis rated higher than 0.42, and had concrete, laminate or vinyl surfaces.
- 6) Covered surfaces that scored above the 0.42 threshold were wood or tile laminate.
- 7) Kitchens and laundry areas with traction-enhancing products improved testing results when applied in high risk areas.

Case Study 4: Healthcare (cont.)

Post-testing, in some instances, a facility had no record of scheduled cleanings or maintenance reporting. In other cases, increased DCOF occurred upon surface recleaning due to the initial low test scores. The resulting meetings resulted in discussions with maintenance workers regarding cleaning schedules, procedures and task. Lacking results caused a singular agreement with each facility to change their floor maintenance program.

RISK control lessons:

- **Require** a written log of floor maintenance activities for tracking dates, areas cleaned, methods utilized and personnel assigned to various tasks.
- **Insist** maintenance workers clean the full floor surface because buildup of debris or cleaning product can increase a slip and fall risk.
- **Scrub** floors in bathing areas where soaps are regularly used by residents. Regular pressure washing and/or steam vacuuming of these areas can remove slip-inducing particle buildup.
- **Keep** the same maintenance schedules for private resident and non-private rooms. Select floor surfaces with a high DCOF when renovating spaces.