

Slips, Trips and Falls



South Carolina School Boards Insurance Trust
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Kevin Brown MBA, CXLT - KTA-Tator, Inc.



Learning Objectives

1. Slip and Fall Facts
2. Factors Associated with Slips, Trips and Falls
3. Slip Resistance
4. Standards
5. How to Measure Slip Resistance
6. Slip and Fall Prevention Methods

Goal:

Reduce the probability for harm to an acceptable level

= Safety

Reduce probability of failure of the traction system to an acceptable level by evaluating, modifying and monitoring the significant factors

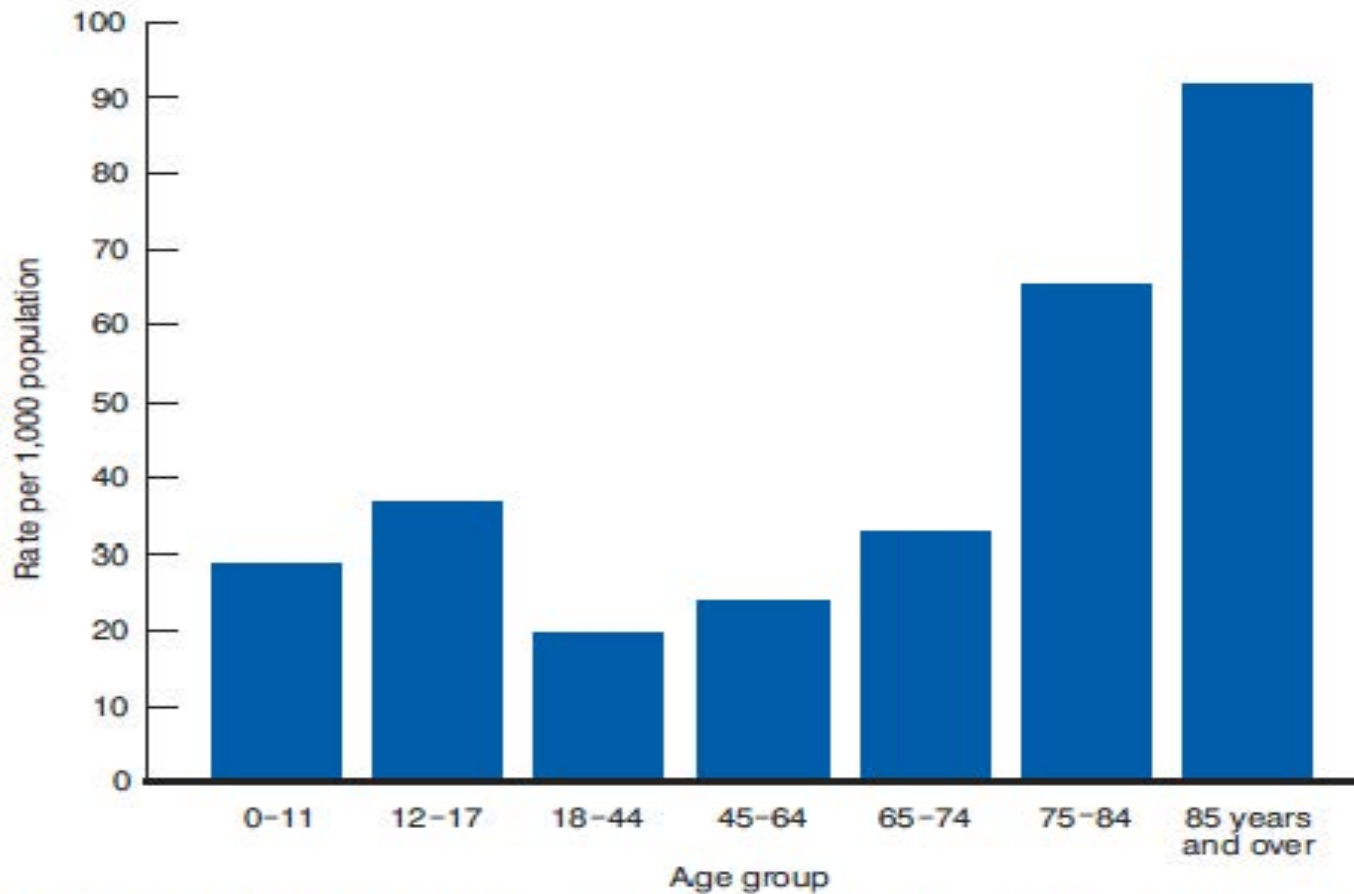
= Walkway Safety

1. Slip and Fall Facts

- ▣ 8.9 million hospital emergency room visits reported due to slip and falls (NSC, 2011)
- ▣ #1 cause of accidents in public buildings. 70% of those occur on a flat level surface (US IC, 2010)
- ▣ #2 cause for workers compensation (US IC, 2010)
- ▣ 1 in 171 will die from a slip and fall (NSC, 2007)
- ▣ 25,000 deaths recorded from falls (NSC, 2009)
- ▣ Average cost of a slip and fall injury is \$28,000 (US IC, 2010)

Child Slip and Falls

- Leading cause of non-fatal injury for all children 0 to 19 (2011)
- 8,000 children are treated in U.S. emergency rooms for fall-related injuries every day (2011)
- 2.8 million children injured per year (2011)



DATA SOURCE: National Health Interview Surveys, 2001-2003. Estimates are based on household interviews of a sample of the civilian noninstitutionalized population.

Figure 1. Annualized rates of fall injury episodes among persons of all ages, by age group: United States, 2001-2003

Industry	Median days away from work	Number	Incidence rate	Event or exposure leading to injury or illness ⁴ (Incidence rate)										
				Contact with objects	Fall to lower level	Fall on same level	Slips or trips without fall	Overexertion	Repetitive motion	Exposure to harmful substances or environments	Transportation incidents	Fires and explosions	Assaults and violent acts	All other events ⁵
Total State government^{6,7,8}	9	75,840	180.0	26.8	7.9	30.2	9.4	34.6	4.1	6.5	10.7	0.3	29.0	20.5
Total goods producing	7	1,890	235.3	69.5	13.6	14.8	6.5	38.1	7.7	6.3	40.8	-	-	37.4
Construction	8	1,830	235.7	70.0	13.6	12.8	6.7	38.6	8.0	6.3	41.5	-	-	37.7
Total service providing	9	73,950	178.9	26.0	7.8	30.5	9.5	34.5	4.1	6.5	10.1	.3	29.5	20.2
Education and health services	8	34,080	163.0	21.4	7.2	29.1	6.6	36.7	2.2	4.9	4.9	.2	35.6	14.3
Educational services	7	10,170	67.2	11.0	5.3	14.9	3.9	15.9	1.6	3.0	3.2	-	1.7	6.6
Health care and social assistance	8	23,910	414.2	48.7	12.0	66.3	13.6	91.0	3.6	9.9	9.4	.7	124.5	34.5
Public administration	10	35,000	185.6	27.2	7.5	31.0	12.1	30.6	5.8	7.4	12.5	.4	25.1	25.9
Justice, public order, and safety activities	12	21,790	291.1	41.3	12.4	51.4	20.0	38.6	5.3	10.5	16.3	.6	48.9	45.9
Total local government^{6,7,8}	8	197,660	184.8	30.9	11.6	30.7	7.9	33.4	3.4	8.5	12.8	.4	15.8	29.4
Total goods producing	11	4,760	458.5	63.9	27.8	43.7	8.4	91.3	11.8	31.7	78.4	-	6.7	93.5
Construction	11	4,740	460.1	64.0	27.5	43.9	8.4	91.8	11.9	31.9	78.9	-	6.8	93.6
Total service providing	8	192,910	182.2	30.6	11.4	30.5	7.9	32.9	3.3	8.3	12.1	.4	15.9	28.8
Trade, transportation and utilities ⁹	17	14,160	301.0	49.8	23.2	34.4	13.0	54.8	7.4	14.8	37.9	-	15.9	49.6
Transportation and warehousing	22	9,760	414.4	67.7	28.1	51.3	18.5	60.2	11.2	21.5	63.7	-	29.0	63.1
Utilities	13	4,390	188.5	32.0	18.6	17.4	7.5	49.5	3.7	8.1	12.0	-	2.9	36.5
Education and health services	7	69,870	113.9	20.0	7.2	27.3	5.3	23.4	2.0	4.2	2.5	-	7.7	14.4
Educational services	6	54,470	101.5	17.8	7.1	26.4	5.2	18.4	1.6	3.4	2.1	-	6.6	13.0
Health care and social assistance	7	15,390	201.0	35.3	7.7	33.6	6.1	58.5	5.0	9.8	5.2	-	15.4	24.5
Public administration	9	99,410	275.8	42.8	17.5	36.0	11.4	44.5	4.7	14.8	25.1	1.0	31.3	46.6
Justice, public order, and safety activities	11	42,960	456.3	62.3	21.1	50.3	16.3	58.0	4.0	23.6	52.3	2.5	82.8	82.9

Educational Services Data

Median days away from work	6.0
Number	54,470.0
Incidence rate	101.5
Contact with objects	17.8
Fall to lower level	7.1
Fall on same level	26.4
Slips or trips without fall	5.2
Overexertion	18.4
Repetitive motion	1.6
Exposure to harmful subs/envIRON	3.4
Transportation incidences	2.1
Fires and explosions	--
Assaults and violent acts	6.6
All other events	13.0



The incidence of slips, trips and falls at work may be even higher than the numbers show. Many workers do not report incidents because they may be minor and make them appear clumsy. (NSC)



2. Factors Associated with Slip and Falls

- A. Floor Surface Characteristics (controllable)
- B. Footwear traction properties (sometimes controllable)
- C. Environmental factors - contaminants such as water, oil, food, etc. (controllable)
- D. Human factors - gait, human activity, psychological conditions of the walker, etc. (not controllable)

A. Floor Surface

Controllable

Utilize flooring materials that have acceptable slip resistance under foreseeable conditions!

- ▣ Walkway Surface Texture
- ▣ Sharpness and Roughness
- ▣ Can be affected by cleaning and wear

Floor Changes in Level

ADA Standards

- ▣ Vertical changes up to $\frac{1}{4}$ " can be without edge treatment
- ▣ Changes in level $\geq \frac{1}{4}$ " and $\leq \frac{1}{2}$ " shall be beveled
- ▣ Bevel with a slope no greater than 1:2
- ▣ Changes in level $> \frac{1}{2}$ " shall be accomplished with a ramp

Flooring Types in Schools

- ▣ VCT
- ▣ Terrazzo
- ▣ Color Quartz
- ▣ Epoxy (Flake, Broadcast)
- ▣ Dyed Polished Concrete
- ▣ Wood
- ▣ Tile
- ▣ Laminates





Other Floor Surface Considerations

JOINT FILLER
CONDITIONS

MOISTURE VAPOR
EMISSION



B. Footwear

Sometimes Controllable

When footwear selection can be controlled, consider the slip resistance of footwear to maximize traction including the required use of special shoes when contaminants are anticipated!

- ▣ ASTM F695 - 01 Standard Practice for Ranking of Test Data Obtained for Measurement of Slip Resistance of Footwear Sole, Heel, and Related Materials
- ▣ ASTM F1240 - 01 Standard Guide for Ranking Footwear Bottom Materials on Contaminated Walkway Surfaces According to Slip Resistance Test Results

C. Environmental factors

Controllable

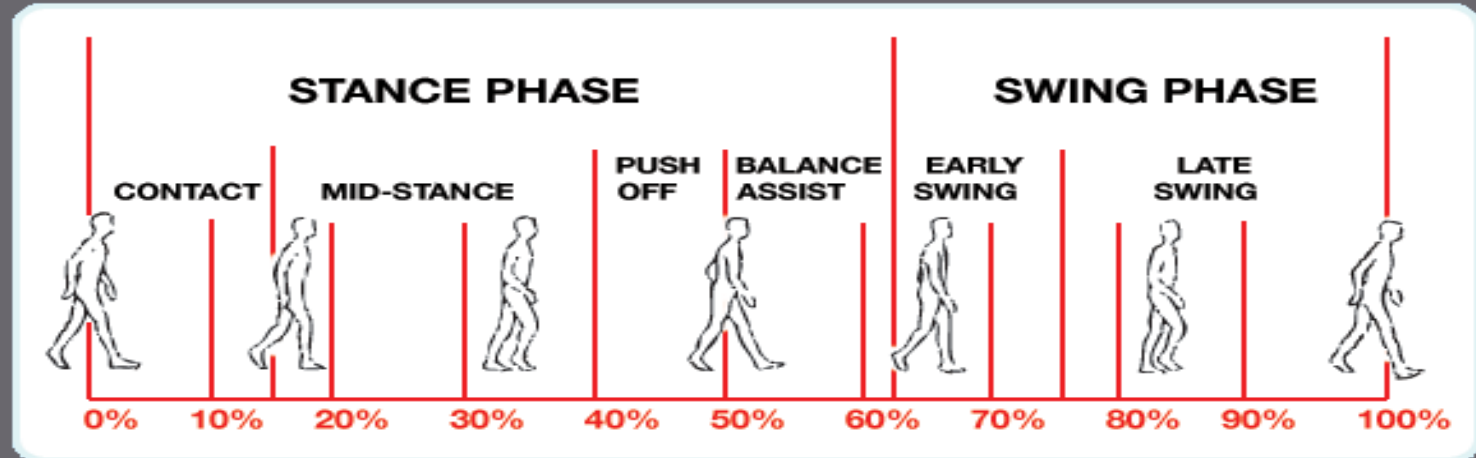
- ▣ Dirt, grease, water or contaminates on the floor
- ▣ Dressings, waxes or finishes
- ▣ Inappropriate materials for environment
- ▣ Surface wear
- ▣ Inadequate cleaning methods

D. Human factors

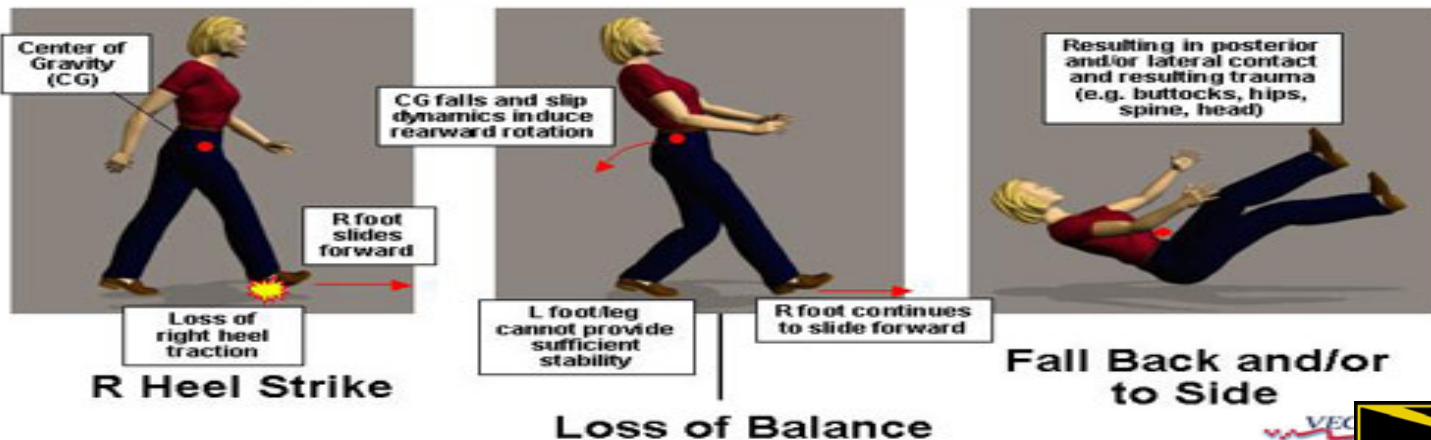
Non-Controllable

- ▣ Human Ambulation – Stride, gait
- ▣ Biomechanics – Interface with surfaces
- ▣ Perception
- ▣ Impairment or health issues

Human Ambulation



Slip and Fall Dynamics



3. Slip Resistance

- ▣ Friction = Resistance to movement of one body over another (interface between floor surface and shoe)
 - $F = \text{Mass} \times \text{Acceleration}$
- ▣ What happens at heel contact?
- ▣ Dynamic condition, not just friction
- ▣ Coefficient of friction = Friction Force/normal force
- ▣ Required Slip Resistance = What a body needs to ambulate or to perform a maneuver or task

COF (coefficient of friction)

- ▣ **SCOF** (Static Coefficient of Friction) - Not in motion and must initiate motion.
- ▣ **WSCOF** (Wet Static Coefficient of Friction) - A measurement of sticktion (when two surfaces stick together as a result of residence time).
- ▣ **DCOF** (Dynamic Coefficient of Friction) - Maintain motion once slipping has begun.
Most applicable to traction

Traction Failure

- ▣ The available slip resistance < Required slip resistance
- ▣ Failure of Traction at interface between walking surface and footwear bottoms
- ▣ Floor surface, Footwear, Environmental and Human factors

4. Standards

- ▣ ANSI 1264.2 suggests 0.5 COF dry conditions
- ▣ 1990 ADAAG references 0.6 COF for level and 0.8 COF for ramps
- ▣ OSHA recommends 0.5 COF
- ▣ UL lists 0.5 COF for dry clean floors

Why 0.5 COF?

- ▣ 0.25 – 0.35 slip resistance needed for normal unloaded straight line walking (Ice = 0.20)
- ▣ Safety Factor (increase to 0.5) because:
 - Perception
 - Human Ambulation
 - Tasks, maneuvers
- ▣ Probability of slip at COF <0.5:

■ 1:1,000,000	0.36
■ 1:10,000	0.29
■ 1:20	0.24
■ 1:2	0.19

IMPORTANT!

**#1 CAUSE OF SLIP IS
THE SUDDEN
UNEXPECTED
REDUCTION IN
SLIP RESISTANCE**



Standards

- ▣ **ANSI/ASSE A1264.1-2007**, *Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace Floor, Wall and Roof Openings; Stairs and Guardrails Systems*
- ▣ **ANSI/ASSE A1264.2-2006** *Standard for the Provision of Slip Resistance on Walking/Working Surfaces*
- ▣ **NFSI B1010.1** *Test Method for Measuring Wet SCOF of Common Hard-Surface Floor Materials*

ASTM Standards

- ▣ **ASTM F1677** *Standard Test Method for Using a Portable Inclineable Articulated Strut Slip Tester*
- ▣ **ASTM F1679** *Standard Test Method for Using a Variable Incidence Tribometer*
- ▣ **ASTM F1694** *Standard Guide for Composing Walkway Surface Investigation*
- ▣ **ASTM F2048** *Standard Practice for Reporting Slip Resistance Test Results*
- ▣ **ASTM F 2508** *Standard Practice for Validation and Calibration of Walkway Tribometers*



5. How to Measure

- ▣ Drag Sled
- ▣ Articulated Strut
- ▣ Pendulum
- ▣ German Ramp Test

Drag Sled

- ❑ BOT-3000 most popular
- ❑ Only device approved by NFSI
- ❑ Measures SCOF not DCOF
- ❑ Negative attributes of “*adhesion*” and “*sticktion*” are associated with these devices due to “*dwell time*”



Articulated Strut

- ▣ Portable Articulated Slip Tester (PAST)
- ▣ Excel Tribometer VIT common for lab and field
- ▣ Accurately measures wet and dry DCOF
- ▣ Meets ASTM F2508 calibration standard





Articulated Strut - Inclination

- ▣ Portable Inclination Articulated Slip Tester (PIAST)
- ▣ Brungraber Mark II used in lab and field
- ▣ Accurately measures wet and dry DCOF



Testing Approach

- ▣ Test walkway surfaces both dry and wet
- ▣ Use representative slider pad that avoids dwell times
- ▣ Sampling plan should include:
 - Each type of flooring material
 - Entryways, vestibules and doorways
 - Approaches such as sidewalks, aprons and ramps
 - Areas subject to change in environment
 - Change in surface wear from one area to another
 - Areas that exhibit a sudden unexpected reduction in slip resistance
- ▣ Additional consideration to ramps and stairways
- ▣ Special activities (e.g.: running, athletic activities)

Slip Test Form

GENERAL INFORMATION										
Facility Name/ #: /				Facility Contact:				Page of		
Address:								Date:		
Technician:				KTA Job No.:				Time:		
Confirm the following items						Yes	No	N/A	Comments	
Unit verified as accurate against certified calibration tile?						☐	☐	☐		
Was new Neolite applied to test foot?						☐	☐	☐		
Was test foot prepared?						☐	☐	☐		
Relative Humidity (%):			Temperature (F):			Test Method Used:				
DESCRIPTION OF TEST LOCATIONS (See Diagram)										
Location No.	Location of Test Area (Room/Floor/Stairway)	Description of Floor/Walkway Materials / Texture		Description of Type of Finish (Floor Finish)		Description of Areas Tested (Floor Condition)		Slope of the surface being tested		
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
SLIP RESISTANCE TESTING										
Location No.	DRY SLIP RESISTANCE TEST RESULTS					WET SLIP RESISTANCE TEST RESULTS				
	0 degrees (mp)	90 degrees (mp)	180 degrees (mp)	270 degrees (mp)	Average (mp)	0 degrees (mp)	90 degrees (mp)	180 degrees (mp)	270 degrees (mp)	Average (mp)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
Use additional sheets as needed										
Instruments		Serial No.			Instruments		Serial No.			
English XL VIT					Calibration Tile – COF:					
Technician:					Project Manager:					
Signature:					Date:		Signature:			
Distribution:					☐ Client		☐ KTA PM		Date:	

6. Slip and Fall Prevention Methods

- ▣ Illumination
- ▣ Footwear
- ▣ Mats and Runners
- ▣ Maintenance
- ▣ Warnings and Signage
- ▣ Material Selection
- ▣ Proactive monitoring

Illumination

- ▣ Inadequate illumination may contribute to trip and falls. Consider adequate lighting levels
- ▣ Resources for guidance:
 - ANSI/IESNA RP-7, *Lighting Industrial Facilities*
 - ANSI/IESNA RP-1, *American National Standard Practice for Office Lighting*
 - NECA-IESNA 500, *Installing Indoor Commercial Lighting Systems*
 - NECA/IESNA 502, *Installing Industrial Lighting Systems*
 - IESNA HB-9, *IESNA Lighting Handbook*

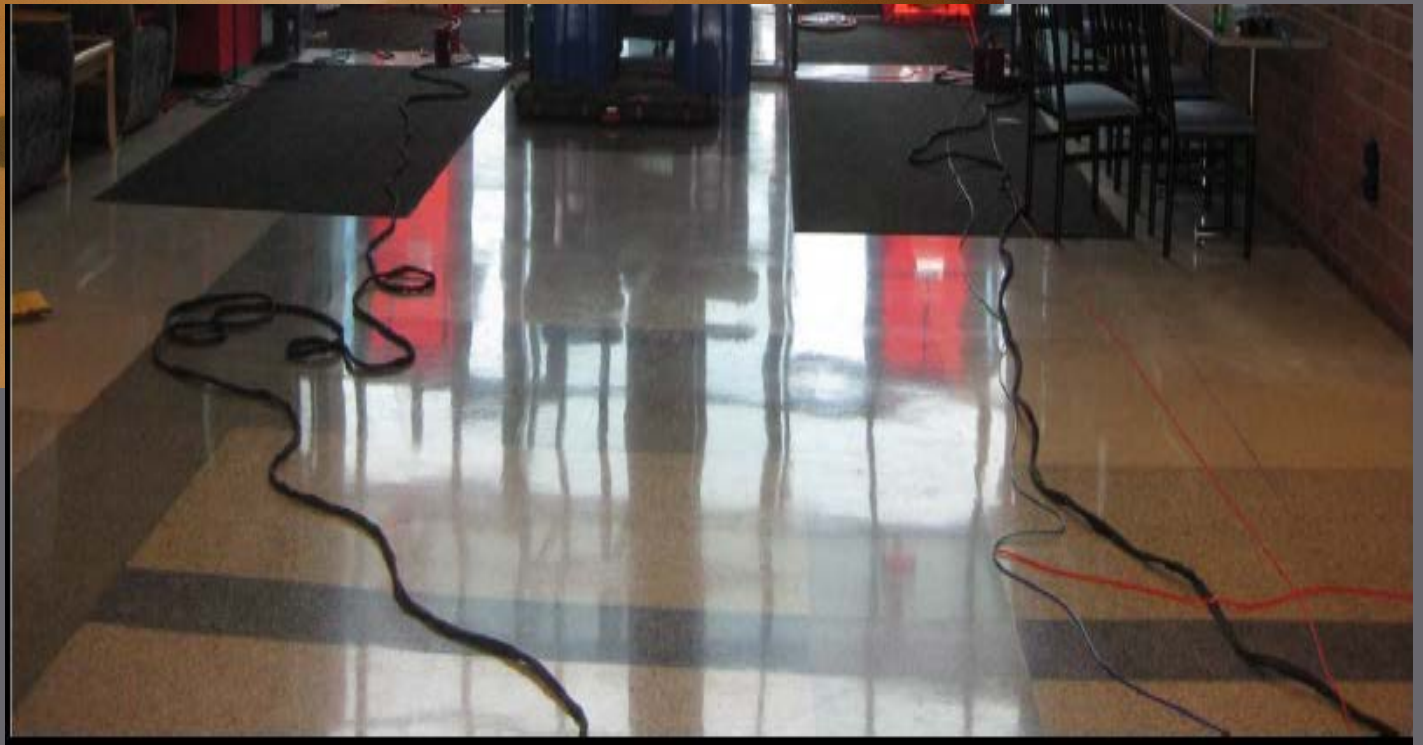
Footwear

When footwear selection can be controlled, consider the slip resistance of footwear to maximize traction, including the required use of special shoes when contaminants are anticipated!

- ▣ SATRA (Shoe and Allied Trade Research Association) recommends:
 - Sole should have a raised heel pattern on the heel and sole with leading edge in many directions
 - Tread pattern should extend over whole sole and heel

Mats and Runners

- ▣ Use at building entries and areas where foreseen contaminants are encountered
- ▣ CRI (Carpet and Rug Institute) defines entrance area as 90 s.f. (6' X 15')
- ▣ Mats/runners used to remove contaminants
- ▣ CRI shows that 80% of soil brought in a building is trapped within first 15' of carpeted surface
- ▣ Rule of Thumb – Footprints or water prints should not be seen beyond the last mat
- ▣ Consider slip resistance, bound and beveled mats
- ▣ Mats should not slip or buckle
- ▣ Cleaning and trade-out



Watch Out!



Maintenance and Housekeeping

- ▣ A written housekeeping program is recommended to ensure consistency and quality
- ▣ Specify materials, equipment, scheduling, methods and training
- ▣ Test materials (e.g.: floor finish, wax, cleaners)
- ▣ Do cleaners effectively break down contaminants?
- ▣ “See spill stand still”
- ▣ Document – Maintain “sweep logs” and routine unannounced inspections - record results

Housekeeping Training

- ▣ Inspection, maintenance and cleaning requirements
- ▣ Inspection, maintenance and cleaning procedures
- ▣ Safe handling and disposal of chemicals and/or solutions
- ▣ Safe operations of maintenance and cleaning equipment
- ▣ Emergency conditions and operations
- ▣ Record keeping and reporting relating to housekeeping and maintenance

Warnings and Signage

- ▣ Provide warning when slip or trip hazard is identified
- ▣ Properly place!!
- ▣ Implement control methods such as:
 - Signage
 - Barricades
 - Containment
 - Authorized Entry
- ▣ **ANSI Z535.2** *Standard for Environmental and Facilities Safety Signs*
- ▣ **ANSI Z535.3** *American National Standard for Criteria for Safety Symbols*



Material Selection

- ▣ *Utilize flooring materials that have acceptable slip resistance under foreseeable conditions!*
- ▣ Many options are available for restoration such as coatings and trowel applied materials
- ▣ Finishes available for VCT to make less slippery
- ▣ What kind of spills are likely?
- ▣ What are the sanitary requirements?
- ▣ What kind of traffic will it have?
- ▣ What is the activity?





Proactive Monitoring

- ▣ Perform occasional testing of floor surfaces to monitor slip resistance and determine effectiveness of cleaning procedures
- ▣ Slip testing can be of value when:
 - A treatment or coating has been applied
 - Monitor the floor cleanliness
 - When there is no history of slip and falls
 - Evaluate prospective flooring materials

Walkway Audit Program

- ▣ Visual Assessment
 - Wear
 - Abnormal conditions, contamination
- ▣ Physical Testing
 - Slip Testing
 - Light meter readings
 - Gloss readings
 - Moisture testing
- ▣ Maintenance and housekeeping review
 - Review maintenance logs
 - Check condition of mops, brooms
 - Check scrubber hours, brush condition, squeegee condition
 - Check PH of water
- ▣ Document

Investigate Slips

- ▣ To reduce slips, trips and falls, managers must stress the seriousness of all incidents that occur, even the most harmless ones
- ▣ Minor incidents may be clues to troublesome areas that may require repair, and could prevent future incidents from occurring
- ▣ Look for the root cause(s) of slip and falls

Standard for Accident Prevention

Recognize the hazard

Understand the defense

Act in time

Questions

Thank You!

